Proceedings

of the International Colour Association Conference

AIC 2024 BRAZIL

AIC 2024 Midterm Meeting

Color Design, Communication Marketing

São Paulo, Brasil
16-19th September

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Time	Mon 16/9	Tue 17/9 TEATRO ESPM (ESPM THEATER)	Tue 17/9 AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)	Tue 17/9 SALA CIVITA (CIVITA ROOM)	Wed 18/9 TEATRO ESPM (ESPM THEATER)	Wed 18/9 AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)	Wed 18/9 SALA CIVITA (CIVITA ROOM)	Thu 19/9 TEATRO ESPM (ESPM THEATER)	Thu 19/9 AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)	Thu 19/9 SALA CIVITA (CIVITA ROOM)	Fri 20/9 - Sun 22/9
08:00		Registration opens									**Optional Tour Foz do Iguaçu**
08:15											
08:30		Opening Ceremony			Registration opens			Registration opens			
08:45											
09:00		Plenary Lecture: Color Strategy in the Age of Artificial Intelligence, *Anat Lechner (Stern School of Business, NYU)* [Session Chair: Paula Cillag]			Plenary Lecture: Color Trends for 2025, *Patricia Fecci (Sherwin Williams)* [Session Chair: Paula Cillag]					AIC General Assembly	
09:15											
09:30											
09:45											
10:00	Workshop 1: Watercolor Painting of Brazilian Plants and Landscapes										
10:15			Color in Branding and Marketing [Session Chair: Jeannette Hanenburg]	Color in Psychology and Physiology (I) [Session Chair: Pichayada Katemake]		Color Semantics and Semiotics [Session Chair: Yuh-Chang Wei]	Color in Interior Design and Architecture (I) [Session Chair: João Carlos de O Cesar]				
10:30								Coffee avaiable *[10:30-11:00]*			
10:45											
11:00					Coffee break *[11:00-11:30]*			Plenary Lecture: The Crossover Colors: Utilizing Nature's Most Abundant and Versatile Hues in All Areas of Design, *Leatrice Eiseman (Pantone Color Institute)* [Session Chair: Paula Cillag]			
11:15		Coffee break *[11:15-11:45]*									
11:30						Color in Art, Culture, and History (II) [Session Chair: Larissa Noury]	Color in Interior Design and Architecture (II) [Session Chair: Andrea Siniscalco]				
11:45			Colorimetry and Color Order Systems [Session Chair: Pei-Li Sun]	Color in Psychology and Physiology (II) [Session Chair: Alessandro Rizzi]							
12:00								Lunch *[12:00-13:00]*			
12:15											
12:30					Lunch *[12:30-13:30]*						
12:45											
13:00	AIC EC Meeting	Lunch *[13:00-14:00]*							Color in Art, Culture, and History (III) [Session Chair: Maria João Durão]	Color and Consumer Behaviour [Session Chair: Nicole Hartmann]	
13:15											
13:30						Color in Design and Visual Communication (II) [Session Chair: Mahshid Baniani]	Color in Interior Design and Architecture (III) [Session Chair: Juan Serra Lluch]				
13:45											
14:00			Color in Art, Culture, and History (I) [Session Chair: Eva-Lena Bäckström]	Color Education (I) [Session Chair: Maggie Maggio]				Plenary Lecture: Colour Design for a Sustainable Future, *Ingrid Calvo Ivanovic (Design Department, Universidad de Chile)* [Session Chair: Vien Cheung]			
14:15											
14:30					Plenary Lecture: Natural Pigments from the Brazilian Rainforest, *Cica Costa (Laboratorio Cores da Floesta)* [Session Chair: Paula Cillag]						
14:45											
15:00		Plenary Lecture: S/S 26 Key Colours and Colour of the Year 2026, *Urangoo Samba (WGSN)* [Session Chair: Paula Cillag]						Coffee break *[15:00-15:30]*			
15:15											
15:30					Coffee break *[15:30-16:00]*				Color in Design and Visual Communication (III) [Session Chair: Luisa M. Martinez]	Special Session: Color in Games and Toys [Session Chair: Maurizio Rossi]	
15:45											
16:00		Coffee break *[16:00-16:30]*			Plenary Lecture: Ecology of Color in Urban Environment, *Larissa Noury* [Session Chair: Vien Cheung]						
16:15											
16:30			Color in Design and Visual Communication (I) [Session Chair: Ingrid Calvo Ivanovic]	Color Education (II) [Session Chair: Robert Hirschler]							
16:45					Poster Session [Session Chair: Vien Cheung] **PCA AREA**			Awards Presentation and Closing Ceremony			
17:00	Registration opens **PCA AREA** Welcome Reception with Samba Percussion Show **PCA AREA**										
17:15											
17:30		Plenary Lecture: Chromatic Design Cases, *POLAR Design Studio* [Session Chair: Paula Cillag]			Workshop 2: Brazilian Rainforest Natural Pigments **ATELIER**						
17:45											
18:00											
18:15		Study Group Meetings Color in Education - **TEATRO ESPM (ESPM THEATER)** Color in Art and Design - **AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)** Environmental Color Design - **SALA CIVITA (CIVITA ROOM)** Color in Games and Toys - **Álvaro Alvim Bloco B Sala de aula-B217 (DE AULA BUILDING B ROOM B217)**									
18:30											
18:45											
19:00					Optional Gala Dinner at SELVAGEM Restaurant in Environmentally Preserved Rainforest Area						
19:15											
19:30											
19:45											
20:00											
20:15											
20:30											
20:45											

AIC 2024 Program at a Glance

last update 13.09.2024 (08:00 São Paulo)

AIC 2024 Midterm Meeting

Color Design, Communication and Marketing

16-19 September, 2024. São Paulo, Brazil

Book of Abstracts

Contents:

AIC President's Welcome 4
AIC Organization 5
Conference Chairs' Welcome 7
AIC 2024 Organizing Committee 8
Technical Program 10
Plenary Lectures 21
Oral Papers 29
Poster Papers 309
Sponsors 387

Conference Topics:

Color in Branding and Marketing
Color and Consumer Behavior
Color in Design and Visual Communication (all forms of design)
Color and Consumer Products
Industrial Color Application (cosmetics, paints, textiles among others)
Color in Interior Design and Architecture
Color Semantics and Semiotics
Color and Psychology
Color and Physiology
Color and Physics
Colorimetry and Color Control and Color Order Systems
Color Education
Color in Art, Culture, and History
Color in Games and Toys

Welcome to the AIC 2024 Midterm Meeting on Color Design, Communication, and Marketing

Dear researchers, artists, professionals, and enthusiasts of color in its many meanings, welcome to the AIC 2024 Midterm Meeting dedicated to the theme of "Color Design, Communication, and Marketing". This year, the meeting is held in São Paulo, Brazil, in this beautiful country of a thousand colors, multi-ethnic and multi-cultural.

The conference is organized in a three-day scientific program and a pre-program day dedicated to two workshops: the first on "Watercolor Painting of Brazilian Plants and Landscapes" and the second on "Digital Color" Mixing. There will also be a workshop on "Brazilian Rainforest Natural Pigments" and Keynote Speakers from all around the world, Anat Lechner, Leatrice Eiseman and Petronio Bendito US, Patricia Fecci, Ciça Costa and Polar Design BR, Urangoo Samba GB, Larissa Noury FR, Ingrid Calvo Ivanovic CL.

The program will have the AIC Student Paper Awards, issued every two years at any AIC Midterm Meeting. Its goal is to encourage students to present their work at the AIC Midterm Meeting and support their interaction with the world color community. I wish to thank the Colour Group (GB) because, thanks to their sponsorship, we will also have the Robert W. G. Hunt International Poster Awards this year.

After the sad years of COVID-19, having an AIC conference exclusively in person is also lovely. The purpose of conferences is to exchange one's research and experiences, talk about them, meet, interact during the breaks, appreciate the posters, and speak without a camera in front of us.

The work of giving the AIC a permanent home is not yet finished. Managing today a global association that carries out the activity of publisher of four diamond open access publications, the Journal of the AIC, the book series Proceedings of the International Colour Association, the Annual Review, and the Newsletter, as well as the management of personal data in compliance with the General Data Protection Regulation, involves a series of legal and administrative obligations. On Thursday, September 19th, there will be an Extraordinary Assembly of AIC Members to propose a few changes to the AIC statute to make it more aligned with Austrian and EU laws and add a new AIC award.

The AIC 2024 Midterm Meeting is a true international conference. I want to thank the Associação ProCor do Brasil that organizes it, the chairs Paula Csillag, Carolina Bustos Raffainer, Vien Cheung, and Ricardo Zagallo Camargo, the Escola Superior de Propaganda e Marketing (ESPM) that hosts the conference, and the sponsors Sherwin-Williams, Abrafati, Lukscolor, RAL, Studio Immagine, Canson, Sinteglas and Sitivesp.

It is thanks to the sponsors and the enormous volunteer work of ProCor and ESMP that it was possible to organize an AIC Midterm Meeting accessible to everyone with an early registration fee very accessible to young people, pensioners, and people who come from disadvantaged countries. For this, I am very grateful to ProCor and Paula Csillag because the science and culture of color must be accessible to everyone. And so it is to all of you, participants, here today that my greeting also goes: thank you for sending your papers and coming here in person.

Enjoy the AIC 2024 Midterm Meeting in São Paulo, Brazil.

The AIC President
Prof. Maurizio Rossi

AIC Executive Committee 2024-2025

EC voting members

President .... Maurizio Rossi (Italy)
Vice President.......... Maria João Durão (Portugal)
Secretary/Treasurer.......... Pichayada Katemake (Thailand)
Ordinary Member.......... Eva-Lena Bäckström (Sweden)
Ordinary Member.......... Valérie Bonnardel (France)
Ordinary Member.......... Ingrid Calvo Ivanovic (Chile)
Ordinary Member (AIC 2025 Congress Representative).......... Pei-Li Sun (Taiwan)

EC consultant members

Auditor .... Tien-Rein Lee (Taiwan)
Auditor .... Javier Romero (Spain)
Immediate Past President .... Leslie Harrington (USA)
JAIC Editor .... Vien Cheung (UK)

AIC Members

Regular Members

Grupo Argentino del Color.......... Argentina
Colour Society of Australia .... Australia
Interdisciplinary Colour Association – Belgium .... Belgium
Associação Pró-Cor do Brasil.......... Brazil
Colour Group – Bulgaria .... Bulgaria
Colour Research Society of Canada .... Canada
Asociación Chilena del Color.......... Chile
Color Association of China .... China
Hrvatska udruga za boje, HUBO .... Croatia
Suomen Väriyhdistys Svy Ry .... Finland
Centre Français de la Couleur.......... France
Deutscher Verband Farbe.......... Germany
The Colour Group (Great Britain) .... United Kingdom
Hungarian National Colour Committee .... Hungary
Gruppo del Colore – Associazione Italiana Colore.......... Italy
Color Science Association of Japan .... Japan
Korean Society of Color Studies .... Korea
Asociación Mexicana de Investigadores del Color.......... Mexico
Forum Farge .... Norway
Associação Portuguesa da Cor .... Portugal

Slovensko združenje za barve .... Slovenia
Comité Español del Color .... Spain
Stiftelsen Svenskt Färgcentrum .... Sweden
pro colore .... Switzerland
Color Association of Taiwan .... Taiwan
Color Society of Thailand.. Thailand
Stichting Kleurenvisie: Het Nederlands Platform Voor Kleur............ The Netherlands
Inter-Society Color Council .... United States

Associate Members

Color Marketing Group (USA)

International Association of Color Consultants/Designers (USA)

Individual Members

Lia Margarita Tapis (Colombia)

Martina Vikova (The Czech Republic)

Jaqueline Carron (France)

Yannis Skarpelos (Greece)

Yulia Griber (Russia)

Andrea Urland (Slovakia)

Kazim Hilmi Or (Turkey)

Conference Chairs’ Preface

Welcome everybody to AIC 2024 Midterm Meeting!

What a wonderful moment to gather so many people that have one point in common: the passion for color! May we say that color chose us, and thus, here we are meeting, as a family of color!

The date of this conference was chosen specifically when Spring is beginning in Brazil, when flowers are blooming and the sun shining! Not a coincidence, this is also the period when we celebrate the Brazilian Day of Color with our national color association, Associação ProCor do Brasil.

The plan for this conference began in 2019, in Buenos Aires AIC EC Meeting. At first, ProCor was invited, but the invitation was declined since ProCor is an association composed of volunteers and we would not have any possibility of hosting it. But, when the invitation was amplified for a partnership with ESPM University, it started to be feasible. And now, here we are!

The conference received 119 abstract submissions from 26 regions. A total of 228 reviews were conducted by members of the Scientific Committee which comprises of over 60 color experts from around the world, who generously offered their valuable time as volunteers to support this critical task. Under the conference theme “Color Design, Communication and Marketing” the oral and poster presentations in the Technical Program are organized into 14 topics: Color in Branding and Marketing, Color and Consumer Behavior, Color in Design and Visual Communication (all forms of Design), Color and Consumer Products, Industrial Color Application (Cosmetics, Paints, Textiles among others), Color in Interior Design and Architecture, Color Semantics and Semiotics, Color and Psychology, Color and Physiology, Color and Physics, Colorimetry and Color Control and Color Order Systems, Color Education, Color in Art, Culture, and History, and Color in Games and Toys. The Technical Program also features a total of eight plenary lectures over three days and the AIC Study Group meetings on Tuesday evening. We hope you also enjoy our selection of workshops: Watercolor Painting of Brazilian Plants and Landscapes, Digital Color Mixing and Amazon Pigments.

We would like to thank ESPM University for the most precious partnership and feasibility of the event and thank each and every person from ESPM, among many, that helped us. We would like to thank our sponsors: Sherwin Williams, ABRAFATI, Lukscolor, RAL, Studio Immagine, Canson, Sinteglas, and SITIVESP. Many thanks to our supporters: ABA, CNPq, Paint Innovation, Pintar, and Visite São Paulo. Many thanks to everyone that helped voluntarily in the committees. All this synergy was very precious!

May we bring more color to the world!

Conference Chairs
Paula, **Carolina**, **Vien** and **Ricardo**

AIC 2024 Conference Chairs

Paula Csillag

ESPM University and ProCor

Carolina Bustos Raffainer

ESPM University

Vien Cheung

University of Leeds

Ricardo Zagallo Camargo

ESPM University

AIC 2024 Conference Committees

Technical Program
Vien Cheung
Robert Hirschler
Paula Csillag
Carol Bustos
Ricardo Zagallo

Social Events
Paula Csillag
Marketing ESPM

Fundraising
Antonio Napole
Paula Csillag
Patricia Fecci
Mari Nishimura
Ricardo Zagallo
Fabio Humberg
Flavia Figueiredo (Finance ESPM)

Finance
Paula Csillag
Flavia Figueiredo (Finance ESPM)
Sandra Bena

Publicity
Jane Mundel
Paula Csillag
Angela Negreiros
Alexandre Lopes
Vien Cheung
Design Lab ESPM
Marketing ESPM

Publications
Vien Cheung
Peter Rhodes
Robert Hirschler
Paula Csillag
João Luis Figueiredo
Ricardo Zagallo

Honor
Dalton Pastore
Tatsuo Iwata
Denilde Holzhacker
Cristiano do Amaral Britto de Castro
Rodrigo Cintra
Elisabeth Dau Corrêa

Scientific Committee

Akira Asano – *Kansai University*

Alain Tremeau – *University Jean Monnet, France*

Alessandro Rizzi – *University of Milano*

Alexandre Leão – *Universidade Federal de Minas Gerais*

André Beltrão – *ESPM University, Rio de Janeiro*

Andrew Stockman – *UCL Institute of Ophthalmology*

Berit Bergstrom – *Swedish Colour Centre Foundation*

Brian Funt – *Simon Fraser University*

Camila Silva – *Universidade Federal do Rio de Janeiro*

Chihiro Hiramatsu – *Kyushu University*

David Briggs – *National Art School, Sydney, Australia*

Donald Dedrick – *University of Guelph*

Douha Y. Attiah – *King Abdulaziz University*

Fiona McLachlan – *University of Edinburgh*

Gabriela Nirino – *UTN FRBA*

Galina Paramei – *Liverpool Hope University*

Gisela Monteiro – *Universidade Federal Fluminense*

Henrique Sobral – *ESPM University, São Paulo*

Hirohisa Yaguchi – *Chiba University*

Ingrid Calvo Ivanovic – *Universidad de Chile*

Ján Morovič – *HP Inc.*

Javier Hernandez-Andres – *University of Granada*

Javier Vazquez-Corral – *Autonomous University of Barcelona*

João Carlos Cesar – *University of Sao Paulo*

Jon Yngve Hardeberg – *NTNU*

Juan Serra – *Universitat Politècnica de València*

Juan Luis Nieves – *University of Granada*

Justyna Tarajko-Kowalska – *Cracow University of Technology, Faculty of Architecture*

Kathy Mullen – *McGill University*

Katsunori Okajima – *Yokohama National University*

Kitirochna Rattanakasamsuk – *Color Research Center, Rajamangala University of Technology Thanyaburi*

Li-Chen Ou – *National Taiwan University of Science and Technology*

Manuel Melgosa – *University of Granada*

Maria João Durão – *School of Architecture, Lisbon University*

Maurizio Rossi – *Politecnico di Milano*

Michela Lecca – *Fondazione Bruno Kessler*

Mikiko Kawasumi – *Meijo University*

Milena Quattrer – *Instituto Nacional de Educação de Surdos*

Osvaldo da Pos – *Università di Padova*

Paloma Carvalho Santos – *Universidade do Estado do Rio de Janeiro*

Paul Green-Armytage – *Curtin University*

Peter Rhodes – *University of Leeds*

Pichayada Katemake – *Chulalongkorn University*

Rafael Huertas – *Universidad de Granada*

Raju Shrestha – *OsloMet, Norway*

Robert Hirschler – *Colour Consultant*

Robert Wei – *Chinese Culture University*

Robin Kingsburgh – *York University*

Shinji Nakamura – *Nihon Fukushi University*

Shino Okuda – *Doshisha Women's College of Liberal Arts*

Suchitra Sueeprasan – *Chulalongkorn University*

Supawadee Theerathammakorn – *STOU*

Takahiko Horiuchi – *Chiba University*

Ulrich Bachmann – *Institut für Farbe und Licht*

Uravis Tangkijviwat – *Color Research Center, Rajamangala University of Technology Thanyaburi*

Venkat Venkataramanan – *McRae Imaging*

Verena M. Schindler – *AIC Study Group on Environmental Colour Design*

Veronica Conte – *CIAUD, Portugal*

Vien Cheung – *University of Leeds*

Vincent Sun – *Chinese Culture University*

Wen-Yuan Lee – *Department of Media Design, Tatung University*

Yoko Mizokami – *Chiba University*

Youngshin Kwak – *Ulsan National Institute of Science and Technology*

Yulia Griber – *Smolensk State University*

Zena O'Connor – *Design Research Associates, Australia*

Technical Program *– last update 13.09.2024 (08:00 São Paulo)*

Tuesday 17 September 2024

	TEATRO ESPM (ESPM THEATER)	**AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)**		**SALA CIVITA (CIVITA ROOM)**	
08:00	*Registration opens*				
08:30	**Opening Ceremony**				
09:00	**Plenary Lecture**: Color Strategy in the Age of Artificial Intelligence *Anat Lechner (Stern School of Business, NYU)*				
10:00					
10:15		**Colour in Branding and Marketing**	Showing the brochure true colors: the interplay of color emotions and cultural values in the cosmetic market *Antônio Costa Alves; Flávio Santino Bizarrias; Edson Crescitelli; Fábio Pereira; Evandro Lopes*	**Color in Psychology and Physiology (I)**	Quantifying emotions evoked by artworks using psychophysical methods: Relationships between emotions and colorimetric structure of abstract paintings *Carlo Gaddi; Marcelo Fernandes da Costa*
10:30			Color interplay with online's shopping attribute's structure and channel strategy: an investigation on consumer experience *Flávio Santino Bizarrias; Marcelo Gabriel; Evandro Lopes; Vivian I Strehlau; Jussara Cucato*		Cues in color: may profile image imply users' personality traits? *Leyan Huang; Rongjin Tian; Yaqing Cai; Yuxuan Bai; Lina Xu; Pan Hui; Luwen Yu*
10:45					Characteristics of Japanese skin color and its associated factors in comprehensive health checkup examinees *Tomoko Kutsuzawa; Wakana Toya; Yuki Akizuki; Satoshi Iwamoto; Fitoshi Ohyama; Shinji Takashimizu*

	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
11:00					
11:15	*Coffee break*				
11:45		**Colorimetry and Color Order Systems**	Identification of quarries in the Cuzco Valley for the extraction of inorganic pigments to produce local artisanal paints *Carlos Guillermo Vargas Febres; Juan de Rivera Serra Lluch; Anna Torres Barchino; Edwin Roberto Gudiel Rodríguez*	**Color in Psychology and Physiology (II)**	Chromaticity contrast thresholds and sufficient illuminance of multi-channel LED for the simulated low vision eyes *Pichayada Katemake*
12:00			Uncertainty evaluation of color measurements for color control and color communication *Erkki Ikonen; Yasaman Rezazadeh; Anders Nilsson; John Seymour; Juha Peltoniemi*		Chromatic analysis in coming of age movies *Milena N Dias; Paula Csillag*
12:15			Color in personal image: for a decolonization of the seasonal color analysis based on the Brazilian skin color *Aliana Barbosa Aires; Josenilde Silva Souza; Josivan Pereira Silva*		Palette politics: balancing empathy and self-expression in color design *Ellen R Divers*
12:30			Translating Albers to CAM16: a case for next-generation color pickers *Nader Sadoughi*		Color and light in the birth environment *Monique Denoni; Natalia Naoumova*
12:45					Investigate the preference and the expectation of Chinese male skin colour for Generation Z *Jiapei Chen; Mengmeng Wang*

	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
13:00	*Lunch*				
14:00		**Color in Art, Culture, and History (I)**	The colors in the axós of the candomblé terreiro Axé Ilê Obá *Aymê Okasaki*	**Color Education (I)**	Colour Literacy Project beta-testing: report from St. Teresa partner school *Colette Harrison; Maggie Maggio; Robert Hirschler*
14:15			Color over volume in contemporary 3D Animation *Carlos Nogueira*		21st century colour education – a student's point of view *Josué C Neves; Gisela CP Monteiro; Pedro Viana; Robert Hirschler; Camila A. P. Silva*
14:30			Contemporary poetics with natural paints *Taís Monteiro; Taís Monteiro; Bianca Stella*		21st century color literacy pilot course at University of Texas *Luanne L Stovall; Honoria Starbuck; Maggie Maggio*
14:45			Gaudi's chromatology: a cross-comparative analysis of colour surface qualities *Maria João Durão*		Pursuing terminological consistency of colour attributes in the Portuguese language *Gisela CP Monteiro; Robert Hirschler; Camila A. P. Silva; Josué C Neves*
15:00	**Plenary Lecture**: S/S 26 Key Colours and Colour of the Year 2026 *Urangoo Samba (WGSN)*				
16:00	*Coffee break*				

<table>
<tr><th></th><th>TEATRO ESPM
(ESPM THEATER)</th><th colspan="2">AUDITÓRIO CASTELO BRANCO
(CASTELO BRANCO AUDITORIUM)</th><th colspan="2">SALA CIVITA
(CIVITA ROOM)</th></tr>
<tr><td>16:30</td><td></td><td rowspan="3">Color in Design and Visual Communication (I)</td><td>Revitalizing public spaces: a guide for chromatic interventions with augmented and virtual reality technologies
Anamaria Amaral Rezende</td><td rowspan="4">Color Education (II)</td><td>Reinforcing colour literacy with colour games
Paul Green-Armytage; Maggie Maggio</td></tr>
<tr><td>16:45</td><td></td><td>Limits and possibilities of using color as information on medicine packaging in the Brazilian market
Camila A. P. Silva; Patrícia Peralta</td><td>Teaching color in a transdisciplinary approach between physics and the arts
Paloma Oliveira Carvalho Santos; Maria Lima; Kim Ramos; Paula de Chiara; Teo Senna; Leandro Silva; Jorge Chaves; Laura Jeunon; Larissa Cysne; Palloma Dreher; Carolina Pacini</td></tr>
<tr><td>17:00</td><td></td><td>Influence of wall color on performance in university offices
Mahshid Baniani</td><td>The seminars “Why did we forget Goethe when we teach optics?”
Kim Ramos; Paloma Oliveira Carvalho Santos; Maria da Conceição Barbosa-Lima</td></tr>
<tr><td>17:15</td><td></td><td colspan="2"></td><td>Research on the correlation and implementation path of children's sense of belonging in color education
Qian Huang</td></tr>
<tr><td>17:30</td><td>Plenary Lecture: Chromatic Design Cases
POLAR Design Studio</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>18:15</td><td colspan="5">Study Group Meetings

Color in Education - TEATRO ESPM (ESPM THEATER)
Color in Art and Design - AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)
Environmental Color Design - SALA CIVITA (CIVITA ROOM)
Color in Games and Toys - Álvaro Alvim Bloco B Sala de aula-B217 (DE AULA BUILDING B ROOM B217)</td></tr>
</table>

Wednesday 18 September 2024

	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
08:30	*Registration opens*				
09:00	**Plenary Lecture**: Color Trends for 2025 *Patricia Fecci (Sherwin Williams)*				
10:00					
10:15		**Color Semantics and Semiotics**	Inclusive beauty: a multidisciplinary approach to designing a nail polish collection - Colorama introduces 'nude da sua cor' *Ana Paula P Nascimento; Pâmela França; Selma C Miranda; Elir Guatiello Palermo; Robson Jandyroba; Erick Malfei; Isis Provençano Souza; Luana Tomaz; Sandra Damas Da Silveira; Ana B Mattos; Letícia F Pereira; Luiza Bessa Lins; Taisa N Veiga*	**Color in Interior Design and Architecture (I)**	Effectiveness of real appearance images and characteristics of building images that alter impressions *Kiwamu Maki; Sari Yamamoto*
10:30			The effect of reading background colour on human cognitive performance based on multi-modal data analysis *Lina Xu; Dehan Jia; Zhongyue Zhang; Leyan Huang; Guobin Xia; Luwen Yu*		The communication of colors in interior design: an analysis of the covers of the world of interiors magazine from the 1990s, 2000s and 2010s *Rebecka M.M. Pires*
10:45					Chromatic metaphors: red as green among Bahrain's Sunni and Shi'a Landscapes *Gareth G Doherty; Maria Vollas*
11:00	*Coffee break*				

	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
11:30		Color in Art, Culture, and History (II)	Anish Kapoor: the use of red and black between materiality and the void *Lucas P. O. Tolotti*	Color in Interior Design and Architecture (II)	Material and color mood boards for birth space designs *Juan Serra; Javier Cortina; Ana Torres*
11:45			The colors of the movie Poor Things: yellow is power *Pedro Felipe P Souza*		Chromatic survey methodology: case study of the Planalto by João Artacho Jurado *Bianca M T Fonseca; Maria Fernanda Brandi; Joao Carlos de O Cesar*
12:00			Cultural landscape and urban polychromy: analysis of the landscape's chromatic identity *Gustavo M Gonçalves; Ana Paula Neto de Faria; Natalia Naoumova*		Color in architecture in the 21st century, and the manifestoes and programs of architects in the 20th century *Joao Carlos de O Cesar*
12:15			"Los Ríos en Colores": color chart from the south of Chile *Elisa Cordero-Jahr; Victor Gerding; Eréndira Martínez; Carlos Rojas; Ingrid Calvo Ivanovic; Catalina García*		Immersive space of coloured light *Nicole Hartmann*
12:30	*Lunch*				

	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
13:30		**Color in Design and Visual Communication (II)**	Color, design, and poison dart frogs *Jada K Schumacher*	**Color in Interior Design and Architecture (III)**	Dorothy Draper: a Brazilian chromatic palette - case study of the Quitandinha hotel *Josivan Pereira Silva; Leonardo P. C. Toni*
13:45			(Post)humans and technology: exploring the colour palette in the visual narrative of Metaverse images by international media outlets *Lina Schmidt*		Color studies in trauma-informed design in spaces *Esther Hagenlocher; Rene Berndt; Morning Star Padilla*
14:00			Color in cultural landscape: cross-cultural differences in strategies for constructing harmonious color combinations *Yulia A. Griber*		Urbanisms of color: exploring communicative roles and evolutionary trends *Beichen Yu; Gareth G Doherty*
14:15			The role of aesthetics and color in sustainable textile practices *Marjan Kooroshnia*		
14:30	**Plenary Lecture**: Natural Pigments from the Brazilian Rainforest *Cica Costa (Laboratorio Cores da Floesta)*				
15:30	*Coffee break*				
16:00	**Plenary Lecture**: Ecology of Color in Urban Environment *Larissa Noury*				
16:45	**Poster Session – PCA AREA**				
17:30	**Workshop 2: Brazilian Rainforest Natural Pigments – ATELIER**				
19:00	**Optional Gala Dinner at SELVAGEM Restaurant in Environmentally Preserved Rainforest Area**				

Thursday 19 September 2024

<table>
<tr><th></th><th>TEATRO ESPM
(ESPM THEATER)</th><th colspan="2">AUDITÓRIO CASTELO BRANCO
(CASTELO BRANCO AUDITORIUM)</th><th colspan="2">SALA CIVITA
(CIVITA ROOM)</th></tr>
<tr><td>08:30</td><td colspan="5">Registration opens</td></tr>
<tr><td>09:00</td><td></td><td colspan="2"></td><td colspan="2" rowspan="2">AIC General Assembly</td></tr>
<tr><td></td><td colspan="3">Coffee available [10:30 – 11:00]</td></tr>
<tr><td>11:00</td><td>Plenary Lecture: The Crossover Colors: Utilizing Nature’s Most Abundant and Versatile Hues in All Areas of Design
Leatrice Eiseman (Pantone Color Institute)</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>12:00</td><td colspan="5">Lunch</td></tr>
<tr><td>13:00</td><td></td><td rowspan="3">Color in Art, Culture, and History (III)</td><td>Colors and meaning making - a rhetorical perspective
Sharon Avital</td><td rowspan="3">Color and Consumer Behaviour</td><td>The effect of colors on quiet luxury consumption: the role of uniqueness and xenocentrism
Flávio Santino Bizarrias; Evandro Lopes; Suzane Strehlau; Kelly Parnwell; Jussara Cucato</td></tr>
<tr><td>13:15</td><td></td><td>The color chart of Jalpan de Serra, Querétaro, Mexico
Maria A Dorantes Lambarri; Ana Torres-Barchino; Irene de la Torre Fornés</td><td>The influence of age on the color perception and judgment: a color meaning study with mouthwash packaging
Ana Laura Alves; Luis Carlos Paschoarelli</td></tr>
<tr><td>13:30</td><td></td><td>Color in between art, technoscience and politics: the Vantablack controversy
Yuri Gabriel Campagnaro; Luciana Silveira</td><td>Visual elements in organic products communication: The impact of yoghurt packaging material and color on consumer perception
Luisa M. Martinez; Ana Bento; Luis Martinez; Filipe Ramos</td></tr>
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(CIVITA ROOM)</th></tr>
<tr><td>13:45</td><td></td><td></td><td>Contemporary Landscape Color Design and Its Origin in the Work of Roberto Burle Marx
Mira Engler</td><td></td><td>The use of colors as an element of customization of the surface of myoelectric upper limb prostheses
Juliana Harrison Henno; Monica Tavare; Chi Nan Pai</td></tr>
<tr><td>14:00</td><td>Plenary Lecture: Colour Design for a Sustainable Future
Ingrid Calvo Ivanovic (Design Department, Universidad de Chile)</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>15:00</td><td colspan="5">Coffee break</td></tr>
<tr><td>15:30</td><td></td><td rowspan="3">Color in Design and Visual Communication (III)</td><td>A critical analysis of in-car lighting design and its impact on driver alertness under nocturnal conditions
Qian Cheng; Guobin Xia; Philip Henry; Luwen Yu; Peter Rhodes</td><td rowspan="3">Special Session: Color in Games and Toys</td><td>A board game for the education of young hair colorists
Simone Liberini; Marco Tarini; Giannantonio Negretti; Roberta Suardi; Alessandro Rizzi</td></tr>
<tr><td>15:45</td><td></td><td>Evolution of the 'under new direction: performatic catwalk' methodology: exploring the neutrality of gray color in design, art, and fashion
Antonio A Rabàdan; Ione Maria Ghislene Bentz</td><td>Visual grouping: a study on preponderances of color or shape in match-three games
Joyce C Cavallini; Paula Csillag</td></tr>
<tr><td>16:00</td><td></td><td>The subconscious of color in the case study, Senso Book: a methodological process for fashion event production
Antonio A Rabàdan</td><td>Color vision deficiency in video games
Andrea Siniscalco; Alessandro Rizzi</td></tr>
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	TEATRO ESPM (ESPM THEATER)	AUDITÓRIO CASTELO BRANCO (CASTELO BRANCO AUDITORIUM)		SALA CIVITA (CIVITA ROOM)	
16:15			The role of colors for digital three-dimensional materials: using colors as a parameterization tool to obtain advanced shaders *Henrique Sobral*		Board games for early screening of color blindness in Italian primary schools *Alessandro Rizzi; Liliana Silva*
16:30					Enjoy learning for wonder of colors and color vision diversity *Tsukasa Muraya; Momoka Nagatomi; Taiju Inoshita; Shoji Sunaga*
16:45	**Awards Presentation and Closing Ceremony**				

Posters

P01	Color harmonies and playful interactions a quantitative analysis of the impact of colors on the design and behavior of the game Trine 4 The Nightmare Prince	*Fabio Augusto A Rodrigues Pereira*
P02	Fresh Appearance and Color in Green Vegetables	*Pablo R Ixtaina; Agustín Pucheta; carlos colonna*
P03	Colors, ideologies and meanings in the 2022 Brazilian elections	*Carla Pereira*
P04	Calibracor: a novel and free software for digital image color calibration	*Luiz Henrique Romanhol Ferreira; Alexandre Cruz Leão; Maria Cecília Almeida Marques; Rennan Neves de Oliveira; Carlos Antônio de Souza Perini; Renato Antônio Celso Ferreira*
P05	The role of colour in the visual narrative of video games	*Josefa Queupuán; Ingrid Calvo Ivanovic*
P06	Color in the city: an analysis of chromatic interventions in the pavement of urban space	*Lauren N G Duarte; Natalia Naoumova*
P07	Color, environment, and sustainability: Faculty of Law, Universidade de Lisboa	*Ana Paula Pinheiro*
P08	ColorApp: technology to educate, inspire and help women make the best color choices for their personal image	*Kisley S Gomes*
P09	Beyond awareness: stimulating pro-environmental actions through colour-driven web interfaces	*Lingxue Tong*
P10	Study of the correlation among mineral contents, instrumental and sensory color of brown sugar	*Vinicius P. M. Xavier; José luis Godoy; Claudio Ueno; Lyssa Sakanaka; Marta Verruma-Bernardi*
P11	Understanding the use of colors and characters in snack packaging sold in Brazil	*Carla Pereira; Carolina Souza*
P12	Methodological proposal for signage design project: chromatic, ergonomic and spatial orientation analysis of the regional council of medicine of the State of São Paulo (Cremesp)	*Jade B Longo*
P13	Warm colors x cold colors – analysis of the preferences of teenagers in a playful business game	*Luiz C Barçante; Bernardo Fajardo*
P14	Cultural factors impacting car color choice: an analysis in the Brazilian market	*Fabio Ferrero*
P15	The subjective use of color: in creative practices with alternative materials	*Antonio A Rabàdan*
P16	Study on reproduction of spatial brightness on a high-luminance large LED display -effects of image color and texture on subjective evaluation	*Kazuto Takase; Mayu Nomoto; Hinako Kage; Kazuyoshi Harimoto; Nozomu Yoshizawa*
P17	Urban polychromy: an experimental methodology tested in Belo Horizonte, Minas Gerais, Brazil	*Bianca M T Fonseca*
P18	A study of utilizing mixed reality (MR) to establish environmental color schemes	*Yuh-Chang Wei; Monica Kuo; Ya-Ping Kuo*

Color Strategy in the Age of Artificial Intelligence

plenary lecture

Anat Lechner
Professor of Business, Stern School of Business, NYU
Co-Founder CEO of Huedata, Inc., The Color Intelligence Company

Biography

Anat Lechner, Ph.D., is a Full Professor of Business Management at the Stern School of Business, New York University, focusing on disruptive leadership, innovation, and strategic change. She is also the co-founder and CEO of Huedata Inc., a Color Intelligence Company. A former Research Fellow at McKinsey & Co. Dr. Lechner has advised global Fortune 100 firms in the Financial Services, Pharmaceuticals, Chemicals, Energy, Food, Tech, Design, Defense, and Retail industries. She has had numerous appearances on the NYT, WSJ, BBC, ABC, FT, Forbes and other premier global media outlets. Anat holds an MBA and a Ph.D. in Business Management from Rutgers University, NJ.

Abstract

Artificial Intelligence (AI) is rapidly becoming mainstream, showcasing its potential to generate greater production efficiencies and, in many instances, superior creative design outputs compared to human efforts. From chair design and DALL·E 2 text-to-image illustrations to Japanese garden architecture and new perfume development, AI is proving to be increasingly powerful and disruptive. This evolution is poised to transform the practice of design as we know it, pushing the boundaries of creativity and innovation across various domains.

This keynote will explore the emerging cross-industry disruption driven by AI, with a focus on creative cognitive technology applications in product, brand, environment, and experience design. By examining these applications, the talk will highlight how AI is revolutionizing traditional design processes, workflows, and outcomes. Within this context, special attention will be given to the necessary transition towards data-driven color decision-making, showcasing how color data analytics and machine learning capabilities can inspire, inform, and validate creative choices of color design, leading to more efficacious design solutions.

As designers increasingly adopt generative AI and leverage data in their practices and decision processes, they need to re-evaluate traditional design principles and up-skill to harness AI's full potential. The talk will provide insights into how designers can navigate these changes, emphasizing the importance of staying abreast of generative AI advancements, capabilities, and tools, and incorporating them to enhance design workflows and results.

The keynote will conclude with a forward-looking perspective on the future of color design in the age of AI, underscoring the transformative potential of creative cognitive technologies and the exciting opportunities they present for the design industry.

plenary lecture

The Crossover Colors: Utilizing Nature's Most Abundant and Versatile Hues in All Areas of Design

Leatrice Eiseman
Executive Director, Pantone Color Institute

Biography

Leatrice Eiseman is a color specialist and consultant who has been called "the international color guru." In fact, her color expertise is recognized worldwide, especially as a prime consultant to Pantone®. She has helped many companies make the best and most educated choice of color for personal or professional development, product development, logos and identification, brand imaging, web sites, packaging, interior/exterior design, or any other application where color choice is critical to the success of the product, promotion, company image or environment.

Lee heads the Eiseman Center for Color Information and Training and is also executive director of the Pantone® Color Institute. She is the author of ten books on color.

Both the New York Times and Fortune Magazine named Lee as a "Top Decision Maker" for her work in color. She conducts many color/design seminars at trade shows, museums, colleges, and universities, delivers in-house color training and is widely quoted in consumer publications and online, ranging from fashion and interiors/exteriors to various trade magazines.

Her academic background includes a degree in psychology from Antioch as well as advanced studies and counseling specialist certification from UCLA. She has studied both fashion and interior design and has taught in both areas. She is a member of the international forecasting group for the Pantone® View Color Planner and develops a home forecast yearly. She also heads the committee for naming Pantone's color of the year and seasonally assists in identifying the top fashion colors for Women's Wear Daily that is shared internationally.

Lee is an allied member of the American Society of Interior Designers, Industrial Design Society of America, as well as the Fashion Group, and has received several awards from the Color Marketing Group where she served as a chairholder. She is a founding member of the Film Institute Museum in Los Angeles and a member of the American Film Institute.

She shares her expertise on color and design for industry and personal image in certified programs presented online and in person.

Color Trends for 2025

Patrícia Fecci
Marketing Manager, Sherwin Williams

plenary lecture

Biography

Patrícia Fecci is Marketing Manager for Color & Design Services at Sherwin-Williams Paints, one of the largest paint manufacturers and distributors in the world. Her job includes responsibility for color management for use in various distribution channels, assisting in the development of color systems (tinting), differentiated color palettes, merchandising combinations and materials, color consulting services, and training for architecture and interior design professionals.

Patrícia also tracks and forecasts color trends and design influences for the coatings industry, creating and giving color presentations to architects and designers internationally.

During her 25-year career with the company, Patrícia has completed projects in many countries, now focusing on South America.

Board Member (2023-2025) of the Color Marketing Group (CMG), the premier international association for color design professionals and also Vice-President of Pro-Cor Brasil Association (Color Association in Brasil).

Abstract

The American multinational Sherwin-Williams, which has been operating in the paint market for more than 150 years, being the largest company manufacturing, distributing and selling paints, celebrates its 80 years of activity in Brazil in 2024 and will present its study of color trends for 2025.

The study is conducted by a group of multidisciplinary professionals, experts from all over the world in color projects for the hospitality, educational, commercial, health segments, etc., analyzing different aspects of the consumer, including social, cultural and economic. And it has been debating the different visions of trends to translate the next colors that will best represent the scenario in the coming years. This color forecast allows you to anticipate tomorrow and shape a world full of more harmonious, intense and versatile colors.

Colors are part of our identity; they move us and have the power to change the essence of everything we touch. Through color, we navigate a new world, having the opportunity to get to know it deeply and insert our personal touch.

Colors can define our mood, awaken feelings, create connections and stimulate new actions and through them we are able to express ourselves.

For this new collection, Sherwin-Williams invites everyone to look within, delve deeply into our roots and revere our heritage to see a future beyond the superficial. This invitation will make us reflect on the connections between colors and what really matters, such as nature, the community, our ancestors and our family.

This collection will make us reflect on how origins can influence and impact the future, bringing references and insights for a new reading of the use of colors. In this presentation, we will bring a lot of inspirational content and possibilities for using colors in internal and external environments, with a focus on decoration, design and lifestyle.

S/S 26 Key Colours and Colour of the Year

Urangoo Samba
Head of Colour WGSN

Biography

Urangoo's extensive experience in colour strategy, macro trends, market needs and consumer expectations drive her role at WGSN. She leads the WGSN Global Colour team to create world-class insight and analysis over interiors, beauty, fashion and consumer tech industries to ensure success across all market levels. Urangoo has a diverse and unique career background spanning nearly two decades of global experience having worked with major design companies such as adidas. Her expertise covers apparel, trend forecasting, footwear and CMF. A keen traveller and foodie, Urangoo was born in Mongolia, raised in London and has lived in Hong Kong and Germany. She brings a global point of view having worked in different parts of the world throughout her career.

Abstract

What is colour forecasting and what will be the colours to invest in 2026?

In this lecture, WGSN's Global Head of Colour, Urangoo Samba will dive into the three key points of colour forecasting:

1) *WGSN research methodology* – In a complex world, trends are born from the convergence of many disparate factors. WGSN observes, synthesises and forecasts these factors through our STEPIC lens to uncover, understand and predict the future impact of market shifts. This methodology is the foundation of all our trend forecasting including colour forecasting, and it empowers us to anticipate signals of change, answer pivotal questions and highlight possible futures for the short, medium and long term.
2) *WGSN data* – WGSN identifies, verifies and tracks colour trends by using a mixture of qualitative and quantitative data and expertise to forecast what is coming in the short-, medium- and long-term future.
3) *WGSN STEPIC* – WGSN's proprietary STEPIC methodology is the foundation for all our forecasts including colour forecasting, synthesising changes across Society, Technology, the Environment, Politics, Industry and Creativity. We unpack how it works and why it provides a more holistic and interconnected approach to predicting the future of colour.
Colour of the Year 2026 and S/S 26 Key Colours – We will finish by revealing the Colour of the Year for 2026: Transformative Teal, explaining why this hue will be relevant for all industries across the globe, and how companies can apply the S/S 26 Key Colours for product success.

Natural Pigments from the Brazilian Rainforest

Ciça Costa
Founder Laboratório Cores da Floresta

Biography

Designer, co-founder of Estúdio In Totum where the principles of design are at the service of social transformation and human development, aimed at creating a healthy, fair, prosperous and happy world. She develops, coordinates, and facilitates social projects in communities, working on social design, valuing local culture and practices and exchanging knowledge. Co-creation of the Movimento Revolucion Artesanal, Lab Cor and Cupu do Quintal (AM). Projects | IPP Amazônia (2011 – Tumbira – AM), Alinhavando o Futuro (2012) with women from RDS Rio Negro and Laborartório Cores da Floresta – Tumbira – Rio Negro/AM since 2019, currently in its 6th edition. Graduated in Social Communication from Faculdade Cásper Líbero and in Physical Education from FEFISA. She participated in the Profides (2015), Delicate Activism and Invisible Artists Program (2016-2018) courses at Instituto Fonte and Proteus Iniatiative.

Abstract

In the forest, colors are not born because we want to produce them. Color arises from the exchange of knowledge and knowing within the community, from the interaction between human beings and nature, how we relate to it and our human capacity to imagine, create and do.

The yellow color of a mango tree comes from the moment we relate to and interact with the tree. From pruning its leaves and branches, boiling and straining, yellow emerges. From the prepared fabric, ties and immersion in the dye come the drawings in color and shape.

In this whole process, it is not enough just to extract the color and dye it; we need to comprehend the cycles of nature, its rhythms, local wisdom and the relationship between the knowledge exchanged with the people of that place, from which we learn and teach. The local people teach us about nature, we teach them about fabric in shape and color. Nature teaches us about its times, cycles, its life.

From this teaching and learning comes the Laboratório Cores da Floresta – Amazônia (Forest Colors Lab), an invitation to experience the forest by relating to nature and the living beings of that place, both human and more-than-human. Lab Cor invites us to experience discovery and to discover ourselves in this place. To remember that we are part of nature and that we relate to it. Out of this immensity that is the Amazon, which shows us that colors are born where there is life.

And so, colors are born. From respect for nature and the knowing of those who live there. From the connection between artisanal work and the hands that turn leaves into color. From learning by doing, which allows us to make, think and create, setting us in motion to go beyond where we are. The exchange of flavors, wisdom and practices between different cultures. The knowledge that turns into wisdom, into care, into respect for life that transforms the society based on the human, the living intelligence of nature, of the forest, of the waters... of life.

plenary lecture

Ecology of Color in Urban Environment

Larissa Noury
Professor of Color in Art and Architecture
ITECOM Art&Design Paris, President-founder Couleur-Espace-Culture » France,
Centre Français de la Couleur

Biography

Painter, designer-colorist, colorist-council architect. Lives and works in Paris, Montmartre for 25 years, Doctor of Art History – Michel de Montaigne University, Bordeaux; Doctor of Architecture – École Polytechnique de Minsk and the Academy of Fine Arts in St. Petersburg.

Abstract

The harmony of colour is a universal, transcultural phenomenon. Whether it is the creation of images, the invention of drawings for the design industry or the construction of urban spaces, it represents a system of coded messages of the visual world that helps us to apprehend, evaluate and act in different contexts. Through the prism of historical and intercultural approach, our study shows the evolution of colour harmony and invites you to an imaginary journey into the infinite universe of colour harmony in different cities of the world. Throughout space and time, it shows us how the phenomenon of colour and its symbolic language have evolved alongside the civilizations.

Today's urban territories need an aesthetic organization just as they need an organization in terms of transport, energy or telecommunications. This is why now more than ever; the question of respect for the environment must include the question of the harmonization of the visual components of the city because this determines the quality of the living environment and the visual ecology of the urban spaces.

Our study is at the crossroads of artistic, architectural, and urban environmental design studies, based on historical and scientific reasoning. We propose the system of 24 colour harmonies classification which help us to explore the infinite universe of colour relationships in Art, Urban design and Architecture.

The results of these investigations are the part of our educational programs for students that we have developed for different grades of academic studies according to our own practice of many years of teaching in Art & Design School and Universities. In this course, the student discover the qualities of color and its functions in art, design and architecture. The challenge is to develop in each student a personalized and sensitive perception of the visual world by offering him a certain theoretical and practical effectiveness. Our methods of analysis and exploration will bring a new and different look at the question of colour culture including material and digital colour, as well as on the question of the integration of color in architectural space (interior & exterior) at the crossroads of visual arts and applied arts.

Creating a Sense of Identity through Design

Polar, Ltda. Design Studio
LAD awarded as best design studio in Brazil

Biography

Polar, Ltda. is a place to design what is identified around people, brands, and spaces. The studio brings together professionals from different cultural backgrounds and specialties, aiming to *design today new perspectives for tomorrow*. Based in São Paulo, Brazil, the studio *collaborates with global clients who are willing to build projects with a purpose above all else*. Working on projects that operate across virtual, print, spatial, and audiovisual platforms, Polar's production ranges from visual identity, packaging, digital media, typography, animations, to editorial projects and more. In its four years of operation, Polar, Ltda. has collaborated with clients such as Nubank, Netflix, Itaú, Rede Globo, WhatsApp, and YouTube.

Colour Design for a Sustainable Future

Ingrid Calvo Ivanovic
Assistant Professor at Design Department, Universidad de Chile

Biography

Colour Designer, Researcher and Consultant. PhD in Design Research, Politecnico di Milano. MA in Image Studies, UAH. Member of the Executive Committee of the International Colour Association (AIC). Member of the Editorial Board of the Color Research & Application, WoS Journal. Member of the Steering Committee of the AIC+ISCC Colour Literacy Project. Member of the Study Group on Colour Education (SGCE) and the Study Group on Environmental Colour Design (ECD) of AIC. Member of the Design Committee of the National Agency for Research and Development (ANID), Chile. Chair of the Cumulus Working Group on 21st Century Colour Education. Assistant Professor of the Design Department of Universidad de Chile, and Lecturer at Politecnico di Milano, Italy. For 15 years, Ingrid has been a full-time researcher and epistemologist in the field of colour, developing methodologies for its study, teaching, and application in design, architecture, and art concerning other research areas such as visual and curatorial studies. Ingrid has presented specialized conferences and workshops in different countries in America, Asia, Europe, and Oceania.

Abstract

During recent years, it has become imperative for design to reflect on the social perspective, as fostering more sustainable user behaviour is a growing field of interest, together with a need for a careful evaluation of ethical concerns. These reflections are also very relevant for colour design, as colour application and production can have a huge impact on water contamination, waste creation and consumers' behaviour, to name a few. Therefore, design discipline and education should motivate a careful evaluation of a sustainable colour applications, stimulating critical thinking and fostering concrete actions related to reuse, recycling, and recovering colours, among others.

This presentation proposes a call for action through eight strategies on colour sustainability to be addressed within design decisions. The strategies are (A) first and above all, "promoting a sustainable colour mindset" through the entire chain of decisions that are taken in a colour design process. Educating designers and consumers on colour sustainability, and collaborating with key ethical stakeholders, are some actions of this strategy. Secondly, (B) "reflecting on colour trends" as the impact of consumer culture and ever-changing colour trends generate more waste and yearly exploitation of the planet's resources. Third, (C) "fostering identity through local colours" can positively shape perceptions of territory and create reconnections with the land and landscapes. Fourth, (D) "exploring sustainable ways of working with colour" as colours and dyes that go beyond traditional pigments are emerging, such as bio colours and nanoscale colours, among others. Fifth, (E) "embracing colour relativity and lifecycles", as colours' fading, and evolution must be accepted and integrated as a normal aspect of a product's lifespan. The sixth strategy is (F) "adopting imperfection: using visible recycled colour", as it can be a clever way to spark discussion and generate excitement about the prismatic potential of the things we throw away, while highlighting the eco credentials of a product. Seventh (G), "upcycling discarded colours", as industrial waste can contain valuable pigments which can be recovered, through experimentation that combines science and art. Finally, the eighth strategy (H) is "performing (more) colour management" to optimize the technological processes of colour production and reproduction.

This study aims to provide guidelines to address these issues in the design process, and therefore, the strategies are presented through suggestions, case studies and examples for their implementation.

Showing the Brochure True Colors: the Interplay of Color Emotions and Cultural Values in the Cosmetic Market

Antônio Pedro Costa ALVES,[1] Flávio Santino BIZARRIAS[1], Edson CRESCITELLI[1], Fábio PEREIRA[1], Evandro Luiz LOPES[1].
[1] Escola Superior de Propaganda e Marketing – ESPM

ABSTRACT

Brochures have transitioned to e-brochures but remain crucial in marketing, particularly in the cosmetics industry, where they significantly influence consumer self-perception and beauty ideals. These brochures utilize visually appealing elements, such as colors and images, to engage customers and convey information effectively. Colors in brochures are strategically chosen to evoke emotions and vary across different cultures. However, research on the interaction between e-brochures, cultural values, and colors is limited. This study draws on the World Values Survey to examine how cultural values affect color choices in cosmetics e-brochures. Analyzing data from 2021-2023, encompassing 24,828 colors from 636 e-brochures across 14 countries, the research uses multivariate analysis to test hypotheses about the relationship between color selection and cultural values. The findings show a significant correlation: warmer, more saturated colors are prevalent in cultures emphasizing survival and traditional values, while cooler colors align with more secular-rational values. The study underscores how marketing strategies align color choices with cultural values and consumer identity, suggesting that e-brochure colors are carefully selected to resonate with the cultural context and preferences of consumers.

1. INTRODUCTION

Colors significantly influence human behavior and emotions, evoking a range of feelings from joy to sorrow. This phenomenon, known as “color emotions,” reflects the emotional responses triggered by specific hues and combinations (Abdullah 2019). While some argue these responses are universal, cultural interpretations of color vary widely, affecting both preferences and meanings. For instance, red may symbolize passion in one culture and celebration in another. In marketing, colors play a crucial role in brand identity, consumer perception, and product differentiation. However, the connection between color emotions, cultural values, and marketing remains underexplored. Our research bridges this gap by analyzing color choices in cosmetics e-brochures across 14 countries (Aslam 2006). We found that warmer, saturated colors are favored in cultures with traditional values, while cooler tones align with secular-rational values. These findings underscore the importance of aligning color choices in marketing with cultural contexts, enhancing the effectiveness of global marketing strategies.

2. METHOD

This research examines cultural aspects of color in e-brochures, focusing on Avon’s front pages from 14 culturally diverse regions, including Brazil, India, and the UK. We analyzed 636 e-brochure front pages from campaigns between January 2021 and December 2023, extracting 24,828 unique colors using a color composition website. The colors were categorized by hue, saturation, and value to understand their cultural significance.

2.1 Research Design

We analyzed data using multivariate statistics to explore correlations between cultural values (Inglehart and Welzel, 2005) and color aspects (hue, saturation, value). We categorized nations into cultural groups: Latin American, Confucian, African Islamic, West and South Asia, Orthodox Europe, and English-speaking countries. Kobayashi's (1981) method assessed color warmth, while Student t-tests and Chi-square tests evaluated statistical significance. The t-test compared group means, and Chi-square tests examined relationships between categorical variables, providing insights into the interplay between cultural values and color perceptions in e-brochures.

Figure 1: E-brochure and color analysis.

We tested whether there is a significant difference between color temperature and national cultural values (H1), countries with higher survival and traditional (self-expression and secular-rational) values, and warmer (colder) and more (less) saturated colors are preferred on the e-brochures' front pages (H2), and whether warmer (colder) colors are more correlated with traditional (secular-rational) values on the e-brochure's front pages (H3).

3. RESULTS AND DISCUSSION

We analyzed a total of 24.828 colors, along different ranges of country regions as proposed Table 1 presents the countries analyzed and their respectives cultural dimensions, and values.

Country	Cultural dimension	Traditional *v* secular	Survival *v* Self-expression
Argentina	Latin American	Less	More
Brazil	Latin American	Average	Average
China - Taiwan	Confucian	More	Average
Colombia	Latin American	Average	Average
Egypt	African islamic	Less	Less
India	African islamic	Less	Less
Malaysia	West and South asia	Average	Average
Mexico	Latin American	Less	More
Philippines	Latin American	Less	More
Russia	Ortodox Europe	More	Less
Saudi Arabia	African islamic	Less	Less
South Africa	West and South asia	Less	Average
UK	English speaking	More	More
USA	English speaking	More	More

Table 1: Countries and cultural values.

We evaluated color temperature in relation to cultural values across various countries, focusing on warm (reds, oranges) and cool (blues, greens) colors. Table 2 categorizes color temperatures by region, revealing preferences linked to cultural orientations. We used a chi-square test to assess significant differences in color temperature preferences among countries. Our findings suggest that warmer colors are favored in traditional, survival-focused cultures, while cooler colors align with secular-rational values. This analysis highlights how global brands can tailor their visual strategies to resonate with the cultural contexts of their target markets.

Temp.	#	Latin America	Confucian	African islamic	West & south asia	Ortodox Europe	English speaking	Total
Cold	N	6,447	633	2,358	1,572	1,002	2,247	14,259
	% CIV5	6.5%	48.7%	58.3%	54.2%	64.4%	62.1%	57.4%
Warm	N	4,956	668	1,686	1,330	555	1,374	10,569
	% CIV4	3.5%	51.3%	41.7%	45.8%	35.6%	37.9%	42.6%

Table 2: Colors temperature and CIVs.

A chi-square test revealed significant differences in color temperature preferences, with warm colors initially appearing dominant ($\chi2 = 120.801$, $p < 0.001$). Pairwise comparisons showed significant variations between countries' use of warm and cool colors ($\chi2 = 374.796$, $p < 0.001$), confirming H1. The analysis also found significant differences in HSV configurations between English-speaking and African Islamic cultures, reflecting distinct cultural values. Our study revealed significant differences in color usage intensity between African and English-speaking cultures. African cultures favored a more vibrant palette, with a mean hue of 138.826 and saturation of 0.444, compared to the lower mean hue of 123.383 and saturation of 0.413 in English-speaking cultures ($p < 0.001$). However, brightness levels remained similar across both cultures. We also found a marked preference for warm colors in African Islamic cultures (58% warm colors) compared to English-speaking cultures (42%), supporting hypotheses 2 and 3, which link vibrant colors with traditional and survival-oriented cultural values.

Color temperature	African islamic	English speaking	African islamic	English speaking	Total
Warm	58%	62%	51%	49%	100%
Cold	42%	38%	55%	45%	100%
Total	100%	100%	-	-	-

Table 3: Color temperature vs most distinct cultural dimensions

4. CONCLUSIONS

Our study explores how cultural backgrounds influence color preferences, particularly the contrast between traditional-survival values and secular-self-expression values. Countries like Argentina and Brazil, with traditional and survival values, favor vibrant colors like bright yellows and greens. In contrast, secular cultures like the UK and USA prefer subdued hues reflecting modern aesthetics. These findings underscore the importance of considering cultural contexts in visual content creation, offering valuable insights for enhancing cross-cultural communication and marketing strategies.

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Color Interplay with Website On-line's Shopping Attribute Structure and Channel Strategy: a Design for Consumer Experience

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ABSTRACT

The rise of online shopping has led to a strategic shift where managers now integrate digital and physical storefronts to enhance consumer experience. This approach is crucial in marketing, focusing on consumer engagement and distribution. The challenge lies in blending physical and digital experiences to influence consumer attitudes and behaviors. While previous research has examined website design and omnichannel strategies separately, this study investigates their combined effect on online shopping dynamics. We analyzed 148 participants' responses to various online shopping setups, focusing on how design elements like color, brightness, information density, and omnichannel presence affect consumer perceptions. Our findings reveal that the need for tactile interaction significantly mediates the relationship between website design and consumer self-extension, with color being the most influential element. This research offers valuable insights into the interplay between color psychology and online shopping design, emphasizing the importance of omnichannel strategies in enhancing consumer engagement in online retail.

1. INTRODUCTION

Website design is a dynamic, multifaceted discipline that plays a strategic role in shaping digital experiences and influencing user engagement. It involves creating visually appealing, user-friendly virtual spaces aligned with business objectives. Key elements include color schemes (Diethelm 2021), typography, layout, and navigation, all contributing to user satisfaction and brand perception. Website design must also consider mobile responsiveness, technical performance, and SEO optimization. Additionally, the study of website attributes like color and information density, combined with omnichannel strategies (Akter et al, 2021), highlights their impact on consumer engagement and self-extension. Effective website design is essential for establishing a strong online presence and achieving digital success, with visual and tactile stimuli (Atilgan and Bayindir, 2021), along with color schemes (Hirschler wt al., 2022).

2. METHOD

We combined multivarite techniques to explore whether (H1) product congruence significantly influences self-extension, (H2) need for touch significantly mediates the relationship between product congruence and self-extension and (H3) whether color (blue-red-yellow, brightness), anthropomorphizing (present-absent), omnichannel strategy (present-absent) and information set size (more or less), may comprise a value function in the perspective of the consumer of website design.

2.1 Research Design

To assess the effect of product congruence on self-extension, mediated by the need for touch, we employed a multiple regression analysis. This analysis quantifies the relationship between dependent and independent variables, adjusting for covariation. Mediation analysis further dissects how an independent variable impacts a dependent variable through a mediator.

We used a three-item 7-point scale for product congruence, a six-item 7-point scale for self-extension, and a twelve-item 7-point scale for need for touch. Additionally, we conducted a conjoint analysis to evaluate the impact of color, anthropomorphizing, omnichannel strategy, and information set size on consumer preferences for a fictitious cosmetics brand. Table 1 presents the utility results.

Atribute	Utility value	Importance
Color		
Red	-0,266	34,833
Yellow	0,132	
Blue	0,134	
Brightness		
More	0,058	16,585
Less	-0,058	
Anthropomorphizing		
Present	-0,119	16,070
Absent	0,119	
Omnichannel strategy		
With omnichannel	0,119	13,972
Withoutom nichannel	-0,119	
Level of information		
More	-0,445	18,541
Less	-0,890	

Table 1: Utility values

3. RESULTS AND DISCUSSION

A total of 148 valid responses were collected, with 82 (55.45%) women, averaging 26.96 years old. Participants regularly purchased a range of products online, including perfumes. The average scores were 4.607 for product congruence, 5.058 for the need for touch, and 5.009 for self-extension. The regression model explained 57.06% of the variance in self-extension (R^2).

Product congruence significantly influenced self-extension (β = 0.585), while the need for touch also had a notable impact (β = 0.162). The mediating effect was significant (effect = 0.064), confirming the hypothesis that tactile interactions play a role in the relationship between product congruence and self-extension. The total effect of product congruence on self-extension was substantial (β = 0.650), underscoring its importance in consumer behavior. These findings suggest that product alignment with self-image and tactile experiences are crucial in online consumer behavior. For online retailers, strategies enhancing product congruence and simulating tactile experiences can strengthen consumer attachment and loyalty. Additionally, the model's value function was significant, with Pearson's R and Kendall's Tau confirming the relationship between variables, highlighting the importance of personalization and sensory engagement in digital shopping. Our analysis of utility values for various website attributes revealed that color was the most influential factor, followed by information level, brightness, anthropomorphizing, and omnichannel strategy. The best combinations are observed in Table 2.

Pack	Color	Brightness	Information	Antropomorphization	Omnichnanel strategy	Total utility	Final ranking
pref1	Blue	Less	More	Absent	With	6.062	pref1
pref2	Blue	More	Less	Present	Without	5.258	pref10
pref3	Yellow	More	Less	Absent	With	5.731	pref3
pref4	Red	More	More	Absent	Without	5.540	pref9
pref5	Yellow	Less	More	Present	Without	5.586	pref5
pref6	Red	More	More	Present	With	5.540	pref6
pref7	Red	Less	Less	Absent	Without	4.980	pref4
pref8	Red	Less	Less	Present	With	4.980	pref2
pref9	Blue	Less	More	Present	Without	5.588	pref8
pref10	Blue	More	Less	Absent	With	5.733	pref7

Table 2: Prefered packages

The package with "Blue" color, "Less" brightness, "More" information, no anthropomorphization, and an omnichannel strategy (pref1) scored the highest total utility (6.062), indicating strong consumer preference. Conversely, packages with "Red" color and lesser information scored lower (4.980), highlighting the critical role of color and information richness in consumer preferences. Anthropomorphization had inconsistent effects, suggesting its impact is context-dependent and interacts with other attributes. Taken togethjer, these resuls confirm all hypothesis.

The findings underscore the psychological impact of color in website design, with "Blue" emerging as the most preferred color, aligning with its associations with calmness, trust, and reliability. When paired with less brightness and more information, this color choice creates a soothing and informative environment that appeals to consumers' desire for clarity and reassurance. In contrast, the lower preference for "Red," often linked to intensity and urgency, suggests it may evoke less positive emotions in an online shopping context. The variable effects of anthropomorphization highlight that its influence depends on how well it complements the overall design. These insights emphasize the importance of carefully selecting colors that evoke the desired emotional response and enhance the user experience.

4. CONCLUSIONS

The study sheds light on the critical role of aligning product offerings with consumer identity and tactile experiences in online environments, emphasizing the psychological connection between consumers and the products they choose. According to self-congruity theory, consumers are more likely to engage with and purchase products that reflect their self-image. This theory posits that the closer a product aligns with an individual's self-concept, the stronger the emotional attachment and the higher the likelihood of purchase. This is particularly relevant in digital contexts, where the absence of physical interaction can pose challenges to establishing a connection between consumers and products. The study's findings reveal that product congruence and the need for touch significantly influence self-extension, suggesting that even in digital environments, sensory experiences can enhance consumer attachment. This underscores the importance of creating online shopping experiences that cater to these sensory needs, whether through virtual try-ons, detailed product visuals, or interactive elements that simulate tactile feedback. Such features can help bridge the gap between physical and digital shopping experiences, making consumers feel more connected to the products they encounter online.

Additionally, the research points to the crucial importance of color, information level, and omnichannel strategies in shaping consumer preferences. Colors play a powerful role in conveying brand identity and influencing consumer emotions, making them a key element in online design. The study suggests that careful management of color schemes, combined with the right amount of information and an integrated omnichannel approach, can significantly enhance consumer engagement and satisfaction. From a practical perspective, these insights call for a more personalized approach to user experience design. Interactive features that resonate with consumers' self-concept, alongside coherent design choices that align with their sensory preferences, can lead to higher levels of engagement and brand loyalty. For online platforms, this means prioritizing user-centric design, optimizing color usage, providing the right level of information, and ensuring a seamless omnichannel experience. By doing so, businesses can create more meaningful and lasting connections with their customers, ultimately driving success in the digital marketplace.

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Shades of Change: the Intersection of Color, Branding, and Social Discourse in Urban Landscapes

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ABSTRACT

Urban landscapes reflect the evolving fabric of modern cities, capturing societal shifts, cultural nuances, and economic trends. In landscape design, color serves not only an aesthetic function but also a powerful communicative role. Traditionally, colors in landscapes were derived from natural sources like plants, stones, and earth pigments, conveying calm and cultural identity. However, since the new millennium, urban landscapes have seen a dramatic shift with the innovative use of highly saturated artificial colors. Understanding these changes requires examining them within their broader cultural context and focusing on their communicative impact. This paper aims to shed light on the emerging use of saturated color in contemporary landscape design by referring to prominent approaches of saturated color in urban environments

1. INTRODUCTION

Entering the 20th century, marketing emerged as a pivotal force for large companies, with urban spaces increasingly dominated by commercial interests. This period marked a significant shift where urban environments became commercial landscapes, deeply influenced by marketing trends. The collaboration between companies and urban spaces transformed public areas into arenas of constant advertisement, extending beyond mere promotional campaigns to shape the very fabric of city life. For instance, in 19th-century Paris, advertising played a role in funding public amenities. Companies constructed public urinals adorned with advertisements, demonstrating an early integration of commercial interests into public infrastructure (Segal, 2000). This trend of integrating advertising into urban infrastructure laid the groundwork for the pervasive commercialization of public spaces.

The past few decades have wintness the occupation of international brands of the city. The phenomenon named brandscapes prevailed urban environments through billboards, ubiquity of shops, sponsorship of public events such as marathons, and funding public institutions like schools (Klein, 2000). The dominance of corporate presence could not longer be distinguished from other aspects of city-life and the erosion of the “private” as well as of local identities. In her book, “No Logo” Naomi Klein describes the process by which an area of Toronto, previously known for its local shops and interesting passers-by was bought by a local corporation. Although parts of the street were bought due its special identity, purchasing it has transformed it into yet another corporate and homogenous area. In other words, the unified aesthetic of outdoor advertising contributed to a homogenization of urban landscapes, making cities appear more like one another and diminishing their distinctiveness.

2. THE BATTLE FOR URBAN SPACES THROUGH COLOR

In In this process of commercialization and unification of urban spaces, color has played an important part. As a crucial element for branding, colors, especially vibrant and eye-catching ones, have been strategically used to achieve a cohesive and recognizable aesthetic across platforms. This tendency has accelerated due to the use of social media, as the flashy screens and short attention spans of those surfing the web (Carr, 2010) demand messages that command attention and invite circulation. With the proliferation of brandscapes, color design endowed with specific branding has dripped from screens to the streets.

A review of color language features in branding may explain why adding distinct colors to urban environments accelerated the similarity of urban spaces in big cities. In branding design, the selection of color schemes is driven by specific strategic objectives. Typically, brands opt for distinct and eye-catching colors to capture attention and stand out (Khattak et al, 2018). To ensure that the color design is memorable, a limited palette is often employed. Primary colors – such as yellow, blue, and red – and colors derived from Basic Color Terms (BCTs), including orange, green, and pink, are commonly chosen for their ability to create striking contrasts and convey clear messages (Sky, 2022). This approach is exemplified in the color schemes used by brands such as IKEA and McDonald’s.

Beyond the fundamental principles of color application in branding, many large international companies adopt similar aesthetic in their brands to maintain a coherent and global presence (Sky, 2022). While the international branding style may evolve over time, it generally seeks to appeal to a broad, global audience. Moreover, it relies on similar findings regarding associations between the product and a desired emotions, for example, food and desire (Spence & Velasco, 2019). This often results in lack of diversity and diminished presence of vernacular aesthetics. Moreover, the international style leads to minimalist approach to color presentation characterised by plain, low modulated, and less textured hues. Furthermore, considering rhetorical purposes, specific colors and color pairs are selected to reinforce persuasive messages, such as the food industry often engaging warm colors. To ensure brand image continuity while competing for attention in urban spaces, these color features are often amplified in outdoor advertising. This leaves fewer options for variations but creates similar impressions of glaring colors.

As major brands increasingly dominate urban spaces with their unified and commercialised aesthetics, local residents have sought ways to counteract this sense of alienation. In response, street art and murals have emerged spontaneously across various urban areas as a means of reclaiming the city. Emphasising individual expression, street art serves as a challenge to corporate agendas, disrupting their messages and advocating for alternative ways of life (Klein, 2000; Lassen, 1999). In some cases, murals is used strategically as a way for place-making (Jue, 2017). It is not surprising to find that saturated and eye-catching colors are also prevalent in this movement. However, differing intentions lead to distinct expressions of colour. In many instances of street art, bold and evocative colours are used expressively to convey emotions rather than to communicate branding messages. These colors are often presented in chaotic and eccentric arrangements, sometimes incorporating intentionally discordant colour pairs as a deliberate statement against the gentrification aesthetics imposed by international brands. There appear to be no constraints on the number of colours selected in street art, as the primary aim is to create visual impact through exaggerated patterns. Colors are often used in highly modulated or complex ways, focusing on depicting objects and evoking emotions rather than adhering to branding principles.

3. NEW COLORS IN URBAN LANDSCAPES

Apart from these two sources, bright colors began to emerge in urban and landscape design, becoming an important force shaping urban landscapes. Unlike traditional landscapes that prefer naturalism and rely on inherent colors from materials, often in natural and neutral tones, contemporary landscapes increasingly feature more saturated, artificial colors. Previous studies have argued that vibrant and conspicuous colors were introduced in environmental design as a strategic solution for provoking social changes (Boeri, 2017). Drawing inspiration from Supergraphics, saturated colors are believed to provide psychological relief while covering unsatisfactory surfaces, aiming to bring positive changes to urban environments (Smith, 1970). However, new colors emerged from contemporary landscapes design seem to have more diverse connections with urban issues.

To understand new colors in landscape design, Beichen's previous research analyzed nearly 700 landscape projects from 2000 to 2019 and their color design features. By examining key attributes of color design from these projects, this paper argues that saturated colors emerged in landscapes with the intention of creating place identity and claiming spaces for people, while also being greatly influenced by commercialization and branding, even forming collaborative patterns with some companies. In the analyzed projects, more than 40% (N=299) engaged only one color, while the majority did not include more than five colors. Yellow, red, blue, and orange ranked highest as the most used colors, often presented in contrasting pairs with good legibility. Furthermore, colors were typically presented in a plain and abstract way, usually in the form of flat paint or coating. These features clearly indicate that color design in these landscapes is influenced by branding principles. Cases such as the Palma de Vecchio Popup Square (see Figure 1a) was designed to promote an exhibition, while the Coca-Cola Pavilion (see Figure 1b) was directly sponsored by Coca-Cola and engaged their signature color for branding.

Figure 1 (a) Palma de Vecchio Popup Square (2015), Bergamo, Italy. Source: Tagliabue (2015). (b) Coca-Cola Beatbox (2012), London, UK. Source: Khan (2012)

By conducting a thorough analysis of landscapes and integrating relevant theories, this paper aims to enhance our understanding of the significant shifts in color design within landscapes. It seeks to reveal the differences and similarities in color language appearing in various urban settings. Through comparing color features, this paper suggests that the dramatic changes in landscape design may be largely influenced by branding demands. Additionally, it aims to delve deeper into the explanation regarding the communicative role of colors; how they evoke emotions and potentially bridge previous divides between worldviews.

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Identification of Quarries in the Cuzco Valley for the Extraction of Inorganic Pigments to Produce Local Artisanal Paints

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ABSTRACT

This communication is focused on identifying quarries in the Cuzco Valley used to extract inorganic pigments to produce local artisanal paints. The importance of this study is highlighted, which aims to preserve and revive the tradition of Cusco rock art, using local lands and incorporating unskilled labor to promote local development. The approach involves extensive analysis that combines geological methods with traditional knowledge and the experience of local experts. The geology of the Cuzco Valley was mapped and an ethnographic investigation was carried out, which included interviews with local artists, elderly people, and experts in oral tradition, to collect information about the location of the quarries used in pre-Hispanic and colonial times. With these pigments, paintings were produced through a local workshop with students from the professional school of architecture, using motifs from the religious architecture of Cusco as a revaluation of the artisanal production of painting. This feedback places scientific research in the historical-cultural framework of the region, ensuring the authenticity and relevance of the results obtained. The importance of identifying the original quarries used during a particular historical period is emphasized, as this provides a solid basis for producing artisanal paintings that are close to the techniques and colors used by the ancestral cultures of the area.

1. INTRODUCTION

Artisanal painting in Cuzco, a city located in Peru, has a rich and diverse history dating back to pre-Hispanic and colonial influences. Over time, it has experienced an interesting development of local styles that reflect the identity and culture of the region (Flores, 2023).

Figure 1: Location of the city of Cuzco. (Note: The city of Cusco was transformed over time, going from the formation of pre-Inca cultures, the Incas, La Colonia, the republican stage and the present, preserving a rich historical center and expression of traditional architecture rescuing construction techniques and ancestral and artisanal art).

The production of paint with soil pigments in Cusco has a long history dating back to the ancient civilizations that inhabited the region. These traditional paintings are not only an artistic expression, but also a way to preserve and transmit local culture and traditions. The technique of extraction and preparation of pigments has been transmitted from generation to generation, becoming an invaluable cultural heritage for the region (Moreno Ortega & Mutumbajoy Chindoy, 2021). Soil pigments play a crucial role in the Cusco region, not only for their aesthetic value in the production of paintings, but also for their cultural and symbolic importance. These natural pigments reflect the richness of the Cusco soil and the deep connection that exists between the land and its inhabitants. Furthermore, its use in artistic practices and traditional architecture contributes to the preservation of cultural identity and the strengthening of the historical roots of the region.

Today in Cusco there are communities that preserve the legacy of the use of traditional materials, techniques and technologies for the production of their homes, maintaining the materiality of the spatial and colorimetric physical expression. The application of coatings on adobe walls and walls of heritage buildings are plastered with applications of milk of lime or previously pigmented silicate dyes, through plasters or layers of paint that help to waterproof the masonry by applying two coats in opposite directions that generally They are white. Soil pigments have become essential components in contemporary architecture in Cusco, offering a unique and traditional alternative for the application of artisanal paints. These pigments, obtained from local minerals and soils, provide a deep connection with the territory and culture. Its use highlights the importance of valuing available natural resources and promotes sustainability in the construction of buildings in the region. In contemporary architecture in Cusco, various types of soil pigments are used to make artisanal paints. Some of the most common are ocher, iron oxide, clay, and diatomaceous earth. Each pigment provides unique shades and characteristics that allow a wide range of aesthetic possibilities, adapting to modern architectural designs with a touch of tradition and authenticity.

Artisanal painting in buildings is a manual and traditional process that involves the creation of paintings using ancestral methods and techniques. This type of paint is characterized by its careful and personalized production, where quality and durability are prioritized. The use of natural ingredients and the application of successive layers to achieve unique tones are an integral part of this ancient art (Navarro & Margagliota, 2020). Natural pigments are one of the essential components in the production of artisanal paints, obtained from sources such as minerals, plants or animals. These pigments bring a wide and surprising variety of unique colors and shades to paintings, allowing artists to explore an infinite palette of creative possibilities. On the other hand, oils and resins play a fundamental role as binders to bind the pigments and form a homogeneous mixture. Oils, such as linseed or tung, famous for their versatility and protective properties, add exceptional richness and shine to color, as well as a silky, smooth consistency that makes application easy. Likewise, resins, such as dammar, known for its transparency and durability, help create a flexible and resistant film that ensures that the paint adheres properly to various surfaces. In short, the combination of these natural elements in artisanal painting not only allows for visually impressive results, but also guarantees the longevity and quality of the work of art for many years (Roquez Ramos & Paredes Dugarte, 2014). In the production of artisanal paints for folk architecture, inorganic pigments play an important role. These pigments are composed of inorganic chemical elements that give the paint different colors and desirable physical properties. Some common inorganic pigments are metal oxides such as iron oxide (red, yellow, brown), zinc oxide (white), and titanium oxide (white), and metal sulfides such as cadmium sulfide (yellow, orange, red) and zinc sulfide (yellow) (Marcano, 2018).

The pigment quarries in Cusco have been used throughout history to obtain pigments used in pre-Hispanic mural painting, in local crafts and textiles, among other uses. In addition to their historical and cultural importance, these quarries also present scientific interest due to the geology of the valley and the properties of the inorganic pigments. Through this study, the aim is to obtain greater knowledge about the geological formation of the valley, the types of rocks present and the distribution of the quarries, as well as to analyze the traditional and modern methods of extraction and processing of pigments. Based on these objectives, it is expected to obtain results that contribute to the conservation of cultural heritage and provide recommendations for future research.

2. METHODOLOGY

The location of the quarries responds to the constant search during the last three years, in which, in routine walks guided by geological maps referenced by specialists, as well as by dialogues with residents who live in said areas or who knew of the location of quarries or efflorescences of colored earth. Therefore, we proceeded to create a map of the location of quarries with the presence of earth pigments that are potentially usable for the production of paints. In these quarries, the color tones were verified, as well as the determination or decantation so as not to be confused with colored rocks (difficult in the grinding process), or colorations resulting from weathering or factors external to the soil itself, with which 42 points were recorded.

Figure 2: Process of extraction, crushing, sieving and production of inorganic pigments.

3. RESULTS

Among the most common pigments are iron oxides, which produce shades from red to yellow, and titanium oxides, used to achieve white, opaque colors. In addition, pigments of mineral origin are used such as cinnabar, which offers shades of intense red, and malachite, which provides different shades of green. Pigments of plant origin are also used, such as indigo, which produces blue tones, and cochineal, which is used to obtain red and purple colors. These pigments are obtained through extraction and grinding processes, guaranteeing their quality and durability in paint production see Figure 3.

Figure 3: Georeferencing map of pigments in Cuzco.

The study area is made up of the following geomorphological units:

a) Slope with landslide deposit (VeQ-co): This geoform is located mostly southeast of the work area; They are made up of colluvial deposits. In this geomorphological unit there are the samples (Sample T-4, Sample T-6 and Sample T-10).

b) Alluvial slope (VeQ-al): This geoform is located mostly northeast of the work area; They are made up of alluvial deposits.

c) Mountain in sedimentary rock (MoS): This geoform is located in most of the work area; They are made up of sedimentary rock formations. In this geomorphological unit there are the samples (Sample T-11, Sample T-12, Sample T-13 and Sample 14).

d) Hill in sedimentary rock (CoS): This geoform is located in the central part of the work area; They are made up of sedimentary rock formations. In this geomorphological unit there are the samples (Sample T-1, Sample T-2, Sample T-3, Sample T-5, Sample T-7 and Sample T-9).

e) Hill in intrusive rock (CoI): This geoform is located northwest of the work area; They are made up of intrusive igneous rocks.

f) Sedimentary plateau (AlS): This geoform is located in the central part of the work area; They are made up of sedimentary rock formations. In this geomorphological unit there is Sample T-8.

g) Alluvial terrace (TrQ-al): This geoform is located in the central part of the work area, south of the city of Cuzco; They are made up of alluvial deposits.

h) River channel (CrQ-fl): This geoform is located in the southern part of the work area; Made up of clastic sediments from fluvial deposits, they have a flat or slightly inclined relief.

Figure 4: Paint colors obtained with inorganic pigments from Cuzco.

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Uncertainty Evaluation of Color Measurements for Color Control and Color Communication

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ABSTRACT

We have measured reflectance spectra of a large number of color reference samples in d:8° geometry with two independent color-measuring instruments. An uncertainty band can be associated with each of the measured spectra, but the problem is the unknown correlation of the reflectance values at the neighboring wavelengths and at more distant wavelengths, which hampers the propagation of reflectance uncertainty to the uncertainty of color quantities. To address this problem, we have carried out spectral analysis of the deviations of reflectance values measured with the two independent instruments. The power-law exponent for the harmonic amplitudes that we found from this analysis is −0.57. Then an iterative process of Monte Carlo simulations was carried out to determine the corresponding power-law exponent of −0.7 describing spectral reflectance deviations from the unknown true value. With this information a proper account could be made on spectral correlations of reflectance values in propagating the uncertainty into color quantities like L^*, a^* and b^*.

1. INTRODUCTION

It is stated in the ASTM standard E2214-20 that "the exact methods for propagating the uncertainty in a reflectance factor measurement into the color coordinates is still a matter of some dispute" [1]. Our aim here is to describe such an exact method. The novel method is based on the recent experimental observation that the spectral deviations of participants from the reference value (i.e. true value) in all radiometric key comparisons have a specific spectral structure [2]: On the average, the amplitude of each harmonic component of spectral deviations is inversely proportional to the harmonic order, corresponding to a power-law exponent $b = -1$.

We have measured and analyzed reflectance spectra of reference samples using two independent instruments. The uncertainty propagation method of [2] needs to be amended here, because the true reflectance values are not known in our measurements. Further analysis of the deviations of measurement results of the two instruments reveals that the power-law exponent to be used in the uncertainty analysis is $b = -0.7$, instead of −1 found in the analysis of radiometric key comparisons. With such additional information, the uncertainty of spectral measurements can be propagated by Monte Carlo simulation into quantities described as spectral integrals, such as color coordinates L^*, a^* and b^* [3].

2. METHOD

The described method can be used for assigning a scientifically justified uncertainty to color quantities. A set of 707 reference samples from NCS Color Ab was measured with two instruments assumed to be equally reliable. The data analysis starts by determining the spectral characteristics of the differences of the reflectance spectra (Section 2.1). The distribution of obtained power-law exponents can then be used to extract information on the characteristics of spectral deviations from the unknown true reflectance values (Section 2.2). Finally, the measured reflectance values are deviated in Monte Carlo simulation according to the determined power-law exponent b related to spectral deviations from the unknown true value, resulting in uncertainty estimates of the studied color quantities (Section 3).

2.1 Analysis of reflectance deviations in measurements with two instruments

The inset of Figure 1 displays two reflectance spectra measured in d:8° geometry with two independently characterized color-measuring instruments. Red circles in Figure 1 indicate the relative deviation of measured reflectances within the spectral range from λ_1 = 400 nm to λ_2 = 700 nm. The solid line is a fit to the deviations by equation

$$\delta(\lambda) = \sum^{N} A_i f_i(\lambda), \qquad (1)$$

where $f_i(\lambda)$ are orthogonal functions based on Chebyshev or Legendre polynomials and A_i is the amplitude of the ith function [2]. The polynomial functions are normalized so that the integral of the square of each function from λ_1 to λ_2 is one. The functions are formed in such a way that they correspond to the ith harmonic, if sinusoidal functions with $2i$–1 or $2i$ zero crossings are used for fitting. The zeroth order function is $f_0(\lambda) = 1$.

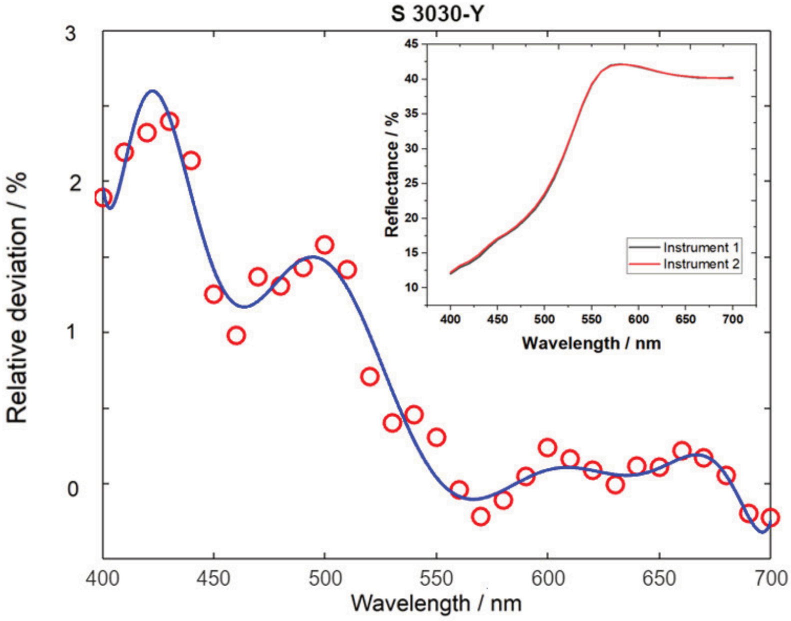

Figure 1: Relative reflectance deviations of NCS sample S 3030-Y measured with two instruments. Red circles indicate measured data and solid line is a fit according to Equation 1. Inset: Measured reflectance spectra.

The harmonic amplitudes obtained from the fit by Equation 1 with $N = 6$ are listed in Table 1. A linear fit ln $= c + k \ln i$ on log-log scale is made to amplitudes with $i \geq 1$. The fit gives a power-law exponent $k = -1.18$, corresponding to the relation $A_i = e^c \cdot i^k$, where constant c is the intercept of the fit at i = 1. The power-law exponent characterizes the correlations of measurement errors at different wavelengths, where a high value of $|k|$ indicates enhanced correlation and a low value at around zero means reduced correlation, corresponding to independent errors at all wavelengths, i.e., random noise.

Table 1. Harmonic amplitudes from the fit of Figure 1 using Chebyshev polynomials.

i	0	1	2	3	4	5	6
A_i / %	0.791	0.734	0.187	0.057	0.158	0.151	0.049

2.2 Distribution of power-law exponents of reflectance deviations

The red histogram of Figure 2 shows the distribution of power-law exponents from all 707 NCS color samples. The number of values within interval [−1.8, −1.6] at −1.7 etc. gives the count number on vertical scale. The mean is $<k> = -0.57$ and standard deviation of the distribution is 0.38. Solid lines indicate Gaussian fits to the histograms.

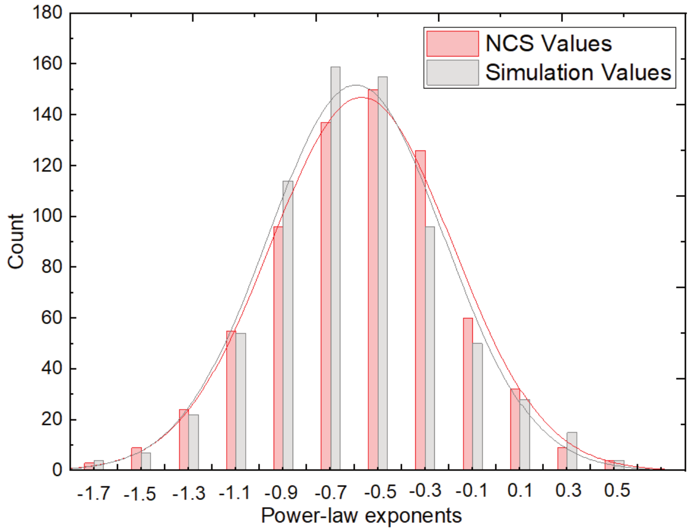

Figure 2: Measured (red) and simulated (grey) distributions of power-law exponents. The simulated distribution is obtained from the difference of reflectance spectra independently deviated according to harmonic content described by power-law exponent b = −0.7.

The power-law exponent b of deviations relative to the unknown true value of reflectance is of interest for uncertainty analysis of color quantities. For this purpose we simulated relative differences of equally reliable reflectance spectra characterized with the same varied value of b. The grey histogram of Figure 2, obtained with $b = -0.7$, successfully produces a good match with the measured distribution. The simulated distribution has the mean of $<k> = -0.59$ and standard deviation 0.37.

3. RESULTS

Uncertainty estimates are calculated from the measured reflectance spectra $R(\lambda)$, such as those of Figure 1, for color coordinates L^*, a^*, and b^*. Monte Carlo method is used to generate the distributions of color quantities with reflectance spectra deviated by

$$R_{dev}(\lambda) = [1 + \delta(\lambda)\, u_c(\lambda)]R(\lambda), \quad (2)$$

where $u_c(\lambda) = 0.01$ is the nominal relative standard uncertainty of all spectral reflectances and $\delta(\lambda)$ is calculated by Equation 1 using different values of N and power-law exponent $b = -0.7$ for the amplitudes A_i. In uncertainty analysis, the amplitudes are normalized as $\sum_{i=0}^{N} A_i^2 = 1$, where A_0 is taken from a uniform distribution within interval [−1, +1], and orthogonal functions $f_i(\lambda)$ are based on Legendre polynomials. The obtained standard deviations of distributions of L^*, a^* and b^* for sample S 3030-Y are shown in Figure 3 as a function of N. The standard deviation at large N becomes independent on N and provides the estimate of standard uncertainty of each quantity.

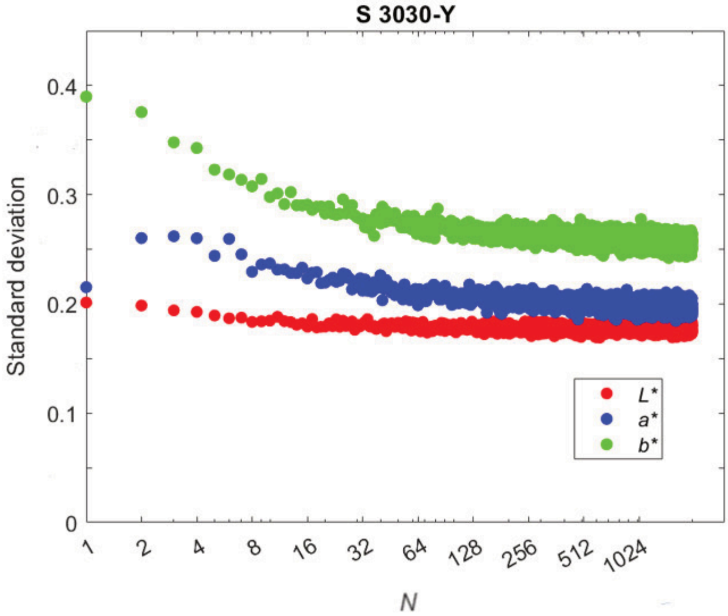

Figure 3: Standard deviation of color quantities. The estimated standard uncertainties of 0.18, 0.20 and 0.26 are obtained in the limit of large N for L, a** and *b*, respectively. The mean values are L* = 65.93, a* = 2.78 and b* = 29.89.*

4. CONCLUSIONS

It can be expected that the new method of uncertainty evaluation of color quantities improves the reliability of color control and color communication, but further work is still needed. The method also meets the challenge of uncertainty propagation from reflectance to color quoted in the ASTM standard [1]. The standard describes a method for estimating the confidence interval for color differences due to repeatability. The method presented here takes into account also the effect of unknown systematic biases hidden in repeatability measurements.

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Color in Personal Image: for a Decolonization of the Seasonal Color Analysis Based on the Brazilian Skin Color

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ABSTRACT

In 1990, especially in the city of São Paulo, the image consultancy market had grown, and the seasonal color analysis was gradually disseminated in the national territory. However, it should be noted that Brazil is a country that has in its genesis a miscegenation of people, coming from different continents, such as Europe, Africa, and Asia. The mixture of different contexts has given rise not only to peculiar cultural and artistic manifestations as to a diversity of racial biotypes. According to the official classification of race/skin color in Brazil, used by the Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE), it's composed by five categories - White [Branco], Brown [Pardo], Black [Preto], Yellow and Indigenous (Travassos, Laguardia, Marques, P.M. et al, 2011). In this way, applying in Brazil the seasonal systems for personal color analysis, especially developed for the North American and the European skin, can be understood as an unfolding of the European colonization process that has been established in our country for a long time, ranging from clothing, furniture, decoration, etc., which led to an importation of the lifestyle from the global north to the global south. This research aims to reflect on the use of the seasonal color analysis for the Brazilian skin color, considering that a broad study is needed to identify the diversity of Brazilian skin types, as well as their peculiarities, for the construction of accurate methodologies. This study will use bibliographic research on decolonization, personal color analysis methods and image consultancy theories in addition to documentary research in data released by national and international institutions of relevant scope.

Keywords: personal image, seasonal color analysis, Brazilian skin color, image consultancy, personal stylist.

1. INTRODUCTION

The concept of personal color analysis as we know it today finds its roots in the work of the north American Suzanne Caygill in 1980, when she launched the book "Color: The Essence of You" (Kyle, 1989). Caygill popularized the idea of associating individual color palettes with the four seasons, linking each season to a specific color family that would ideally enhance an individual's natural features. Souza (2023) identifies the launch of the book "Color me Beautiful" in 1987 by Carole Jackson in the United States as a milestone in the studies on image consultancy and personal color analysis. Over time, the global north, especially European countries, and the USA, have strengthened research and studies in the field, expanding the season systems for personal color analysis. In Brazil, this process was introduced in the late 1980s, with the emergence of the first professionals in the area, known as personal stylists (Souza, 2023).

2. THE DEVELOPMENT OF COLOR ANALYSIS AS A FIELD OF WORK AND STUDY

In the 90s in Brazil, especially in the city of São Paulo, the image consultancy market had grown, and the seasonal color analysis was gradually disseminated in the national territory. However, it should be noted that Brazil is a country that has in its genesis a miscegenation of people, coming from different continents, such as Europe, Africa, and Asia.

3. SEASONAL COLOR ANALYSIS IN BRAZIL: THE IMPORTANCE OF A DECOLONIZATION

Personal colorimetry is a widely used method to identify the colors that most enhance the beauty and harmony of a person's skin. Initially based on the seasonal system that divides people into four main categories – spring, summer, fall, and winter – this method has evolved to include eight more intermediate seasons: light summer, mild summer, pure summer, light spring, intense spring, pure spring, dark winter, intense winter, mild winter, soft autumn, dark autumn, and pure autumn.

However, it is important to note that the initial application of this method was validated in a predominantly Eurocentric skin sample, reflecting hegemonic tones and undertones that do not always apply to a diversity of phenotypes. Especially in the Brazilian context, with its rich ethnic and cultural diversity, the traditional approach to colorimetry may not fully capture the complexity and variety of skin tones present.

In Brazil, the dissemination of personal colorimetry was driven by the translation of books and manuals originally written in English and French, highlighting the importance of adapting and contextualizing this method to meet the unique needs and characteristics of the Brazilian population. The plurality of skin tones existent in the country, ranging from warm to cool tones, and even combinations of temperatures, as observed in different regions of the face, highlights the need for a more inclusive and comprehensive approach in the field of personal colorimetry.

In this way, it is essential that professionals who work with personal colorimetry in Brazil are aware of the diversity and complexity of local skin tones, seeking to adapt and enrich existing practices to reflect the true diversity of the Brazilian population. According to the official classification of race/skin color in Brazil, used by the Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE), it's composed by five categories - White [Branco], Brown [Pardo], Black [Preto], Yellow and Indigenous (Travassos, Laguardia, Marques, P.M. et al, 2011).

4. CONCLUSIONS

Therefore, applying the seasonal systems for personal color analysis to Brazilian types, especially developed for the North American and the European skin, can be understood as an unfolding of the European colonization process that has been established in our country for a long time, ranging from clothing, furniture, decoration, etc., which led to an importation of the lifestyle from the global north to the global south. The appreciation and celebration of the plurality of colors and individual characteristics contribute to a more authentic and inclusive approach to the universe of beauty and fashion in the country.

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Translating Albers to CAM16: a Case for Next-Generation Color Pickers

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ABSTRACT

The universally taught art-educational material *Interaction of Color* by Josef Albers is used to form a case-study proposing CAM16 as an alternative to the commonly used HSB and HSL pickers (endemic in most graphics software). For vibrating and vanishing boundaries, Albers states colors must be equally light but from differing hues, a task impossible to execute in HSB and HSL. Albers' terminology is catalogued, identifying synonymous CIE definitions that quantify lightness. Albers' examples of vibrating and vanishing boundaries validates the translation. CAM16 shows the ability to create vibrating and vanishing boundaries without manual color picking. Until CAM16 tools are introduced, the author encourages educators to address the confusion HSB and HSL pose.

1. INTRODUCTION

CAM16, a color appearance model (CAM), is more compatible with Josef Albers' *Interaction of Color* than industry standard color pickers HSB and HSL. His most difficult exercises, vibrating and vanishing boundaries, require equal lightness: an attribute poorly described in HSB and HSL, but accurately quantified in CAM16 (Li et al. 2017).

The majority of color pickers are mainly HSB. CIELChab pickers are rare (Gimp 2024); if including alternatives, most common software include only CIELab (Adobe 2024). HSB and HSL show perceptually vague attributes adjacent to accepted terms describing color appearance, such as "brightness" and "lightness". Its misleading metrics are generally regarded as a pain-point of the digital graphic workflow (Abeln 2011). Although HSB (Hue, Saturation, Brightness) and HSL (Hue, Saturation, Lightness) are different systems, they are analogous interpretations of identical colors. Specific instances of the maximally chromatic choice within a single hue in the systems are "apex colors". For example, HSB coordinates (H = 0°, S = 100%, B = 100%) and HSL coordinates (H = 0°, S = 100 %, L = 50%) identify the same apex red (#FF0000). With numerically identical B and L values, actually perceived lightness widely vary (O'Leary 2022). In most digital interfaces, they are usually the only attributes of "brightness" or "lightness" readily available.

2. METHOD

2.1 Translating Albers' Terminology

In writing that "Munsell defines value as the lightness of a color ... we use 'light intensity' instead as a self-explanatory term" (Albers 2013: 73), Albers definitively equates his "light intensity" to Munsell's "value," an analogue of CIE's "lightness"(Kuehni 2001). In further explanations of "light intensity," Albers, writes that "these pictures consist of grey shades of the finest gradations between the poles of black and white," (Albers 2013: 12) confirming that when Albers writes of "light intensity" he is really refering to "lightness" as defined by the CIE (CIE 2020).

Vibrating and vanishing boundaries require what Albers calls equality in "light intensity," so CIE lightness – HSB & HSL's weakness. Albers admits this is "challenging," (Albers 2013: 62) especially when choosing colors from different hues (Albers 2013: 12).

2.2 Sample Measurement and Calculations

To ensure the integrity of deducing Albers' intent, measurements were taken of a pristine copy of the first edition of *Interaction of Color* published in 1964, from the Alfred and Blanche Knopf Library archived by the Harry Ransom Center at The University of Texas at Austin (Albers 1964). In his book, vibrating boundaries are shown in 3 examples: 2 in plate XXII-1 and 1 in plate XXII-2; vanishing boundaries are shown across 3 examples: plates XXIII-1, XXIII-2, and XXIII-3.

The flat surfaces were measured by a Nix Spectro L, in measurement mode M2 (Nix Color Sensor). The orange and blue (with concentric circles) example in plate XXII-1 was omitted from study due to the instrument's inability to accurately measure the thin blue lines, so only the right page (blue and red checkers) of plate XXII-1 was considered, along with plates XXII-2, XXIII-1, XXIII-2, and XXIII-3, totalling 5 exercises analyzed.

XYZ tristimulus values were calculated under D65 with the 1931 2° standard observer. Tristimulus values were converted to the sRGB space, yielding HSB & HSL values. The IEC's definition for the assumed viewing conditions for sRGB was used for the CAM16 and CIECAM02 calculations (IEC 1999), with static parameters: standard ambient illumination of 80 cd/m^2, adapting field luminance 20%, illuminant white point of D65, surround parameter "average," and discounting the illuminant (Colour Documentation 2024). CIELab values were calculated under D65.

2.3 Reverse Engineering: Interpreting Albers' Plates

The lightness values of the surface color pairs were compared in various CAMs. The chosen systems and appearance correlates which this paper refers to as L were CIELab's $L*$, CAM16's J, CIECAM02's J, HSB's B, and HSL's L. By assessing CIELab's $L*$, Google's HCT is also assessed, as its T "tone" is derived from $L*$ (O'Leary 2022).

The lightness value of one color L_1 and L_2 were subtracted with formula $\Delta L = |L_1 - L_2|$ The ΔL value indicates the discrepancy of the system's lightness difference from Albers' assertion of equivalence, with perfect agreement being $\Delta L = 0$. The higher the ΔL, the higher the disagreement. Due to the nature of the data evaluated, an equality of values, conventionally indicative of non-relation, really indicates significant agreement and relation. H_0 states $\Delta L > 0$, no relation to Albers, with alternative hypothesis H_a stating $\Delta L = 0$, perfect relation to Albers. Paired one-tailed two-sample t-tests evaluate significance.

2.4 Testing CAM Performance: Duo-Tone Vibrating Boundaries

Albers' instructions were put into practice using 6 background colors chosen (in HSB & HSL, $H = 0°, 60°, 120°, 180°, 240°$, and $300°$). With the background color being named sample 1, the vibrating test foreground color (2) was calculated by having equal lightnesses $L_1 = L_2$, hues diametrically opposite for high hue contrast, $h_1 + 180° = h_2$, and chroma (or saturation in HSB and HSL) the maximum possible for that hue and lightness pair within the sRGB gamut. CIELab calculations were performed in CIELChab to yield hue and chroma.

3. RESULTS AND DISCUSSION

3.1 Reverse Engineering: Interpreting Albers' Plates

With null and alternative hypotheses H_0: $\Delta L > 0$, H_a: $\Delta L = 0$, and significance threshold $a = 0.01$, the data indicate CAM16 with $p = 0.0099$ (Table 2) as agreeing with Albers' claim of equivalent lightness the most. The greatest limitation of this test is the small sample size of 5 plates.

Table 1. Calculated lightness differences, $\Delta L = |L_1 - L_2|$, of measurements per CAM.

Plate	HSB (*B*)	HSL (*L*)	CAM16 (*J*)	CIECAM02 (*J*)	CIELab (*L**)	Albers' Assertion
XXII-1	2.64	8.56	1.31	0.48	3.44	0.00
XXII-2	12.85	35.39	2.15	1.41	0.10	0.00
XXIII-1	5.40	8.04	2.19	2.07	1.43	0.00
XXIII-2	5.24	3.28	0.37	0.26	0.24	0.00
XXIII-3	3.32	2.60	0.80	0.73	0.19	0.00

*Table 2. Paired one-tailed two-sample T-test of H_0: $\Delta L > 0$, H_a: $\Delta L = 0$, threshold for significance a = 0.01, significant values = ***.*

Statistic	HSB (*B*)	HSL (*L*)	CAM16 (*J*) ***	CIECAM02 (*J*)	CIELab (*L**)
Mean	5.89	11.58	1.36	0.99	1.08
P value	0.0159	0.0647	0.0099***	0.0204	0.0830

3.2 Evaluating CAM Performance: Duo-Tone Vibrating Boundaries

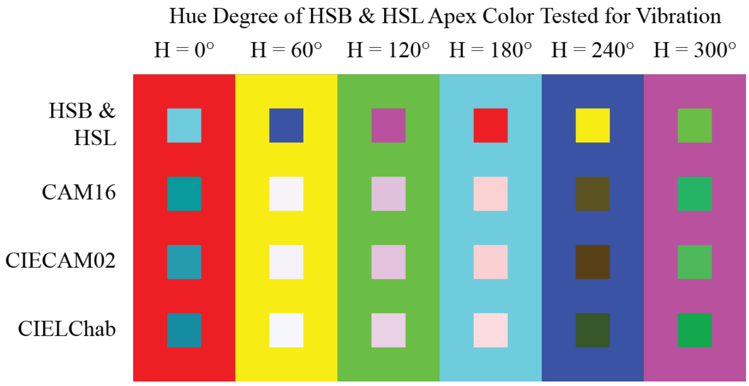

Figure 1: Various CAMs' calculated vibrating boundaries for multiple HSB apex colors.

In following Albers' instructions on producing vibrating boundaries, HSB & HSL perfomed poorly in each tested case (see Figure 1). CAM16 reliably produced vibrating boundaries without manual adjustment, proving forwards compatibilty with Albers.

4. CONCLUSIONS

This paper does not deal with the specifics of how a new tool would be implemented in a workflow, but is the necessary precursor of that dialogue. It proves CAM16 and similar models integrate tightly with the one of the artistic canon's most celebrated authoritative texts, *Interaction of Color* (Albers 1964). Together, the formerly dichotomous fields and perspectives mutually validate each other.

To the educator: remain teachable. When more robust tools become available, be open-minded to learning them, to begin teaching them. Continue to emphasize and re-emphasize the importance of sharpening skills of perception and color discernment, especially in light of HSB and HSL's limitations and misinformation.

CAM16 demonstrates the novel ability to automatically, rapidly, and reliably execute Albers' most challenging and labor intensive maneuvers: vibrating and vanishing boundaries. The core principle of authentically prioritizing perception transcends the differing jargon of the seemingly contrasting artistic and scientific disciplines.

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The colors in the axós of the candomblé terreiro Axé Ilê Obá

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ABSTRACT

This work constitutes a concise excerpt from the ongoing doctoral research in Social History under the guidance of Professor Marina de Mello e Souza. The research focuses on the axós, the attires of the candomblé house, Axé Ilê Obá, with an analysis spanning from its foundation in 1950 to the present day. Axé Ilê Obá holds the distinction of being the first candomblé house designated as historical and cultural heritage of São Paulo by CONDEPHAAT. Currently, it practices the *queto* nation, venerating the orixás, deities of the Yoruba people. The objective of this communication is to present a correlation between the colors used in the attires of candomblé's deities and their *itans* (myths), which underpin the choices and combinations of hues. In a historical analysis, the presentation aims to demonstrate that one of the elements considered most traditional in the aesthetics of candomblé garments, the colors, also undergoes alterations over the years. Colors are intricately connected to the types of fabrics, and despite their numerous sacred foundations within this religious attire, chromatic changes are evident, reflecting the context of each candomblé house and events in contemporaneous African continent. For instance, saturated tones for the popular industrially printed ankara, and pastel tones for Nigerian-Austrian embroidered fabrics, always accompanied by white in laces, laises, and cotton, symbolizing origin, and creation for the Yoruba people. The analysis also compares the Yoruba chromatic system to the Brazilian one, as Yoruba color analysis categorizes shades into three tones (dúdu – black and dark colors, pupa – red, and funfun – white and light colors) with distinct meanings and applications in everyday and ceremonial textiles. Therefore, it is crucial to perceive how the *itans* in Brazilian candomblé are (re)interpreted and how myths from a contemporary African continent also broaden such interpretations. The investigation involves an analysis of *queto* candomblé attires through photographs, paintings (especially those commissioned for Axé Ilê Obá by Agnes doSantos), and accounts from the 1950s to the present, with a more substantial visual photograph. It also includes contemporary records in the candomblé's house (especially from Axé Ilê Obá's official photographers, Felipe Marcondes, and Eduardo Cancissú) and field studies during public festivities at the Axé Ilê Obá in the neighborhood of Jabaquara, São Paulo. Therefore, the colors in these attires serve as communicative elements, narrating the stories of the deities and portraying the adaptations and resistances of traditional *terreiro* communities.

1. INTRODUCTION

This work is an excerpt from the doctoral research in Social History titled "The Dress of Axé Ilê Obá," supervised by Professor Marina de Mello e Souza. The study investigated the attire of this Candomblé *terreiro* from the house's opening in 1950 to the present day. The doctoral research aimed to analyze the continuities and changes in the aesthetics of these garments from the first *terreiro* in São Paulo, which was listed as a historical and cultural heritage site by the Council for the Defense of Historical, Archaeological, Artistic, and Touristic Heritage (CONDEPHAAT). Among the analyzed elements, one of the most traditional aspects of attire is the color of the garments. In the costumes of the deities, the orixás, these colors directly relate to the *itans* (myths), underpinning the choices and combinations of shades. However, it was observed that beyond the foundations in the stories of the orixás, other characteristics also influenced the attire: the individual's hierarchy in the *terreiro*, the fabrics used, the rites in which the clothing was worn, and the era and context of the *terreiro* at that time.

2. METHOD

For this historical analysis of the colors present in the garments at the Axé Ilê Obá Candomblé *terreiro*, photographs from the *terreiro's* collection were examined. This included older records provided by Bia of Oxum and Telma Witter, as well as current records from the house's official photographers, Eduardo Cancissú and Felipe de Oxaguiã. Other older photographs of the *terreiro* were also found in academic research conducted by the children of Axé Ilê Obá, such as the investigations by Renato Correa (2014) and Cecília Negrão (2018), as well as the book by the second mother-of-saint of the house, Sylvia Egydio de Oxalá (1980). In addition to these sources produced by the Candomblé practitioners themselves, an important material analyzed was the paintings by Agnes DoSanto, commissioned by Mother Sylvia in 2002. These paintings depict the orixás with their attire as they appeared in the *terreiro* during that period. The paintings aimed to be faithful to the actual garments of the time, which can be verified by comparing them with photographs of the same clothes. Currently, the paintings remain on display in the terreiro's barracão and have also been reproduced on the external walls of the *terreiro*, making them visible to everyone in the Jabaquara neighborhood of São Paulo. For this comparative investigation of the garments from the inauguration of the *terreiro* in the 1950s to the present day, I conducted field visits during the *terreiro's* public ceremonies, known as xirês, and interviewed the current mother-of-saint, Paula de Iansã, as well as representatives from workshops that make clothes for the children of Axé Ilê Obá: Odó Iná workshop, Okàn Rere workshop, and Patuá Confecções.

2.1 Yoruba chromatic theory

The colors present in Brazilian Candomblé attire, according to anthropologist Vagner Gonçalves da Silva (2022), are translations and adaptations of chromatic use in African cults. Changes have occurred; Professor Vagner Gonçalves asserts that colors are not as definitively assigned in the African continent's cults. However, it is important to understand the foundation of the Yoruba chromatic theory to comprehend the modifications found in Candomblé. Unlike Western color theories, for the Yoruba people, all colors descend from three primary colors: funfun (white), dúdu (black), and pupa (red). Funfun encompasses all light colors, especially white, and represents seniority and the wisdom acquired over time, reminiscent of gray hair. Understanding life as a spiral process, this color represents both life and death. It is the color worn by Candomblé practitioners inside the *terreiro* and also outside, in the clothes worn on Fridays, dedicated to *Oxalá*, the *funfun orixá*, associated with white. Dúdu includes all very dark colors, such as indigo, dark red, and black. For the Yoruba, dúdu represents the unexplored. In Candomblé, black is not used in entire outfits but may be used in those related to the orixá Exu. In Candomblé, black is not associated with mourning, as white is the funerary color. Finally, pupa includes warm tones, such as red. Pupa represents youth, with its vitality and vibrancy. All other colors, in Yoruba theory, derive from these primary ones. Thus, these are also the tones present in initiation body paintings in Candomblé, using white pigment (efum powder), dark blue pigment (waji powder), and red pigment (osun powder). Just as in Western color theory, there is a color wheel; in Yoruba culture, this color wheel also symbolizes the circularity of ages, life, and continuous rebirth; without a finite linearity between one color and another and between life and death (Abiodun 2014).

2.2 Colors, hierarchy, and seniority in Candomblé

Candomblé is a religion with visible hierarchical positions signified through its attire. Generally, the more colorful the clothing, the higher the person's rank, reflecting their longer tenure within the religion, completion of initiation rites, duration within the house, or assignment to specific roles. Before initiation, a person is called an *abiã* and may only wear white, the color of the *funfun orixás*, the deities of creation. After initiation, the person becomes an *iaô*. Over time and with acquired wisdom, they may begin to wear other colors. Upon fulfilling the seven-year initiation rites, a person becomes an *ebômi*, eligible to wear saturated colors, patterned fabrics, etc. If a person is chosen as an *equede* (a female role that does not incorporate orixás) or *ogã* (a male role that does not incorporate *orixás*), they undergo different initiation rites from those of an *iaô*. Due to the responsibilities associated with these roles, they are already considered senior within the religion and may wear colorful clothing. The highest hierarchies are the *ialorixá* (mother-of-saint) or *babalorixá* (father-of-saint), who are *ebômis* that initiate others and are the religious leaders of the house. These leaders are permitted to wear saturated colors.

2.3 Axós for each moment

The colors of attire in Candomblé can also indicate which moments or rites are being performed. Generally, there are three distinct types of clothing: everyday attire, known as "clothes of feed," and "clothes of *xirê*," which include festive attire for each practitioner and the attire of the orixás themselves. Everyday attire worn in the *terreiro* is designed for work and, therefore, shows less hierarchy. These are typically white, the base color in Candomblé and the color of *Oxalá*. Floral patterned skirts can sometimes be seen, but generally, white is the predominant color. "Clothes of *xirê*," respecting each person's hierarchy, usually feature the colors of the deity honored at the celebration. For example, during a *Xangô* bonfire, practitioners will wear red and brown; for *Oxalá's* waters, everyone will be in white. When the *orixá* manifests in the *barracão*, they will be adorned with the colors that tell their *itans*. For instance, when a daughter of *Oxum* embodies the deity, she may wear yellow attire, representing gold, a metal associated with *Oxum*, and also referencing her myth of washing a single outfit so much (due to her love for the *orixá Xangô*) that it turned yellow. If the *orixá's* aspect (quality) is different, it may recount other myths through its attire, changing the colors of the garments. The term "quality" refers to variations of the *orixá*, relating to their myths and relationships with other deities.

2.4 Colors and fabrics

A significant influence on the colors of Candomblé clothing is the types of fabrics used, especially when they are printed or embroidered. Colors are intrinsically linked to fabrics, and although they have foundations within this religious attire (sacred rules), chromatic changes are present, reflecting the context of each *terreiro* and the religious, and political movements occurring in Africa. The so-called (re)Africanized *terreiros* employ many printed fabrics known as *ankara*, featuring garments with more saturated tones. Another type of fabric imported from the African continent, widely used, is the Nigerian-Austrian industrial embroideries. These are traditionally produced in lighter, pastel tones. Lace fabrics, *laises*, and cotton are often white (Souza 2007).

3. RESULTS AND DISCUSSION

Analyzing photographs, and paintings, and interviewing the Candomblé practitioners of the *Axé Ilê Obá terreiro*, it was possible to identify three distinct aesthetic phases marked by the religious leadership of the house: from 1950 to 1985, the *terreiro* was founded and led by Father Caio of *Xangô*. Father Caio was a singer and had *Oxum*, the deity of gold, as his secondary *orixá*. These characteristics brought a great intensity of brightness and saturated colors to everyone's attire. After Father Caio's death, Mother Sylvia of *Oxalá* took over the house from 1986 to 2014. Due to Mother Sylvia being the daughter of an *orixá* who exclusively wore white, everyone's clothing became lighter. Since Mother Sylvia's death, her daughter, Mother Paula of *Iansã*, has led the house since 2015. The current *ialorixá* has revived the use of more saturated colors, influenced by her *orixá*, *Oiá*, but also due to her connection with ateliers that make the *terreiro's* garments and import fabrics from the African continent, such as *ankara* fabrics.

4. CONCLUSIONS

There are elements of Candomblé attire that are immutable, related to the foundations of the religion and the mythologies of the *orixás*. The author Rowland Olá Abiodun introduces the concept of visual *orikis*, which can be applied to Candomblé garments. *Orikis* are words, phrases, or chants of greeting and evocation in Yoruba that possess axé, the vital energy. That is, we can say that the clothes act as visual *orikis*, narrating the myths of the orixás, primarily through the colors present (Abiodun 2014). However, an aesthetic aspect is linked to the leadership of the house, the available textile technologies, and the (re)Africanization aspect, which brings an updated influence from the African continent. Therefore, the colors in these garments are communicative, telling the stories of the deities, and also painting the adaptations and resistances of the traditional *terreiro* communities.

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Color over Volume in Contemporary 3D Animation

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ABSTRACT

This paper explores the evolution of 3D animation in the context of its growing dominance over traditional 2D animation in the entertainment industry. Over the past fifty years, 3D software has aimed to create images indistinguishable from photography, embodying what philosopher Willem Flusser describes as a "technical image" grounded in empirical science. This approach has been particularly dominant in the production of animated feature films, where risk aversion often leads to a reliance on technical novelty, as seen in films like "The Lion King" (2019) and "Toy Story 4." However, the release of "Spider-Man: Into the Spider-Verse" (2018) by Sony marks a significant departure from this trend, embracing a graphic style that challenges the realistic norms of 3D animation. This movement towards a more experimental visual approach, as seen in earlier works like Michel Ocelot's "Azur and Asmar" (2006) and David OReilly's short film "Please, Say Something" (2009), reflects a broader shift in the industry. This shift questions the traditional emphasis on spatial volumetrics in favor of more direct and expressive uses of color, signaling a complex response to visual fatigue, budgetary constraints, and the hybridization of animation techniques.

1. INTRODUCTION

Over the past half-century, images generated by 3D software have been characterized by their attempt to simulate all physical aspects of nature, rendering them indistinguishable from photographic images (MANOVICH, 2006, p.7). This type of image, commonly referred to as CGI (Computer Generated Imagery), represents a culmination in the long history of automated image-making processes.

According to philosopher Willem Flusser, this type of image falls under the category of "technical images," which are produced by devices (FLUSSER, 2002, p.13). Flusser defines devices as "products of technology, which in turn are applied scientific texts." Flusser argues that these devices displace the artist, as they objectify processes that previously relied on the artist's subjectivity.

When discussing the CGI-generating device, it is important to consider its historical antecedents, which trace back to the European Renaissance with the adoption and dissemination of linear perspective calculations and optical instruments that discretize the image. Five centuries ago, these developments began the process of displacing the artist by bringing objectivity to the image-making process. The understanding and rationalization of luminous phenomena by scholars such as Johann Heinrich Lambert in the 18th century can also be seen as laying the scientific foundation upon which modern CGI rests.

All these processes and understandings were digitally automated starting in the 1970s. Arlindo Machado (1997, p. 232) masterfully summarizes the central tenet of 3D synthesis, classifying it as a "hypertrophy of the aesthetic postulates of the 15th century," an aesthetic whose quality is linked to its degree of analogy with the referent, resulting in a type of image that has become increasingly ubiquitous and transformative of subjectivities on a global scale.

3D animation distinguishes itself from traditional 2D animation, which dominated feature film production for nearly a century, through its ability to maintain spatial coherence and to simulate with precision the various tones that produce the volumetrics of characters and objects as we experience them in the world.

Initially, the development of 3D simulation systems was restricted to the American military apparatus and a few university centers of excellence. Today, the multibillion-dollar cinema market is its main sponsor, generating challenges, opportunities, and subjectivities. Each year, new capabilities, previously nonexistent, are incorporated into the software, enhancing its illusionistic abilities and creating an image that cinema desires and pursues, as it has the means to sell it for its novelty value.

The relationship between cinema and the scientific advancements in simulation is constantly evolving and can be observed primarily in Hollywood family feature films, understood here as the main driver of digital developments towards realism (ELSAESSER, 2018, p. 198). It is in feature films that the technological frontier of 3D synthesis most fully manifests, a frontier in constant expansion and crucial to global subjectivation processes. As with any capitalist endeavour, the feature film production space is risk-averse. In 2019, films such as the 3D remakes of “The Lion King” and “Toy Story 4” followed the traditional and safe bet on the value of technical and illusionistic novelty, a value supported by the obsolescence of what came before and which always prioritizes the technological over the aesthetic (DUBOIS, 2004, p. 34-35).

2. COLOR OVER VOLUME IN CONTEMPORARY 3D

At the same time, contrary to the more traditional production flow, Sony Animation Studios released “Spider-Man: Into the Spider-Verse” (2018), a film that developed a visual style opposed to the realistic dictates of 3D software, adopting a graphic character that departs from traditional three-dimensional volumetrics, utilizing flat colors and the simulated use of halftone screens found in paper prints.

When a major studio like Sony makes such a risky move, it is possible to speculate that the wave now sweeping through this hegemonic production space began in smaller productions and short films, spaces that are typically less risk-averse and more inclined to seek unconventional and sometimes cheaper solutions as a means of distinction amidst an increasingly incessant and redundant flow of images.

Nearly fifteen years before the release of “Into the Spider-Verse,” this movement, which values color as a graphic element in 3D animation, can be traced to the work of the idiosyncratic Franco-Algerian filmmaker Michel Ocelot. In 2006, Ocelot produced an important 3D feature film called “Azur and Asmar.”

Ocelot, born in 1943, built his career on other references, stemming from his successful career as a short filmmaker, especially those in 2D animation and cut-out animation made with silhouette paper pieces, following in the footsteps of the famous German filmmaker Lotte Reiniger. Ocelot’s move to 3D animation was a step he himself described as his personal crossing of the Rubicon (OCELOT, ca. 2008).

In “Azur and Asmar,” Ocelot hybridizes the two-dimensional thinking that governed his personal work with 3D animation through specific and unique procedures. Ocelot’s poetics generously traverse the space of stories aimed at children, and the visuality achieved in this work evokes children’s illustrations through the intensive use of uniform color blocks and a proposal that avoids movements toward the depth of space, preferring movements and staging on an invisible plane parallel to the screen. This results in great compositional clarity, typical of a more graphic treatment of color. In an interview, when asked about the use of 3D animation, Ocelot stated:

> I was the boss, not the computer, so I decided what I wanted. Many computer films talk too much about what the computer can do instead of telling the story, but here I was thinking about a fairy-tale-like story, nothing realistic, where we play at make-believe. (OCELOT, 2009).

Ocelot does not work to simulate an image that pre-exists in the real world, an image typically bathed in light, with its volumes modulated by the angle between object and observer, as the base software intends to do. Ocelot hybridizes 3D animation processes with his trajectory of valuing color blocks without volumetric disturbances. The process present in this film is one of orchestrating the software based on the author's prior experiences, a hybrid thinking marked by his experience as a cut-out animator that permeates the production stages before the image, resulting in an unparalleled imaginary in 3D animation. It is a hybrid and questioning image, an image unlikely from the perspective of the devices' program (FLUSSER, 2008, p.30), entering the realm of art.

Similar movements can be observed in various short films, a privileged space for experimentation, such as David OReilly's well-known "Please, Say Something" (2009). Like Ocelot, OReilly employs characters that could be associated with a children's universe, a couple consisting of a cat and a mouse. However, the script tells the story of a contemporary couple in crisis, represented by a cat and a mouse. He is a rude and violent writer concerned with producing his book, while she seeks, in every way, to be noticed and loved. It evokes the historically established roles of anthropomorphic animals in so many cartoons – a reversed, adult "Tom & Jerry" – as Robert Crumb did with his disruptive "Fritz the Cat" in the 1960s.

Just as Ocelot clarifies how his previous work directed his visual thinking, OReilly takes a path that questions the relentless escape from obsolescence, a hallmark of the mainstream 3D production flow. OReilly publicly released a document justifying his aesthetic construction based on economic production concerns, operating a severe self-restriction of resources by making explicit the intervals that make the computational aspect visible.

OReilly's image results in solid patches that do not seek the illusionistic effect of three-dimensional volumetrics; that is, the procedure renounces the thousands of intermediate color tones in favor of a few or even a single tone. Although not a new orchestration in itself, I cannot recall seeing it applied so intensively and explicitly, exploring a series of aesthetic characteristics historically relegated to the margins of the main 3D animation flow. More than emulating another visuality, as in Ocelot's work, OReilly brings to the forefront the artifice involved in the construction of his space and characters, exposing the complexities of his own illusion. A world constructed according to its own rules, moving in the opposite direction of the mimetic canon, making evident the expressive power of his two-dimensional, monochromatic blocks, without striving to hide the software that forms the basis of his creation.

We are witnessing an expansion of visual possibilities that involve the tensioning of aspects so dear to 3D, such as spatial volumetrics, in favor of using colors in a more direct and pure manner. It is a complex movement that deals with the fatigue of certain visualities, with budgetary questions, and with the hybridization of non-photographic production methods.

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Contemporary Poetics with Natural Paints

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ABSTRACT

This article aims to contribute to the development of knowledge about natural pigments from Latin America for the production of works in the field of Visual Arts, justified by the appreciation of ancestral knowledge, involving artistic, cultural, and historical aspects. These practices are often interconnected with expressions of identity, with art history and reflections on environmental sustainability. The adopted methodology combines the artistic practice of the authors at the intersection of the languages of installation and painting, with multidisciplinary theoretical studies. From a brief historical perspective, natural pigments are substances extracted from nature, sourced from minerals, metals, plants, and animals, and are classified as inorganic or organic. Inorganic pigments, also known as mineral pigments, have been used by our ancestors since prehistory, being rich in oxides collected from the deepest soil layers. After a process of settling and grinding, these pigments ensure excellent quality, durability, and color stability. Mineral pigments fit Ralph Mayer's (1999) definition, which differentiates them from dyes by being insoluble in water. They are solid particles, dispersed. On the other hand, organic pigments, which come from plant and animal sources, generally appear first as dyes: obtained from infusions, since they are soluble in an aqueous medium, and the permanence of the colors are unstable. To become lake pigments, the precipitation of the organic dye with an inert binder or mordant, usually metallic salts, ensures greater resistance and color fixation. A notable example is the color blue from the indigo plant (*Indigofera suffruticosa*), cultivated in tropical and subtropical regions. The first evidence of dyeing with this plant was found at *Huaca Prieta*, in Peru, about 6,000 years ago, indicating the ancient use of this dye by regional communities[1]. Variations of pinks and reds are extracted from brazilwood or cochineal. Brazilwood, an endangered tree species, provides less durable dyes, while cochineal, an insect that lives on cacti, offers more intense and permanent dyes. Cochineal was widely used by the Aztecs in the region now known as Mexico. After being brought to Europe by the Spaniards in the 16th century, this lake pigment became favored by artists like Rubens (1577-1640) and Caravaggio (1571-1610). As for brazilwood, it was commercially exploited by the Portuguese for textile dyeing.

1. INTRODUCTION

This essay seeks to delve into how procedures prior to industrial technologies are present in creative artistic practices through the use of natural colors and pigments from Latin America, especially in Brazil, for the production of works in the Visual Arts field. By aligning sustainable practices with cultural revival, the use of natural pigments, whether mineral or organic, fosters a dialogue between the traditional and the contemporary, while also promoting a reconnection with ancestral practices and reflecting on cultural identities.

Unfortunately, over the years, a lot of traditional knowledge has been lost due to colonization, which violently imposed a new culture, politics, and economy on the indigenous people. The violence of colonization severely impacted indigenous native populations. Currently, the decolonial movement seeks to challenge Eurocentric paradigms and promote cultural diversity. The revaluation and rediscovery of natural pigments is an important part of this process.

[1] See full article. Available at: https://www.science.org/doi/10.1126/sciadv.1501623. Accessed: Aug 14, 2024.

2. METHOD

The research on natural pigments and paints begins with an investigation into the historical and cultural practices associated with these materials. This includes reading historical, ethnographic, and literary documents to understand the traditional use of pigments across different cultures. Conversations with local communities who preserve this ancestral knowledge are also important, as they allow for a cultural exchange that respects traditions and seeks sustainable sources for pigment extraction.

After identification, the raw materials are processed into pigments through techniques such as boiling and grinding. The formulation of paints requires mixing with natural binders, creating solutions adapted for different medias, such as painting and fabric dyeing. Tests are conducted to ensure color stability and compatibility with various substrates, adjusting formulations as necessary to optimize efficacy and durability.

It is important to emphasize how in Visual Arts research, in particular, each artist seeks their personal language and expressiveness. The choice of materials is not only technical but also laden with cultural and aesthetic meanings that intertwines with the artist's intentions, directly impacting the concepts and enjoyment of the works. By selecting natural pigments and paints, for example, artists not only explore chromatic diversity but also engage in a dialogue with tradition and sustainability, which impacts the narrative and aesthetic experience of their creations.

This search for personal expression in the visual arts field is a process where the chosen materials play a fundamental role in the communication and interpretation of the works. Thus, each piece becomes a unique manifestation of the artist's intentions, while also dialoguing with the collective meanings shared by society.

3. RESULTS AND DISCUSSION


Figure 1: Untitled, 2024. Naturally dyed fibers and bamboo, 165cm × 200cm. Figure 2: Kitchen of Color, 2024. Lake pigments in powder and glass. Photos: Hamed Almeida Braga.

In *Untitled* (figure 1) Bianca Stella works with natural dyeing. The artist is particularly interested in the discussion between color and the specifics of the material itself. She prepares the infusion of raw materials in a pot, like in a cauldron, which alludes to ancestral practices of manually extracting dyes.

The presented work uses pomegranate fruit peels to dye fibers yellow and green, and *barbatimão* branches for pink. This highly artisanal and intuitive process brings a new perspective to dyes. They gain a significance akin to the sacred, reminiscent of ancient healing rituals, and recall another era, with life rhythms entirely different from those we experience today in a society that prioritizes value in its operating logic.

The cotton substrate, commonly used in traditional and historical painting, establishes a dialogue with the nature of the dye through its sustainable characteristics. In this installation, the fabrics are lightly and subtly configured over the bamboo structure, which articulates with the space. From this work, what remains is the interaction of colors and the immersive experience of walking around it.

On the other hand, *Kitchen of Color* (figure 2) consists of small glass jars storing lake pigments, extracted from various plant-based raw materials, some cultivated by the artist herself. They speak of the affectivity that permeates the making process, which extends over days, like a daily coexistence.


Figure 3: With the slightest deviation, it would be elsewhere, 2023. Wood, soil, natural fiber, lime, and mineral pigment, 300cm x 250cm. Figure 4: Stumps, 2024. Wood, mineral pigment, and gum arabic. Variable dimensions (larger side: 70 cm). Photos: Taís Cabral.

Experiencing the city as an artistic experience is an idea that permeates the works presented by artist Taís Cabral, who addresses daily movements, mainly in the cities of São Paulo, SP, and Curitiba, PR, in Brazil. They are linked to processes of perception, like a mapping of images, sensations, and routes. These works result from the experience of the senses, imagination, and memory, reviving aspects of the history of the cities.

The installation *With the slightest deviation, it would be elsewhere* (figure 3), a wall made with the bioconstruction technique known as *pau-a-pique*[1], simultaneously becomes a large-scale painting within that space by its structure, colors, and materials – such as the use of earth as a natural mineral pigment, and lime as a binder to compose both its structure as well as the mortar and paint.

It was located at the end of the trail of the Ópera de Arame (Curitiba, PR), where the passage would normally continue but was partially interrupted by the work: at that moment, it was possible to bypass it because its structure interrupts the path yet also leaves passages and small windows. At the end of the exhibition, the work was dismantled and all the materials were repurposed or simply returned to their place of origin. The soil was reincorporated into the land at the Ópera de Arame, and the wood was reused for other purposes. *With the slightest deviation*, the site-specific work went to other places.

It evolved into another work, *Stumps* (figure 4), which touches on the concept of upcycling[2] and demonstrates how, in the course of things in the world, materials gain new material layers and meanings. *Stumps* is made from collected and repurposed wood, natural mineral pigment (regional soil), with gum arabic. Regarding this work, curator Milena Costa offers the following reflection: "*In a capitalist society, collecting establishes an enchanting relationship with the objects around us, despite them not possessing monetary value. Logs, soil turned into paint, and remnants of the previous work compose the pieces. The lines on the wood's surface form a map that carries within it the trajectories of the creative process and the materials in the world*".

[1] Pau-a-pique is one of the earliest construction techniques used since the beginning of colonization in Brazil, when Lusitanian practices were combined with indigenous and African customs.

[2] Upcycling is the process of using inputs or waste in a function different from the one for which they were originally designed.

4. CONCLUSIONS

The research and use of natural pigments provide an interdisciplinary field that unites history, science, and art, starting with the appreciation of ancestral cultural practices and the preservation of traditional knowledge. The process of extracting, formulating, and applying pigments allows for a sustainable use of resources and enriches contemporary artistic practice, providing artists with a rich and diverse palette.

The continuous documentation and sharing of discoveries are fundamental to expanding knowledge in the field of Visual Arts. An organized research bibliography on the subject is still scarce; however, since the 1950s, there has been an increase in research, particularly in recent years in Brazil, mainly driven by independent researchers from various fields. Detailed documentation and its sharing ensures that valuable knowledge and techniques are transmitted to future generations.

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Gaudi's Chromatology: a Cross-comparative Analysis of Colour Surface Qualities

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ABSTRACT

This paper analyses Antoni Gaudí's (1852-1926) application of colour materials and techniques on the surfaces of his work. Eusebi Güell acquired an estate situated on the southern face of Monte Carmelo, 17-hectares overlooking Barcelona and the Mediterranean sea. Güell intended to build a housing development there in the style of the British garden city, and entrusted Gaudí with that ambitious project. The work began in 1900, but with the discontinuity of the initial housing project and the death of Güell, the City Council opened it to the public as Park Güell in 1926. Gaudí created the most emblematic polychrome architecture of Barcelona in the first decades of the twentieth century, when new ideas pushed science and technology further, aligning with Gaudí's constant need to experiment and innovate in all architectural and design realms. Gaudí covered many of his buildings in elaborate polychrome mosaics, however some cladding processes were only possible due to the technique he created- trencadis-, and with which he experimented largely in Park Güell. Trencadís was inexpensive for decorating and cladding the many curves that characterize the complex geometries of Gaudí's buildings and allowed for a closer imitation of nature in terms of colour variations, reflection, perceived movement and material contrast. Gaudi's aesthetics reflected his various sources of inspiration: belief in the rebirth of Catalan nation, Mediterranean cultural influences of colour cladding, scientific and technical excellence, permanent research for innovation, and hands-on experimental approach. Park Güell represents the convergence of architecture and nature, similar to the experience of an immersion in a dreamlike theatrical setting created by his extraordinary imagination.

1. INTRODUCTION

Barcelona was the most relevant expression of aesthetic renewal allied to the idea of a future where tradition and modernity were intertwined. The connection of tradition and modernity was at the core of Catalan Modernisme that stood out from the rest of Spain in the late nineteenth century, greatly due to a flourishing industry and artisanship. Such incentives paved the way for a Catalan identity based architecture, that Gaudí's former professor and director at the Escola d'Arquitectura at Barcelona, Lluis Domenech i Montaner encouraged (Nonell et. al., 2012).

A significant reference for Modernism was the English Arts and Crafts movement, particularly through the work of William Morris and John Ruskin that echoed Viollet-le-Duc's unity of the arts. They also reignited the decorative arts and the use of techniques that employed native artisans and industrial processes of elaborate stone, wrought iron, stained glass, carved wood, mosaics and other organically inspired forms and details.

Since the Middle Ages that in Catalonia and Valencia, Mudejar or Arabic buildings were clad in ceramics. Besides the tradition of covering walls with coloured tiles, its durability, higienic qualities, low-cost, and source of beauty, makes it an exceptional material for the application of colour to architecture.

2. METHOD

2.1 Communication networks: routes and viaducts

Due to the steep slopes of the land where the Park was built, Gaudí built routes that connect the lowest part of the Park- the entrance, and the highest- the Calvary, where a chapel was planned to be built but is now a mound crowned by the three crosses. To allow for movement across the uneven terrain, and link the many parts of the park, viaducts and routes were constructed with the site resources. In other words, all building materials were extracted from the ground. This alone would justify Le Corbusier's appreciative words, following a 1928 visit to Gaudí in Barcelona: "the work of a man of extraordinary force, faith and technical capacity, manifested throughout his life in the quarry." (Le Corbusier, 1967: 22-23)

The network of structures of constructive and artistic grandeur include porticos, columns, ceilings and walls forming arcade galleries acting as retaining walls, clad in stone hiding a structure of brick; rows of columns tilting towards the interior uniting with the vault; grotto-like ceilings, or tilted helicoidal columns. Visually, the viaducts and routes frame a multiplicity of views of Barcelona and enhance the hillside textures, depths and overall complex compositions.

The method of application of ceramics by using local materials and the recycling thereof, as well as his methods of prefabrication and consequent reduction of water are examples of Gaudi's environmental concerns, even if not by the present standards.

2.2 **Colour surface qualities**

Gaudí invented a technique named trencadís that differs from ceramic mosaics in the cutting process. It owes its name to the Catalan "trenca" that means cut or break. Hence, while the ceramic mosaics are cut into regular sizes and shapes, trencadís results from pieces cut into irregular shapes, or debris, in some cases, and put together with mortar.

The adoption of trencadís, as colour surface technique is the core of the following analysis. It takes into account four zones or elements based on visual and perceptual aspects; religious and spiritual inspirations; symbolic, allegoric and cultural influences; materials, cladding techniques and processes.

a) Administrative lodge and caretaker's lodge – The **entrance** to the Park is flanked by two lodges, the administrative and the caretaker's lodges, a field for experimentation with natural organic forms, and a broad range of colour palettes (Fig.1). While Gaudí innovates with trencadís technique to adorn curved surfaces he also experiments with new beam structures and parallel arches, that are flexible and adapt to organic volumes. The administrative and caretaker's lodges seem to come directly out of Brother Grimm's fairytale Hansel and Gretel. The first inspired by the bread and sugar house and the latter, by the witch's house and its suggestion of poisonous mushroom cupola. Trencadís is used as surface colour on the terrace, combined with stone, on the prefabricated crenellations, on the tower, on the spire and its four-armed cross. On the caretaker's lodge, this technique is used fully to cover the roof, its two terraces and crenellations.

Figure 1 The Administrative lodge (left, centre) and caretaker's lodge (right)

b) **Staircase** – On the entrance forecourt, the **staircase features sculptural elements** that serve as fountains, channeling water through its most meaningful elements: halfway down, the shield of Catalonia; below the flag, the head of a serpent; and most predominant, the sculpture of the mythological dragon. On the upper fountain, a tripod, remnant of the Greek oracle of Delphi owing to the tripod on which the fortune teller sat.

c) Hypostyle Room- A 1,500 m^2 space whose upper terrace rests on 86 Doric columns, the bases of which are adorned with trencadís, as are the semicircular domes of the ceiling. The ceiling is decorated by white trencadís, interrupted by the vaulted zones where there are no columns and rosettes where organized in saturated colours and textured compositions. Gaudí designed a sophisticated rainwater collection system: the columns that support the central terrace serve to capture rainwater and direct it to a subterranean cistern. This water circulates through fountains and is used to irrigate the plants.

d) The Nature Square sits above the Hypostyle Room. It is a wide-open space conceived as a Greek theatre, and a community meeting place for the residents of the initial residential project. The balcony, situated 150m above sea level, provides a panoramic view of the Park, the city of Barcelona and the Mediterranean.

Gaudí worked with artisans and bricklayers, always collaboratively, involving multi-disciplinary teams. The undulating bench is the main feature of the Square, and is clearly the mixture of sculpture, craftwork and architecture (Fig.2). Clad in trencadís the motifs of the bench range from allegorical to symbolic references to nature and religion. There is also a letter J. which is believed to be the initial of Gaudí's collaborator Josep Maria Jujol (1879-1949), who designed the bench (Fuster, 2009). Jujol was the main contributor to the colour arrangements and compositions in the Park, mixing colours from fragments of glass, porcelain, tiles and ceramics in general.

Equally, with the forms of these benches, Gaudí experimented with curves using prefabricated modules, combining concave and convex shapes. Due to its undulating movement, the back support of the bench is visible from the Square.

Figure 2 The Nature Square undulating bench

3. CONCLUSION

Gaudí considers beauty to be found in the colour that emerges simply from the imitation of nature. However, in order to reproduce nature's constructions, he not only imitated nature but studied and extracted from it both its aesthetic and structural principles. Gaudí claims that ornamentation has always been and will be coloured; that everything in the plant and animal kingdom, geology, and topography has colour contrast more or less vivid, so that we have to colour part or all of an architectural feature (Gaudí, 2002:46).

Trencadís, the technique he invented, allows innovative experimentation with curved surfaces; creates variations of colour hue, saturation and tone closer to nature; glazed surfaces create perceived movement and reflected light and depth, texture, shapes, volumes and wealth of colour contrast.

Gaudí's use of colour justifies it to be the element that gives architecture character, style and beauty, the three attributes of colour when applied to architecture. Gaudí used colour as a harmonizing element to this micro-universe of winding paths, organic shapes and polymorphous style, where Mediterranean light, nature and architecture meet.

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Revitalizing Public Spaces: A Guide for Chromatic Interventions with Augmented and Virtual Reality Technologies

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ABSTRACT

This article refers to an investigation that explores color as a form of identity expression in urban public spaces, serving as the object of study. It seeks to identify, understand, and grasp how the use of Virtual Reality (VR) and Augmented Reality (AR) technologies can contribute to the development of projects of this nature. The goal is to understand how the use of color in the processes of city modification, especially in public spaces in underprivileged urban areas, can support the resignification and reaffirmation of local identity, with the aim of structuring the bases for a creative and collaborative chromatic intervention. This intervention focuses on contexts of socioeconomic deprivation and urban renewal, validating the use of AR and VR as modeling and verification tools associated with Creative Placemaking.

In addition to discussing the relationship between color and urban space, especially the issue of place identity (Boeri, 2017), the research analyzes the possibility and viability of transforming renewable public spaces. It also discusses the use of technology as a low-cost way of modeling and verifying results. Secondary objectives include providing subsidies and methodological bases for the development of chromatic projects and raising awareness among students, architects, designers, and urban planners about the use of color as an expression of identity.

The methodology involved a creative placemaking action – an experimental urban intervention project focused on inserting the user into the design process (Scherer, 2017). The intervention was proposed for the surrounding area of a public staircase with 70 steps on the outskirts of Diadema, located in the Southeast Zone of Greater São Paulo, Brazil. AR and VR technologies were used as modeling tools and for the virtual visualization of results. The experimental design was structured in phases (Hanington, Martin, 2012; Kumar, 2013; Friis, 2015). The planned activities were divided into five phases, with the first four following the steps organized by Friis (2015) in his collection of Co-creation Cards: Collection, Comprehension, Concept, and Creation. A fifth phase, called Verification, will be included at the end, involving prototyping (Hanington, Martin, 2012) of the proposed chromatic project in AR and VR for delivery and presentation to community representatives and stair users for evaluation of the proposed project.

As a result of the research, the article will present the Guide for Chromatic Interventions in Public Spaces, using AR and VR (3D, immersive) models. This guide proposes a method for developing chromatic designs for renewable public spaces, outlining the construction process for each stage of development. It is organized into three chapters: Collection, Comprehension, Concept, and 3D Modeling; Creation; and Communication, Verification, and Prototypes. I will certainly help students, architects, designers, urban planners, and artists who coordinate, design, or wish to develop this type of project, especially those who do not feel confident, given the lack of color literacy of these professionals.

1. INTRODUCTION

Color, through contrasts, values, saturation, tones, masses, and proportions, complements visual information, revealing the spatial organization of the environment (Petit, Siret & Simonnot, 2018). In an urban setting, color contributes to producing and communicating a sense of place (Suarez, 2018). Chromatic expression actively participates in social changes, reflecting identity in various forms.

To explore this identity, the method proposed in “Geography of Color" by Dominique and Jean-Philippe Lenclos (1999) is fundamental. However, Lenclos' method has limitations, particularly outside historical areas. Aiping Gou critiques the objectification of material tones as insufficient to understand contemporary urban color contexts (Petit, Siret et Simonnot, 2018). The perception of colors is complex, influenced by many interacting parameters (Petit, Siret et Simonnot, 2018).

Color plays a crucial role in urban life, reinforcing identity, design, and construction. Understanding local color mapping techniques and effectively documenting and communicating chromatic projects can prevent misinterpretations, such as creating “falsely picturesque landscapes” (Steinmetz, 2001 apud Petit, Siret et Simonnot, 2018).

This article presents an experimental project for a major staircase in Diadema, São Paulo, Brazil, resulting in a “Guide for Chromatic Interventions in Public Spaces with AR and VR models,” outlining a method for developing chromatic projects of this nature. (Link to the Guide/ Issuu/2024).

2. METHOD

The methodology for the Escadão’s chromatic project aligns with the theoretical and practical synergy emphasized by Peter Zumthor (2006) and Juhani Pallasmaa (2011), highlighting the importance of perceptual aspects and bodily experience in space. The experimental project was structured into five phases (Hanington & Martin, 2012; Kumar, 2013; Friis, 2015), starting with analysis, concept, creation, and communication (Friis, 2015) and ending with Verification involving AR prototyping and presentation for evaluation.

A) **Stage I.** Phase I – Analysis**:** Involved visual research and semantic analysis of the staircase, including visits (Guide’s pages 21 to 31) guided by resident Edmilson Lima, whose contributions were essential in the recognition of the surroundings. On these occasions, measurements were made, in order to guarantee the 3D model. In addition to the photographic survey and digital drawings, cartography and Color Geography were used (Lenclos, 1982, 1999, 2004); visual reading and semantic interpretations using Kobayashi’s Color Image Scale (1991) also the Subjective Color Method (Galeotti, 2018). Phase II. Concept: (Page 32 to 37) preparing the semantic image panels (Bestley; Noble, 2013; Cassidy (2008), Garner & McDonagh-Philp (2001) and Lucero (2012). Analyzing and understanding the dominant and identity colors, their relationship with form and the consequent establishment of a chromatic palette.

B) **Stage II. Creation** (pages 54 to 77): Based on chromatic studies based on palettes obtained in phase II. In addition to digital techniques, freehand drawings and painting were explored. To produce the AR, a 3D digital model was created, when the use of photos was essential. After this rendering, two chromatic proposals were finalized.

C) **Stage III. Communication** (pages 80 to 85): The executive project and its documentation were produced on printed boards, for presentation to community representatives. In the fifth and final phase, Verification (page 86 to 101), the completion of prototyping (RA and VR) taught us that they are 100% valid tools such as digital mockups and verification models, but they are not viable as a tool of communication, presentation of results (Pages 102:103), due to the lack of technological resources in Brazilian urban peripheries.

3. RESULTS AND DISCUSSION

The experimental project's stages were systematized into the **Guide for Chromatic Interventions in Public Spaces with AR and VR Models**, outlining a method for chromatic interventions in public spaces using AR and VR. The guide is divided into three stages (Table1):

1. **Selection of Location, Research, and Visual Analysis**
2. **Creation of the Chromatic Project**
3. **Communication and Verification with AR and VR**

Table 1. Summary of the Guide's stages and activities.

Stage 1 - Selection of Location, Research, and Visual Analysis	**Stage 2 - Creation of the Chromatic Project**	**Stage 3 - Communication and Verification with AR and VR**
Selection of Location	Preliminary Studies	Final Documentation
Atmosphere and Visual Research	Experimentations	Prototyping with AR and VR
References and Iconographies	Application of Chromatic Guidelines	Presentation to the Community
Analysis and Visual Reading of Panels	Careful Finalization	Challenges and Limitations
Chromatic Synthesis		The edited Guide is available via access link: (Link to the Guide/ Issuu/2024).
3D Model - Mockups		

The guide provides a framework for color interventions in public spaces, emphasizing community participation and advanced technologies for visualizing and verifying proposals. It combines analogue and digital techniques for effective communication and comprehensive understanding, serving as a starting point for new discussions and community renewal.

4. CONCLUSIONS

This guide not only provides a detailed framework for color interventions in public spaces, but also highlights the importance of community participation and the use of advanced technologies to visualize and verify proposals. The combination of analogue and digital techniques allows for effective communication and a comprehensive understanding of the proposed chromatic interventions, serving as a starting point for new discussions and community renewal. Developing an experimental project to structure a Guide proved to be valid and effective tool for helping architects, designers, and activist artists.

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Limits and Possibilities of Using Colour as Information on Medicine Packaging in the Brazilian Market

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ABSTRACT

The use of consistent colours in packaging design strengthens brand identity, promotes recognition, and enhances product distinctiveness on store shelves, benefiting commercial competition. This becomes especially important when consumers interact directly with packaging without a seller's mediation. However, legal restrictions limit colour use in certain sectors, such as pharmaceuticals. This study explores the challenges faced by designers and professionals in the pharmaceutical industry regarding colour use. It examines how to legally protect the distinctiveness and visual appeal of medication packaging and the potential and limitations of colour in this context. The methodology included a bibliographic survey on colour use in medication packaging and intellectual property laws, followed by field research in retail outlets to analyse and photograph over-the-counter medications. Packaging was catalogued based on information hierarchy, text differentiation, and colour usage. The study focused on packaging for paracetamol, dipyrone, and ibuprofen, noting a predominance of green and red, which, while familiar, could cause consumer confusion by reducing product distinctiveness. In Brazil, colours alone cannot be registered as industrial property unless distinctively combined. Finally, the findings highlight the importance of strategic colour use and trademark registration as competitive advantages.

1. INTRODUCTION

In 2022, the pharmaceutical industry generated “more than R$131.2 billion in sales of more than 5.7 billion packages of medicines” (SCMED, 2022, p.9). This is a sector that brings countless benefits to the country, from job creation to the supply of medicines to the general population. Like most products sold today, medicines require packaging both for basic functions of storage, protection, and transportation, as well as for marketing functions, such as attracting, informing, and convincing the consumer that they are making the right choice. At the point of purchase (POP) awaiting the buyer's decision, packaging performs an important role, serving as a “silent salesman” (Pilditch, 1973), especially for Over-the-Counter (OTC) drugs. It assists the consumer when making a purchase decision, avoiding confusion in choosing the correct product.

The way the consumer makes a decision is a consequence of the way he perceives the information posted on the packaging, i.e., the way he interprets the information received and correlates it with his past experience. Considering that packaging uses a mixed language (both verbal and visual), the importance of colours and images at such a decision-making moment must be emphasised. It is important to study the visual design of these packages in order to determine to what extent a given group of consumers is able to clearly distinguish and identify the brands of the products they wish to purchase.

The consistent use of colours in packaging design reinforces a brand's identity and promotes its recognition, contributing to its distinctiveness on store shelves and consequently favouring commercial competition. When users are in direct contact with these packaging without the mediation of a seller, the contribution of colour becomes even more relevant. However, not all industrial sectors have the freedom to use colour without legal barriers, such as in the case of medications.

Motivated by this issue, the present study was elaborated. The objective was to bring a discussion about the challenges imposed on designers and other professionals in the pharmaceutical sector. How can the desired distinctiveness and visual attractiveness for such medications be legally protected? Also, how can colour contribute in this aspect? What are its possibilities and limitations?

2. METHOD

Firstly, a bibliographic review was carried out regarding the use of colours in medication packaging, as well as the current legislation on intellectual property protection. Then, field research was conducted to retail outlets to analyse, select, and photograph over-the-counter medications, those available in the areas outside the service counters. That is, those for which the mediation of a seller is not necessary. Subsequently, packaging cataloguing was carried out, using technical terminology to cover: the hierarchy of information displayed on the packaging; differentiation between technical texts and marketing texts; and description of the colours used, as well as their percentage and location on the packaging.

2.1 Bibliographic review

The packaging must convey all relevant information about the product, contributing to its proper use. They must contain mandatory information about the medicine, established by resolutions published by Anvisa (2014). As for the use of colours on medication packaging intended for the trade market, the requirements are only regarding the application of three coloured stripes according to the medication categories. The red stripe (Pantone 485) should be used on medications that pose an intermediate risk of adverse effects to the user and must be prescribed by a healthcare professional. The black stripe (Pantone Process Black) should be used on controlled medications that affect the central nervous system and can cause dependence or lead to death. The yellow stripe (Pantone 116) is for generic medications. The OTCs medications in this study are non-prescription and, therefore, do not require the use of a specific colour.

Although OTCs do not need to follow a specific colour palette, there are good practices for using colours so that the role of providing information to consumers is fulfilled. The non-governmental organisation *Institute for Safe Practices in the Use of Medications* published in April 2023 a bulletin entitled *Safety of medication labels and packaging* (Ismp, 2023). The document compiles safety recommendations for medication labels and packaging, based on national legislation and international documents from Canada, Australia, United States, European Union and United Kingdom. It is recommended to use texts in colours that contrast with the background of the packaging. The background in the area containing essential information should preferably be white or another light colour, highlighting the generic name, concentration and route of administration. Warning and cautionary information should be highlighted. For the contrast of information, the three attributes of colours should be considered: hue; value; and chroma. It is recommended to opt for contrast of complementary colours; or contrast of light colours with dark colours; or combinations of vivid colours with low chromaticity colours. Moreover, the brand and visual identity of the packaging should not distract the user and the health professional or prevent the effective communication of important information such as name, composition, concentration and route of administration. There should be a balance between these elements and the essential information that should appear on the labels.

Despite the limitations on creative and innovative designs in medicine packaging, intellectual property protection remains crucial. Protecting the visual elements of secondary pharmaceutical packaging through trademark or industrial design registration helps maintain product identity, builds consumer trust, and prevents counterfeiting. This protection enhances brand value, fosters consumer loyalty, and differentiates products in competitive markets, where visual appeal can significantly influence consumer decisions.

When it comes to industrial design registration, Brazilian legislation offers the possibility of registering both three-dimensional and two-dimensional objects (Inpi, 2023). In the case of secondary packaging for medicines, the three-dimensional shape of the cartridge (rectangular) of these is not eligible for registration because it falls into the category of common or vulgar shape, which is a basic shape in which there was no creative effort on the part of the author. Therefore, the only option is to register two-dimensional objects, that is, the ornamental set of lines, colours, images, graphic signs, surface patterns, typographic fonts or any other type intended for surface ornamentation. Colour is one of the visual characteristics of an industrial design. However, the registration of an industrial design that uses a specific colour or colour combination does not give the holder exclusive rights to use it. According to Inpi (2023), the mere difference in colour or colour combination does not constitute a sufficient differentiating element to guarantee the originality of an industrial design. Therefore, it could not be registered.

2.2 Field research and packaging cataloguing

A field research was conducted to retail outlets to analyse, select, and photograph over-the-counter medications, those available in the areas outside the service counters. For the packaging cataloguing process, it was considered the main face of the packaging. It was used two documents prepared by the *Health Surveillance Agency* so as to identify the information (mandatory and non-mandatory) that must appear on the main face of the packaging: the manual for drug packaging (Anvisa, 2014); and the model for secondary packaging of non-prescription drugs (Anvisa, 2024). The recommendations regarding the “good use” of visual design presented in the Ismp bulletin (2023) were used to analyse the layout of the information and the use of colours on the packaging. Finally, the TinEye software was used in its colour extraction function to identify the percentage of colours used on the packaging of generic and similar drugs in relation to the reference drug.

3. RESULTS AND DISCUSSION

Through correlation of bibliographic data and field research, the opportunity to investigate medication packaging with three active ingredients was observed. They were: paracetamol; dipyrone; and ibuprofen. Packaging of reference, generic, and similar medications were compared. The predominance of green and red colours was noted. They both generate familiarity with the active ingredient, but can also lead to consumer confusion as they reduce distinctiveness among competitors. With regard to the hierarchy of information displayed on the packaging, it consists of three parts, two of them with mandatory information. For the vertical cartridge, from the top to the bottom: Part 1) company brand, product name, active pharmaceutical ingredient, concentration; Part 2) marketing texts and visual elements, such as icons or abstract forms; and Part 3) pharmaceutical form; route of administration; restriction of use by age group; quantity. This sort of hierarchy disposition allows a differentiation between technical texts and marketing texts. The marketing information is highlighted by the fact that they are in the centred area of the grid, right above to yellow stripe in the case of generic options. Moreover, it also contrasts with the other elements by the use of colour contrast and abstract shapes or icons.

4. CONCLUSIONS

Even though colours, in isolation, are not subject to industrial property registration in Brazil - unless arranged or combined in a peculiar and distinctive manner - results show that it can contribute to drug identity. The predominance of green and red on the packaging of three main pharmaceuticals active for pain and fever (paracetamol, dipyrone, and ibuprofen) come across to historical and symbolic connection of these colours to Pharmacy treatment (Dillemann and Delaveau, 1992), while familiar, could cause consumer confusion by reducing product distinctiveness. It was not find national industrial design registration for the drugs of reference.

However, it was noted that Sanofy company recently changed the visual design of its reference medicament (Novalgina). The new colours are still greenish but darker, contrasting to the similar and generic options that still follows the old colour palette. It is hoped that such research will encourage designers and entrepreneurs to focus on the strategic use of colour, as well as the importance of trademark and industrial design registration as a competitive advantage.

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Influence of Wall Color on Performance in University Offices

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ABSTRACT

The aim of this study is to examine the impact of color on the attention and performance of university professors. To reach the purpose of this study, an experiment consisting of three tasks (questionnaire, performance test, and attention test) was conducted. The participants were 31 Japanese university professors between the ages of 41 and 57. The participant was seated at a desk where a colored panel was hung in front of it and had to perform the tasks. There were 12 colored panels in total and the colors were chosen based on the results of the previous study (Baniani, 2023). The size of the panels was 840 × 840 mm, and the distance between the participant and the panel was 70 cm. In the questionnaire section, while looking at the colored panel, they had to say whether they like the color or not, if the color makes them feel calm, helps them focus, makes them want to be more active, or if it motivates them to work. Then, they needed to do the Bourdon Attention Test, developed by Benjamin Bourdon (1955), and finally a performance test which consisted of writing the pronunciation or *yomikata* of kanji characters suitable for their level. The experiment was conducted in Japanese, and all the questions were done randomly among the participants. It was observed that there were no significant differences between male and female participants ($P<0.05$), therefore all the results of this study are based on the participants as a whole. Orange, light orange, yellow, and light yellow had positive influence on both performance and attentions tasks ($P<0.05$). Interestingly, in the questionnaire section, nobody associated light orange with a color that gives them motivation to work. The participants didn't perform well in both tasks in front of the white wall which was seen in the previous study (Baniani, 2023) as well ($P<0.05$). In sum, it was observed that liking or disliking a color doesn't have an influence on performance or attention ($P<0.05$). Moreover, white may not be the most suitable office color as everyone believes it to be.

1. INTRODUCTION

This is a continuous research project. The first part was presented in 2023 (Baniani, 2023), and this is the second part of the study. Since wall color is one of the largest physical components in an office and it stimulates cognitive response and affects behavior as well (Duyan and Unver, 2016), therefore, the aim of this study is to examine the impact of color on attention and performance of university professors.

2. METHOD

2.1 Participants

31 Japanese university professors (17 female and 14 male) between the ages of 41 and 57 (M=49.3) participated in this study. Prior to the study, they were tested for color vision deficiencies using the Ishihara Color Blind Test, and everyone passed.

2.2 Procedure

To reach the aim of this study, an experiment consisting of three tasks (questionnaire, performance task, attention test) was conducted. The participant was seated at a desk where a colored paper (Table 1) was hung in front of it and had to perform the tasks. The size of the panels was 840 × 840 mm, and the distance between the participant and the panel was 70 cm.

The illumination level was between 800 and 840 lux. They were also required to perform the tasks in front of the plain wall which was white (N 9.5).

Table 1. Munsell notation of the colors used for the panels.

Color name	Hue	Value	Chroma	Color name	Hue	Value	Chroma
Red	5R	5	14	Light Red	5R	9	2
Orange	10R	5	16	Light Orange	10R	9	2
Yellow	5Y	8.5	14	Light Yellow	5Y	9	2
Green	2.5G	5	12	Light Green	2.5G	9	2
Blue	10B	5	12	Light Blue	10B	9	2
Purple	5P	4	12	Light Purple	5P	9	2

The experiment was conducted in Japanese, and the three tasks were conducted in random order as following:

Questionnaire: In this section, while looking at the colors (including the wall), the participants had to say whether they like the color or not, if the color makes them feel calm, helps them focus, makes them want to be more active, or motivates them to work. They also needed to look at the color and write the first word that comes to their mind.

Attention Test: They needed to do the Bourdon Attention test developed by Benjamin Bourdon (1955).

Performance Test: In this task, the participants had to write the *yomikata* (pronunciation) of Kanji characters which was suitable for university professor level.

3. RESULTS AND DISCUSSION

3.1 Attention Test

Participants needed to do the Bourdon Attention Test in front of the panels and the wall. The test was composed of 20 lines with 22 letters in each line. Participants were asked to find the letters a, b, and q in the text in 2 minutes. The results can be seen in Figure 1. The participants performed better in front of warm colors rather than cool colors ($P<0.05$). The highest attention scores were in front of red, orange, and light orange. Although this result contradicts some studies such as a study conducted by Hong et al. (2008), but the panel used in this experiment was 840×840 mm, and this might have affected the results. The result might have changed if a bigger panel was used. However, based on this result, it can be argued that warm colors used in a smaller area as accent colors can have a positive effect on performance, although more research is needed. On the contrary, they performed poorly in front of light blue and white ($P<0.05$).

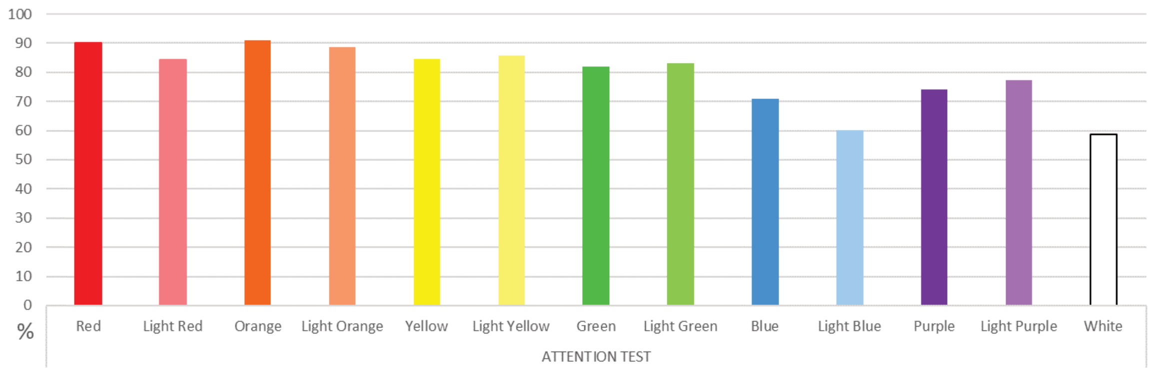

Figure 1: Results for Attention Test

3.2 Performance Test

In this section, participants had to write the pronunciation of 6 Kanji characters in 1 minute. The number of correct pronunciations was calculated. As can be observed from Figure 2, participants performed well in front of orange, light orange, yellow, and light yellow. They also performed well in front of green and light green among the cool colors. Similar to the results of the attention test, they performed poorly in front of light blue and white (P<0.05). The result regarding white has been seen in other studies (e.g. Kwallek et al., 2006) as well. This result was further observed in the first step of this research project (Baniani, 2023) as well. Therefore, it can be said that white may not be the most suitable office color as everyone believes it to be.

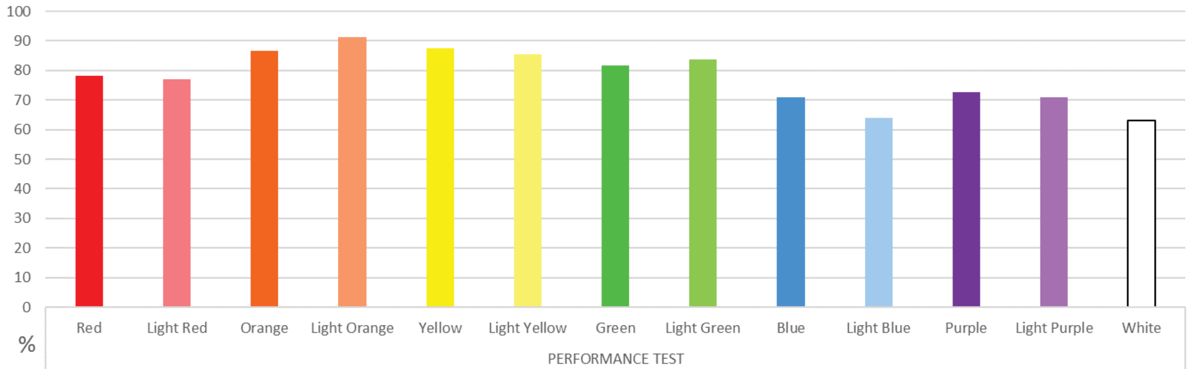

Figure 2: Results for Perfomance Test

3.3 Questionnaire

The participants were asked if the color in front of them helps them focus, or if it motivates them to work. The results can be seen in Figure 3. The top figure is the results to the question about motivating them to work, and the bottom figure indicates the results about helping to focus. Majority of the participants selected saturated colors as colors helping them focus or motivate them to work (P<0.05). Nobody selected light red, light green, or light blue as colors helping with focus. Yellow was selected the highest and 92.5% said that it motivates them to work. Yellow was associated with being bright and healthy and one participant said, “it looks like I can concentrate”. Red was selected next as a color of motivation, and it was associated with passion.

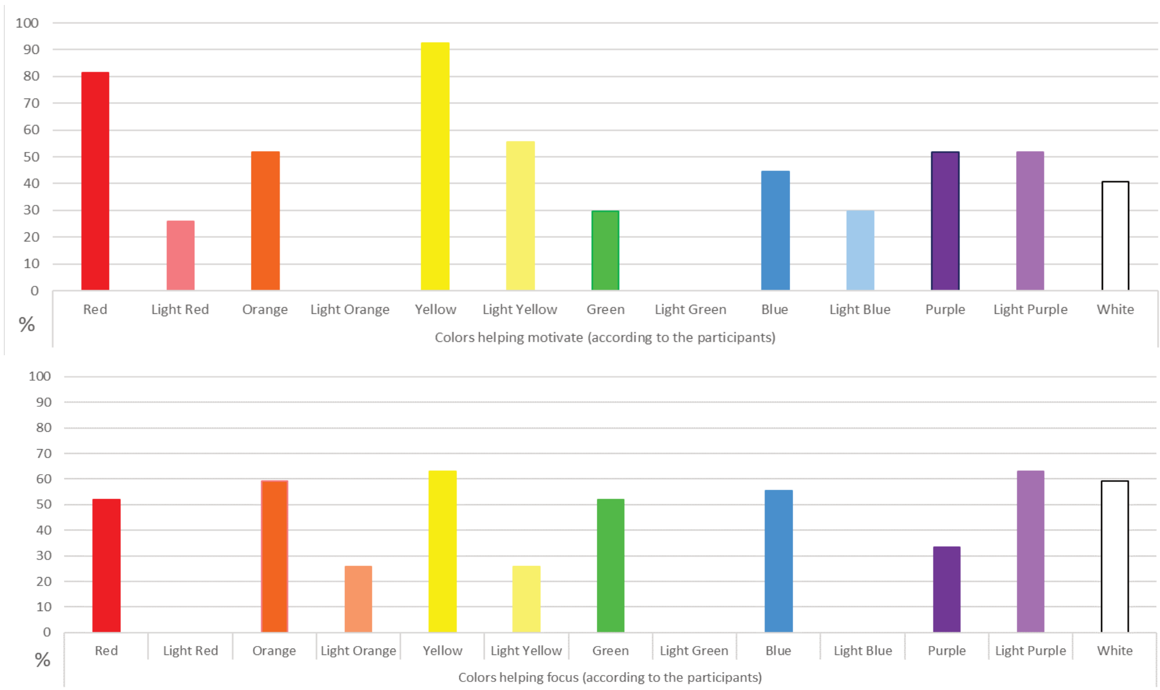

Figure 3: Colors helping to motivate and focus (according to the participants)

4. CONCLUSIONS

It was observed that participants performed better in front of warm colors regardless of saturation or brightness, although they rated saturated colors more positively in terms of motivation and focus. Moreover, white may not be the most suitable color for office walls.

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Effect of Scene Illumination in Images on Perception of Hardness

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ABSTRACT

This study aims to analyse its effect on the perception of hardness in images by conducting psychophysical experiments using images captured under different scene illumination conditions and constructing models for the evaluation values obtained. We created a material chart comprising 19 characteristic materials, and constructed visual stimulus images by photographing the material chart in a dimmable room under nine types of diffuse scene lighting. The images were evaluated on a six-point scale. Ten observers participated in the experiment. The results showed that within the range of colour temperatures used in the experiment, the higher the colour temperature, the stronger the impression of hardness. Therefore, the colour temperature of the scene illumination in the image influences the perception of hardness. The results of the multiple regression analysis showed that by using only two variables, contrast features and illumination colour temperature, we constructed a model with an accuracy of $R > 0.90$.

1. INTRODUCTION

The perception of materials is essential in our daily lives, and these materials have been actively studied in recent years (Spence 2020). In particular, various studies have been conducted on the superficial material properties of objects, such as gloss, transparency, and roughness, which are properties of lower-order materials. In a previous study, Tanaka et al. asked observers to evaluate 34 real stimuli with 10 different materials in an illumination environment equivalent to D65 and modelled glossiness, transparency, and roughness using image and physical features (Tanaka et al. 2019). We also modelled glossiness using the physical features of glossiness for real stimuli presented under diffuse illumination (Tanaka et al. 2023). In both these studies, observers observed and evaluated real objects under a certain lighting environment, and the evaluation results were modelled using physical or image features. In contrast, Tanaka et al. showed that the material of a real object and its colorimetric colour-reproduction image can change (Tanaka et al. 2015). Because the nature of the information obtained from the evaluation of a real object and that of a display image is different, it is necessary to understand the mechanism of material perception close to the display images, which are separated from the real object. The illumination and observation conditions are important factors in the appearance of objects, and their interactions determine their appearance. However, our visual system is equipped with functions, such as colour constancy, that allow us to robustly perceive the colour and brightness of objects in response to changes in these conditions. Colour constancy has long been a core area of human colour vision research. In recent years, there has also been an interest in studies on the visibility of materials (Fleming 2017, Komatsu & Goda 2018), and several studies have shown that colour constancy is enhanced when the surface of an object has a specular reflection of gloss. However, most of these studies discuss the effects of perceptual changes in response to real-world lighting changes and have not examined the effects of changes in the lighting environment on human perception in display images.

In this study, scene illumination is defined as the illumination that illuminates an object. The purpose of this study is to analyse the effects of scene illumination on the glossiness and perception of hardness in images. In other words, we focus on the illumination of the space where the object is photographed rather than on the ambient illumination that is observed.

2. EXPERIMENT

2.1 Material Chart

In this study, a material chart of 19 characteristic materials was constructed. An image of the chart and details of the materials used are shown in Figure 1. The dimensions of each material were 50 mm × 50 mm. Most of the materials were achromatic, and the background was black. The height of each specimen was 20 mm.

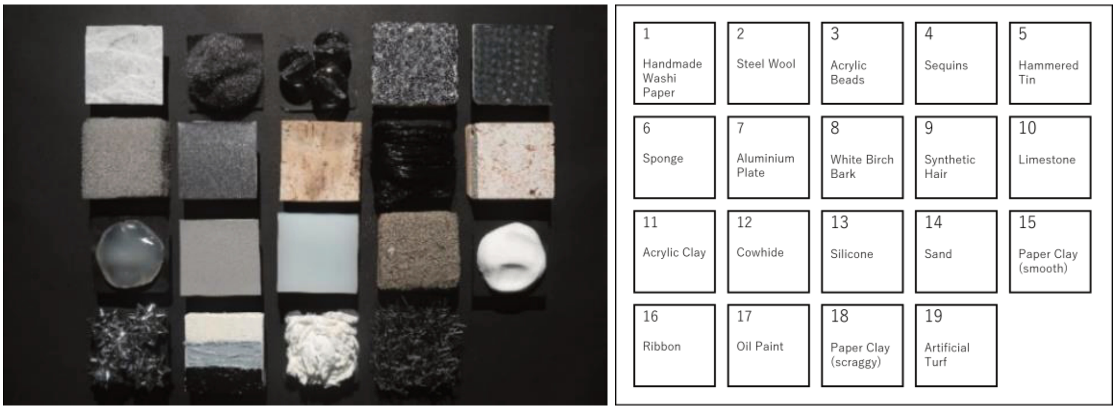


Figure 1: Material Chart.

2.2 Stimuli

The image stimuli used in the experiment were captured using a digital camera (Canon Inc., EOS 5D Mark IV) with a white balance and other settings disabled under nine different lighting conditions that were illuminated as diffuse light using a dimmable LED light (Panasonic, iD6900W100) embedded in the ceiling of the laboratory. The nine lighting conditions were three colour temperatures (3000 K, 4000 K, and 5000 K) and three illuminance levels (500 lx, 750 lx, and 1000 lx). The CIE xy chromaticity coordinates and illuminance were measured using a spectroradiometer (Konica Minolta, Inc. CL-500A).

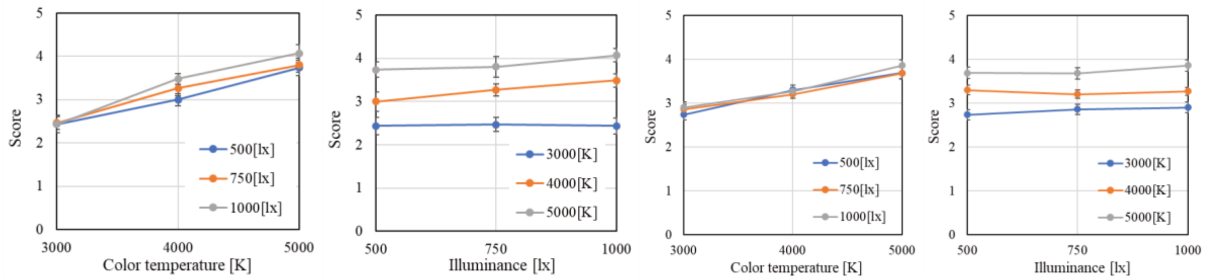
The captured images were downsampled from 6,720 × 4,480 [pixels] to 1,123×748 [pixels]. This is designated as “image stimulus A.” Next, 171 image stimuli (19 materials ×9 illuminations) consisting only of individual materials were generated by cropping each material of image stimulus A at 175×175 [pixels]. We denote this as “image stimulus B.” Image stimulus A assumes that the illumination colour can be estimated from the image, whereas image stimulus B assumes that it is difficult to estimate the illumination colour from the image.

2.3 Procedure

Ten normal colour vision observers in their 20s participated in this experiment. The observers were asked to rate the glossiness and hardness of the image stimuli on a display (EIZO Corporation, ColorEdge CG277) on a six-point scale ranging from 0 (minimum) to 5 (maximum). The experiment was conducted in a dark room after 5 min of adaptation to the dark. As this experiment was conducted on surface textures obtained from images, it was judged that fixing the viewing distance would not be appropriate, because the results would be affected by differences in visual acuity. Therefore, the viewing distance was set to the distance that the observer would normally observe.

3. RESULTS AND DISCUSSION

Figures 2(a) and (b) show the results of the hardness evaluation for image stimulus A. As shown in Figure 2(a), the hardness evaluation value increases with increasing colour temperature at all illuminance levels. However, as shown in Figure 2(b), the perceived tendency of hardness differs depending on the colour temperature: at 3000 K, the evaluation value is almost constant regardless of the illuminance, whereas at 4000 and 5000 K, the evaluation value increases slightly with increasing illuminance. Figures 2(c) and 2(d) show the results of the evaluation of the hardness sensation in image stimulus B. Similar to image stimulus A, the results for image stimulus B also showed an increase in hardness perception with increasing colour temperature. These experiments showed that the colour temperature of the scene illumination affected the perception of hardness, regardless of image stimuli A and B. The same characteristics were obtained regardless of the image stimulus, suggesting that illumination constancy may not play a dominant role in determining hardness.



(a) *(b)* *(c)* *(d)*

Figure 2: Evaluation score. (a), (b): image stimulus A, (c), (d): image stimulus B.

A model was constructed for the experimental results of image stimulus B using multiple regression analysis, with the score obtained from the evaluation experiment as the objective variable and the image features obtained from the image as explanatory variables. The final model is expressed by the following equation:

$$score = 0.29 \times cont + 0.38 \times color\ temp + 3.28$$

where cont refers to the contrast of the image features, as defined in the literature (Sharan et al. 2008), and color temp indicates the colour temperature estimated from the image. Using only image features for the evaluation values obtained in the experiment, it was possible to construct a highly accurate model with an accuracy of $R > 0.90$. As hardness is essentially a surface texture perceived by the sense of touch, it is difficult to construct a model using only image features related to the appearance of the image and evaluated only by vision. However, we evaluated the impression of hardness in an image with the limitation of only visual perception and showed that it was possible to construct a highly accurate model using only image features for the results. This result suggests that the impression of hardness can be judged initially and stably based on information empirically obtained from visual images.

4. CONCLUSIONS

We analysed the effect of scene lighting on the perception of hardness by conducting psychophysical experiments using images of material charts composed of materials with various characteristics captured under different lighting conditions. These results suggest that the colour temperature of the scene illumination may affect the perception of hardness. A highly accurate model was constructed by multiple regression analysis using the evaluation values of the image stimuli and the image features calculated from the images. The model derived in this study is valid only for the ranges of illuminance and colour temperature set as the experimental conditions. Further experiments are required to verify the model outside the range of the experimental conditions.

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Quantifying Emotions Evoked by Artworks using Psychophysical Methods: Relationships between Emotions and Colorimetric Structure of Abstract Paintings

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ABSTRACT

We conducted an experiment where 55 Brazilian participants (mean age = 31; SD = 1.1; 29 women) ranked ten abstract paintings based on six emotional descriptors. We analyzed the ranking data using interval psychophysical scale based on the Law of Comparative Judgment. Additionally, we examined specifics components of the color structure of paintings to check if similarities or differences in the emotional level can be justified by the use of color.

We found negative correlations among tense-calm, enthusiastic-depressive, and exciting-boring, and positive correlation for exciting-enthusiastic. The LM regression shows a tendency for saturation in influencing some emotions, but a part of that, the lack of relationship between colorimetric structure and the emotional intensity of the paintings suggests that color may not significantly influence emotional judgment, while other elements and attributes within visual perception may play a more significant role and require further investigation.

The study provides a straightforward protocol for evaluating emotions in paintings. Its application to the Brazilian population may yield new insights into the interactions between cultural, visual, and artistic elements and specific emotional preferences.

1. INTRODUCTION

Art is a powerful medium for expressing human emotions, eliciting responses that reflect both universal and culturally specific perceptions (Redies, 2015). Understanding these emotional responses is complex in psychology. Universal reactions can be triggered by colors, lines and shapes, but individual preferences influenced by personal experiences complicate quantifying emotions in response to visual stimuli.

This study explores emotional engagement with visual art by quantifying abstract paintings based on the Affective Circumplex Model (Posner et al., 2005). This model suggests emotions form a circular structure based on two fundamental neurophysiological systems, where each emotion is a linear combination of these systems, predicting complementary or opposing emotional responses. Finally, we analyzed the color structure of the paintings to verify relations between the use of color and the intensity of the emotions.

We propose a methodology involving a ranking order task, easily executable outside traditional lab settings, to accommodate larger and more diverse groups. This is particularly useful in scenarios with limited initial data and experimental resources, common in social experiments and preference studies (Yu et al., 2023).

2. METHOD

2.1 Sample Preparation

The sample included 55 participants (mean age = 31; SD = 1.1; 29 women) between 18-68 years, completed high school, no visual arts degrees, no more than 2 years working in art/design. All had corrected visual acuity of 20/20 or better (ETDRS–Tumbling E chart, Xenônio Rep. Prod., São Paulo, Brazil) and were free from conditions that affect vision. Color blindness was checked using the 38-plate Ishihara test (Kanehara Trade Inc., Tokyo, Japan).

We used 10 paintings as stimuli (Figure 1) devoid of figurative and realistic elements, by artists from the mid-19th to early 20th century, and six emotional descriptors: tense, calm, enthusiastic, depressing, exciting, and boring.

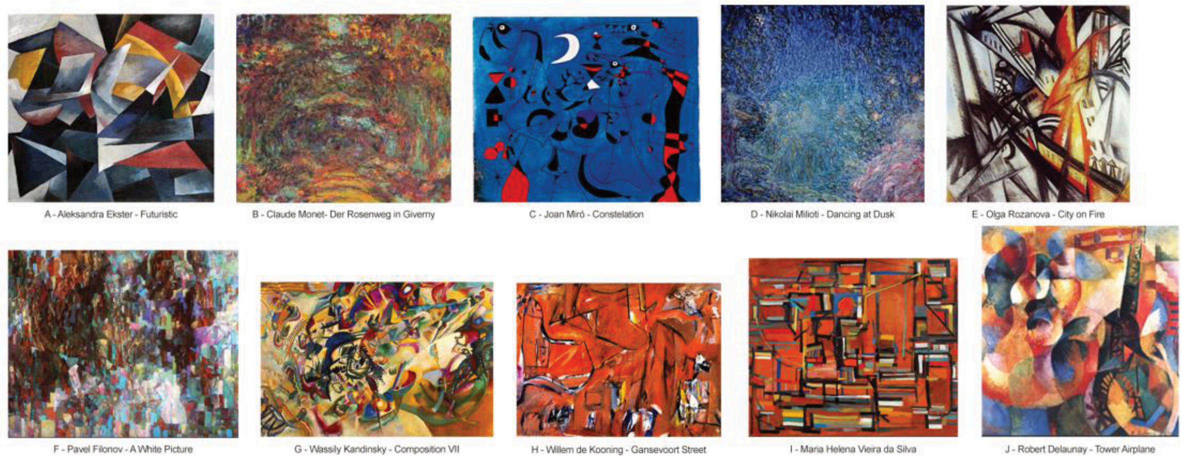

Figure 1: Images of the paintings used in the experiment.

2.2 Psychophysical Experiment

Participants entered a well-lit room with a table. The researcher explained the experiment, randomly drew an emotional descriptor card, read it aloud, and placed it on the table. Participants then ranked 10 images, initially stacked face down, based on the emotional intensity described by the card. The order was noted, the images were shuffled and restacked, and the procedure was repeated for all descriptors.

We organized the ranking data into a binary correlation matrix, containing the probabilities of each painting being chosen over another (Thurstone, 1931). Using this matrix, we applied the Law of Comparative Judgment, assuming normal distribution variance and equal variance for all stimuli (Thurstone, 1927). We converted the probability values from the matrix into distances, adapting a normal bell curve where 1 unit represents 75%, the midpoint between a random guess and absolute certainty. The painting with the lowest value was defined as zero on the scale, and values for other paintings were added sequentially to position them on the scale. This procedure was repeated for all emotional descriptors.

3. RESULTS AND DISCUSSION

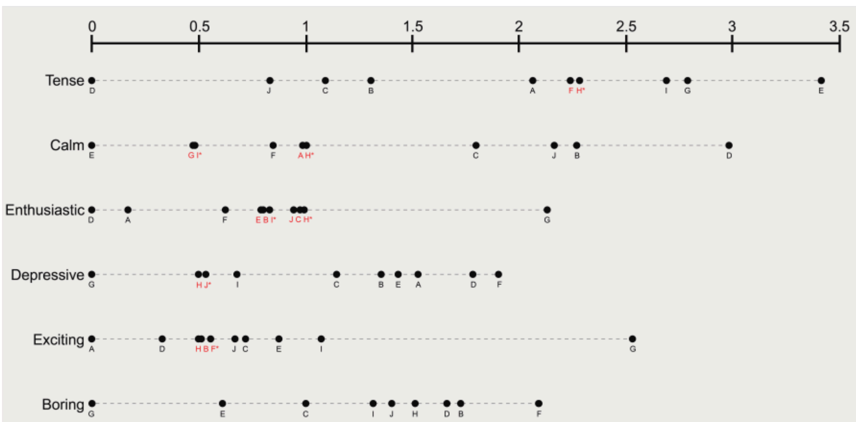

Figure 2: Psychophysical interval scale.

**Paintings that clustered on the scale. We used a paired Student's t-test with a 95% confidence interval to determine if there is a statistically significant difference.*

Almost all the paintings were easily ranked under the descriptors tense, calm, boring and depressive, indicating a consistent interpretation of these emotions for the selected artworks. However, the descriptors enthusiastic and exciting proved more complex. Painting G showed nearly double the distance compared to the others, which were closely clustered on the scale.

Pearson's coefficient revealed negative correlations among tense-calm, enthusiastic-depressive, and exciting-boring ($r < -0.85$, $p < 0.05$), suggesting a direct opposition of these emotional states. A positive correlation was found for exciting-enthusiastic ($r = 0.90$, $p < 0.05$).

We analyzed the color structure of the paintings to verify if their distances on the scales could be justified by similarities or differences in the use of color. For this, we adjusted the color gamut in CIELAB of each painting similar to Montagner et al. (2016) to derive three statistical parameters: ellipse area, axis ratio and hue angle.

Table 1. Linear Multiple Regression.

Emotions	**R^2**	**F-statistic**	**p-value**	**Significative variances**
Tense	0.45	1.60	0.28	
Calm	0.40	1.32	0.35	
Enthusiastic	0.70	4.18	0.064	Ellipse area($p = 0.01$)
Depressive	0.70	4.51	0.06	Ellipse area ($p = 0.02$)
Exciting	0.50	2.31	0.18	
Boring	0.32	0.93	0.48	

The area of the gamut of the paintings had a significant effect on the perception of enthusiastic and depressive. No other independent variable (ratio, angle) showed a significant association with the intensity of emotions.

4. CONCLUSIONS

Overall, the paintings could be ranked for emotional descriptors and allocated to a quantitative interval scale, which allows us to determine the distances between the paintings for each emotion in standard deviation sample units. Applying this consistent scaling approach facilitated a more comprehensive and robust statistical analysis.

The results indicated a negative correlation for opposing emotions, suggesting that the paintings can be represented within the affective circumplex model. Descriptors like tense, calm, boring and depressive showed a clear and spaced distribution of paintings on the scale, with significant and proportional distances between them. In contrast, the descriptors enthusiastic and exciting exhibited more complex patterns, with many paintings clustered at a single point on the scale. These findings suggest that certain sets of visual elements evoke emotional responses that can be consistently differentiated, while other emotional responses are more susceptible to individual interpretations. The results show a tendency for saturation in influencing some emotions, but a part of that, color may not significantly influence emotional judgment, while other elements and attributes within visual perception may play a more significant role and require further investigation.

The study provides a straightforward protocol for evaluating emotions in paintings. Its application to the Brazilian population may yield new insights into the interactions between cultural, visual, and artistic elements and specific emotional preferences. The methodology could facilitate future studies of visual artworks and their relationship with emotions, enriching the understanding of aesthetic experience.

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Cues in Color: May Profile Image Imply Users' Personality Traits?

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ABSTRACT

This study delves into the intricate relationship between color choices in profile images and personality traits expressed on Xiaohongshu (RED), a prominent Chinese social media platform, aiming to better understand the role of color in conveying deeper personality dimensions. Utilizing the Myers-Briggs Type Indicator (MBTI) framework, the research analyzes a stratified random sample of 1,600 user profiles to ensure a broad representation of personality variation. Methodologically, computer vision via OpenCV is employed for color data extraction, and transfer learning with the pre-trained VGG16 network classifies image content, enhancing analytical depth. Statistical methodologies, including Pearson correlation and logistic regression, are used to illuminate potential relationships between color preferences, content, text length, and MBTI classifications, advancing our understanding of personality manifestation through digital media's visual and textual dimensions.

Preliminary results reveal significant correlations between color features and MBTI types. For instance, extraverts (E) tend to select vibrant hues such as purple and red, while introverts (I) prefer darker tones such as black. Intuitives (N) favor warmer colors and less color richness, and sensors (S) opt for cooler hues and richer colors. Feelers (F) and Thinkers (T) are differentiated by higher and lower color saturation, respectively. Judging (J) and Perceiving (P) types exhibit distinct aesthetic preferences, with Judging types preferring more structured aesthetics and Perceiving types leaning towards more fluid aesthetics. Additionally, the length of biographical narratives correlates with conscientiousness, reinforcing the role of text as a complementary personality indicator.

Anticipated outcomes are poised to refine our comprehension of digital identity formation by demonstrating how color and textual cues in profile images can collectively inform predictions of personality types. By capitalizing on the combined predictive power of color and text in profile representations, platforms can engineer highly personalized user experiences, devise tailored avatars, and craft strategic marketing initiatives deeply rooted in an understanding of color psychology.

Keywords: Color psychology, Personality, Social Media, Profile image

1. INTRODUCTION

In the digital age, profile images play a crucial role in shaping online identities and first impressions (Westerman et al. 2015). Color, as a powerful visual cue, conveys personality traits and influences online self-expression (Palmer 2010). While studies have explored correlations between personality dimensions and image characteristics—such as agreeableness with positive expressions and openness with aesthetic focus (Liu et al. 2016), the specific link between color and MBTI personality traits remains underexplored. This study addresses this gap by investigating the correlation between color features, content style in profile images, and MBTI personality traits on Xiaohongshu (RED), a platform rich in MBTI discussions. Additionally, it examines the predictive power of color, content style, and text length in identifying MBTI types. By leveraging MBTI as a framework, this research aims to deepen our understanding of how color in profile images reflects personality, with implications for enhancing personalized recommendations and advancing digital marketing strategies.

Ultimately, this study contributes to the broader understanding of digital identity formation and online self-presentation. The hypotheses for this study, outlined in Table 1, focus on the potential associations between MBTI personality types and specific characteristics of users' profiles.

Table 1. Research Hypotheses

H1	**Color Features** (average hue, average value, average saturation, color tone and hue entropy) of profile image are correlated with MBTI types.
H2	**Content Style** (realistic/cartoonish) of profile image correlates with MBTI types.
H3	**Text Length** of users' profile correlates with MBTI types.

2. METHOD

In this study, the systematic data collected and analyzed user profiles from the RED platform. To ensure data representativeness and analytical precision, this research employed stratified sampling and conducted multi-dimensional data processing. The following sections detail the data collection and processing methods.

Data Collection: The primary dataset was sourced from RED, a platform known for fostering extensive self-expression through user-generated "notes." A stratified sampling approach was employed, focusing on the top 10 trending posts for each MBTI type. Users who explicitly self-identified their MBTI classification were randomly sampled from the comments section of these posts. Profile images and biographical details were harvested, ensuring participant anonymity, resulting in a balanced dataset of 1600 unique user profiles, with 100 entries for each MBTI type.

Image Processing: All profile images were standardized by converting them to the JPG format and resizing to a homogeneous 10x10 pixel grid. Leveraging OpenCV, the images were then transformed from the RGB to the HSV color model. Within the HSV color space, the average hue, value, and saturation were calculated for each profile image. To ensure the predominant color is accurately represented, pixels with extreme values of value and saturation (below 50 or above 200) were excluded from the calculation of the average hue. Based on the calculated results, the images' tones were categorized as warm, cool, or neutral. Additionally, hue entropy was computed to quantify the richness and diversity of colors present in each image.

Classification and Text Metrics: Using transfer learning with the pre-trained VGG16 neural network, profile images were classified as realistic or cartoonish. Text length was used as a proxy for the degree of self-disclosure and measured using Excel. MBTI classifications were deconstructed into dichotomous variables (E/I, S/N, T/F, J/P) to facilitate statistical analysis. The data processing procedure is shown in Figure 1.

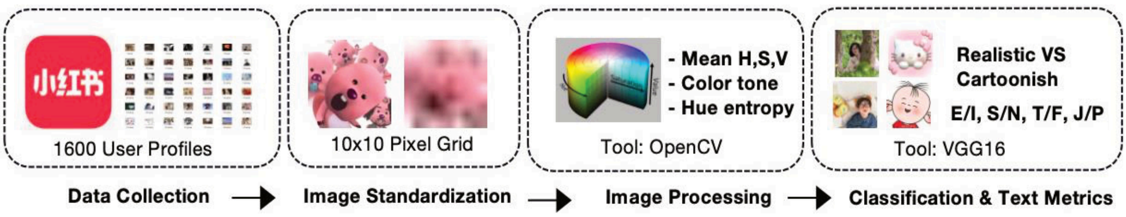

Figure 1.Data Processing Procedure

3. DATA ANALYSIS AND RESULTS

The data analysis included three steps: correlation analysis to explore variable connections, an analysis of dominant color preferences, and logistic regression to assess the predictive power of profile image variables on personality traits.

Correlation Analysis: Focusing on seven variables (average hue, color tone, average value, average saturation, hue entropy, content style, and text length), the Pearson correlation coefficients (r) and significance levels (*p*-values) are summarized in Table 2, with significant associations indicated by asterisks.

E/I: Extraverted users had Profile Images with higher average saturation (r = .093, $p < .05$), higher hue entropy (r = .069, $p < .05$), and longer text lengths (r = .103, $p < .05$). Introverted users preferred less saturated Profile Images (r = -.093, $p < .05$) with shorter text lengths (r = -.103, $p < .05$).

S/N: Sensing users favored Profile Images with cooler color tones (r = .045, $p < .05$) and realistic styles (r = .088, $p < .01$), while intuitive users preferred warmer color tones (r = -.045, $p < .05$) and cartoon styles (r = -.088, $p < .01$).

T/F: Feeling users chose Profile Images with higher saturation (r = -.097, $p < .01$) and richer colors (r = -.124, $p < .01$), while Thinking users selected lower saturation and more concentrated colors (r = .097, $p < .01$; r = .124, $p < .01$).

J/P: Judging users preferred Profile Images with lower brightness (r = -.052, $p < .05$) and realistic styles (r = .109, $p < .01$), while Perceiving users favored brighter and more varied styles (r = .052, $p < .05$; r = -.109, $p < .01$).

The research hypothesis that color features and content style of profile images correlate with MBTI types is supported, as significant correlations were found between specific MBTI dimensions and color attributes, such as saturation and hue entropy, as well as content style preferences. The hypothesis that text length correlates with MBTI types also holds true, with significant differences observed between extraverted and introverted users in terms of text length.

Table 2. Pearson Correlation Analysis Results

Variables		Average_ Hue	Color_ Tones	Average_ Value	Average_ Saturation	Hue_ Entropy	Text_ Length	Conent_ Style
E/I	Pearson	.059*	-.008	.127**	.093**	.069**	.103**	-.036
	Sig.	.019	.755	.000	.000	.006	.000	.147
S/N	Pearson	.011	-.062*	.017	-.009	.075**	.029	.088**
	Sig.	.657	.014	.504	.726	.003	.242	.000
T/F	Pearson	.030	-.033	.010	-.097**	-.124**	-.032	-.075**
	Sig.	.238	.183	.699	.000	.000	.202	.003
J/P	Pearson	.000	.005	-.052*	.039	-.003	.012	.109**
	Sig.	.995	.843	.039	.123	.903	.629	.000

Dominant Color Analysis: Then we computed the dominant color (black, blue, brown, gray, green, orange, purple, red, teal, white, yellow) for each image and performed a cross-tabulation analysis. Notable differences in the distribution of certain colors (variance > 10) indicated preferences in color usage based on personality traits. Specifically, extraverts (E) tended to use more red and purple, while sensors (S) showed a preference for less red compared to intuitives (N). Thinkers (T) preferred more gray and white and used less yellow. Judgers (J) and perceivers (P) displayed no clear preference among the colors, showing a more even distribution. These findings suggest that personality traits can influence color preferences in Profile Images, providing insights into how individuals express their personalities visually online.

Logistic Regression Analysis: To see if we could predict users' personality type based on these features, we set up four models focusing on one of the four personality dimensions. The models for predicting E/I, S/N, and T/F had prediction accuracies of around 59%, 57%, and 56%, respectively. The model for J/P had an accuracy of about 55%. Interestingly, people who score high in "feeling" and "judging" were predicted slightly better, with accuracies of around 66% and 69% respectively. Even though the overall prediction levels were modest, these results suggest that there is potential in using social media profile information to guess someone's personality.

4. CONCLUSION AND DISCUSSION

This study uncovers significant correlations between profile image characteristics and MBTI personality traits, revealing distinct patterns in color preference and style. Extraverts are inclined to use vibrant and colorful images, particularly featuring red and purple hues, while introverts opt for darker, less saturated visuals. Sensing types tend to prefer cooler, realistic tones with minimal red, whereas intuitive are drawn to warmer, more cartoon-like styles. Feelers favor images with higher saturation and richer colors, contrasting with thinkers who gravitate towards lower saturation, concentrated color schemes, and a greater use of gray and white, with minimal yellow. Additionally, judging types typically choose images with lower brightness and realistic styles, while perceiving types favor brighter and more varied images. Interestingly, judgers and perceivers show a more balanced distribution across the color spectrum, without a strong preference for specific hues.

The findings of this study underscore the role of color as a powerful visual cue in interpreting personality through profile images. The relationship between specific hues and personality traits – such as the association of vibrant reds and purples with extraversion or cooler tones with sensing cognition – highlights the communicative power of color in digital environments. This insight enhances our understanding of how color choices in online self-presentation can reflect underlying personality traits, contributing to a deeper understanding of digital identity formation.

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Characteristics of Japanese Skin Color and Its Associated Factors in Comprehensive Health Checkup Examinees

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ABSTRACT

We measured the skin color of examinees who underwent a comprehensive health checkup using a spectrophotometer to elucidate the characteristics and factors associated with skin color in middle-aged and older Japanese individuals. A total of 208 examinees (62.1 ± 10.9-year-old, men: women 89:119) were enrolled. The skin color measurements were taken from the forehead and bilateral inner forearms using a spectrophotometer (CM-700d, Konica Minolta) and expressed as L^*, a^*, and b^*. Additionally, vital signs (body temperature [BT], blood pressure [BP], and pulse rate [PR]) and percutaneous oxygen saturation (SpO_2) were recorded. Data on age, Body Mass Index (BMI), medical history, and laboratory parameters such as hemoglobin (Hb), hematocrit (Ht), creatinine, and total bilirubin (Bil) levels were obtained from the health check records. The analysis revealed that women's skin color had significantly higher L^* values and lower a^* and b^* values compared with that of men. The forehead exhibited lower L^* and higher a^* values than the forearms. The examinees were categorized into three age groups: under 60 years, 60–69 years, and over 70 years. Among men, no significant differences in skin color were observed across the age groups at any measured site. In contrast, women aged 70 and older had significantly lower L^* and higher a^* values on the forearms than those aged <60 years. Hb levels correlated with L^* and a^* in the foreheads of both men and women and with L^* in both forearms of women. Bil was associated with b^* in the foreheads of both sexes and with b^* in both forearms of women. These findings indicate sex differences in skin color, with men's skin color being darker and more reddish/yellowish than that of women. Additionally, the forehead skin color was darker and reddish than the inner forearm skin color, likely due to sun exposure. The impact of age on skin color was particularly evident in the forearms of women with low melanin levels. Furthermore, Hb and Bil levels may influence skin color.

1. INTRODUCTION

In clinical settings, medical personnel often assess the severity of a patient's condition based on facial skin color. However, this is a subjective measure, complicating information sharing. Skin color can be objectively indicated using lightness (L^*), redness (a^*), and yellowness (b^*) in the CIELAB color space. Unfortunately, despite the large number of elderly patients, studies on the colorimetry of elderly skin are scarce. Skin color is primarily related to skin thickness, melanin, and hemoglobin (Hb). However, no reports have examined the relationship between skin color and blood pressure (BP) or Hb levels in middle-aged and older adults. This study aimed to measure the skin color of individuals undergoing comprehensive health checkups using a spectrophotometer to clarify its characteristics and to investigate the relationship between skin color and sex, age, BP, and laboratory data.

2. METHOD

2.1 Participants

A total of 208 examinees (62.1 ± 10.9-year-old, 38~85-year-old, men/women: 89/119) undergoing a comprehensive health checkup were investigated. Patients with end-stage kidney disease or liver cirrhosis were excluded. This study was approved by the Institutional Review Board for Clinical Research of Tokai University (22R099 and 23R095). Written informed consent was obtained from all participants.

2.2 Study Protocol

Vital signs (body temperature [BT], BP, pulse rate [PR], and percutaneous oxygen saturation [SpO_2]) and skin color were measured on the day of the health checkup of participants. The skin color measurements were taken from the forehead and bilateral inner forearms using a spectrophotometer (CM-700d; KONICA MINOLTA, Tokyo, Japan). The experimental parameters were: measurement diameter, of 8 mm; light source set to D65, mirror reflection not included (SCE); and viewing field of 10°. Data on age; Body Mass Index (BMI); medical history; and laboratory parameters, such as Hb, hematocrit (Ht), creatinine, albumin (Alb), and total bilirubin (Bil) levels were extracted from the health check records.

2.3 Data analysis

Data are presented as mean ± standard deviation. Variables were compared between men and women using an unpaired t-test. To investigate the influence of age on skin color, examinees were divided into three age groups: under 60 years (men/women: 35/47), 60–69 years (men/women: 27/36), and 70 years and older (men/women: 27/36). Skin color differences among the three measured sites across the three age groups were compared using a one-way analysis of variance with Holm's post-hoc test. Relationships among skin color, vital signs, and laboratory data were assessed using Pearson's correlation coefficient. Statistical significance was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Gender Comparison

Of the 218 participants, 32 had hypertension, 18 had diabetes, 24 had hyperlipidemia, and 15 had received cancer treatment. Table 1 presents the profile of participants. No significant differences were observed in age, BMI, or SpO_2 between men and women. However, BP and PR were significantly higher in men than in women. Additionally, Hb, Ht, and Bil levels were significantly higher in men than in women.

At each measured site, men had significantly lower L^* values and higher a^* and b^* values than those of women (Table 2). The forehead skin had lower L^* and higher a^* than that of the arm in both sexes (Table 2). This result may be related to increased melanin levels induced by tanning in men and on the forehead. Despite their older age, the study participants had higher L^* values and lower a^* and b^* values than those in a previous study on skin color among Chinese women (de Rigal et al., 2010). This indicates that the skin of Japanese women has become lighter in recent years, as reported by Kikuchi et al. (2018).

Table 1. Profile of participants

		Men(n=89)			Women(n=119)			p
		mean		SD	mean		SD	
Age	year-old	62.2	±	10.2	62.0	±	11.4	0.914
BMI		23.4	±	2.7	22.7	±	3.9	0.104
SpO_2	%	96.6	±	0.8	96.5	±	1.0	0.724
Pulse rate	/min	71.2	±	10.6	75.4	±	9.2	0.003
Systolic BP	mmHg	140.5	±	18.2	132.3	±	17.2	0.002
Diastolic BP	mmHg	88.4	±	12.6	81.8	±	10.7	0.000
Mean BP	mmHg	114.4	±	14.5	107.0	±	12.8	0.000
Hemoglobin	g/dL	14.7	±	1.2	13.2	±	1.2	0.000
Hematocrit	%	45.0	±	3.4	41.0	±	3.2	0.000
Albumin	g/dL	4.27	±	0.25	4.22	±	0.23	0.131
Bilirubin	mg/dL	0.87	±	0.29	0.71	±	0.2	0.000

SpO_2: percutaneous oxygen saturation

Table 2. Skin Color

	Men(n=89)					Women(n=119)				
	mean		SD			mean		SD		
Forehead	56.83	±	2.60	##		61.64	±	2.71**	##	
Right arm	63.23	±	3.37		##	65.76	±	2.66**		##
Left arm	62.65	±	3.38	##		65.41	±	2.66**	##	
Forehead	13.43	±	1.76	##		10.89	±	1.65**	##	
Right arm	7.71	±	1.62		##	6.79	±	1.45**		##
Left arm	8.19	±	1.64	##		7.06	±	1.39**	##	
Forehead	18.56	±	1.77			17.22	±	1.96**		
Right arm	18.22	±	2.03			17.31	±	2.03**		
Left arm	18.53	±	2.03	##		17.49	±	1.94**		

**: p<0.01 (men vs women, non-paired t test), ##:p<0.01 (one way ANOVA, Holm)

3.2 Age-Group Comparison

No significant differences in skin color were observed in the foreheads of either sex or bilateral forearms of men across the three age groups. In contrast, women aged 70 and older had significantly lower L^* and higher a^* values on the forearms than those aged <60 years. Rigal et al. (2010) reported a slight, non-statistically significant decrease in L^* values in the foreheads of Chinese women with age. The skin on the inner forearms of women with less sun exposure showed the effects of aging.

3.3 Relation to BP and Laboratory Data

The mean BP was not related to any L^*, a^*, or b^* values of any measured site in men or women. Hb levels correlated with L^* in the forehead of men (r=-0.353, p<0.01) and women (r=-0.273, p<0.01) (Figure 1) and in both inner forearms of women (right: r= -0.219, p<0.05; left: r= -0.181, p<0.05). Additionally, the Hb levels were associated with a^* values in the forehead of men (r = 0.234, p < 0.05) and women (r = 0.249, p < 0.01) and left forearm (r =-0.181, p < 0.05) of women. Alb levels were not correlated with skin color variables. Bil levels correlated with b^* on the forehead of both sexes (men r=0.277, p<0.05; women r= 0.187, p<0.05) and both forearms in women (right r= 0.253, p<0.01; left r= 0.192, p<0.05). These results suggest that blood Hb is related to L^* and a^* values but not to mean BP, which is the driving pressure of the microcirculation. Additionally, Bil levels may be associated with b^* values.

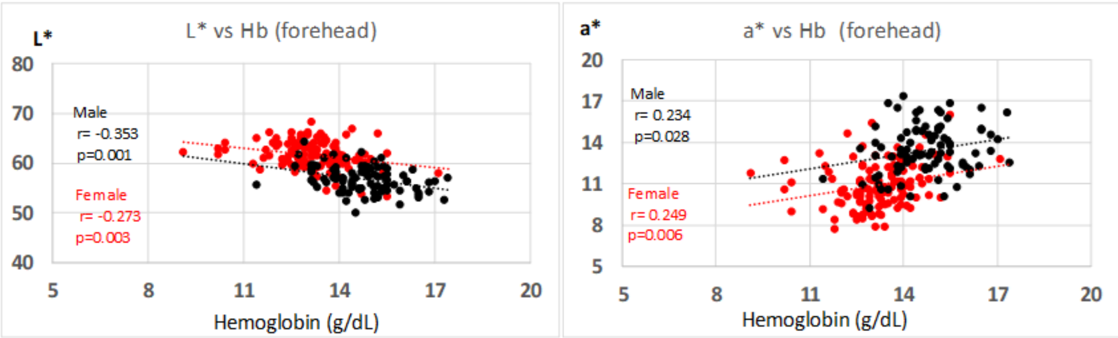

Figure 1: Relationship between skin color and hemoglobin (Hb)

4. CONCLUSIONS

Skin color in men was lower in lightness and more reddish/yellowish compared with that of women for both the forehead and arms. For both sexes, the forehead exhibited lower lightness and a more reddish hue than the arms. This phenomenon is likely related to melanin (tanning). The effect of age on skin color was not observed on the foreheads of men and women or the arms of men; however, the arms of women aged 70 years and older were less bright and more reddish than those under 60 years. Additionally, Hb and Bil levels may be associated with skin color.

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Chromaticity Contrast Thresholds and Sufficient Illuminance of Multi-channel LED for the Simulated Low-vision Eyes

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ABSTRACT

This research determines the sufficient illuminance of the optimised multi-channel LED on chromaticity contrast thresholds in simulated low-vision eyes under diverse illuminance conditions. A comparison will be made with white LED and fluorescent lamps as control measures. Chromaticity contrast (CC) quantifies the colour differences between two areas based on their chromaticity coordinates, independent of luminance. The study included two visual acuity levels with blurred lenses and three cloudy lens levels within the low vision category. Blurred lenses provide good colour perception with blurry edges, while cloudy lenses yield lower chroma due to fogginess. Simulated low-vision observers aged 20 to 25 were randomly presented with stimuli featuring red text on green backgrounds and vice versa, along with six chromaticity contrast levels. The experiment utilised a two-room setup with limited visibility, allowing only the Landolt C to be observed. The stimulus room's illuminance levels varied from 10 lx to 1,000 lx, while the observer room maintained a constant 300 lx with no additional light. For simulated blurred lenses, increasing illuminance from dark to 300 lx did not yield distinct CC thresholds across visual acuities. The CC threshold remained consistent when stimulus room illuminance rose from 300 to 1,000 lx, indicating that 300 lx is adequate. With cloudy lenses in a dark room, the CC threshold was stable as illuminance rose from 300 to 1,000 lx, but 1,000 lx was insufficient for clear CC observation. Over 1,000 lx illuminance is necessary for clear perception with cloudy lenses. A similar pattern was observed for green text on a red background, although the chromaticity contrast threshold was lower. Adequate CC can enhance image features, facilitate object recognition in image processing and computer vision, improve visual quality and readability, and create a visually comfortable environment.

1. INTRODUCTION

Chromaticity contrast (CC) significantly influences visual perception, especially in low-vision individuals. This effect shows in visual processing aspects such as night vision, stereopsis, and contrast sensitivity. Investigating the impact of chromaticity contrast in these areas can inform the development of improved visual aids and environments for low-vision individuals. The following analysis examines chromaticity contrast's effects on visual perception in low-vision individuals based on relevant research.

CC considerably impacts night vision disturbances, including halos and straylight. ReCCsearch indicates that blue stimuli most adversely affect these disturbances, impairing visual discrimination in low-light conditions. This impact is more significant than that of red, green, and achromatic stimuli, which are similarly effective in visual discrimination yet less influenced by straylight (Castro-Torres 2024). The link between straylight and visual disturbances implies that controlling chromaticity contrast, particularly in blue hues, may alleviate night vision challenges for low-vision individuals (Castro-Torres, 2024). CC affects stereopsis, particularly among colour-deficient individuals like those with Daltonism. For these individuals, red-green patterns notably influence stereoacuity more than black-white patterns, suggesting that chromaticity contrast can modify depth perception (Sun 2018). This observation underscores the necessity of incorporating chromatic contrast considerations in visual evaluations and aids for colour vision-deficient individuals, impacting their depth perception capabilities (Sun 2018). In individuals with age-related macular degeneration (AMD), chromatic contrast sensitivity is significantly diminished at low spatial frequencies. This reduction is especially pronounced for isoluminant red-green and yellow-blue contrasts compared to achromatic contrasts (Valberg 2007). The attenuation of luminance contrast sensitivity due to weak colour presentation further complicates visual perception for low-vision individuals, with lower saturation colours suppressing luminance-driven neural activity and inhibiting luminance contrast discrimination (Negishi 2021). Enhancing chromaticity contrast may bolster visual perception for low-vision individuals. Algorithms that augment colour contrast on digital platforms, such as web pages, can assist low-vision individuals by modifying text and background colours for better contrast (Yan 2015).

This research investigates the requisite illuminance for discerning chromaticity under optimised multi-channel LED by determining the chromatic contrast threshold perceived by simulated low-vision eyes with blurred and cloudy lenses across five illuminance levels. The stimuli comprise red text on a green background and vice versa of the Landolt C.

2. METHOD

2.1 Experimental Setup and Psychophysical Experiment

A two-room technique, one for stimuli and another for observers, was introduced in the experiment. Two types of stimuli, red Landolt C of 2x2 inches on a green background and vice versa were printed (Epson SureColor SC-P9000) on a semi-gloss photographic paper with six levels of chromatic contrast. They were attached to a rotating wheel in the stimulus room. The CIELAB value and xyY chromaticity coordinate under five illuminances: 10 lx, 30 lx, 100 lx, 300 lx and 1,000 lx were recorded at the observing distance of 77 inches. The Landolt C of individual contrast has a small gap of C in eight directions. The wavelengths of LED channels in mixed light LEDs are blue, green, red and yellow, and the white LED, including the spectral power distribution, is shown in (Plerksophon 2023).

The stimulus was presented randomly to low-vision observers aged 20 to 25 with three visual acuity levels, who viewed the Landolt C on a grey background through a small window. They were tasked with assessing the contrast of the letter C and identifying the gap's direction. A correct response indicated contrast perception, while an incorrect response suggested a lack of contrast perception.

3. RESULTS AND DISCUSSION

Thresholds of two types of simulated low-vision glasses, examining three levels of visual acuity (VA) and with/without ambient light, are analysed. The thresholds without ambient light remain stable, while those with ambient light exhibit fluctuations.

In the context of blur-simulated low-vision (Figure 2), thresholds for green text on a red background (GR) decrease with increasing VA. At lower and medium VA levels, threshold increments in both ambient light conditions are comparable, yet at the highest VA, a discrepancy arises between conditions. Specifically, the threshold is elevated in the absence of ambient light. A minimum illuminance of approximately 300 lux is necessary for GR, with critical contrast thresholds for severe and medium low-vision being 0.3 and 0.22, respectively. An increase in illuminance does not affect the threshold. Conversely, for slight low-vision and normal observers, even at 300 lux, thresholds diminish slightly from 300 to 1000 lux. RG yields higher thresholds than GR across all VA levels without ambient light.

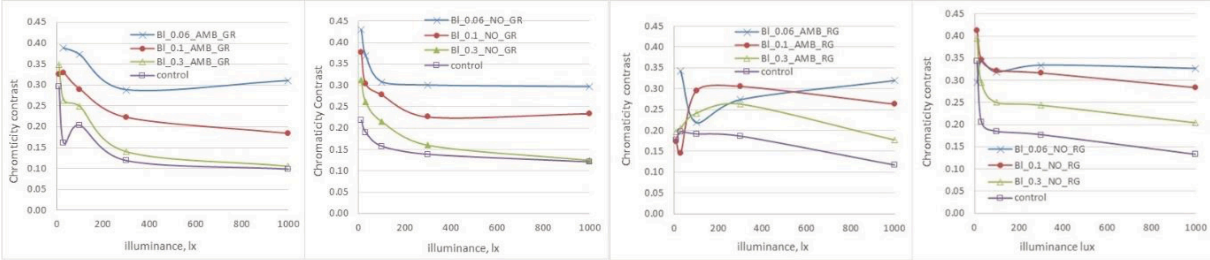

Figure 2: Thresholds of blur simulated low vision with VA of 0.06, 0.1 and 0.3 when viewed with the green letter C on a red background (GR) and vice versa (RG), with (AMB) and without ambient light (NO) in the observer's room.

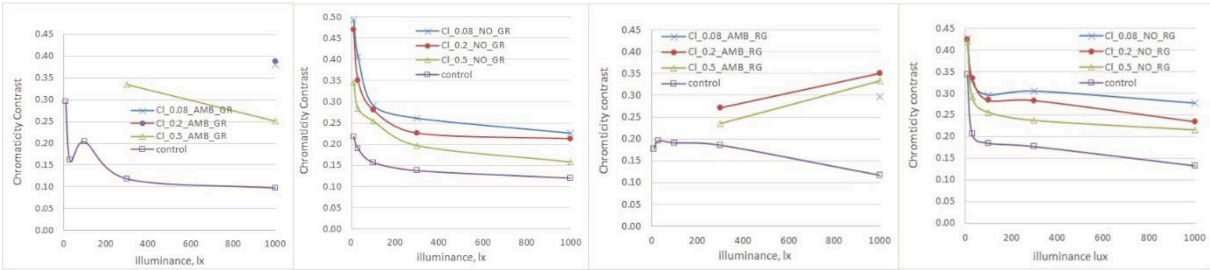

Figure 3: Thresholds of cloudy simulated low vision with VA of 0.08, 0.2 and 0.5 when viewed with the green letter C on a red background (GR) and vice versa (RG), with (AMB) and without ambient light (NO) in the observer's room.

Cloudy simulated low vision (Figure 3): It is similar to blurry vision in that RG gave higher thresholds than RG in all VA without ambient light. Under the viewing with the ambient light, the simulated cloudy vision was found to be difficult to perceive CC.

While chromaticity contrast can enhance visual perception, it is vital to acknowledge individual differences in colour perception. Variables such as age and specific visual impairments can affect chromaticity perception, necessitating tailored approaches in visual aids and environmental design (David 2019). Furthermore, while improving chromaticity contrast may support visual perception, it is essential to balance this enhancement with the risk of increased visual disturbances, particularly in low-light settings (Castro-Torres 2024). Grasping these complexities can lead to more effective strategies for aiding individuals with low vision.

4. CONCLUSIONS

Viewing the red text and green background by the simulated blurred lenses, when the illuminance in the observer's room increased from the dark to 300 lx, the CC thresholds of all visual acuities were not distinct. The threshold was maintained when the illuminance in the stimulus room rose from 300 to 1000 lx. It showed that the illuminance of 300 lux is sufficient. Viewing the same stimulus by the stimulated cloudy lenses from the dark room, the CC threshold was maintained when the illuminance increased from 300 to 1000 lux. Viewing from the brighter room, the illuminance of 1000 lx is insufficient to see the CC. It shows that an illuminance of over 1000 lx is required for the cloudy lenses. A similar pattern shows for the green text on the red background, but the chromaticity contrast threshold is lower.

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Chromatic Analysis in Coming of Age Movies

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ABSTRACT

The purpose of this article is to focus on scenes and their colors in films from the subgenre of the drama genre, commonly Hollywoodian, Coming of Age subgenre. The approach to colors and visual language in the scenes of a movie has the importance of exploring possible messages that can be transmitted to the viewer. This article is the result of a research that contains both bibliographical and empirical findings, in which scenes from four selected Coming of Age films were analyzed using an analysis script. The intention was to explore the possible variable emotions and significance of the colors and visual language of these scenes, and how altogether they may cause an impact over who is watching. Bearing in mind that we often understand and absorb less than half of the content and visual language of a feature film, this research explores this language through colors, describing its connections and applications with and in the characters and settings of these films.

1. INTRODUCTION

When we analyze a scene from a film, it is important to understand that there are several layers that make the film what it is. For Mahnke (1996), the brain is the main protagonist responsible for the process of color meanings and the strength of impact they achieve. Every color viewed in the outside world is encoded by the brain into feelings, thoughts and actions. According to Brown (2016), light has the cinematic ability to reach viewers on an emotional level. Depending on the type of lighting and shadow applied to a scene, it can be interpreted positively or negatively by those watching.

The Coming of Age genre of modern films portray the growth of children and adolescents and are not only entertainment for the public of this age group; they are also films that address social problems, and works of a personal nature, being, often semi-autobiographies of modern directors. In general, films about youth dramatize situations and events surrounding the child's or adolescent's entry into new domains of psychosocial experiences and the adolescent's or young adult's encounters with the pleasures and dangers of modern life (Uytdewilligen 2016, Schmidt 2002).

The theoretical framework done for this research covered the topics on the concept of color; its psychology; its application in the cinematographic world; visual language in cinematography; the concept of Coming of Age films; and how colors help to highlight the drama in this genre of films.

2. METHOD

For the empirical research, an analysis script was developed using the theoretical framework that was developed. With this script, the selected films were analyzed, which were: The Perks of Being a Wallflower by Stephen Chbosky (2012), Lady Bird by Greta Gerwig (2017), Little Women by Greta Gerwig (2019) and Dead Poets Society by Peter Weir (1989). These Coming of Age titles were chosen because they are known and acclaimed within the genre. These works were selected not only because they accumulated nominations in important awards, both for the films and for the actors who star in them, but they also address delicate and pertinent themes about adolescence. The scenes chosen for the analyses were selected based on the criteria of visual prominence and importance to the plot. For example, moments of great tension between the main character and his interpersonal conflict, scenes that draw attention due to their vibrant colors or lighting contrast or scene composition.

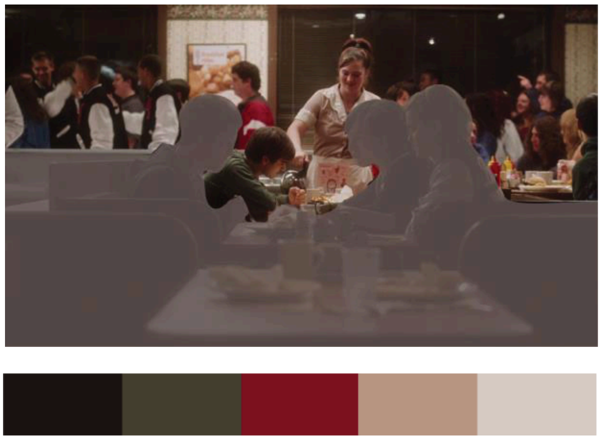
3. RESULTS AND DISCUSSION

Due to space limits, only one analysis will be here described, a scene from the film, "The Perks of Being a Wallflower". This film was chosen to represent growth in its solitary and shy form, which is what we commonly see in Charlie's facet. The main character of this plot has just entered high school after the loss of his best friend, finding himself alone and trying to make friends and survive bullying in a classic American high school cliché scenario. As the film progresses, we discover more about his past traumas and how everything still affects him.

Figure 1: Scene from the movie The Perks of Being a Wallflower, 13"15'.

In the context of this scene, Charlie, the main character, goes to a diner in his town after a football game at his high school, with the new friends, Sam and Patrick, that he met during the game.

This film scene can be divided into two planes, or facets. The first of these happens when we exclude Charlie's table from the scene. When we do this, we perceive a place with greater contrast of colors and pure hues, such as red on the students' jackets in the background. What stands out in this shot is not the meaning of the colors themselves, but rather the dynamism they cause in this part of the scene by presenting more vibrancy in hues. When we do the opposite, leaving Charlie's table and excluding the rest, the place seems to become darker and much less dynamic. The darkness and absence of colors in this scene conveys a place with no light, no life and no joy. Mahnke (1996) describes that, in an emotional context, different types of saturation impact the viewer in different ways, while more saturated colors convey more joy and dynamism. Therefore, we can have the perception that there are two different universes in the scene, in which Charlie and his friends live in a parallel world, duller and with no joy.



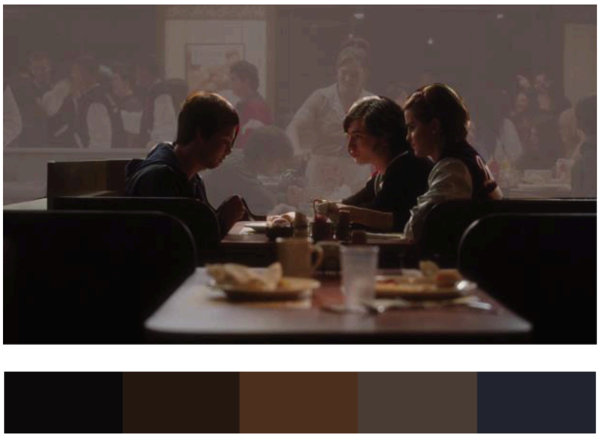


Figure 2:Scene from the movie a Wallflower, 13"15': Without characters

The Perks of Being a Wallflower, 13"15': With characters

The lighting of the scene is, according to Brown (2016), artificial background. This fact is very important for us to understand the dynamics of the scene, since, although the main characters are in the center of the frame, they are not the focus of the scene. And it will become even clearer if we look at Charlie's group of friends separately from the rest of the restaurant. When we remove the rest of the scene, we have the impression of a darkened environment, as if the lights were turned off. The dark tones are noticeable between the space of the tables that surround them, and how, around them, there is no movement, but rather, monotonicity, as if they were even in another place. Its dark, low-contrast palette indicates a world stagnant in darkness.

On the other hand, if Charlie and his friends are removed from the frame, we will have the impression that we are watching another scene. Behind them, the euphoria and joy are much clearer. The environment behind them has lighter and warmer colors, with a pure red hue, in addition to having more contrast.

The light and warm colors present a perception that the environment is warmer, where there is life, while the red hue conveys vibrancy, also forcing the idea of joy and vibrancy, in contrast to the other part of the scene. The focus of the scene is on the people in the background, even though they are not in the center. The lighting is clearer as well as the dynamic contrast that we see here describes exactly the type of experience that Charlie and his friends live throughout the film. It is very symbolic that, even though they are the protagonists of a scene, visually they do not have a prominent role in a film that talks about the invisibility, loneliness and difficulties of American high school. We can interpret that they are not highlighted in the scene because they are in fact "socially invisible".

There is a factor that enriches the depth of this scene, which is characterized by the contrast of light and dark shades in the scene. Csillag (2015) states that tonal contrasts influence the perception of depth and the figure x background relationship. Brighter images appear closer when they are on a dark background. Therefore, the greater the contrast of a scene, the greater depth it presents, and therefore, in this scene, the fact that the characters in the background are better lit makes us perceive that they advance perceptually, as if Charlie and his friends were more hidden and behind them.

The elements of the scene complement each other to convey the message and a possible interpretation that Charlie and his group of friends, despite being the main characters of the film, are not protagonists of the narrative they live. Being in the middle of the screen and far in front of the people in the background does not give them the same presence that the people in the background – the other students and their groups of friends – have.

4. CONCLUSION

The objective of this research was to analyze the chromaticity of scenes from four Coming of Age films and how some contextual elements relate to its chromaticity, benefiting the intention of the plot. Considering the arguments brought up, and the conclusion of this research we can conclude that a motion picture does not only carry the messages that are spoken by the actors. Mostly, there are hidden symbols created with colors that may lead us to vast interpretations that combine with what the movie is trying to tell us, which this research addressed and may guide future cinematographers.

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Palette Politics: Balancing Empathy and Self-expression in Color Design

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ABSTRACT

This article highlights the ways in which color professionals in the fields of art, interior design and branding differ in their use of color based on the particular goals of their context, and how that may become an obstacle to successful project collaborations. Interior designers must empathize with the audiences they serve to create environments that promote wellbeing, but they may also work alongside artists and branding professionals who operate under different assumptions. The virtual absence of evidence-based guidance on the psychology of color has left color professionals to their own devices when choosing colors, which can lead to color missteps in spaces which serve a diverse public. In the second decade of the 21st century we have developed sufficient evidence to begin setting standards, benchmarks for the use of color in public spaces, especially in healthcare settings. It is worthwhile to examine the purpose and boundaries of each profession, explore areas of overlap in their use of color, and propose an approach to help diverse professionals work together for the greater good.

1. INTRODUCTION

Color is political. Choosing a wall or sofa color can provoke a heated debate between partners, one that ends with either a negotiated solution or a project that comes to a screeching halt. Color professionals have more language, experience and education to bring to that debate, but when it comes down to choosing colors even seasoned designers may not agree. This is because color is both personal and subjective, and people vary greatly in their perception of color as well as the interpretation of its meaning. A person's experience of color may be impacted by physical factors such as yellowing lenses or color blindness, which in turn affect the very first act of seeing color (perception). Age differences can lead to stark variations in how people feel about color, and the trends of one's youth may clash with those of today's generation. Cultural differences, geography, landscapes and weather also affect the perception of color, although globalization is beginning to exert an equalizing effect. Technology can settle disputes about a color's *hue* family, but a color's *meaning*, let alone what colors will go well with it, remains controversial

The absence of an objective paradigm of meaning to guide the use of color – and a common language to discuss it – can have serious ramifications. One of them is lack of standards in how color is used in healthcare settings. Spaces where people are waiting or being examined or having procedures can provoke fear, anxiety and sadness, emotions which can actually interfere with healing. Designers have the power to make matters better or worse for patients and their families through their color selections, yet this process has historically been a subjective one. We live in an age of evidence-based design, however, and fortunately evidence is now available to help interior designers, artists and branding professionals incorporate a degree of objectivity into their design thinking.

2. 21ST CENTURY PSYCHOLOGY OF COLOR

In his seminal book, *Interaction of Color,* Josef Albers examined how the appearance of colors can shift depending on the colors that surround them. His work highlighted the often surprising perceptual effects of color, but until recently the *psychological* effects of color interactions have largely remained unexplored. One reason is that researchers have typically studied one color at a time in order to (ironically) suppress color interactions that could interfere with their findings. In contrast, color design is always a matter of "colors together", so that the findings of traditional color research have had limited utility in design applications. Past investigations have primarily centered on Newton's ROYGBV depiction of the light spectrum, leaving aside the millions of variations of them that exist in the physical world which are employed by designers in their projects every day. Today, new research on the psychology of color goes beyond hue to explain how *value* and *chroma*, the other two dimensions of color, also contribute to the meaning of colors, and a model of color psychology is emerging that encompasses all the colors that we can see.

This new paradigm is based upon the work of psychologists Valdez & Mehrabian (1994), who investigated how the three dimensions of color (hue, value and chroma) correlated with Pleasure, Arousal and Dominance, the three dimensions of PAD Theory, a human response model with roots in environmental psychology. In the field of psychology Dominance and Arousal are important concepts; Dominance first refers to people's perception of whether control is under their command or someone else's. Arousal refers to the degree of response/engagement exhibited by a person, and it can range from low (unresponsive, depressed) to high (hyperactive, overstimulated). Outside the field of psychology these terms unfortunately carry connotations which can skew their meanings, so this article may also employ the more common terms "Power" and "Energy" when referencing Dominance and Arousal.

In a nutshell, Valdez and Mehrabian found that Dominance (Power) was associated with the dimension of value, with low value colors perceived to be stronger, more powerful than high value colors. This is true for all the hues. Arousal (Energy) is correlated with the chroma dimension, with more vivid colors being perceived as having the highest energy and very muted grayish colors having the lowest. A subsequent study (Divers, 2020) confirmed that there are clear patterns of meaning associated with variations in value and chroma, as illustrated in the Color Compass (Divers, 2023). When we combine these new theories and findings with the earlier ROYGBV research there emerges a clearer and more complete picture of how the psychology of color actually works. It requires that we expand our concept of color to include more global terms, e.g., *pale*, *dark*, *vivid, muted*, and that we focus less on judging individual colors, and more on trying to understand how they interact with the other colors in a palette. This is a radical departure from prescriptive color psychology, where, for example, designers are instructed to use "calming blues" in healthcare settings, which in the hands of inexperienced or uninformed designers may led to cold and uninviting spaces. The traditional focus on hues can have the unintended consequence of narrowing designers' thought process down to a single hue where they, unsurprisingly, get stuck. In effect, yesterday's "hospital green" has been replaced with "hospital blue". When we shift away from thinking solely about hue to considering value and chroma as well, we not only broaden the range of available color options, we also take into account their effect on people's psyche. If one knows that Energy is associated with chroma, it is not a far stretch to assume that too much chroma may intensify the feelings of someone who is experiencing fear/anxiety. The opposite extreme, low chroma grayish colors, may do little to counter feelings of sadness or depression. That said, as vivid and grayish colors temper each other they may be used together effectively if they are used in the right proportions.

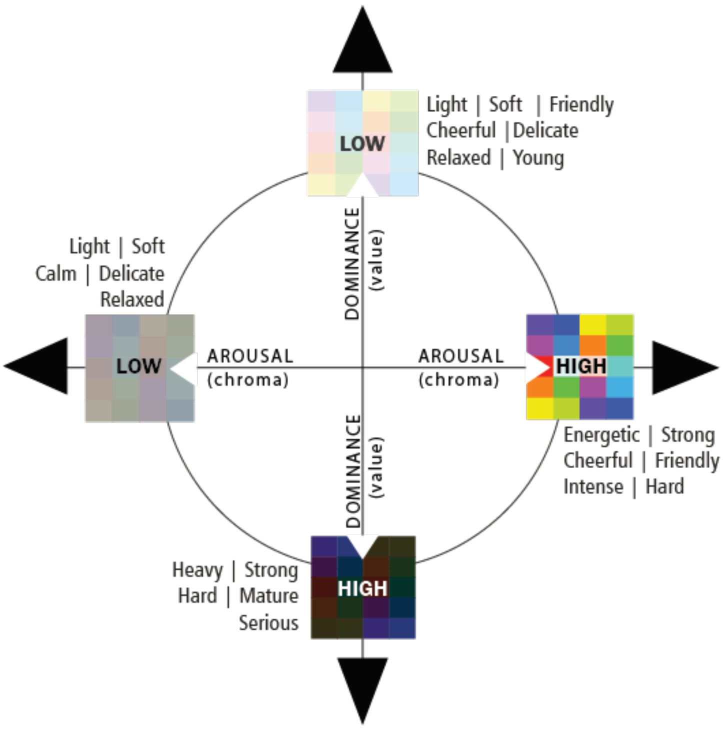

Figure 1. Color Compass (Divers, 2023)

Thus, colors are themselves political. When we consider factors which influence politics in the human realm, Power and Energy are high on the list. People who are physically large or imposing – or those with boundless energy – have the most influence, or power, and those with neither the stature nor energy to resist defer to them. It works the same way in the world of color: dark and vivid colors wield the most power, and vivid colors the most energy, so we must consider their impact and manage them accordingly within the palette.

3. EVIDENCE-BASED COLLABORATION

This new paradigm can aid interior designers as they consider how color may affect people who are facing health challenges in clinical settings, so it is imperative that they understand how this 21st century color psychology paradigm works. But interior designers do not always work alone; they often collaborate with other design professionals who may use color in a different way, e.g., artists, branding professionals and the like, who could also benefit from understanding the new paradigm. For instance, a designer may hire an artist to paint a mural in a children's hospital. Things can quickly go awry without a rational discussion of how color should be used, because artists and interior designers have different priorities. While interior designers must think objectively about the health, safety and wellness of the people who inhabit a space they design, artists may be more inclined to approach a project from a more personal and subjective point of view. Outside of the healthcare setting we welcome being surprised –even shocked – by artists' ideas and creations, but in a healthcare setting where there is sufficient drama already, a more measured approach is needed. A high chroma mural which the artist intended to be "cheerful" may overwhelm a nauseated child. If artists and designers have a common understanding about how color psychology works, however, they can rationally discuss the types of colors that would be appropriate in a particular application. Branding professionals may also partner with designers when a space, for instance, is associated with an organization like a university, that already has an established brand. How easy or difficult it is to incorporate a brand into interior design depends, of course on the colors of that brand. Dark or highly chromatic brand colors can overtake and dominate the design in ways that are detrimental to creating a hospitable environment. To avoid this, there has to be an understanding that the first priority is the health of visitors to the facility. The recent branding trend where other elements of design, such as shape, are integrated into the brand fortunately allow for more flexibility when it comes to color. A versatile visual identity makes a designer's job much easier, and in fact allows for even more creative ways to incorporate color into the design.

4. CONCLUSION

The politics of color design are not unlike traditional politics where people of different parties (or even the same party) may not see eye-to-eye on all issues, yet when they agree on a few foundational principles, they can work constructively for the benefit of society. In the context of color design for healthcare, it would be helpful if all color professionals could agree that the goal of human wellbeing supercedes branding goals and artistic self-expression. Further, based on the evidence, they must understand that value and chroma may affect comfort more than hue, and that extremes of value (Power) and chroma (Energy) should be used prudently. In a personal communication with author and teacher of architectural color Frank Mahnke said, "You know, it's not so much about what to do as it is about what NOT to do." Over a decade and much research later, it seems he was right – only now we know WHY we should (or should not) do it. What is required is that the designer hone in on the messaging of value and chroma and simultaneously balance the principles of unity and variety. There is art to this and efforts are underway to develop and test methods to teach designers how to do that.

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Color and Light in the Birth Environment

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ABSTRACT

The moment of childbirth is a significant experience in the life of both the woman and the baby, and the sensations experienced during this process can directly influence the parturient's experience. Cozy environments with a stress-free atmosphere can favor the progression of labor, and architecture can be understood as a medical gesture through the humanization of space. In this context, color and light play a crucial role, being intrinsically intertwined aspects that directly influence environmental perception. To explore these aspects, the research was conducted through a case study at the University Hospital (HU) in the city of Pelotas, RS, Brazil. Data were collected through observations, photographic records, and semi-structured interviews with parturients, covering two groups: SUS users and private service users. The configuration and size of the rooms, natural and artificial lighting, and the color palette were evaluated using the Natural Color System chromatic ordering system. The physical survey of the environment's characteristics was conducted by the researcher and contrasted with the subjective evaluations of the users, including physical, sensory, and emotional aspects. The analysis revealed a predominantly achromatic color palette, with variations of gray. Colors appeared only in support equipment, such as blue balls, partially green bed linens, and beige MDF furniture. General lighting is provided through windows and ceiling fixtures with cold-colored lamps, without the option of dimming; one of the rooms has a window facing only another internal environment, with no view of the outside. The absence of colors and the overall aesthetic of the environment were criticized by several parturients, who described the spaces as frightening, cold, and impersonal due to the lack of decorative elements and attractive colors, not providing visual stimuli that would bring calm and tranquility during childbirth. Despite meeting technical and safety requirements, the analyzed birth environments fall short in terms of humanization and warmth. Improvements in decoration, lighting, and color choices are essential to transform these spaces into more welcoming and humanized environments, providing a more positive and comfortable childbirth experience for all women.

1. INTRODUCTION

The moment of childbirth is a significant experience in the life of both the woman and the baby, and the sensations experienced during this process can directly influence the parturient's experience. Cozy, safe environments with a stress-free atmosphere can favor the progression of labor (Ulrich et al., 2008). Phenomenological understandings of architecture have embraced the inherent emotionality and mood of spatial experience, involving the ecological complexity of the mind-body interrelationship with the surrounding environment (Pallasmaa, 2005). Thus, architecture can be understood as a medical gesture through the humanization of space (Toledo, 2006). The humanization of space is a guideline of the Federal Government through the National Humanization Policy of SUS Care and Management (HumanizaSUS), which states that a healthy environment is one that provides welcoming and appreciation (Brazil, 2013). The humanization of spaces involves many aspects of interior design, including the use of colors, coverings, textures, lighting, and contact with the outside (Boing, 2003). In this context, the objective of this work is to qualitatively analyze the impact of light and color on the perception of visual comfort in childbirth environments, investigating how these characteristics can contribute to the humanization of natural childbirth.

2. METHOD

The research employs a qualitative approach developed through a case study and was conducted using two types of data collection: archival and field, with the fieldwork subdivided into physical and evaluative surveys.

The archival survey involved documentary and bibliographic research, using books, theses, dissertations, articles, and texts found in the databases of the Capes Periodicals Portal, Scopus, SciELO, and Google Scholar. The physical field survey was conducted by the researcher through observations, photographic records, sequential analysis of the birthing environments, and color measurements of the environment using the NCS electronic scanner. The evaluative field survey involved the participation of users (analysis of their perceptions) and was carried out through individual semi-structured interviews.

The case study was conducted at the University Hospital (HU) in the city of Pelotas, in the state of Rio Grande do Sul, Brazil. This hospital was chosen because it is a teaching hospital that encourages and fosters academic research, conducts natural childbirth for various socioeconomic groups, and is one of only two places with a neonatal ICU in the city.

The sample of participants in this research consists of women aged 18 to 50 who had their first natural childbirth experience at this hospital between 2021 and 2024. The study involved ten voluntary women (biological sex female), divided into two groups: those served by SUS and those served by private healthcare. To achieve the objective, the interview included the following questions: (1) Overall, what did you think of the place where the birth took place?; (2) How would you rate the lighting in the delivery room? Was it adequate to create a comfortable environment?; (3) Did you notice the colors in the room? If so, how would you rate the pleasantness of these colors on a scale of 1 to 5?; (4) Were the colors and decor of the delivery room pleasant and relaxing for you?; (5) Were there any visual elements (pictures, photographs, plants, etc.) that contributed to a more welcoming environment?

The environments analyzed in this research were two SUS delivery rooms and four private delivery rooms. These locations were chosen due to their relevance, as they were the spaces where the interviewed women's deliveries took place. The selection allowed for a comparison between public and private contexts, providing a more comprehensive understanding of the experiences of pregnant women in different care settings.

3. RESULTS AND DISCUSSION

The physical field survey highlighted that the color palette of the birthing environments (Figure 2) was predominantly achromatic, with variations of gray. Colors were visible only in support equipment, such as blue balls, bed linens in shades of green, and beige wooden furniture. Since they were located in the same hospital, the environments followed a standard color scheme for ceilings, walls, doors, and furniture, consistent with the other hospital spaces, without any particular distinction.

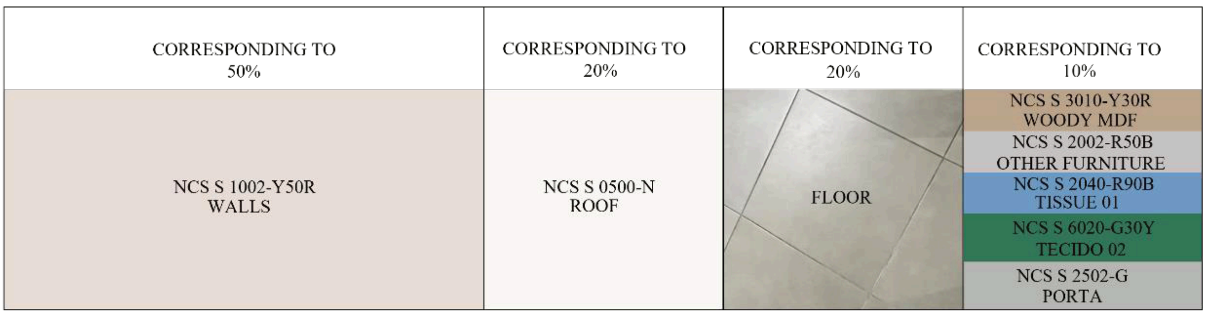
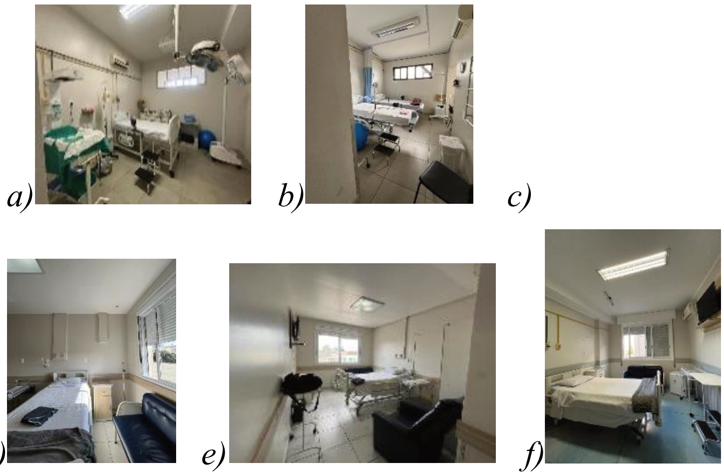


Figure 1: Chromatic palette found in the environments analyzed

The general lighting came from windows and ceiling fixtures with cold-colored lamps, without the possibility of adjustment. One of the rooms (SUS) had a window facing only another room in the hospital, with no external view. In the private rooms, the situation was slightly better, with the presence of windows that allowed natural light to enter and offered a view of the outside, creating a somewhat more welcoming atmosphere. However, the general lighting, still provided by cold-colored lamps without a dimming option, limited control over the lighting ambiance, which is essential for visual and psychological comfort. The introduction of spotlights and focal lamps in some rooms was an improvement, but the lack of flexibility in the intensity of the general lighting remained a significant limitation.



a) b) c) d) e) f)

Figure 2: Analyzed birthing environments: a) Room 2; b) Ppp room; c) Room 1; d) Room 2; e) Room 3; f) Room 4.

The overall assessment of the birthing location revealed a diversity of perceptions among the interviewed parturients, highlighting a wide range of experiences and feelings associated with the birthing environments. Several parturients described the birthing environment as frightening, cold, and impersonal. Participants mentioned that Delivery Room 2 (SUS) seemed primitive and cold, both in terms of temperature perception and overall visual atmosphere. The lack of warmth and the sense that the PPP room (SUS) was just another place within the hospital environment, without visual elements to make the space more welcoming for the mother, were emphasized.

The absence of vibrant and warm colors and the overall aesthetic of the environment were criticized by many parturients, who described the spaces as intimidating, visually cold, and impersonal due to the lack of decorative and attractive elements, not offering visual stimuli that promoted calm and tranquility during childbirth.

Although the size of most rooms was considered adequate, the poor lighting was a frequent complaint, causing discomfort and a demand for adjustable options.

4. CONCLUSIONS

The research demonstrated that the aesthetics of birthing environments, including the lighting and colors used, play a crucial role in the experience of parturients. The lack of vibrant and warm colors, combined with the predominance of cold and impersonal lighting, contributes to an atmosphere that is often perceived as intimidating and cold. The SUS delivery rooms, in particular, were seen as less welcoming due to the absence of decorative elements that could humanize the environment. In contrast, the private rooms, although also presenting limitations in lighting flexibility, offered a slightly more positive experience, mainly due to the presence of windows that allow natural light to enter.

These findings reinforce the importance of birthing environments that carefully integrate decor, color, and lighting to create a more welcoming and humanized space. Improvements such as the introduction of warmer colors, the possibility to adjust light intensity, and the addition of pleasant visual elements can transform these spaces into environments that promote the well-being and emotional comfort of parturients. Therefore, when considering future interventions, it is crucial to focus on creating environments that not only meet technical and safety requirements but also provide a more positive and welcoming experience for all women, respecting their physical and emotional needs during childbirth.

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Investigate the Preference and the Expectation of Chinese Male Skin Colour for Generation Z

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ABSTRACT

A trend of "neutral sex look" for Chinese celebrities dramatically influences the appearance preference of Generation Z in China. Also, the rise of male makeup influencers has led to the widespread acceptance of male beauty products in the market. Researches were carried out to investigate the skin colour preference of females, which assisted cosmetic product development. However, limited research is focused on men. Our previous studies of skin colour preference found that the feminine/masculine beauty concept for Chinese males has changed, and a less masculine appearance is preferred. In this research, we further studied the skin colour preference of Chinese males and investigated the appearance they wanted or expected to be built. Surveys and psychophysical experiments were carried out in this research. There are 223 subjects, aged 19-24, including 135 females and 88 males, participated in this research voluntarily. Firstly, each subject needs to complete a questionnaire about the ideal appearance of Chinese males. Then, he/she participated in a psychophysical experiment that investigated the relationship between skin colour and the ideal Chinese male appearance characters. Twenty-six skin colours were selected based on the skin colour gamut of the Liverpool and Leeds skin colour database. These skin colours were rendered on the face of a Chinese male as the stimulus. Six adjectives that can be used to describe characters with Chinese male appearances were studied. There are two sets of questionnaires designed for female and male subjects, respectively. The survey results showed that both gender groups preferred less masculine appearance, which inferred that they were more civilized. The female group is more focused on the details of the appearance than the male group. The psychophysical results revealed that the preferred skin colour of females and males were different. The female group is more sensitive to the yellowness of the skin than the male group and considers skin colour with high yellowness to be less preferred. Both groups showed that redness is closely related to masculinity. The results reveal the beauty concept of Generation Z in terms of skin colour. The agreement and disagreement between the males and females of Generation Z regarding expected Chinese male appearance are delineated.

1. INTRODUCTION

Skin colour is considered to be an important factor in facial preference judgment, and many researchers revealed the relationship between skin colour and judgments. Most of the research was focused on the "beauty of the women's skin colour", a small number of studies were focused on males' skin colour. The reason behind this circumstance can be the needs of the cosmetic market, where females are the target consumers. Since the "neutral sex look" for Chinese celebrities dramatically influences the beauty trend of Generation Z in China (Wen 2021), they are no longer considered to be the only group concerned about skin colour. With male make-up influencers becoming trending, cosmetic products for males become popular (Lau 2018). In our previous research, we found that skin whiteness is a critical factor for the Chinese male facial image preference, especially for Generation Z (Wang 2022). They were greatly influenced by online social media and tried to be a part of the beauty trend. For the last decade, the China culture tide movement let young Chinese start to reconsider their "identity". They try to seek a match of inner and outer beauty from past densities. Instead of becoming a "xiao xian rou", they try to appear like someone with an elegant personality of the past. In this study, we try to further investigate the beauty of Chinese males' skin colour of Generation Z. We try to find a clue from this study what kind of appearance they wanted or tried to build.

2. EXPERIMENTAL DESIGN

2.1 Subjects and Stimuli

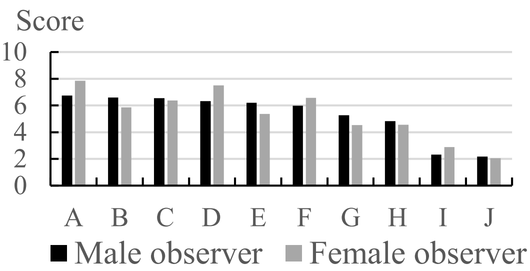
A total of 223 participants, including 135 females and 88 males, aged 19 to 24, voluntarily took part in this study. Six terms were selected to be examined, including youth, healthy, likeable, masculine-feminine, “Wen” and “Wu”. “Wen” and “Wu” are two traditional characters of Chinese males. The Wen can be referred to as delicate, scholarly and gentle. The Wu can be referred to as masculine, cheerful and forthright (Louie 2022). The stimuli were a Chinese male facial image with skin colour that was selected from the Liverpool and Leeds skin colour database (Wang 2019). Twenty-six skin colours were selected and used to generate stimuli.

2.2 Research Process

This study includes a survey and a psychophysical experiment. For the survey, two sections were included. One is to investigate the opinions of males using cosmetic products. Another is about the image of an ideal male. The psychophysical experiment was carried out in a dark room. A calibrated monitor was used to carry out the experiment. The subject took a colour blindness test first. Only the one who passes the test shall join in the experiment. Each subject was signed with an experiment ID number to log in to the survey and experiment system. The subject needs to adapt to the dark environment for at least 5 minutes before conducting the experiment. The psychophysical experiment includes 325 image sets, which take about 40 minutes.

3 RESULTS AND ANALYSIS

The results of the survey showed that both genders consider the male should apply make-up in some situations, such as formal meetings. The preferences of males or females are consistent. The “radiant and energetic, cheerful and optimistic” male image is the most popular, while the “handsome and stylish” and “gentle and scholarly” images are the least popular, for both genders. Females show a stronger preference for the “neat and delicate, gentle and modest” male image than males. For the males, the “mature and efficient” male image is preferred (see Figure 1). Overall, both genders prefer male images with neutral terms and descriptions. the terms related to masculine or feminine which are used to describe a male image are not preferable.



A: Radiant and energetic, cheerful and optimistic
B: Spirited and efficient, calm and composed
C: Mature and steady, with a reserved demeanor
D: Neat and delicate, comfortable and appropriate
E: Full of heroic spirit, with a broad and simple manner
F: Gentle and elegant, kind and considerate
G: Physically robust and strong
H: Dashing and debonair, straightforward and carefree
I: Handsome and stylish, with a trendy and cool appearance
J: Gentle and scholarly, refined and courteous

Figure 1: Score of the discretion of male images for male and female subjects

The psychophysical experiment results showed that the disagreement between male and female results occurs in the high whiteness skin colour ranges and low whiteness ranges. Female results showed a stronger attitude change than the males. And females are more sensitive to the hue angle changes. The results also showed that reddish skin appeared younger and more feminine (see Figure 2).

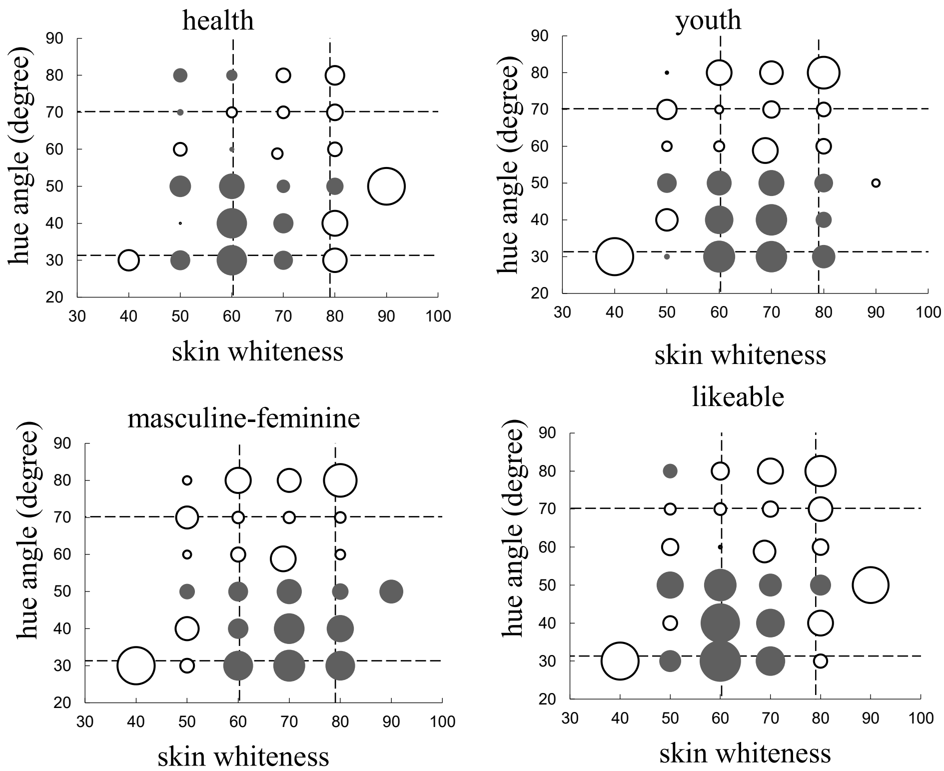


Figure 2: Bubble chart of male skin colour vs youth, healthy, likeable, masculine-feminine

The “Wen” appeared to be stronger at high whiteness and a reddish skin colour region. The “Wu” was found to be low in skin whiteness, and appeared with high redness or yellow. Skin with maximum redness or yellowness can enhance the masculinity of the male image. For the skin whiteness equal to 60 and the hue angle ranges from 30 to 60 degrees (the orange bubbles), the Wen and Wu are no longer affected by skin colour (see Figure 3). Compared with “Wen” and “Wu”, the “Wen” skin colour was the one with skin whiteness equal to the average of the male group and with a reddish tone. When the whiteness moves to the high/low whiteness section, and the hue angle moves towards the yellow, the male appears to be more “Wu”.

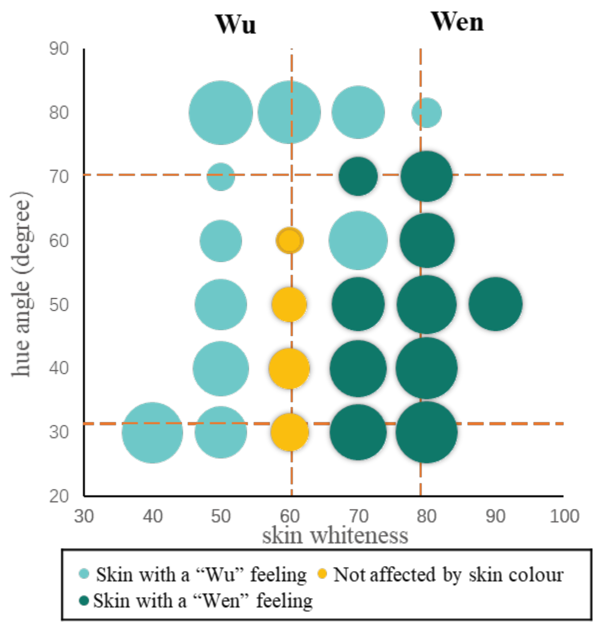


Figure 3. The skin colour and Wen and Wu

4. DISCUSSION AND CONCLUSION

This study presents further research on the Chinese male skin colour preference of Generation Z. A survey and a psychophysical experiment were carried out to investigate Generation Z's options of the male wearing make-up and the relation between skin colour and description terms. The study results show that both genders preferred the neutral sex appearance of males. revealed that the preferred skin colours of females and males were different. The female subjects are more sensitive to the hue angle changes than the male. The traditional character "Wen" and "Wu" results show that Generation Z has a limited agreement with the traditional idea of male aesthetics. They combined the "yin-yang" philosophy with the "Wen-Wu" concept, which formed a neutral sex view of male aesthetics. This represents a significant break from traditional male-centred narratives, resulting in a fresh approach to contemporary judgments of male appearance.

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Colour Literacy Project Beta-testing: Report from St Teresa Partner School

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ABSTRACT

St Teresa RC Primary School in Irlam, UK is the first partner school to complete two series of teacher trainings during the beta-testing phase of the Joint ISCC/AIC Colour Literacy Project (CLP). Designed to test a new, foundational, interdisciplinary colour curriculum, the goal of this first phase of the project is to update teachers on core concepts related to colour education in the 21st century. In 2020, following the start-up of the project, St Teresa's was nominated as a partner school by Colette Harrison who volunteered to act as the CLP coordinator for the school. With the full support of the Head Teacher, Sandra Burgess, the school initiated a pre-survey assessment of the children's colour knowledge at each grade level, scheduled the first series of combined teacher and staff trainings, and arranged for CLP materials and resources to be sent to the school. This paper reviews the preliminary results of the school's past four years of engagement with the CL. The effectiveness of the CLP approach at St Teresa's School can be seen not only in the growth of knowledge about core colour concepts but also in the student's expanded vocabulary and use of descriptive language. It was also refreshing to observe the teacher's and student's willingness to experiment, play and explore as part of the learning process.

1. INTRODUCTION

St Teresa RC Primary School in Irlam, is a one form per year school, in a small post-industrial town at the edge of the city of Salford, NW England. Children start in Nursery at age 3 and graduate in year 6, aged 11. Staff consists of the Head Teacher, 8 teachers, 9 teaching assistants and 4 support/admin staff. Average class size is 30. In addition to teaching a year group, each teacher has school-wide responsibility in a specific subject area. The school encourages a variety of approaches to capture the imagination and potential of each child. The teachers strive to build transferable skills and knowledge, while developing the student's confidence to discuss their thoughts and share ideas about the world around them and beyond.

In 2018-2019, in light of recent changes in the National Curriculum, the Head Teacher of the St Teresa RC Primary School instigated a full-curriculum review. After many meetings and much discussion, the teachers and staff responsible for Art3 decided to implement a new approach focused on exploration and experimentation.

To support the aims of the new curriculum, the School participated in the first phase of the Colour Literacy Project from 2020-2024 and joined the UK based Access Art group in 2019.

The new curriculum recognized the need for both students and teachers to 1. develop skills in noticing their surroundings and observing closely, 2. realise that mistakes are vital to discovery and understanding, and 3. prize developmental steps as much as final outcomes.

2. METHOD

The CLP foundations team facilitated virtual teacher trainings in the spring and fall of 2020 and in the spring of 2021 during meetings of the whole staff of St Teresa's. To prepare for the training sessions, the school staff met with the CLP team informally via Zoom, to watch David Attenborough's Life in Colour together in the April 2020. The documentary sparked many questions and set the stage for the training sessions to follow. The project mailed sets of colour tools that are required for the beta-test exercises to the school. The set included a tile sorting set, LED flashlights, a set of filters and other materials used in the exercises.

2.1 Teacher Training Sessions

The teachers and staff participated in the first two CLP series consisting of 3# virtual training sessions in 2021 and 2022. The format for each session included short presentations by the Colour Literacy team accompanied by hands-on activities. The two series together totalled 14 hours of professional development focused on expanding colour education as an interdisciplinary subject. During the training it was made clear that the purpose of the exercises is to provide foundational colour knowledge for the teachers so that they are able to more confidently design their own age-appropriate programs for the children.

The teachers completed the first set of training, the Eye Opener Series, during staff development sessions in the spring of 2021. The Eye Opener Series is aimed at expanding colour vocabulary and illustrates, at a very simple level, the complexities of colour perception and how colour is always contextual. Regardless of their background and colour experience, the teachers approached these exercises with fresh eyes. They found that their eyes were opened as they either experienced something new, re-framed a familiar idea, refreshed their past learning, or finally understood a longstanding puzzle.

The second set of training, the STEAM (Science, Technology, Engineering, Arts, and Math) Series, spanned the fall of 2021 and the winter of 2022. The STEAM Series exposed them to the more technical, scientific aspects of colour. Once again, the hands-on interactive experience with things like colour filters, LED flashlights, and colour mixing media thrilled them in ways that they did not expect out of a set of science and technological exercises. These training sessions revealed how the power of observation, critical thinking skills and deductive reasoning skills enhanced the teachers' colour knowledge in a surprisingly wide variety of ways.

All the teacher training exercises provided an experience-based approach that emphasized looking and describing colour experiences for building foundational colour knowledge. The spirit of investigation and the encouragement of free play stimulated creativity and perceptive thinking. These training sessions were 90 minutes long at the end of the teachers' day, yet they sincerely enjoyed every minute of it. They were fully engaged and invested in performing all exercises with focused purpose to learn the concepts while laughing and gleefully enjoying the hands-on experiences.

Figure 1 Sorting Household Items

Figure 2 Image of Teacher Training

2.2 Baseline Colour Vocabulary Assessment

Before attempting to share their newfound colour knowledge with the children, the Headteacher asked staff for a baseline bench-mark assessment of colour vocabulary usage from a sample of children from each class in the school. (Ages 3 to 11). A few simple questions were devised to partner a reduced sample of Hue Families from the tile sorting set. Children were asked to organise tiles into related groups and share any names for the different colours and character types. Results of the pre-test showed there was little vocabulary expansion from the youngest to the oldest children. In addition, teachers realised their own use of colour language had been quite limited before the teacher training and looked forward to sharing their expanded colour knowledge with their classes.

2.3 Colour Literacy in the Classroom

Following the teacher training, the teachers extended what they learned and made it their own by developing new colour activities at age-appropriate levels. Amazingly, they found that they were able to engage the students across all the ages in experiments and discussions about colour in many subject areas.

Year 5

Figure 3 Image of Mood Clock

Year 5

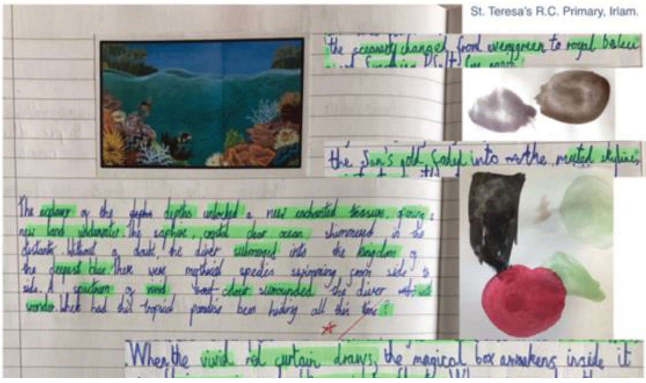

Figure 4 Cross-curricular use of colour vocabulary

2.4 International Colour Days

At the end of the final STEAM session in February 2022, the teachers at St. Teresa's voted to celebrate International Colour Day (ICD) school wide in each of the classrooms. The success of this special day led to the decision to celebrate ICD in both 2023 and 2024.

The International Colour Days have been great fun and looked forward to each year. All teachers and teaching assistants are involved. The children usually wear uniforms, but on Colour Days the school is uniform free and full of colour!

Figure 5: Exploring Colour in 3D

Figure 6: Exploring Light and Filters

3. RESULTS AND DISCUSSION

In 2024, the school conducted the same baseline colour vocabulary assessment from a sample of children in each year group (the same children as previously interviewed where possible). There were clear signs of an increase in developing colour vocabulary, as the children moved up through the school.

In recent feedback sessions with the teachers and staff, the need for an appropriate glossary of terms was stressed by staff. The CLP Team developed an accompanying glossary for the exercises with both "new" and "old" terms connected to concepts. One teacher found the students expanded awareness of colour so valuable that they have requested a colour resource box to sit in the middle of the student's ganged tables, accessible for all lessons.

Reflecting the strong impact of CLP in the school, the 2024 graduating class requested, and were given, a colour description tool to use as a personal reference at their next schools.

4. CONCLUSIONS

St. Teresa's recognises an effort towards consistency in terms of our expanded colour viewpoint, requires a whole school approach. This is why all teaching and assistant staff are involved. New staff will require some support and colour training.

The Head Teacher and Senior Leadership Team have valued the expansion of colour vocabulary and an emphasis on looking closely to feed other curriculum areas. Thus, they have requested a further curriculum review to highlight opportunities for colour work/discussion in all curriculum areas. This is to be added to long term subject plans over the next academic year 2024-2025.

The most important conclusions from the beta-testing at St Teresa's is that learning colour in the 21st century is fun for both teachers and students and that experiential learning helps get the message across in a way that sticks!

ACKNOWLEDGEMENTS

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21st Century Colour Education: A Student's Point of View

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ABSTRACT

This paper reviews the results of the workshop "Colour with Purpose", based on the approach proposed by the Colour Literacy Project (CLP 2024), from the perspective of the two students who assisted in organizing the workshop. It took place in Brazil at the Fluminense Federal University (UFF) and is part of the "Colour Applied to Design Extension Project" at the same university, The workshop was organised within the Industrial Design course, at the Department of Design and Technology of the School of Engineering. The idea of developing this project came about after realising that there was no specific course on colour at the university. Throughout 2023, the extension project team (professor and two students) studied the book "Colours in the Visual World" by Harald Arnkil (2013); and held fortnightly online classes with Robert Hirschler, both members of the CLP team. The result was the development of the workshop, bringing learning closer to the reality and professional needs of product designers. The event lasted four hours and was divided into theoretical and practical parts. The first part dealt with colour fundamentals as developed by the CLP, and concepts such as colour characteristics, White's Illusion and Koffka's Ring, the latter two being the target of exercises applying theory to practice in part two. The application of the practical exercises was generally positive, but it was possible to observe difficulties in carrying out certain aspects of the exercises, revealing the need to extend the duration of the workshop to that of a short course, allowing the students more time to learn and develop the knowledge acquired. The main goal of such a course is the training of design professionals equipped with knowledge of concepts and topics that will make a difference in their professional areas.

1. INTRODUCTION

This article discusses the inclusion of formal colour teaching in higher education design courses, highlighting the need to update methods as proposed by the Colour Literacy Project (CLP). The CLP is a joint initiative between the Inter-Society Colour Council (ISCC) and the International Colour Association (AIC) and advocates for a hands-on, experiential approach to colour education.

Here are presented and discussed the results of an extension project conducted at UFF in 2023, as part of the undergraduate Industrial Design course entitled "Colours Applied to Design". This initiative marked the beginning of a long-term study aimed at developing a course on colour. In collaboration with Dr. Robert Hirschler, co-chair of the CLP, the CLP philosophy could be explored through online classes, during which valuable insights and an up-to-date bibliography on the teaching of colour were provided.

In view of the above, an extension project was used as a space to develop a course on colour, based on the most recent precepts in the field, according to the CLP. The project, currently underway at UFF's Department of Design and Technology, ended its first cycle in 2023 with the workshop "Colours with Purpose" and, despite its long-term nature, is already showing positive results that are in line with its main objective.

2. METHOD

The first steps consisted of a bibliographical survey on the theory and practice of colour and fortnightly meetings with the co-chair of CLP, a specialist in the subject. Divided into three stages, the process included: 1. studying the book "Colours in the Visual World" by Arnkil (2013); 2. online classes; 3. organizing the workshop.

The process began with a survey of bibliographic material about colour, followed by a filter focused on the relationship between colour and design. Arnkil's book was chosen at the recommendation of the CLP. As the book was only available in English, one of the students translated and summarized each chapter, helping to develop a basis for the content.

Through the online classes the project team was able to learn about the concepts, research and experiential approach covered by CLP, as well as its six tenets. We carried out the exercises created by the CLP that taught about how colours are contextual and influence each other when placed side by side. At that moment, the design professor had the idea that it would be interesting to use product shapes, such as furniture and clothing, instead of generic shapes; this way, colours could be applied with a defined goal. That's how the name of the workshop was born. The last stage consisted of planning the workshop and preparing the presentation and practical activities. The focus was on the topics of White's Illusion and Koffka's Ring, as well as simultaneous contrast and the laws of Gestalt.

To facilitate the understanding of White's Illusion, a series of illustrations were created for the class. Additionally, a physical model was constructed to assist the student's comprehension. This model was made by cutting 15 parallel and equidistant lines into a black sheet, with 8 of these lines painted white, alternating between black and white. Then, two identical figures were cut out of orange paper and positioned so that one passed over the black lines and the other over the white lines. The result was a physical display of White's Illusion that can be changed and interacted with, as illustrated on *Figure 1* (left).

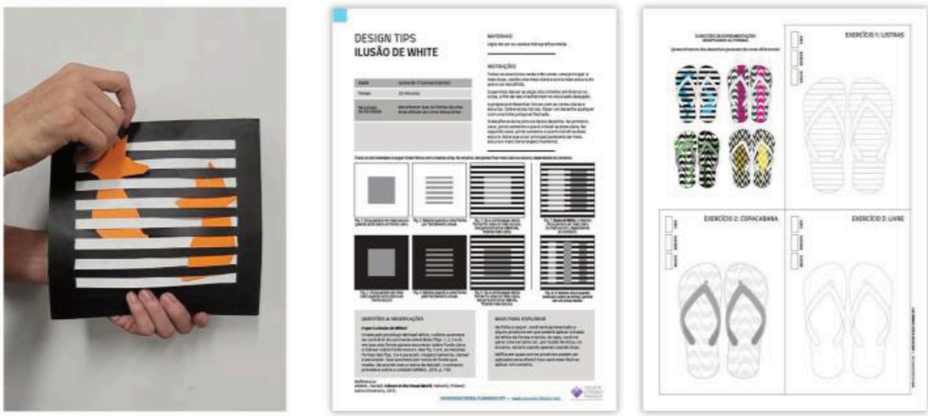

Figure 1: White's illusion kit: physical model; instructions; exercises.

To adapt the exercises proposed by the CLP to meet the students' needs, three pairs of sandals figures were used. The first pair had stripes drawn in parallel, following the example of White's Illusion. The second, had a Copacabana beach sidewalk pattern. The third, was left blank for the students to create their own patterns. The first step was to lightly draw the same shape or silhouette on both sides of the sandals and, with a marker, paint black stripes, paying attention to paint over the drawing on side A, and around the drawing on side B. After erasing the drawing from the white lines of B, the students painted the figure with their chosen colour, completing the illusion. The same process was followed on the other exercises, with the third one allowing the participants to decide their own striped pattern (*Figure 1,* right).

The CLP's graphic exercise format (*Figure 1* middle) was maintained for its didactic structure that estimates the time required for the activity, indicates the necessary materials, and provides detailed instructions. The exercise may eventually be offered for inclusion on the

Project's website, as a way of repaying for the knowledge and help given. The instructions were translated to Portuguese, with more detailed explanations condensed into just two black-and-white sheets per student. This optimized the space and reduced the amount of paper used, making the project economically feasible at a public university, and contributing to less waste production.

For Koffka's Ring, two sheets were prepared, the first with the theoretical explanation and the second with three independent exercises: a piece of furniture that opens and closes a door, a pair of sandal slides that move apart and come together, and a coat that opens and closes its arms, showcasing the illusion in different and creative ways. The drawings were also made with folding and cutting instructions and, just like with White's Illusion, it was included with small squares for the students to plan the colours before painting. The ring was used only in the first case, for the other examples, the students were free to test different shapes beyond the ring (*Figure 2*).

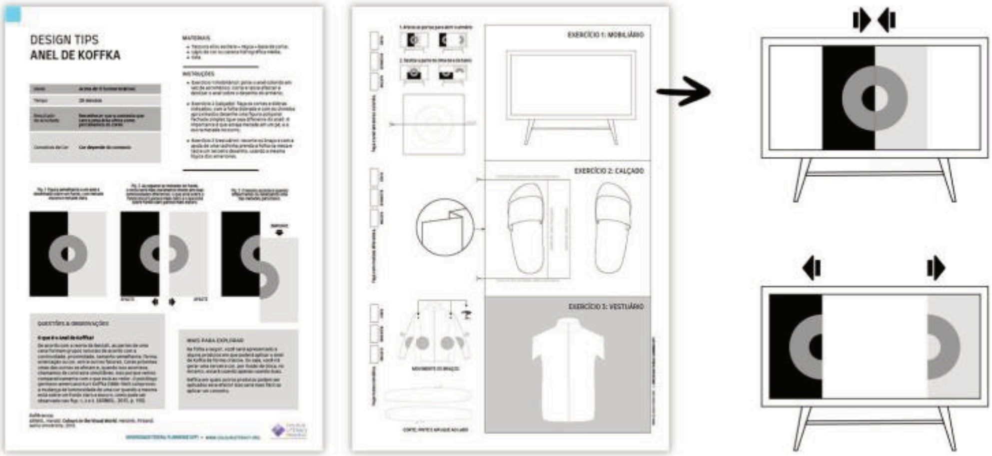

Figure 2: Koffka's ring kit: instructions; exercises; zoom in on exercise 1.

Changing the structure of the experiments without breaking the illusions required several changes and tests, making it possible to determine the level of complexity required and the time needed. During the development, some colleagues were enlisted and tasked with testing the exercises, those tests were timed to better understand the time to be allocated for the assignments. In order to facilitate the completion of the exercises and to guarantee that the illusions would work, the participants made use of an Instagram camera filter called "Noir" (Sugiarta, 2023). This filter turns coloured photos into shades of grey, making it easier to check the colour lightness, and choose pencil colours that contrast with each other.

3. RESULTS AND DISCUSSION

The "Colour with Purpose" workshop occurred on November 23, 2023, from 2 p.m. to 6 p.m. in a specialised classroom, located at the UFF School of Engineering, and was attended by ten students. The project team wrote down the workshop schedule to guide both the team and the attendees at each stage. In the theoretical section, each team member was assigned with different topics. For the practical section, colouring tools were provided as well as printouts, two of which were written instructions on White's illusion and Koffka's ring in case consulting was needed. Among the exercises, the students were most enthusiastic about the Koffka's Ring jacket and White's Illusion sandals.Some saying that they only believed once they saw it happen on paper and with the physical model rather than on a screen.

To conclude, a form was created to collect the participants' impressions at the end of the workshop. The students were unanimously positive about the theory and practice. Half of the respondents said they had not been familiar with the subject, while the other said they had known it partially. Part of the class said they had never thought about colour from the point of view presented, stating that they would be able to apply the content learned, proving the need and effectiveness of a course on the subject of colour, with participants also expressing a desire to learn more on the subject.

4. CONCLUSIONS

The preparation of the exercises proved to be one of the greatest challenges, both in maintaining the integrity of the illusion and in applying it to design in a practical rather than aesthetic way, as well as in introducing concepts that were appropriate for the syllabus and class duration. However, the material brought some unforeseen questions, such as the interaction with ill-defined concepts and disagreements in word usage, mainly on the terms describing the three dimensions of colour, for which the team was unprepared. Despite the efforts to create smaller drawings, the time still felt constrained.

Transmitting and disseminating this knowledge also proved to be challenging, as the subject can seem complex to observers, with many viewing the study of colour as merely psychological. However, the CLP's model of experiencing colours first was essential and effectively implemented during the workshop, providing students with a tangible understanding of the phenomena. It became clear that the subject is extensive and that offering a specific course would be valuable to allow more time to explore and delve into issues that designers could apply in their projects.

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AET 339 Color Literacy: A Pilot Course in Color Education

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ABSTRACT

This paper provides an overview of AET 339 Color Literacy, a pilot course taught at the University of Texas at Austin (UT) in Spring 2024. Developed in collaboration with the Colour Literacy Project (CLP) and based on the core concepts of the CLP Cornerstones (Describing Colours, Experiencing Colours, Perceiving Colours, Working with Colours), AET 339 is the inaugural post-secondary course to align with the Project's mission: recognizing color as a meta-discipline that bridges the sciences, arts, design, and humanities in order to meet 21st century challenges and opportunities. The course explored color literacy as a foundational skill set designed to expand students' understanding of color science, its cultural significance, expressive power in visual storytelling, and its integral role in creative industries. This overview examines the course structure, content, and student experiences to highlight its effectiveness as a vital meta-disciplinary color learning model.

1. INTRODUCTION

Offered through the UT Department of Arts and Entertainment Technologies (AET), AET 339 Color Literacy was designed and team-taught by Luanne Stovall, UT Lecturer and member of the Colour Literacy Project Steering Team, and Dr. Honoria Starbuck, UT Professor and AET Foundations Lead. The AET program equips graduates with the technological mindset needed to create meaningful experiences in both physical and digital spaces. AET students hone their storytelling tool kit across the fields of visualization, sound, games, live event technologies, and immersive media. Structured within UT's Learning Management System and delivered in the classroom to thirty-five undergraduate students, AET 339 consisted of four modules: Color Perception, Color Interaction, Color Psychology, and Color Design. The approach was grounded in students' direct experience of perceiving, judging, comparing, using, and appreciating color phenomena. Due to the success of the AET 339 pilot, the course will be offered in Spring 2025.

2. INSTRUCTIONAL DESIGN

Curriculum design fostered a dynamic learning environment in which students applied scientific principles to creative endeavors, culminating in essential visual communication skills.

2.1 Module Design

A key goal of AET 339 was to bridge the gap between artistic and scientific approaches to color. This was achieved by four modules that integrated theoretical knowledge with practical application and fostered creative exploration grounded in scientific principles.

The Color Perception Module employed a scientific lens to investigate the interplay of light, matter, and human perception. Students engaged in a color perception lab using Miro, a digital whiteboard, to research and collaboratively create visually compelling educational posters. A follow-up exercise explored color perception across species with implications for visual storytelling for non-human characters. (CLP Cornerstone: Perceiving Colours)

The Color Interaction Module provided students with hands-on experience through color interaction labs. Using tools such as the Color Compass (Divers 2023), students explored proportional color relationships and how the juxtaposition of colors influences perception. Activities included sorting colors according to lightness and chroma, then analyzing resulting perceptual shifts. Site visits to the Blanton Museum's installation design lab and a lighting lab in Payne Theater exposed students to color literacy tools and techniques in action. Students emphasized how these site visits transformed their approach to design. (CLP Cornerstone: Describing Colour)

The Color Psychology Module examined color's cultural and historical significance, exploring how interpretations vary across contexts. One collaborative exercise challenged teams to create and pitch a poster showcasing a set of 7 colors. The assignment required a name for the palette, a thematic image, theme-related color swatches with hex codes, and a compelling story. The pitch also included a description of the target audience and a fun team photo. Students explored the psychological effects of colors by applying color literacy skills to create visually cohesive designs. (CLP Cornerstone: Living in Colour)

The Color Design Module featured a final project in which students created a two-minute animated visual expression sourced from their weekly Color Diary and their learning journey through the three core modules. In their final project, students applied their cumulative knowledge of color science, color interaction, and color psychology to craft visual narratives expressing their personal creative voices. (CLP Cornerstone: Working with Colour)

2.2 Pedagogy and Assessment Design

AET 339 wove together diverse teaching methods, including lectures, guest speakers, site visits, discussions, readings, collaborative teamwork, and hands-on labs. Assessment methods included pre- and post-course surveys, daily open-ended questions, graded online color diary entries, reading responses, and a conversational exam following each module. Student-empowering conversational exams were designed to integrate assessment seamlessly into class discussions. Each conversational exam showcased students' open-ended questions and enhanced students' understanding of course material. Students also gained confidence in their communication skills, particularly in relation to design vocabulary and module concepts. Exam scorecards encouraged self-reflection, vocabulary development, and active participation in group discussions, contributing to a richer learning experience and potential for career success.

> This class has helped me in expressing myself with more intention and confidence. The difference between my first oral exam and my last is staggering. I'm able to speak my thoughts much easier now and performing meaningful analysis and conversation no longer seems so intimidating. (Course Evaluation Survey, Spring 2024)

3. RESULTS AND DISCUSSION

3.1 Student Perspectives

The university's Course Evaluation Survey revealed positive student feedback on several aspects of the course. Students valued the personalized teaching methods and supportive learning environment. They found the conversational exams particularly effective in fostering critical thinking skills and profoundly appreciated color's fundamental impact on design. Students felt empowered by their newfound abilities to wield color literacy skills.

> …the use of the exams is very innovative and interesting, I love it! It makes us apply knowledge we have and even think outside the box into possibilities we never considered, it definitely helped me learn more. (Course Evaluation Survey, Spring 2024)

> One aspect that helped me was adopting a curious mind and thinking more broadly about our relationship with color and our base understanding of it. (Course Evaluation Survey, Spring 2024)

3.2 Call to Action

We are issuing a call to action to ignite a global movement in 21st century color literacy at the post-secondary level. The AET 339 and the Colour Literacy Post-Secondary teams continue to develop meta-disciplinary materials to share with educators around the world. Educators across the fields of art, game design, fashion, marketing, architecture, social sciences, and beyond are invited to join the initiative to cultivate a generation equipped to wield the power of color in our increasingly visual world.

4. CONCLUSIONS

Through a dynamic blend of evolving research and theories, hands-on experiences, and creative projects, the course provided students with a fundamental understanding of color perception, interaction, psychology, and design. AET 339 Color Literacy successfully positioned color as a multifaceted discipline with practical applications. The positive student feedback, coupled with the course's innovative structure and assessment methods, establishes AET 339 as a model for future color literacy programs in higher education.

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Pursuing Terminological Consistency of Colour Attributes in the Portuguese Language

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ABSTRACT

The present study is part of an academic project aimed at reviewing and analysing the literature on colour in Brazil and Portugal, to understand and unify the various nomenclatures and definitions found in the Portuguese language for the field. The final goal of the project is to propose a Brazilian standard on colour terminology.

The main contribution of this study is to initiate a more consistent and effective dialogue among those who use colour in their professional activities, whether designers, artists, graphic producers, advertisers, or communicators. We argue that if students and professionals encounter more consistent literature on colour, the subject will be seen with the seriousness it deserves while avoiding possible communication breakdowns among peers.

1. INTRODUCTION

Verbal colour communication is well-nigh impossible: colour is a pre-verbal, visual phenomenon. It must be perceived (and enjoyed) subjectively; and perceptions are individual. However, both in our everyday communication, and even more so in teaching, we must express verbally all the different aspects of colour and try to convey what kind of colour we are thinking of. Of course, showing a physical example of the colour we have in mind makes the communication far more efficient, but this is not always possible.

We may take one example to show how linguistic inaccuracies occur in one language and are then taken over in translations. Luria (1974) tries to illustrate the problem by saying that "the human eye can distinguish up to two or three million different ***hues*** (цветовых оттенков), but a human being has only twenty or twenty-five ***color*** names (названий цвета); a person perceiving a particular ***hue*** (оттенок) isolates its primary feature and assigns it to a ***color category*** (цветовой категории)[1]." Here the author makes the very common mistake (present in many languages) of confounding "hue" and "colour" – which are not the same. Confounding these two terms has been duly carried over also into the Spanish (Luria 1997) and Portuguese (Luria 2005) translations as *matiz* and *cor/color*.

This one example illustrates that colour terminology is far from being unambiguous, and although there are some terminology standards in English, they are also problematic. The aim of our terminology project is to collect and discuss some of the most important colour-related words in Brazilian and some Portuguese standards, dictionaries and in relevant literature sources; discuss the possibility to eliminate – or, at least, diminish – unambiguities and suggest a list of words with definitions to be included in a future Brazilian standard by ABNT (the Brazilian Association of Technical Standards).

2. METHOD

The first step of the project was the collection of colour-related terms in three classes of sources: (1) Brazilian technical standards; (2) monolingual and bilingual dictionaries and (3) original and translated colour literature in Portuguese. The next step was the evaluation of the terms and their respective definitions in discussion with a team of colour specialists, and the third step will

[1] English translation Luria (1976)

be the recommendation of preferred usage. Where possible, the suggested definitions will be compared with the English equivalents which can be found in the few authoritative English language sources: the select few of modern books on colour, such as those by Arnkil (2021) and Berns (2019); the relevant ASTM, CIE and ISO standards, the web site of Briggs (2024) and the - as yet unpublished – Glossary by the Colour Literacy Project (CLP 2024).

2.1 Brazilian Technical Standards

We could find only three ABNT standards: NBR 11160/ MB-3181 (1989 - withdrawn), NBR 12694 (1992) and NBR ISO 105 J03 (2010) in which some colour terms are defined. NBR 12694 is based on the ASTM D1535 describing the Munsell system, and NBR ISO 105 J03 is a translation of the corresponding ISO standard on the CIELAB and CMC colour difference equations.

2.2 Monolingual and Bilingual Dictionaries

The best-known dictionaries of the Brazilian Portuguese language are the Aurelio, the Houaiss and the Michaelis. Priberom shows both Brazilian and Portuguese usage. We have looked up and compared the definitions / descriptions of the colour words we have found in the Portuguese language literature. Of the many English-Portuguese dictionaries we used the Michaelis, where we started with the English words and noted their equivalent in Portuguese.

2.3 Colour Literature in Portuguese

We have studied the most important textbooks, articles and master's and PhD theses published in Brazil and Portugal, and collected the frequently used colour words, preferably with their definitions[1].

3. RESULTS AND DISCUSSION

In the following we shall discuss our findings on the words describing the three dimensions of colour: Hue, Lightness and Vividness (Chroma/Saturation).

3.1 Hue

Hue is one of the perceptual attributes of colour, judged by its similarity to one of the colours red, yellow, green or blue, or to a combination of adjacent pairs of these colours arranged in a closed ring[2]. In everyday language it is often used in the sense of "colour", and this of course may lead to misunderstandings in English, but also in translations as illustrated above in the Introduction. All three ABNT standards use *tonalidade* for hue, two of them (NBR 12694 (1992) and NBR ISO 105 J03 (2010) as *tonalidade cromatica.* In Portuguese hue is very often translated as *matiz,* but in many references, e.g. in Aurelio (2010) other terms are used as synonyms: *nuança, tom, tonalidade*. Houaiss (2007) also uses these terms as synonyms of *matiz*, but also includes *meio-tom.* Michaelis (2024b) translates the terms as *cor, nuança, coloração, matiz* , thus adding to the confusion of equating hue and colour.

Nuança (nuance in English) has quite different meaning in the NCS system. To make matters even worse, Michaelis explains that *nuança* is "the gradation of a colour"; while *meio-tom* (half tone), which is hue for Houaiss, is the equivalent of lightness. We could continue these examples where the simple term "hue" has half a dozen translations in Portuguese, some of those can also have very different meanings according to other authors.

1 The complete list of these sources is available from the authors on request

2 Based on the CIE e-ILV definition https://cie.co.at/eilvterm/17-22-067

3.2 Lightness

Lightness is the attribute of colour which describes how light or dark a colour looks, for example the greyscale which runs from light (white) to dark (black). It is used to describe coloured objects rather than coloured lights[1].

This is a relatively simple term, and many sources translate it as *luminosidade* (the term used in all three ABNT standards.) However, some authors e.g. Csillag (2015) and Boerboom e Proetel (2020) use *tonalidade* for this concept, which is confusing, particularly because for others (Araujo, 1991) *tonalidade* is the equivalent of hue. And, to make matters even more complicated, the same authors use another word, *brilho* as a synonym of *luminosidade* as well, as if it was equivalent to lightness, but *brilho* is more likely gloss, brightness, or shininess.

3.3 Vividness (Chroma / Saturation)

Vividness is the attribute of colour describing how intense or muted a colour looks, or how close to neutral (achromatic) or far from it a colour looks. Related terms are chromatic strength, purity, intensity. Vividness in the everyday sense is easily understandable and not tied to any colour order system such as Chroma (Munsell) or Chromaticness (NCS), and not as difficult to interpret as Saturation (Hirschler and Schwarz 2023). Vividness was more precisely defined by Berns (2019).

In Portuguese *vivacidade* is not used, this colour attribute is generally referred to as *pureza, saturação* or *croma.* All the three Brazilian technical standards quoted translate "Chroma" (a term used in the Munsell system) as *saturação* – but the two are definitely not the same. Details on the definition and usage of these terms can be found in Briggs (2024). One of the most absurd examples is from the highly acclaimed book by Dondis (1973, 2003). She managed to say that "Hue is the color itself, or chroma…" – a mistake truly translated into Portuguese as *"Matiz ou croma, é a cor em si…"*.

4. CONCLUSIONS

We have illustrated by the few examples above the difficulties of expressing colour terms verbally. In English it is extremely problematic and in Portuguese – if possible – even more so. The problem is two-fold: the concepts are ill-defined, and there is no agreement on the usage of words.

While we cannot possibly solve this problem, we may attempt to improve the situation by making the accepted definitions more widely known and try to select the words which are more widely accepted in the Portuguese-speaking colour community. The final goal of this project is the recommendation to ABNT of forming a standards committee with the purpose of creating a technical standard of colour terminology.

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[1] Based on the definition proposed by the CLP Vocabulary (unpublished)

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Reinforcing Colour Literacy with Colour Games

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ABSTRACT

Games are a fun way to expand colour awareness, to introduce new language and to keep new information alive. Education about colour begins by developing an awareness of the full range of colours that can be seen, learning terms to describe and distinguish what is seen, and recognizing that the colours we see are related in three dimensions. For the Colour Literacy Project, we developed a set of coloured tiles that students sort into groups: colours of the same character, that are pale, dark, muted, or vivid, and colours that belong in the same hue family. We combine the character and hue family terms into a simple naming system – 'vivid red', 'muted green' etc. While the tiles are useful for exercises in sorting, they also lend themselves to use in games. Playing games, where tiles must be placed next to other tiles of the same character, or from the same hue family, helps to reinforce these core concepts. The concepts are further reinforced if the colours are named as a game proceeds. Experience has shown that, without this kind of reinforcement, students typically revert to the limited ideas they held before. We have also developed packs of playing cards in colours of the sorting set that can be used in other games. Feedback from some who have played these games has been encouraging. One reported that she found herself noticing subtle differences between colours that she would once have dismissed as being 'the same'.

1. INTRODUCTION

The foundation of colour literacy is awareness of the full range of colours that can be perceived or imagined combined with an understanding of how colours can be related in three-dimensional space. We have argued elsewhere (Green-Armytage and Maggio 2023) that sensitivity to differences in colour can be diminished when children are taught to name colours and when they are introduced to the traditional colour wheel. Our sorting set has pale, dark, muted, and vivid colours in each of nine hue families and a nine-step grey scale (figure.1). We have explained elsewhere how and why we chose the colours that we did (Green-Armytage and Maggio 2021, 2023). We have made prototype sets of tiles and playing cards with these colours which we have used in sorting exercises and in games. The games serve to reinforce the concepts in an enjoyable way.

Figure 1: Colours in the sorting set for the Colour Literacy Project.

2. THE GAMES

The basic aim of the games is to reinforce the concepts introduced in the Colour Literacy Project. We do not aim to overturn what students may already have been taught, but to offer a richer framework within which 'old knowledge' can be enhanced. There are other games with similar aims. We would like to acknowledge the influence of *The Colour Card Game* devised by Robyn Peacock-Smith (Peacock-Smith and Green-Armytage 2009) and the naming game *Colours of Babel* devised by Dimitris Mylonas (2018).

2.1 Persistence of old knowledge

As 'old knowledge' we include terms for naming colours and the traditional colour wheel. Books to teach children how to name colours, almost without exception, limit the names to the so-called 'basic colour terms': black, white, red, green, yellow, blue, brown, purple, orange, pink, and grey (Berlin and Kay 1969). The colours in a traditional colour wheel are all vivid. The colour wheel is two-dimensional with no place for the pale, dark and muted colours that are prevalent in our surroundings. There is nothing intrinsically wrong with that set of names, or with the colour wheel as a model of colour relationships, but both are limited as well as limiting. We are advocating a richer model of colour relationships in three dimensions, with a corresponding system of naming, that can help students to gain a wider appreciation of colour and the range of descriptive possibilities. Such a model can be a steppingstone to more advanced studies. It can also provide a framework for evaluating processes for mixing paints, inks, and lights as well as theories of colour combination and colour harmony. Our experience has been that students may respond initially to this kind of new information but typically revert to old knowledge in later tasks. As an example, a group who had been introduced to the set of colours in the sorting set, and the corresponding system of names, did not use the expanded naming system on a later occasion, but reverted to the basic colour terms when asked to name the colours seen in their immediate environment.

2.2 Reinforcing new knowledge

The aim of the games is to reinforce 'new knowledge'. Knowledge can take many forms. Here we are concerned with three aspects: 1. knowledge that comes from looking closely at a large number of different colours, 2. knowledge of how colours of the same character and from the same hue family are related in three-dimensional space, and 3. knowledge of a simple naming system that can be a bridge from the limitations of the basic colour terms to the precise notations of a colour order system. The more students play, the more will they retain the new knowledge and be able to see how the old knowledge relates to the new.

All the games involve looking closely at different colours and recognizing the ways in which colours are different and yet related. We believe that people will not only have fun playing the games but will also develop greater sensitivity to these differences and relationships as they look more closely at the colours they see in the games and in their environment.

2.3 Colour Naming Game

Similar to the *Colours of Babel* game by Dimitris Mylonas, played at the Munsell Centennial Symposium in Boston in 2018, this introductory game can be played to highlight the difficulty of identifying colours with words. Played in teams of two, each player is given a different subset of the sorting set colours to describe in writing. Team members then take turns to decide which colours are meant by their partners' descriptions. Points are scored for successful matches. The game was first played at an in-person meeting of the Colour Society of Australia in March 2019. In 2020, it was successfully played in 'virtual rooms' during the online *ISCC Color Impact 2020*.

2.4 Colour *Dominoes* Games

Two games to reinforce the concepts of colour character and hue family were introduced at the national conference of the Colour Society of Australia in October 2023. The games have similarities to *Dominoes*. In the first game players build a sequence of tiles where each tile that is added must match the character, or be from the same hue family as the previous tile. This is the simplest of the games and can be played immediately after students have completed the sorting exercises. It is a good way to reinforce the concepts of character and hue family while the experience of sorting is still fresh. In the second game, players each build a separate arrangement where tiles connect with other tiles on up to all four sides. Again, connections can only be made between colours of the same character or from the same hue family, so those concepts are further reinforced. Points are scored for connections made. Completed arrangements will have a distinctive feature: there will be no sharp contrasts between adjoining colours. A muted blue might connect with a muted magenta on one side, a muted orange on another side, a vivid blue on a third side and a pale blue on the fourth side. In each case there will be a visible relationship between connecting colours so that the eye can wander easily from one colour to the next. This second game also offers scope for some strategy and tactics. Players take turns to select colours for their arrangements and can choose colours to thwart the other players as much as to enhance their own scores.

2.5 Colour *Rummy* Game

New sets of playing cards were introduced at a meeting of the Colour Society in Western Australia in early May this year. Two games were played. The first game has similarities to *Rummy*. The aim is to collect sets of three cards that have the same character, are from the same hue family, or are all neutral (black, white, greys). As the sets are laid out, it is easy to see how the colours in each set are related; concepts of character and hue family are made particularly clear as is the distinction between the chromatic and neutral colours. It is also possible to appreciate the aesthetic principle of unity and contrast in colour combinations. For example, colours from contrasting hue families will be unified if all are muted.

2.6 Colour *Uno* Game

The second game is based on the card game *Uno*. Two packs of cards are used. One pack is of plain colours; the other has pictures where one colour is dominant. The picture cards relate the colours to objects in the environment. Players are dealt seven cards and take turns to play a card that has the same character or is from the same hue family as the previous card. If unable to play, an extra card must be drawn. The aim is to go out by playing all cards. Cards with neutral colours are the equivalent of the action cards in *Uno*. A neutral can be played at any time. Other players, in turn, must then draw an extra card. The one who played the neutral card can then play any card and normal play resumes. While this game reinforces the concepts of character and hue family, it strongly reinforces the naming system. As each card is played it must be named. Of all the games this is the most fun.

2.7 Future developments

We are planning to add to the range of colours in the set of playing cards. Four more hue families will mean that there would be 13 cards in each of four 'suits'. Pale, dark, muted, and vivid colours would be the equivalent of spades, hearts, diamonds, and clubs. This would make it possible to play versions of conventional card games. Adding more characters would extend the range of possibilities when collecting colours from the same hue family. Additional hue families and characters would also emphasise the point that the sorting set is simply a convenient set of landmarks in colour space. Many more hue families and characters could still be added in the spaces between the colours in the present set.

3. CONCLUSIONS

Feedback from those who have played the games has been very positive. Some have made suggestions for improvements and simplification. Most encouraging are the comments from players that playing the games has opened their eyes to the rich variety of colours in the world and the subtle ways in which one colour can be different from, or related to, another colour. Although many adults played the games during testing, the games are mainly designed for children. Our principal partner school, where teachers have been helping us develop exercises for the Colour Literacy Project, is St Teresa's Primary School near Manchester, England. Teaching assistant Lorna Greenwood introduced the games to a group of students from years 4 and 5. She reported (private communication) that "pupils enjoyed the game, found it fun, easy to follow and were outwardly excited by the game."

It is too early to judge if the games will achieve our long term aim of expanding beyond the 'old knowledge' and reinforcing the 'new knowledge' that includes the ability to see and describe a full range of colours in relation to a three-dimensional colour system. The key is constant repetition. Playing the games regularly may be the best way to achieve this.

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Teaching Color in a Transdisciplinary Approach between Physics and the Arts

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ABSTRACT

In 2023, a partnership was formed between the Institutes of Arts and Physics of the Rio de Janeiro State University, with the aim of fostering interdisciplinary debates on the topic of Colour Education in order to develop original didactics for teaching color in the most diverse areas and levels. The group's debates provided problematizations and updated perspectives regarding color studies and historical experiments. From the outset, both Newton's and Goethe's spectrum were considered; the study of industrial color systems was integrated with optics; and the cultural approach and artistic and poetic expression of color, integrating specialists from different areas: Physics, Arts and Philosophy.

An important feature in our research is this methodological assumption: a multidisciplinary and collective approach, integrating researchers from different areas interested in the debate about ways of teaching color. In the interaction between these different researchers, it was found that, on the one hand, if in high school Physics classes, more precisely in the study of Light (Optics), teachers do not honor and deepen the teaching of the subject “Color”; on the other hand, for art teaching professionals, understanding ordering systems can help creative professionals to have a systematic understand of the dynamic relationships between colors and reproducibility, for that it is also important to know the objective data as paint codes and notations that present their components and formulas in relative and quantifiable proportions.

Therefore, one objective of the research was to develop a way to stimulate interest in color research and the recognition of the relevance of the topic, both for professionals in the areas of Physics and Arts teaching, and to recognize that in the future, young people might be professionals who will need prior knowledge about “Color” to carry out their professional activities. After 4 months of work, the group decided to develop a didactic proposal for mixing colors in unusual materials and processes to observe the influence of the substrate's characteristics (roughness, base color) on the subjective experience of color through playful experiences.

In order for this proposal to be democratically applicable to all economic strata of society and to engage all types of audiences, we were careful to investigate economically accessible, everyday materials that could still convey the main concepts and promote precise experiences with tones. We have arrived at a proposal for a “slime coloring workshop with synthetic food colorings”, due to their stability and availability. We chose the three shades of standard food colorants closest to the printing industry standard, CYMK, to generate all the mixtures. The workshops were held from December 2023 in a high school class at Colégio Gálatas in Vila Valqueire, Rio de Janeiro. We aim that our proposal will manage to raise young people's awareness of the topic of color and that alternative materials can indeed be effective for the approach to color systematization.

1. INTRODUCTION

Our research group objective was to raise young people's awareness of the topic of color: to bring the main parameters to a broad range of Brazilian students and professionals (from adolescents to adults), making it an accessible and non formal exercise by using affordable materials and a rather simple procedure in order to maximize the results – the broad comprehension of color mixing parameters (hue, saturation, lightness). Starting from a meeting between disciplines – arts and physics, theoretical and practical, we aim to build a colorful didactic workshop that would truly be transdisciplinary, on the border between knowledge. Just as the poet and scientist Goethe managed to criticize the Newtonian proposal: "colors are actions and passions of light" (GOETHE; GIANNOTTI. 2011: 61). We believe that the study of colors should not be based solely on the acceptance of stable norms, but rather on an experimental practice that leads to a philosophical approach: coherent teaching and a constant and curious search. We have put certainties on hold and, by investigating other ways to teach color, we put it into perspective by expanding its academic, scientific and artistic possibilities.

2. METHOD

2.1 Finding the best materials

Our research group worked together for five months, in weekly face-to-face meetings from August to December, 2023. After the first module, a theoretical one, introducing a varied bibliography on color, one of the first exercises was to explore the concept of "facture" following Josef Albers' famous didactic proposition of a "haptic illusion" (Albers, 1975: 08). It consists of putting together very different materials, natural and artificial and observing and discussing their differences in appearance and reflection of light. We increased the exercise by painting with the same material (gouache paint) on those different surfaces, concluding that the color differs (lighter or darker) because of the different levels of absorption of the surfaces. This led us to research colors in very different materials, both the full color of algae candies (dyed with chlorophyll, annatto, anthocyanin and carotene) and natural juices; as well as painted surfaces, such as ceramics painted with underglazes paints.

Figure 1: Facture exercises - the same pain over different surfaces

Some undergraduate color courses usually exercise mixing paints in order to promote an accuracy on color experience. However, usually those are very expensive paints, such the Dutch Rembrandt gouache. Dealing with sophisticated materials made most of the students very tense. We wanted to create a cheap workshop, so that it could be replicated without difficulty. Therefore, when we discovered that artificial food colorings currently have colors very close to those of the graphic printing system, resulting in a very broad spectrum of tones, it seemed to us to be the best solution as a base material for the experiments.

2.2 Formatting and conducting the color workshops

Three shades chosen were the closest to the concept of primaries related to the printing industry standard, CYMK, to generate all the mixtures: tartrazine yellow E 102, brilliant blue E133, and magenta INS 127 – three standard food colorants.

We formatted the workshop with three phases. a first theoretical presentation of the different mixtures in light and mixtures in materials. Then, the challenge was to achieve as many shades as possible by mixing just three dyes with the transparent glues. We advised students to use the slime activator when they reached a satisfactory tone. After having a lot of fun, we took the students to a third final phase, in which the aim was to organize the colors in the spectral sequence.

3. RESULTS AND DISCUSSION

The main workshops were held from December 2023 in a high school class at Colégio Gálatas in Vila Valqueire, Rio de Janeiro. But we also had the opportunity to hold the workshop with a group of undergraduate students in artistic education (in July 2024 at the Federal university of Minas Gerais in Belo Horizonte), and the end result was more profound. The students realized that tones that had very different saturation from spectral colors, such as light pink and dark green, required a third organizational dimension, such as the historical concepts “Hue, value and Chroma” (MUNSELL, 1907: 19). So, in this workshop, it was possible to introduce the most complete ordering systems, presenting the concepts of saturation and luminosity as well. However, at the end, most of the testimonies of the older students were similar to the younger ones: they emphasized how the playful aspect was important for students to detach themselves from a paradigm of right and wrong, arriving more fluidly at a conceptual understanding.

Figure 2: Slime Color workshop with undergraduate students.

4. CONCLUSIONS

The final reports were all about the playful and even fun experimental collective aspect. Students managed to overcome the “fear of making mistakes” by mixing colors into glues and manipulating slimes. In the final conversation about the second phase of the exercise, when it was proposed “ordering the cups”, we managed to move towards the idea of the need for a three-dimensional system to account for the three dimensions of “ideal” colors. Also, more advanced students came to spontaneously perceive the need for a third dimension in color organization systems. This gives us the opportunity to continue developing this workshop to deepen the learning of color concepts.

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The Seminars "Why Do We Forget Goethe When We Teach Optics in Physics Classes?"

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ABSTRACT

This communication summarizes a set of seminars applied to a diverse audience, made up of young physics teachers, undergraduate students in physics and in arts, photographers, designers, ceramists and mediators working in a science museum. This is a work to publicize the contributions of Johann Wolfgang von Goethe in the field of color studies and chromatic phenomena, based on already completed master's research, which also included experimental activities with prisms where participants were able to appreciate the colorful apparitions - just as described by Goethe in his works. The results of these seminars were diverse: undergraduate physics students produced final coursework on Goethe's work dedicated to the theme of colors; artists declared that they could better understand the physical elements of color, especially the phenomena of prismatic refraction; as well as science museum mediators approved the incorporation of part of the prismatic experiments carried out at the seminar into the collection and into the list of activities promoted by the museum. Also noteworthy is the surprise at the discovery of magenta as a prismatic color that appears in the refraction not of a ray of light, but rather a ray of shadow. We conclude that, in physics teaching in Brazil, it is necessary to continue disseminating Goethean ideas and methods related to colors, especially for physics teachers.

1. INTRODUCTION

What do we, physics teachers, know about the contributions of Johann Wolfgang von Goethe (1749-1832) to the study of colors? In Brazil, we have noticed that currently references of his studies are absent from both secondary and higher education curricula.

In recent master's research (Ramos, 2022), we showed that the lack of in-depth knowledge on the part of physics teachers about Goethe's work or, even, their total lack of knowledge, results from the fact that the German led a major controversy in his time addressed to the figure of Isaac Newton (1642-1727), on his theory of light and colors and to his followers: by placing the controversy at the center of the debate, Goethe's many contributions to the field of chromatic phenomena were relegated to oblivion and to the severe judgement of posterity. Our research proposes to revisit this Goethean legacy because, after all, if he committed and defended conceptual errors, this cannot be why his name in the history of light and colors should be erased from school and university curricula. In other words, we are proposing that it is important that physics teachers – and certainly their students – have contact with their discoveries on the subject during their training.

Therefore, we created the seminars "Why do we forget Goethe when we teach optics in physics classes?" which were part of the continuity of the aforementioned master's research, which aimed to reach young physics teachers, both recently graduated and still in initial training. We were happy to also reach photographers, designers, art teachers and science museum mediators.

In total, 4 seminars were held with a total audience of around forty people.

2. METHOD

Each seminar was divided into 4 moments:

1. Biographical presentation of Johann Wolfgang von Goethe; historical and scientific contextualization of the state of knowledge about light and colors at the time of his studies.
2. Description of Goethe's work on colors; discussion of his method and discoveries, namely complementary colors and magenta as a prismatic color.
3. Experimental activity mediated with prisms distributed among participants. To carry it out, we followed the "prismatic experiments" that Goethe himself describes in (Goethe, 2011). We also used the cards that appear in this book and that were originally created by the author to facilitate the execution of the experiments.
4. Brief discussion of the controversy (Goethe, 2016); conversation about possible applications of Goethe's contributions to the teaching of colors in physics classes, in the mediation and collection of science museums and in the practice of artists.

Moments 1 and 2 were based on a previously prepared expository presentation. Moment 4, focused on the dialogue of participants encouraged to think collectively about the didactic and practical potential of ideas and, above all, of the Goethean method, revealed a diversity of initiatives, which we will comment on later in the results.

Goethe, in his text, created a set of experiments with prisms that, according to his intention, would please teachers and their students. We obtained a good quantity of regular triangular acrylic prisms, with different opening angles, and distributed them among the participants. Initially not knowing what to do with the instrument, many positioned it on tables and soon tried to project beams of light produced by their cell phones. However, we follow Goethe's proposal of subjective prismatic experiments, that is, with the prism in front of the eyes, observing the chromatic appearances in this way. Once accustomed to the prism and encouraged to freely observe the colors being evoked around it, we began to project onto the presentation screen the cards that Goethe himself created to be observed through the prism. Figure 1 is an example of these cards.

Figure 1: Card produced by Goethe (Goethe, 2011).

We have also produced other images with similar geometric patterns, always working in high contrast in black and white, and project them onto the presentation screen.

3. RESULTS AND DISCUSSION

We can say that the discovery of magenta as a prismatic color brought pleasant surprises. Even among physicists, more accustomed to the phenomenon of prismatic refraction, the appearance of this color was received with novelty. As we know, this was one of the experimental conclusions that Goethe reached, precisely when developing and conducting an "inverted" application of Newton's famous "Experimentum Crucis", from 1672. Instead of a beam of light falling on a prism, a beam of shadow.

The first seminar had as participants a diverse group of photographers, ceramists, art teachers and students, as well as a physics teacher (Figure 2). This seminar was held in the context of an extension group at the University of Rio de Janeiro, in a partnership between the Institutes of Arts and Physics, whose theme was the development of didactics for teaching by heart. The second and third were applied to a specific audience of physicists, mostly made up of undergraduate students; Finally, the fourth seminar took place for science museum mediators, focusing on evaluating and expanding the activities of an internal sector of the collection, specific to optics, visual phenomena and color theories.

The results are also diverse: among artists, we hear reports about the importance, for their creative activities, of a greater understanding of the physical foundations of color, the relationship and the origin of complementarity as a chromatic phenomenon. Low-cost teaching applications were designed and carried out in a public school in the city of Rio de Janeiro, in the classes of the physics teacher who was present in the extension course; some physics students (second seminar) produced final coursework on Goethe's Doctrine of Colors; the third, which is available on YouTube (Ramos, 2023), resulted directly in the invitation to hold the fourth seminar for science museum mediators. In turn, they decided that they would start to develop part of the prismatic experiments described by Goethe, since the museum would be able to have the necessary experimental apparatus.

Figure 2: Art students and teachers manipulating prisms and observing Goethe's cards.

4. CONCLUSIONS

We believe that teaching and learning color cannot give up experimental practices. Present to teachers in training, especially physics, that our optics classes are greatly enriched when phenomenological approaches are introduced. We see then that Johann Wolfgang von Goethe, in this sense, deserves a more prominent place in our references. We believe that sharing those experiences at this meeting may strengthen the certainty that the teaching-learning of color in physics classes can provide aesthetic, experimental and scientific development to individuals and instigate critical thinking. After all, the history of light and colors is full of controversies. The one between Goethe and Newton is certainly one of the richest. Particularly: the discovery of magenta as a prismatic color; and to consider, instead of a ray of light falling on a prism, a ray of shadow. We will continue with the seminars, expanding and improving them for different audiences and conditions, hoping to contribute to the strengthening of color studies and practices.

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Research on the Relationship and Implementation Path of Children's Sense of Belonging in Color

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ABSTRACT

This study explores how color education can cultivate children's sense of belonging, focusing on school, community, and cultural belonging based on Urie Bronfenbrenner's ecosystem theory. Through field surveys and questionnaires, the research identifies the positive impact of color education on children's sense of belonging and proposes strategies to enhance it. The findings suggest that color education significantly contributes to children's emotional, social, and cultural development.

1. INTRODUCTION

Colors play a vital role in human life, especially for children, who are naturally curious and observant. Color education not only fosters creative thinking but also promotes interpersonal interaction, emotional exchange, and the development of a healthy personality. Erich Fromm first introduced the concept of belonging in 1941 (Liu 2015), and Abraham Maslow later included "the need for belonging and love" in his hierarchy of needs theory (Chen 2021). This study proposes that color education can cultivate children's sense of belonging, ensuring they feel recognized, accepted, and affirmed by their collective environment.

2. THE CORRELATION BETWEEN CHILDREN'S COLOR EDUCATION AND SENSE OF BELONGING

The relationship between color education and sense of belonging is analyzed through two aspects: characteristic elements (collective, role, and cultural identity) and structural elements (school, family, community, and culture) based on Bronfenbrenner's ecosystem theory.

2.1 Characteristic elements of the formation of childhood sense of belonging

Color Participation and Collective Identity: Cooperative learning in color education enhances social skills, self-esteem, and emotional intelligence, fostering collective identity (Incheon National University of Education 2003; Kim 2009).

Color Application and Role Identification: Color education helps children develop gender, identity, and self-identity, as seen in studies on children's animated films and school uniforms (Cha 2017).

Color Understanding and Cultural Identity: Color education connects children with their cultural heritage, promoting cultural confidence and national belonging (Wang 2017).

2.2 Structural elements of the formation of childhood sense of belonging

Bronfenbrenner's ecological systems theory highlights the importance of family, school, community, and culture in shaping children's sense of belonging. Color education should integrate these systems to foster a sense of belonging from familiar to broader cultural contexts (Yu and Han 2014).

3. RESEARCH CONCLUSION

School Belonging: Students felt more fulfilled and connected to their school through color education activities (Figure 1).

Community Belonging: Community color activities improved children's interpersonal relationships and attachment to their community (Figure 2).

Cultural Belonging: Students expressed a strong interest in learning traditional color knowledge, indicating a positive impact on cultural identity (Figure 3).

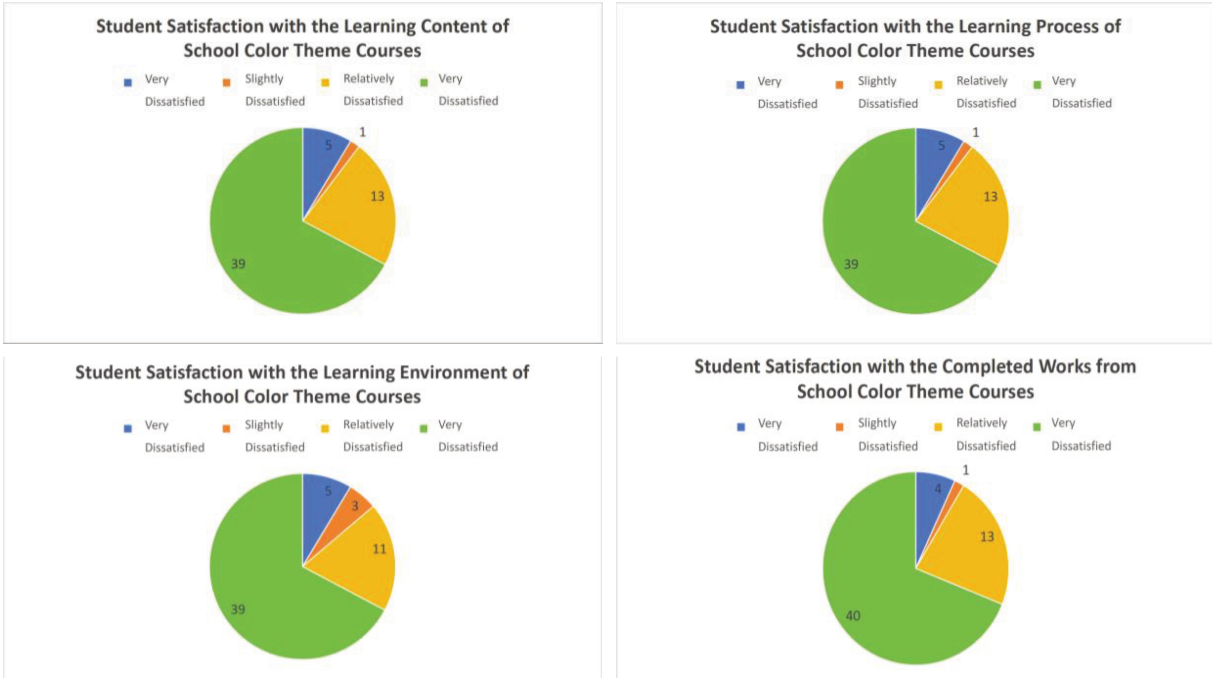
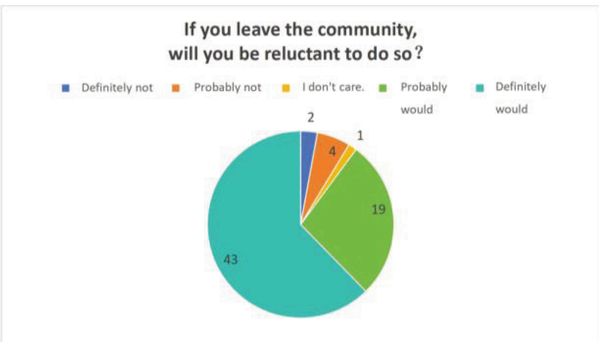


Figure 1: Survey on students' satisfaction with the content, process, environment, and completed works of school color theme courses activities.



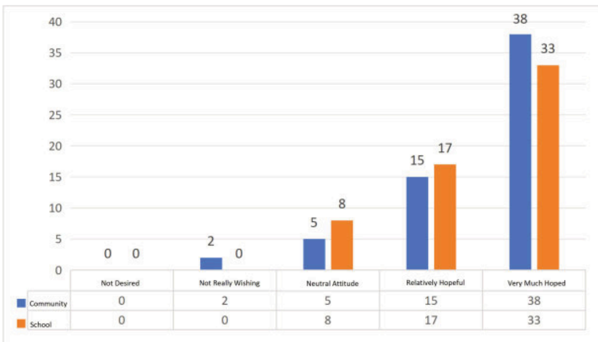


Figure 2 (left): Survey on community retention of children caused by color activities. Figure 3 (right): Survey on children's willingness to learn traditional color knowledge through school/community color activities.

4. STRATEGIES FOR ENHANCING CHILDREN'S SENSE OF BELONGING THROUGH COLOR EDUCATION

In summary, the survey feedback from "Dongmao Street Primary School" fully proves that children's color education has a related impact on the sense of belonging of schools, communities, and cultures. On this basis, based on previous practical experience, the author has summarized the following improvement strategies for corresponding types of sense of belonging:

4.1 Adhering to integrity and innovation, developing traditional color culture through multiple channels

Experience Festival Colors: Integrate traditional festival colors into classroom activities to enhance cultural identity (Ham 2014).

Understanding Regional Colors: Explore regional color aesthetics through ethnic costumes and historical buildings (Fujii 2017).

Color of Ancient Poetry: Use ancient poetry to teach children about the cultural significance of colors.

4.2 Searching for colors, multi ring festival guiding community landscape transformation

Encourage children to engage in community color activities, such as creating color cards and redesigning community spaces, to foster a sense of ownership and belonging (Moon 2018).

4.3 Meimei and Gong, multi subject participation in campus design collaboration

Involve children in designing school environments using color mazes and maps to enhance their connection to the school (Moon and Han 2018).

5. EPILOGUE

This study demonstrates that color education significantly enhances children's sense of belonging in school, community, and cultural contexts. By integrating color education into various aspects of children's lives, educators can promote positive self-identity, collective consciousness, and cultural appreciation.

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The Canarymeter: The Power of Colours in the Serinus Canaria Kingdom

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ABSTRACT

Flowers provide one of the most spectacular variations in terms of colour semiotics, with a great range of tones from white to black. In addition to this variety, the contrast with the green pigments derived from chlorophyll is added (Nadot, 2020). In the animal kingdom, birds also allow a multicoloured variation of their colours, especially the household canary.

Around the year 1600 a flock of small songbirds, Serinus Canaria, was brought from the Canary Islands to the European mainland. When reproducing in the domestic environment, some chicks began to have different feather colours from their parents, called mutations. By 1709 there were already 16 mutations recorded (Chanteloup, 1709).

According to the Ornithological Federation of Brazil, the colour of a household canary is made up of three basic components: Variety, Type, and Category. The Variety comprehends six background colours: Recessive White, Dominant White, Yellow, Ivory Yellow, Red, and Ivory Red. The Type comprehends four colours: Black Melanin, Brown Melanin, Pheomelanin, and Lipochromic (Non-melanic). The Category is represented by Intense, Snowy, Male Mosaic and Female Mosaic. In addition, canaries can exhibit oxidations, which lighten, darken or pulverize melanin in feathers: Cobalt, Eumo, Jasper, Mahogany, Onyx, Opaline, Pastel and Topaz. Canaries can also have red eye colour, beaks and feet, as well as yellow beaks. In principle, all these characteristics can be combined, which does not allow us to estimate the rising of new mutations. The set that makes up the colour of a canary is called Nomenclature, and each canary has its own nomenclature.

Lipochrome is a carotenoid of plant origin that, after being metabolized, is deposited in the feathers. In the plumage of canaries there are only two types of lipochrome, yellow or red. Lipochrome can be deposited throughout the plumage of canaries, extending to the ends of the wings and tail, or being deposited only in certain regions of the plumage.

Eumelanin can be black, brown, or pheomelanin and is deposited in parts of the plumage, forming the design and wrapping, and in the eyes, feet, and beaks. Pheomelanin is deposited mainly on the edges of feathers.

A particular colour canary is identified by its nomenclature, such as *Agate Cobalt Red Male Mosaic* (Type + Oxidation + Variety + Category).

This article shows in a clear and simple way the process of formation of more than 800 colours of canary currently and officially approved for evaluation and competition according to the international norms foreseen in the World Ornithological Confederation, and present a system for identifying the colours of domestic canaries, called Canarymeter. The Canarymeter is a figure that presents all the nomenclatures of the colours classified by the Ornithological Federation of Brazil. In it, the creator identifies all the possible variables of the colours that a given nomenclature contains. The Canarymeter, regardless of how many types, varieties and categories that may exist, can be updated constantly, replacing a huge list of colours and making life easier for breeders who don't need to memorize a huge list of canary colours.

Keywords: Serinus Canaria, Household Canary, Canarymeter, System of Colours.

1. INTRODUCTION

Each household canary, belonging to the *serinus-canaria* species possesses several distinct features that contribute to the colouration of its feathers. These include background colour, melanin colour, categories, and mutations, which collectively create a unique visual appearance. Additionally, certain characteristics complement each other, such as the colour of the eyes, beaks, and paws, which may be clear, black, red e yellow. Each visual appearance is named Nomenclature (Anuário Oficial FOB 2024).

2. CLASSIFICATION PARAMETERS FOR BRAZILIAN HOUSEHOLD CANARIES

Three characteristics make up the Nomenclature for colour canaries: Variety, Type, and Category. There are Non-Melanic an Melanic canaries.

Variety (Background Colour) is a term used to assess the Lipochrome (Quality, Quantity and Uniformity). There are six: White, Dominant White, Yellow, Ivory Yellow, Red and Ivory Red. Type is a term used to identify the nature (quality) and degree of pigmentation of the melanin contained in the design, the framing, the feet, and the beak. These canaries are: Blue, Copper, Green, Agate, Gray Wings, Cinnamon, Isabelle – and their mutations – Satine, Pheo, Cobalt, Eumo, Jasper, Mogno, Opal, Onyx, Pastel, and Topaz. Melanin colours are three: Black Melanin, Brown Melanin, and Pheo Melanin. Melanic canaries present stripes that follow the design of the ground colour and come from the head, the end of the beak, up to the tip of the tail and wings, combining with the ground colour. Black and brown melanin canaries are identical in design and form, changing only in colour. Pheo melanin canaries present a light brown tone only in the edges of the feathers and the inner part remains with the ground colour of the bird, providing a "marron-glacé" visual effect in the canary. In Brazil, Black Melanin with White Backgound is Blue, or Dominant Blue. The one with Yellow Backgound is Green or Ivory Green. The one with Backgound Red is Copper or Ivory Copper. It has dark eyes, beak and paws. These canaries may present all mutations. Category is a term used to determine the way the Lipochrome is distributed on the plumage: Intense, Snowy, Male Mosaic and Female Mosaic, except for the canaries with a White and Dominant White background. Mosaic canaries present dimorphism in connection with the sex (Chen, N. 2020).

3. CANARYMETER

The Canarymeter is made up of four concentric disks. The inner disk has all canary colours with White and Dominant White background. The second disk contains all colours of canaries with Yellow and Ivory Yellow background. In the third disk are all the colours of canaries with Red and Ivory Red background colour. The fourth and last disk contains the eight mutations. It is important to highlight that there are no Intense, Snowy, Male or Female Mosaic in White or Dominant White canaries. The first version of the Canarymeter had 576 colours. In 2024, there are already other colours that are being homolated, which will make there more than 800 colours (Figure 1).

Figure 1: The Canarymeter

Table 1 shows the meaning of the abbreviated words (Nomenclatures) in the Canarymeter.

Table 1 – Nomenclatures inside the boxes

Nomenclature	*Agate*	Albino	**Blue**	Cinnamon	**Copper**	Dominant	Female
Abbreviations	*Ag*	Al	**Bl**	Cn	**Cp**	Do	Fm
Nomenclature	**Green**	Grey	*Isabelle*	Male	Pheo	**Red**	
Abbreviations	**Gr**	Gy	*Is*	Ma	Ph	**Re**	
Nomenclature	*Satine*	Silvered	Urucum	White	Wing	Yellow	
Abbreviations	*Sa*	Sv	Ur	Wh	Wn	Ye	
Red Letter = Red eyes				Yellow letter = Dominant			

Yellow, Ivory Yellow, Red and Ivory Red background colours are classified by category INTENSE, SNOWY, MALE MOSAIC and FEMALE MOSAIC.

The three first circles contain, in addition to the background colour (the colour that fills the circle), the Nomenclatures written in rectangles. The rectangles also contain:

- Colour and Type of Melanin are represented by the colour and formatting of the letter. Canaries with large Melanin are written in bold. Canaries with thin Melanin are written in italics.
- Colour of Beak and Feet, represented by the colour of the box frame.
- Colour of Eyes. If the eyes are red, there is a letter written in red.
- Visual Sensation, represented by the colour inside de box.

Table 2 shows the nomenclature of canaries inside the boxes.

Table 2 – Nomenclature inside the boxes

LIPOCHROME (Non melanic)	Red, Ivory Red, (Rubino and Urucum), Yellow, Ivory Yellow (Lutino, Yellow Beak), White and DominantWhite (A lbino).
BLACK MELANIN	**Blue**, **Copper**, **Green**, *Agate*, Gray Wings.
BROWN MELANIN	**Cinnamon**, *Isabelle*, *Satine*.
PHAEO	**Phaeo Albino**, **Phaeo Lutino**, **Phaeo Rubino**.

The beaks and feet of the canaries can be of four colours (Light, Black, Red or Yellow) and on the Canarymeter they are represented by the colour of the outline of the box.

4. FINAL CONSIDERATIONS

The research on Colour Semiotic in Canary Culture is just beginning. We hope that this article will spark interest in more refined studies. The Canarymeter aims to turn the learning these colours easier, as its construction is based on the same principle – if you know how to read a certain colour, you can read all the others. It is easy because it is simple. It is simple because it is easy!

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Inclusive Beauty: a Multidisciplinary Approach to Designing a Nail Polish Collection - Colorama Introduces 'nude da sua cor'

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ABSTRACT

In a country like Brazil, with its remarkable diversity that includes 55 of the 66 skin tones mapped worldwide, the need for inclusive beauty products is paramount. This paper explores the development of Colorama's "Nude da Sua Cor" nail polish collection, a project driven by the desire to offer a diverse range of nude shades that not only resonate with current trends, but also meet the growing demand for inclusivity in the beauty industry. This collection is a journey of self-expression, celebrating the diversity and unique beauty of each individual. Inspired by the rich tapestry of skin tones found in Brazil, it will feature a palette ranging from soft beiges to deep browns, each meticulously selected to enhance natural beauty. Recognizing the complexity of creating a truly inclusive collection, a multidisciplinary approach was adopted, integrating expertise from design, marketing, product development, diversity and inclusion, personal color analysis, color science and consumer science.

1. INTRODUCTION

The beauty industry's historical lack of inclusivity, particularly towards people of color, is increasingly challenged in the era of liquid modernity (Bauman, 2001). As traditional beauty standards become more fluid and individualized, there is a growing demand for products and practices that celebrate the beauty of diverse skin tones. This shift is evident in the expanding definition of "nude" across various industries. Once a concept often limited to a narrow range of light beige tones, "nude" is being redefined to encompass the richness of multiple skin tones, as seen in products like colored pencils, lingerie, and headbands. This evolution towards inclusivity is also impacting the cosmetics industry, particularly in areas like skin color measurement and foundation matching. Furthermore, research into color trends in fashion reveals a growing preference for neutral shades, reflecting a desire for versatile and timeless aesthetics.

This paper examines the meticulous development of Colorama's "Nude da Sua Cor" nail polish collection, a project born from the understanding that inclusivity is not just a trend, but a fundamental shift in the beauty landscape. This initiative sought to redefine "nude" in the Brazilian context, offering a collection that truly reflects the country's diverse beauty, following the principles of color perception outlined by Johannes Itten in "The Art of Color" (Itten, 1961). The collection blends scientific color analysis with consumer perceptions and expert opinions to provide a range of nude nail polish options designed to flatter a spectrum of skin tones while aligning with contemporary preferences for sophisticated and enduring color palettes.

2. METHOD

The development of the “Nude da Sua Cor” collection was structured in four distinct phases, each employing specific methodologies:

Phase 1: Contextualization and Market Analysis

- **Global Color Trend Analysis**: It was examined global color trends, drawing insights from sources such as Autumn/Winter 2023/2024 palettes from New York Fashion Week and London Fashion Week. This analysis identified color stories that highlighted the rise of neutrals. We also considered societal shifts in color preferences, as discussed in Leatrice Eiseman’s “Pantone Guide to Communicating with Color” (Eiseman, 2000), and the increasing relevance of personal color analysis, particularly within the digital sphere.
- **Competitive Landscape Analysis**: A thorough review of competitor product offerings was conducted to understand existing nude shade ranges and identify potential gaps in the market.
- **Brand Portfolio Analysis**: Colorama’s existing product portfolio was assessed, analyzing sales data and consumer feedback to understand preferences for previous collections and identify successful color stories.
- **Criteria Definition**: Based on the insights gathered from the analyses, the team established criteria for selecting shades for the “Nude da Sua Cor” collection. This included representing the three primary skin undertones (warm, cool, and neutral) and the three primary contrasts (light, medium, and dark), resulting in a framework for nine distinct nail polish shades.

Phase 2: Shade Selection and Development

- **Pantone Shade Verification**: A Pantone tool with a spectrum of nude shades was used to ensure the accuracy and visual harmony of the selected colors.
- **Nail Color Analysis**: Volunteers representing diverse skin tones participated in nail color analysis sessions. This involved testing various shades to determine the most flattering and complementary options for different undertones and depths being analysed by the color experts.
- **Spectrophotometer Analysis:** Colorama’s laboratory team used a spectrophotometer to obtain objective color measurements in the LAB color space. This ensured the chosen shades aligned with the established criteria and would translate consistently across different skin tones.
- **Shade Refinement and Testing**: From an initial pool of 138 potential tones, experimentation and combination narrowed the selection down to 25 shades. These shades underwent rigorous testing on a diverse group of volunteers to assess their performance and suitability.
- **Final Shade Selection**: After meticulous evaluation, nine definitive shades were chosen for the “Nude da Sua Cor” collection, representing the culmination of scientific analysis, expert input, and consumer feedback.

Phase 3: Naming and Collaboration

- **Collaborative Naming Workshop:** Recognizing the importance of culturally sensitive and relevant naming conventions, Colorama partnered with AfroSOU, L’Oréal’s racial affinity network, to host a collaborative naming workshop. This workshop brought together individuals from diverse backgrounds to generate inclusive and meaningful names for each shade in the collection.

Phase 4: Launch and Communication

Colorama crafted a compelling launch campaign built on two distinct but complementary pillars:

- **"Nude da Sua Cor" (**Your Color Nude): This pillar championed inclusivity and diversity. Marketing materials celebrated the spectrum of "nude," showcasing how the collection's range beautifully complemented unique skin tones. This approach challenged traditional beauty norms, positioning the collection as a celebration of individuality. Technical aspects, like the meticulous shade development process, were highlighted to reinforce the expertise behind this inclusive approach.
- **"Nude do Seu Mood"** (Your Mood Nude): This pillar desires positionate the collection as a tool for self-expression and aligning it with broader trends in fashion and wellness. Messaging emphasized the versatility of the shades to evoke different moods and complement personal styles. By tapping into these lifestyle territories.

3. RESULTS AND DISCUSSION

Launching in September, the "Nude da Sua Cor" collection demonstrates significant potential to advance inclusivity in the beauty industry. This expectation stems from a multidisciplinary development approach grounded in:

- Prioritized Representation: The collection embeds a demonstrable commitment to diversity and inclusion, moving beyond superficial representation to address the needs of a diverse consumer base.
- Data-Driven Development: Market research, competitor analysis, and consumer insights minimize risk and suggest strong market potential based on evidenced consumer desires.
- Expertise-Based Product Development: Collaboration with color science, personal coloring, and diversity and inclusion experts strengthens product quality, relevance, and cultural sensitivity.

These factors strongly suggest that "Nude da Sua Cor" will resonate with consumers seeking diversity and representation in beauty products, potentially positioning Colorama as an industry leader in inclusive beauty and setting a positive precedent for future innovation.

Figure 1: Nude da sua cor key visual of the campaign

4. CONCLUSIONS

Colorama's "Nude da Sua Cor" nail polish collection exemplifies the power of a multidisciplinary approach in developing inclusive beauty products. By combining market research, color science, collaborative partnerships, and a genuine commitment to diversity, Colorama successfully created a product that celebrates the beauty of all skin tones. This project serves as a model for other brands seeking to create more inclusive and representative product offerings, recognizing the beauty industry's responsibility to reflect the diversity of its consumers.

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The Effect of Reading Background Colour on Human Cognitive Performance based on Multi-modal Data Analysis: A Study of Gender Differences

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ABSTRACT

There has been a significant increase in available information, in the current global context. In this trend, there is a growing need for people to improve their cognitive abilities in order to effectively process and manage the vast amounts of information they encounter. Colour, as a key element of the human cognitive system, has demonstrated a notable impact on information processing. However, the effects of background colour on human cognitive performance remain underexplored. Therefore, the primary objective of this study was to investigate whether different reading background colours affect human performance on cognitive functions and the specific mechanisms of this effect. To address these objectives, eight low-saturation colours with a standard white have been selected in the CIE LAB space. Forty participants (20 males and 20 females) were recruited, and the task response times, accuracy rates, brain activities data (fNIRS), and eye-tracking data were collected to assess participants' cognitive performance across different reading background colours.

The results showed that there were gender differences in human cognitive performance under different reading background colours. Specifically, the cognitive data indicated that gender had a considerable impact on the response times of participants ($p = 0.003$, $= 0.206$), female participants had faster response times than males. The physiological data of the FNIRS showed that there was a significant gender-colour interaction ($p = 0.027$, $= 0.055$) in the FPA-L region associated with higher cognitive functions, male participants exhibited higher activation on orange backgrounds ($p = 0.001$). In the DLPFC-R region related to executive power and attention, the interaction between gender and colour was significant ($p = 0.022$, $= 0.057$). Furthermore, the eye-tracking data suggested that male participants had more difficulty with task searches on grey, blue, and purple backgrounds ($p < 0.035$). Cognitive load is higher in females as evidenced by average pupil diameter.

Keywords: *Reading Background Colour, Multi-modal Data, Cognitive Performance, FNIRS, Gender Differences*

1. INTRODUCTION

Cognitive abilities are essential in information-rich environment nowadays, where maintaining cognitive health is increasingly important due to varying challenges across populations (Levitin 2014). Recent research underscores the significant influence of colour on cognitive performance, such as, red enhances detail-oriented tasks and blue boosts creativity (Mehta and Zhu 2009). Additionally, highly saturated colours affect arousal, memory retention, and children's cognitive abilities (Xia et al. 2021; Kuhbandner and Pekrun 2013; Brooker and Franklin 2016). However, the pervious research has focused on basic or highly saturated colours and has assessed only response time and accuracy, neglecting gender interactions and physiological responses. This study fills this gap by examining the effects of low-saturation background colours on cognitive performance through a multimodal approach, including cognitive performance data, fNIRS for brain activation, and eye-tracking data. The study particularly explores how reading background colour and gender influence visuospatial perception, a critical cognitive ability involving the manipulation of visual images in the mind.

2. METHOD

To achieve the research objectives, eight low-saturation colours and a standard white as background colours have been selected in the CIE LAB space (Table 1). ensuring equal luminance and a consistent luminance contrast of 0.33 with the title text. The luminance and chromaticity were measured using a JETI specbos in a dark psychology laboratory. The average Delta L and Delta E between target and real colour are 0.26 and 6.13.

Table 1. The characteristics of the reading background colour.

Hue	Squares	Target			Real			ΔL	ΔE
		*L**	*a**	*b**	*L**	*a**	*b**		
Gray		50.00	0.00	0.00	50.46	-0.78	0.12	0.46	0.91
Red		50.00	22.00	11.00	51.10	29.31	13.61	1.10	7.84
Orange		50.00	13.00	22.00	51.18	17.75	26.71	1.18	6.79
Yellow		50.00	1.00	25.00	50.67	2.28	29.75	0.67	4.96
Green		50.00	-20.00	13.00	49.50	-31.01	12.99	-0.50	11.02
Cyan		50.00	-13.25	-7.00	49.27	-23.66	-8.56	-0.73	10.55
Blue		50.00	-2.15	-24.00	49.50	-9.73	-25.34	-0.50	7.71
Purple		50.00	20.00	-13.00	50.96	23.83	-11.54	0.96	4.21
White		90.00	0.00	0.00	89.70	-0.77	-0.83	-0.30	1.17

Forty participants participated in the experiment. Conducted in a dark psychological laboratory, the experiment involved a 3D visuospatial cognition task with randomly presented background colours and tests to eliminate bias (Fig 1.1). Participants, equipped with a Tobii eye tracker and fNIRS cap, completed tasks as quickly and accurately as possible (Fig 1.2 and 1.3). Data collected included task response time, task accuracy rates, brain activities (fNIRS), and eye-tracking metrics to assess cognitive performance across different background colours and genders.

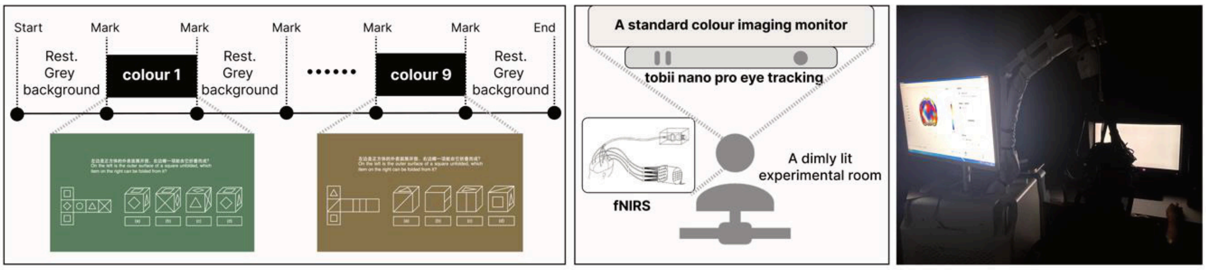

Fig. 1.1 Flowchart illustrating the process of 3D visuospatial cognition task *Fig. 1.2 Schematic diagram layout for experiment* *Fig. 1.3 Experimental physical environment*

Figure 1 Experimental procedural and setting

3. RESULTS AND DISCUSSION

The results showed that there were gender differences in human cognitive performance across different reading background colo A mixed ANOVA analysis, with gender as a between-subjects factor and color as a within-subjects factor.

The Cognitive Data: Gender had a significant effect on participants' response times($F[8, 33] = 2.624$, $p = 0.003$, $= 0.206$) as shown in Table 2, with female participants had faster response times than male participants, particularly on green ($p = 0.015$) and grey backgrounds ($p = 0.021$). Additionally, background colour significantly affected response times ($p = 0.009$) and accuracy rates ($p = 0.008$), demonstrating that both gender and colour influence cognitive performance.

Table 2: Effects of gender and colour and gender × colour on response time and accuracy rate

Variable	Source	df	F	p	Partial Eta Squared (η_p^2)
Response time	Gender	8.000	2.624	**0.003***	0.206
	Colour	1.000	9.886	**0.009***	0.065
	Gender × Colour	8.000	0.872	0.540	0.022
Accuracy rate	Gender	1.000	0.266	0.609	0.007
	Colour	8.000	2.655	**0.008***	0.065
	Gender × Colour	8.000	0.630	0.752	0.016

Brain Activities Data (fNIRS): The prefrontal cortex (PFC) were measured with relative changes in oxygenated hemoglobin (HbO) concentration using multichannel fNIRS instrument. Data were preprocessed using MatLab, Homer2 and NIRS_KIT. The results indicated significant effects of gender, colour (Table 3, 4 and Fig 2.2), and their interaction on activation in the left frontal pole area (FPA-L) and right dorsolateral prefrontal cortex (DLPFC-R). For the specific locations, please refer to Fig. 2.1. In the FPA-L region associated with higher cognitive and decision-making functions. the main effect of gender approached significance (F[1, 41] = 3.804, p = 0.059, = 0.091), with significant effects of colour (p = 0.046) and their interaction (F[8, 41] = 2.208, p = 0.027, = 0.055). Male participants exhibited higher activation on orange (p = 0.001) and yellow (p = 0.044) backgrounds. In the DLPFC-R area related to executive functions, working memory, and attention control, as well as the main effect of colour was significant (p = 0.042), the interaction of gender and colour was significant (F[8, 41] = 2.279, p = 0.022, = 0.057), with males showing higher activation on grey backgrounds (p = 0.066), suggesting gender-specific responses to colour stimuli.

Table 3: Effects of gender and colour and gender × colour on FPA-L and DLPFC-R

Variable(ROI)	Source	df	F	p	Partial Eta Squared(η_p^2)
FPA-L	Gender	1.000	3.804	0.059	0.091
	Colour	8.000	2.005	**0.046***	0.050
	Gender × Colour	8.000	2.208	**0.027***	0.055
DLPFC-R	Gender	1.000	0.464	0.500	0.012
	Colour	8.000	2.040	**0.042***	0.051
	Gender × Colour	8.000	2.279	**0.022***	0.057

Table 4: Pairwise comparisons of gender differences across colours on FPA-L

Colour	Gender Comparison (I-J)	Mean Difference	Standard Error	p-value	95% Confidence Interval
Red	Male vs Female	0.022	0.011	0.054	0.00 to 0.044
Orange	Male vs Female	0.031	0.009	**0.001***	0.13 to 0.049
Yellow	Male vs Female	0.018	0.009	**0.044***	0.001 to 0.036
Blue	Male vs Female	0.019	0.01	0.059	0.001 to 0.039

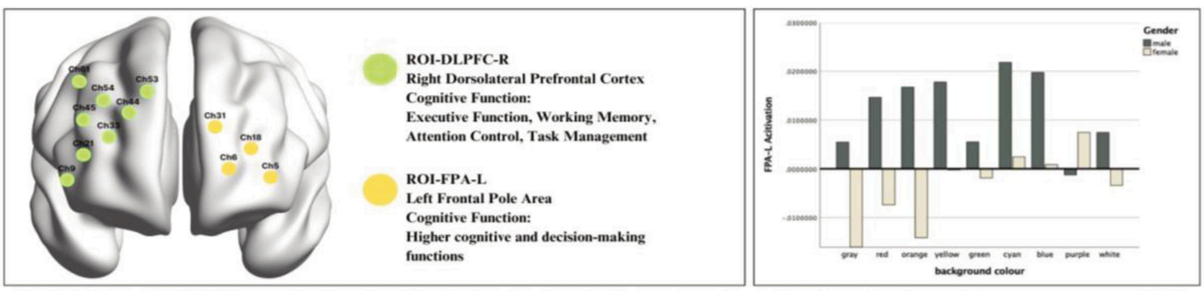

Fig. 2.1 FPA-L and DLPFC-R Corresponding Channels and Cognitive Functions (Based on Brodmann's area) *Fig. 2.2 Activation of gender differences across colours on FPA-L*

Figure 2: Schematic representation of brain regions and details of statistical results

The Eye-Tracking Data: Significant main effect of gender on at average duration (F[1, 33] = 8.837, p = 0.005, = 0.193). Female participants showed longer processing times on red, cyan, white, grey, purple, blue, orange, and yellow backgrounds ($p < 0.045$). Gender also significantly impacted number of fixations (F[1, 33] = 4.203, p = 0.047, = 0.100), with male participants had more difficulty with task searches on grey, blue, and purple backgrounds ($p < 0.035$). Additionally, the interaction between colour and gender indicated a higher cognitive load in females, as suggested by average pupil diameter (F[8,33]=2.044,p=0.041, =0.049). For statistic details, please see Table 5.

Table 5: Pairwise comparisons of gender differences across colours in eye-tracking data

Variable	Colour	Gender Comparison (I-J)	Mean Difference	Standard Error	p-value	95% Confidence Interval
Average duration	Gray	Male vs Female	-45.4	17.18	**0.012***	-80.178 to -10.622
	Red	Male vs Female	-64.05	18.727	**0.002***	-101.961 to -26.139
	Orange	Male vs Female	-51.6	22.463	**0.027***	-97.075 to -6.125
	Yellow	Male vs Female	-45.150*	21.823	**0.045***	-89.329 to -0.971
	Cyan	Male vs Female	-64.950*	19.177	**0.002***	-103.773 to -26.127
	Blue	Male vs Female	-50.600*	20.117	**0.016***	-91.324 to -9.876
	Purple	Male vs Female	-44.850*	16.919	**0.012***	-79.101 to -10.599
	White	Male vs Female	-46.250*	16.796	**0.009***	-80.251 to -12.249
Number fixations	Gray	Male vs Female	48.650*	16.941	**0.007***	14.355 to 82.945
	Blue	Male vs Female	33.800*	13.224	**0.015***	7.03 to 60.570
	Purple	Male vs Female	46.850*	21.443	**0.035***	3.442 to 90.258

4. CONCLUSIONS

This study reveals that background colour significantly impacts cognitive performance, with notable gender differences. Female participants showed faster reaction times and higher cognitive loads on green, grey, and purple backgrounds, while male participants showed higher brain activation on orange, yellow, and red backgrounds. These findings suggest practical applications in designing educational and work environments, where colour schemes could be tailored to enhance cognitive efficiency based on gender-specific responses. However, the study's focus on low-saturation colours, which may limit the generalizability of the results. Future research could expand by including a broader range of colours, diverse demographic groups, and exploring the long-term effects of colour on cognitive performance. Additionally, examining how colour impacts other cognitive functions beyond visuospatial perception could provide a more comprehensive understanding of the role of colour in cognitive processes.

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Anish Kapoor: the Use of Red and Black between Materiality and the Void

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ABSTRACT

Anish Kapoor, a contemporary Indo-British artist, has an extensive body of work that explores various themes such as the sacred, the void, and the body through a dialogue with sculpture and an array of materials including pigment, wax, and PVC. Creating artworks that range from small pieces to large scale, Kapoor expresses dense conceptual poetics through color in relation to space. In recent decades, the artist has increasingly focused on works that emphasize corporeal intensity through visceral elements, a trend that has become more prominent since the mid-2010s, encompassing both paintings and three-dimensional pieces. Concurrently, another central theme in Kapoor's oeuvre, the void, has been explored in recent years through series such as *Non-object (Black)*, which utilize Vantablack technology, an industrial material absorbing over 99% of reflected light. These two bodies of work, which address both visceral materiality and the black void, occupy the same poetic and chronological space in Kapoor's oeuvre. This article aims to establish a relationship between the visceral and the void through Kapoor's utilization of red and black in such artworks. Additionally, the concepts of abjection as proposed by Julia Kristeva, in dialogue with interpretations by Hal Foster, will inform the discussion alongside other critical perspectives from scholars such as Homi K. Bhabha, Daniel Arasse, Maurice Merleau-Ponty, and Julia Kristeva.

1. INTRODUCTION

In Kapoor's works, it is common to observe the predominance of the following colors: black, red, white, and blue. For this article, the focus will be on the colors red and black. To investigate these inquiries, some works and their engagement with color, void, and materiality will be analyzed based on the author's visit to the *Anish Kapoor* exhibition, held at the Gallerie dell'Accademia and Palazzo Manfrin in Venice in 2022. This exhibition marked the public debut of the *Non-object (Black)* series, made between 2019 and 2021, deepening the discourse on the void within Kapoor's work in direct interaction with the audience. Simultaneously, a significant selection of his artworks exploring the visceral and material aspects were also presented, offering not only a closer examination of these pieces as a poetic unity but also fostering an appreciation and aesthetic connection that reconciles these two thematic strands – the void and the materiality – through the mediating influence of color and its capacity to delineate space both within and outside the artwork.

2. METHOD

This article adopts a bibliographic methodology to draw connections between color, art history, and the work of Anish Kapoor. The analysis will be conducted considering phenomenology and the concept of spatial and cultural difference. Despite the strong presence of Hindu concepts in Kapoor's works, the artist rejects being labeled as an Indian artist – not as a way of denying his origins, but to avoid a reductionist approach to his production. Indian theorist Homi Bhabha, a key figure in understanding Anish Kapoor, shows that there is an eagerness to bring Kapoor's autobiographical element to the forefront of the discussion in analyzing his work. For example:

> *How sort've Hindu is his use of red? Does the blue refer to Yves Klein or to the Lord Krishna?* Such a secular sacerdotalism brings in its wake a method of interpretation that scours Kapoor's *oeuvre* for connections to Kant, Nietzsche, Artaud, Freud, Lacan, Derrida (to say nothing of Hindu or Buddhist texts), all of which affirm, in their diverse ways, the uplifting, transcendental direction of the Being of Art and Existence. (Bhabha 2009: 27)

Kapoor's work inhabits what is called the *third space*, arising from cultural difference. For Bhabha (1994: 162), "The question of cultural difference faces us with a disposition of knowledges or a distribution of practices that exist beside each other, [...] designating a form of social contradiction or antagonism that has to be negotiated rathen than sublated". It is not just the subject asserting their participation in the world, but negotiating this agency from the relationship established as an Other and with the Other. In an interview with Kapoor, Bhabha states that there is something in the artist's work that is not present, a kind of in-between (Kapoor 2011a). Therefore, understanding Kapoor's poetics from the Third Space is essential to avoid the pitfalls of a biographical investigation conditioned by his origin, and it also allows working with the multiplicities, contradictions, and ambiguities present in his work. Thus, the concept is presented as a methodological path for this article, as there are various epistemological crossroads that arise in unveiling the possibilities of emptiness and materiality – enhanced by color – within the artist's work. Therefore, proceeding with the investigation, we present a brief bibliographical overview that approximates the red and black colors to Kapoor's works.

2.1 The Red

The issue of ritual and blood, highlighted in the color red, appears unequivocally in Kapoor's work and discourse. From an inquisitive corporality provided by blue and its darkness, the red sought by the artist will also reveal itself in the dark, though in a different way, as he mentioned in an interview with Marcello Dantas (2006: 24): "Red is the color of the earth, not of deep space. It is, obviously, the color of blood, of the body. I have the feeling that the darkness it reveals is deeper and more closed than blue and black"[1]. The darkness of red, then, is connected to the inner space of the body in connection with the earth. According to the artist, "everything starts from the body: blood, sexuality, breathing" (Kapoor 2011b: 72). This centrality of red historically assumes significance in two moments: its crowning in Antiquity until the Modern Age as "the color of colors," taking on cultural and symbolic relevance in various regions of the world; and its decentralization with Newton's experiment (Pastoureau: 2001). However, this decentralization has no place in Kapoor's work. As Baume (2008: 22) states, "it is red that has played the most central role in the artist's iconography, exploited for its visceral strength, formal possibilities and cultural resonances".

2.2 Black

Like red, black is culturally laden with ambivalence. In Anish Kapoor's work, one can observe a duality between matter and the primordial void that black provides. The piece *Void* (1993) appears simply as a black square on the wall. Any resemblance to Kazimir Malevich (1879 – 1935) would not be coincidental. One of the important milestones in art history is Malevich's *Black Square* (1915). The Russian artist sought to reach the zero of form, announcing a tabula rasa and the supremacy of feeling. It is evident that, in Kapoor's work, the darkness defined by black approaches the void as an active and potent field. In the creative process of his own poetics, he presents his Kapoor Black, an exclusive material used to coat some of his works. This material is the result of research that began in the 2010s in collaboration with Surrey NanoSystems, the manufacturer of *Vantablack*, a compound made of carbon nanotubes capable of absorbing up to 99.965% of visible light. Its application extends across various fields, from space and military engineering to the automotive industry and aesthetic possibilities. In 2016, Anish Kapoor secured the exclusive rights to use the material, with a spray called *Vantablack S-VIS*. Considering the use of this material, how might it deepen the exploration of themes like darkness, interiority, and the void in Kapoor's work, through materiality and the illusion of absence?

3. RESULTS AND DISCUSSION

Non-object (Black), when viewed from the front, the works appear as two-dimensional black geometric forms. However, as the viewer wanders the gaze to the side, circling the artwork, it

[1] Translated by the author.

seems to leap into view. What initially presents as two-dimensional gains depth, a three-dimensionality that, although always inherent in the work, at once reveals itself as an intense black void, capturing and carrying the gaze into the depths of its pictorial constitution, pulsating and standing out from the surface. By naming the work a non-object, how does Kapoor discuss the very notion of the object in artwork? Bhabha (2009: 32) states, "What drives the life cycle of Kapoor's sculpture is what he repeatedly calls the 'non-object': it is the emergence of new space that is also a virtual or negative space, that is engendered through the splitting of the object". This thinking of nothingness and emptiness aligns with what Homi Bhabha and Kapoor (2011a) advocate through the term "in-between".

Figure 1. Anish Kapoor, Non-object (Black), 2019. Mixed media. 39 cm × 39 cm × 12 cm. Anish Kapoor Exhibition. Gallerie dell'Accademia and Palazzo Manfrin, Venice, Italy, 2022. Source: Author

A parallel that can be drawn with Kapoor's *Vantablack* works is the question of the Annunciation in Renaissance artworks, as proposed by Daniel Arasse in his book *Take a Closer Look* (2019). A significant issue at the time was precisely representing what was not seen at the moment of the Annunciation, namely, the conception of the Virgin Mary. The Annunciation would be the moment of the Incarnation, "the coming of the incommensurable into the commensurable, of the unfigurable into the figurable realm" (Arasse 2013: 37). So, when *Non-object (Black)* evokes this aesthetic controversy of what can be phisically shown in an artwork, the works in question assert themselves as non-objects, due to their instability and the possibility of multiple entries of the gaze. There is the limit of representation: the work manifests a fission potency by destabilizing both its ontological unity and the relationship between itself and the subject. The visible and the invisible are constructed and deconstructed simultaneously, through an ambiguity in which it is possible to see, but at the same time, there is the latency of something that remains concealed. It is what is not only in front of the individual but surrounds them – what appears between people and between things, in the interval, in silence. In this sense, it is essential to understand what Merleau-Ponty (1968: 113) highlights as visible and invisible in his work. In the working notes of *The Visible and the Invisible*, the philosopher reflects on the invisible. It is important to note that this term is not a logical negation of what is visible but a modality of the same transcendence. The visible, if defined as the dimensionality of Being, presents a relationship of overlapping and encroachment – a spatiality – that allows the simultaneous existence of the invisible: something that is hidden, elsewhere, but could become evident; non-figurative dimensions of what is visible.

At the same exhibition in Venice, along the *Non-object (Black)* series, Kapoor presented a line of works that do not render the object invisible, but opens it up, revealing its interior. This object is the body in its visceral state. As a guiding example, we refer to the work *Internal Objects in Three Parts* (2013-2015): a set of three canvases, each featuring a cluster of silicone in shades of mostly red color, but also black and white. Its three parts allude to diffuse and bloody organicity, resembling exposed viscera. It represents the interior of the human body, which is here surpassed and scrutinized – not in its biological precision, but in its carnal profusion, ambiguity, and even disorder. This more recent production by the artist, as evidenced by the work in question, reveals itself not before causing a kind of discomfort, a repulsion: a feeling of something abject. Kristeva (1982) investigates that the idea of the abject is connected to items of nourishment, dirt, and waste. Disgust related to food constitutes one of the most elemental pieces of abjection. For example, the skin of milk – the cream – which, upon touching the lips, causes nausea, disgust. Kristeva argues that, from the moment this abjection is present in the newborn individual, this element, the curdled milk, separates the infant from the mother and father who present it, simultaneously making the food not an "other" to "me," leading to an abjection, an expulsion of one's own being. Anish Kapoor acknowledges the presence of the abject in his works, and its connection to Kristeva's theory is evident, both in his artistic productions and in the exchange of correspondences and interviews between them. In a letter addressed to Kristeva, Kapoor delves into his maternal obsessions that lead him to explore the profound feminine. He emphasizes the presence of blood and earth: "Blood as the primal stuff of community and of identity becomes the primal ritual matter. Blood and earth are of course painting, and sculpture and they are the ritual materials of psychic projection" (Kapoor 2022: 220). It is apparent that Kapoor understands the artistic object linked to his visceral works as a manifestation of that which is interior and would, therefore, be larger than the external body, larger than the skin. This stature would indeed be that which is abjected by the human body itself.

4. CONCLUSIONS

A conclusion that can be delineated in this article is that the relationship between the void and the materiality is not mutually exclusive, and, as the use of color demonstrated – more than the physical scale or the space that the artwork is installed – what truly brings the perceptual relationship between the void and the materiality together is the phenomenological space, which creates the in-between or a third space. Such space is, as the article elucidated, only brought forward by color.

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The Color of the Movie *Poor Things*: Yellow Is Power

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ABSTRACT

Poor Things is a film that follows Bella Baxter (Emma Stone), a young pregnant woman who committed suicide and was brought back to life by scientist Dr Godwin Baxter (Willian Defoe). To save her, however, it was necessary to exchange the adult brain for that of the fetus, making Bella a unique woman, a child in an adult's body. The film's cinematography is quite peculiar and this is the first film with sections recorded with Kodak's new negative, Ektachrome with color reversal. The art direction of the work is carefully concerned with establishing the main chromatic concepts of the film, and an analysis of the colors of this work necessarily moves between the colors of the main character's costumes and scenario. The three main colors used by the protagonist are yellow, a light blue, and a light pink, an obvious reference to the three primary colors for pigments, magenta, cyan and yellow. Yellow in particular carries several symbols and is the most present color in the entire film, being associated with the most striking moments of the work.

1. INTRODUCTION

With digital cinema, films began to be captured by digital cameras that convert light into pixels, replacing the film recording process. This allowed for greater flexibility in the production, editing, and distribution of films, as well as facilitating the application of complex visual effects. The precise manipulation provided by pixels enabled new approaches to color in films.

> This final step in the quest for the smallest constitutive element of the image was achieved thanks to the computer. The computer not only allowed for complete control over the image point – pixel – but also replaced the analog automatism of television techniques with calculated automatism, resulting from a numerical treatment of the image information. (Couchot 1993: 38).

The pixel is a completely controllable element of the image in terms of color and also serves as the primary interface between an observer and a digital medium. However, in the realm of audiovisual media, especially cinema, its emergence was not readily accepted. The digital image was considered "too simple" in comparison to film images. The pixel lacks texture, grain, and materiality. This debate was quite prominent in discussions about the early digital films.

Digitalization not only transformed production and distribution but also, conversely, created a demand to replicate the aesthetics and qualities of analog film. The pixel, as the fundamental unit of the digital image, became the new standard, yet many filmmakers and industry professionals have sought ways to capture and preserve the texture and depth of traditional film. In this context, the return of films like Kodak's Ektachrome, a transparency film known for its vibrant colors and refined detail, represents an attempt to combine the best of both worlds.

The film Poor Things (Yorgos Lanthimos, 2024) utilizes this specific negative extensively throughout its narrative. Ektachrome is a color reversal film, also known as slide film. This means it produces positive images, or slides, rather than negatives. Unlike negative films, which need to be enlarged or projected onto a positive form, slides can be projected directly. Ektachrome is valued for its vibrant colors, high sharpness, and contrast. The texture and depth of the images produced by this film are notable, with a generally finer grain compared to other types of negative films.

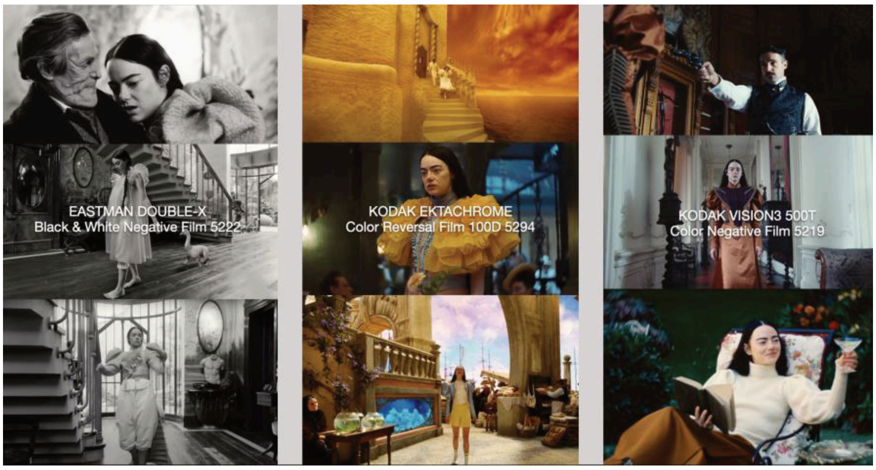

Figure 1 – The three moments and film negatives of Poor Things

2. THREE DIFFERENT IMAGES

In Poor Things, we follow Bella Baxter, a woman subjected to an unusual procedure by an eccentric scientist: after committing suicide while pregnant, the scientist implants the baby's brain in place of hers. The film is divided into three distinct phases. The first represents Bella's childhood, the second covers her adolescence, discovery, and exploration of the world, and the third shows hers mature decisions, struggles, challenges, and more responsible behavior.

The cinematography director chose to divide the aesthetic concept into three distinct moments, using three different types of negatives. The first part of the film, all in black and white, uses the Eastman Double-X 5222 Black and White negative, the development of the film uses Kodak Ektachrome with color reversal, as already mentioned, and the final sequences of the film rely on the most sober and less saturated Kodak Vision3 500T. About that the cinematography director says:

> The DOUBLE X 5222 stock has a superb scale of tonal contrast and grain, and it was a real joy to shoot in B&W" […] "Of course, the 500T is such a versatile stock that you can use for all sorts of interior/exterior day/night situations. […]
>
> Yorgos is always willing to try new things and really liked idea of the saturated color palette and contrast that come from the wide dynamic range of the Ektachrome stock. I had not really used it much before, certainly not on this scale, and it took a little time to get my head around exposing it correctly. (Ryan 2023)

In cinema, Ektachrome is particularly valued in projects seeking a nostalgic or stylized look, as the film can add specific texture and tone that are often difficult to replicate digitally.

> The colors are invitingly rich and vivid, like vibrant reds that really bounce-off the screen, but it never looked cartoon-like. The blacks are really dense and contrasty, and the skin tones are true-to-life. It supported the otherworldly looks of the bold set and costume design and was a great way to visually depict the fantastical adventure Bella goes on. (Ryan 2023)

3. THREE DIFFERENT COLORS

The look of a film encompasses various visual elements, such as color choices, lighting, textures, scene composition, costumes, and sets. Each film can have a unique look that reflects the creative vision of the director and the production team. Creating a film's look is a creative process aimed not only at establishing a cohesive visual aesthetic but also at reinforcing the theme, style, and message of the work.

> The visual that meets both narrative and artistic needs is known as the “look.” The possibilities for color manipulation that emerged with the advent and control of the pixel have provided directors with a new creative avenue. Different looks can be associated with narratives, characters and their moods, the environments of the work, and more. (Souza 2018: 128)

The art direction in Poor Things makes intentional use of color to deepen the narrative and intensify the viewer’s experience. The colors yellow, pink, and blue are chosen not only for their vibrant aesthetics but also for their symbolic meaning. Yellow, in particular, is emphasized during moments of tension and violence, reflecting danger and aggression. ‘The black hair and the yellow, these are nature’s warning colors. These are the colors of bees, wasps, and caution tape.’ (Freestone 2024)

In a crucial scene, the complete saturation of yellow accentuates the protagonist’s epiphany about the cruelty of the world, highlighting the fundamental role that color plays in shaping the film’s atmosphere. Wearing yellow and being surrounded by yellow scenes are signs that the film will depict the character’s evolution toward maturity throughout strength and violence.

While yellow is associated with violence and tension, blue is used to represent passivity and acceptance. This color is applied strategically to reflect moments when the protagonist is subdued by circumstances or accepting her reality. Pink is a color that appears less frequently in the film, but its presence is significant. It is used to mark the moments of discovery and pleasure for the protagonist, contrasting with the more intense and oppressive colors. Pink symbolizes pleasure and self-expression, providing a visual relief from the tensions created by the other predominant colors. When pink appears, it is associated with the protagonist’s discovery of personal pleasures and freedoms, such as sex, alcohol, and dancing.

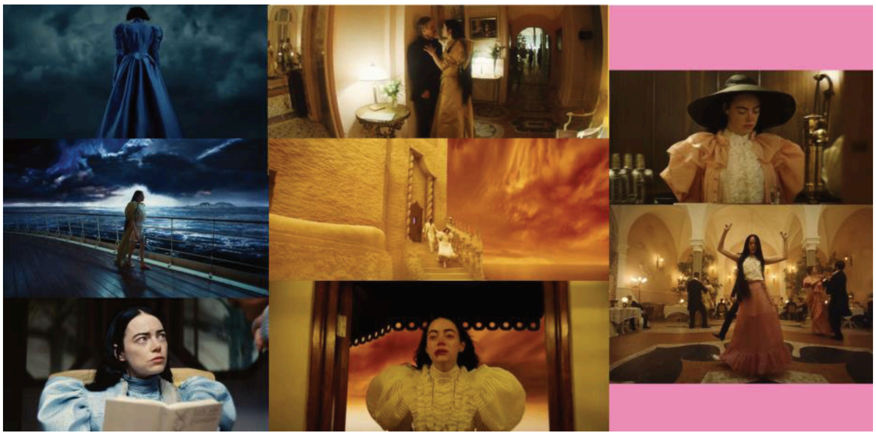

Figure 2 - Some of Poor Things’ yellow, blue and pink scenes

In several moments of the film, the three colors – yellow, cyan blue, and pink – appear together on screen, and sometimes in the protagonist’s clothing. The use of these colors together suggests the complexity of her emotions, illustrating how she navigates tension, acceptance, and pleasure in an interconnected manner.

4. CONCLUSION

The use of color in Poor Things is not merely decorative but serves a profound narrative purpose. Yellow intensifies the sense of danger and revelation, reflecting the protagonist's moments of highest tension and epiphany. Cyan blue represents passivity and acceptance of reality, providing a visual contrast to the more intense colors. Pink, although less frequent, marks moments of pleasure and self-expression, offering a respite from the experiences of tension and acceptance. Together, these colors create a visual palette that not only enriches the film’s aesthetic but also deepens the viewer's understanding of the protagonist’s emotional journey.

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Cultural Landscape and Urban Polychromy: Analysis of the Landscape's Chromatic Identity

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ABSTRACT

The Chromatic Identity of landscapes concerns the way natural and applied colours are present in the landscape and their relationship with the involved cultural group. The loss of chromatic identity in traditional Brazilian settlements is linked to global trends of homogenization of lifestyles and cultural values. The development of analysis methods suited to this context could help preserve the chromatic specificities of the landscape. The aim of this study is to organise and apply a method to assess the chromatic identity of landscapes. The developed method organises the understanding of Chromatic Identity into three conceptual dimensions: Content (physical characteristics of colours), Structure (ways that colours are organised in landscape elements), and Dynamics (alterations of colours in space and time). The method is, finally, applied to a fishing village in Southern Brazil.

1. INTRODUCTION

The current scenario of globalisation, with its tendency towards the homogenization of lifestyles and cultural values, has introduced new challenges to safeguarding the *Chromatic Identity* of landscapes shaped by traditional social groups (Tuan, 1980, Andreotti, 2013). The loss of Chromatic Identity is a reality in Brazilian historical centres and traditional settlements (Gonçalves and Faria, 2021). Characterising it with suitable methodologies can potentially support coherent planning strategies to safeguard the landscape typicalities. In this direction, our study aims to organise and apply a method to assess the chromatic identity of landscapes. The method was applied to a fishing village located on the shores of Dos Patos Lagoon, in the city of Pelotas, Southern Brazil.

2. METHOD

The developed method is based on reviews of a series of theories and methods from different authors who studied colour in Architecture and Urban Planning such as Lenclos (1983), Efimov (1990), Lancaster (1996) and Naoumova (2009). We adopt the understanding of Chromatic Identity organised into three dimensions: Content, Structure, and Dynamics.

Firstly, Chromatic Content concerns the analysis of the physical characteristics of colours: a) the colours of different elements of the landscape, natural and anthropic; b) the examination of scale and observation distances, and c) the chromatic attributes of colours (hue, luminosity, and intensity) for each type of element. Secondly, Chromatic Structure describes the distribution of colours in the landscape elements and is observed on a general and local scale. Lastly, Chromatic Dynamics comprise the assessment of changes in chromatic content and structure over space and time. Figure 1 illustrates the Scheme for Chromatic Identity's Analyses.

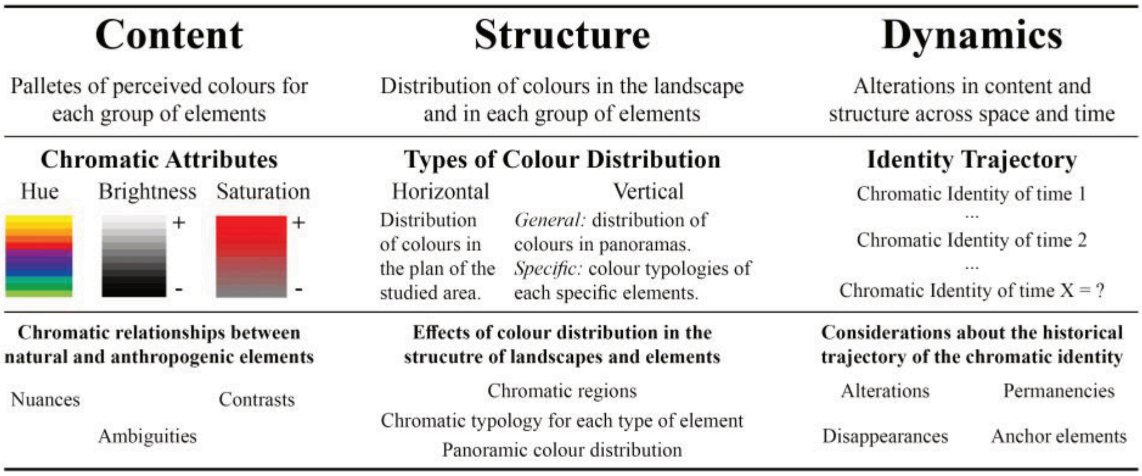

Figure 1: Scheme for Chromatic Identity's Analyses

3. RESULTS AND DISCUSSION

3.1 Case Study Characterisation: Z3 Fishermen's Village in Pelotas, RS, Brazil

Z3 Fishermen's Village is a settlement on the shores of Dos Patos Lagoon, with a unique cultural landscape and chromatic identity (Figure 2). The traditional fishing techniques are rooted in generational knowledge that shapes the locals' environmental understanding and fishing practices. Connections to the natural environment and artisanal skills are evident in the local architecture and urban spaces. Boat carpentry abilities are employed in buildings and their decorative elements. The vibrant colours seen in boats are also extend to architecture, clothing's and public spaces, reflecting the inhabitants' aesthetic preferences and enthusiasm in creating and maintaining the symbols of their cultural identity.

Figure 2: Cultural Landscape and Chromatic Identity of Z3. Source: authors.

The cultural landscape of the village, however, is currently facing a process of degradation. Environmental, territorial, housing, and socioeconomic crises have led to a decline in the traditional practices and a diminished appreciation of local culture, especially among the younger generation. This ongoing process highlights the challenges faced by the community in maintaining its cultural heritage amid modern pressures and changes.

3.2 The Chromatic Identity of Z3 Fishermen's Village

The Chromatic Identity *Content* analyses were defined separately for the general and specific contexts. In the general context, analyses capture larger elements: natural environments and urban landscapes. In the specific context, the focus is on the colours of smaller components such as building façades, window frames, construction details, and vegetation.

The natural landscape next to the village is characterised by distinct colour palettes for different ecosystems: lagoon (greenish-brown); sand strips (beige hues); marshes (broad range of greens, reddish-browns, greenish-browns, yellowish ochres, and greyish-pinks), *Restinga* forests (darker greens, from yellow-greens to blue-greens and grey-greens); and coastal fields (yellowish palette with shades of brown, green, moss, and ochre). The specific scale of the natural environment shows more saturated colours and hues from the blooming and fruiting vegetation, adding tones of yellow, pink, red, beige, and white to the palette.

The anthropogenic landscape, on the general context, is characterised by intense colours on building façades and boats. On the specific context, the landscape components were categorised into buildings, clothing, boats, and planted vegetation. The dominant hues in buildings are blue, green, cyan, yellow, violet and orange, with variations in intensity and brightness, often accompanied by white. Boats predominantly feature intense forms of orange, cyan, blue and green, with orange being recurrent due to its use in boat interiors. Clothing shares similar dominant hues with buildings. Planted vegetation includes various shades of green, pink, red, yellow, white, and violet. The most relevant aspect of the chromatic identity of the analysed landscape are the preferences for the use of contrasting and intense colours, considering natural and anthropogenic elements.

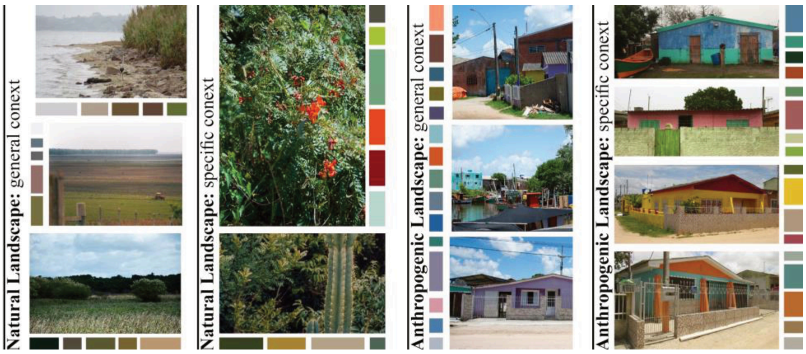

Figure 3: Examples of palettes for natural and anthropogenic landscapes.

The analysis of Chromatic Identity *Structure* of horizontal distribution of colours in the anthropogenic landscape revealed distinct 'Chromatic Regions', differentiating between the centre and peripheries of the settlement. In the central area, buildings are often painted in intense colours, and the predominant chromatic connection between elements is medium to high contrast. In the peripheral fish market zone along the coast, the colour palette features varied and contrasting hues along with white, and façades often display thematic paintings, such as signs, advertisements, aquatic animals, and nautical motifs. In the coastal zone dominated by warehouses, shipyards, and other structures supporting fishing activities, colours reflect the natural hues of construction materials: the greys and browns of wooden buildings and piers, and the extensive range of oranges and browns from uncoated clay masonry. Here, contrasting palettes are mainly seen in boats and the clothing alone.

For the vertical distribution of colours, the most notable anthropogenic elements in the landscape are the buildings. A typological analysis of the buildings, as reported in Gonçalves and Faria (2021), identified that 80% of the constructions could be grouped into five residential typologies. These residential typologies were analysed focused on chromatic content (hue, brightness, and intensity) and distribution on building elements (walls, window frames, details, and ornaments). The results showed that building façades predominantly feature two to four colours, and four chromatic structuring trends: a) very light details, window frames, and ornaments on intense background walls; b) intense or dark window frames, details, and ornaments on very light background walls; c) dark window frames with very light details and ornaments on intense background walls; d) intense, dark, or very light window frames with intense details and ornaments on a differently intense background wall. Regardless of the chromatic typology used, the distribution of colours typically follows and reinforces the perception of scale, components, and textures of the buildings.

The Chromatic Identity *Dynamics* are significant for the natural landscape. Wetlands and coastal fields undergo several changes throughout the year, from intense green hues during periods of frequent rain to more monotonous, grey tones during dry and cold periods. Forests have two distinct periods: more saturated greens in Summer and more greyish hues in Winter. The annual dynamic displays brighter colours in Spring, intense colours in Summer, paler and browner tones in Autumn, and muted and greyish colours in Winter.

To evaluate the Chromatic Identity *Dynamics* of anthropogenic elements, we compared a survey conducted by Naoumova *et al*. (2002) and a survey by the current authors in 2018. The analysis indicated a persistence of dominant hues in buildings and the contrasts employed, with significant transformations: a) increased frequency of violet and purple tones and greater variation in the brightness and saturation of green and blue shades; b) increased presence of lighter shades within the blue and green colour ranges. Additionally, darker brown tones have been reduced in favour of more intense orange and red colours, and less saturated greyish hues have decreased while the use of pure grey has become more frequent.

4. CONCLUSIONS

In this paper, we defined Chromatic Identity and organised and applied a method to assess it, based on three dimensions: Content, Structure and Dynamics. These help break-down the concept, facilitating its application. In the current context of cultural standardisation, our approach highlights the importance of perspectives that counter this trend, including the integrative comprehension and planning of Chromatic Identity. This study also serves as a reflection for professionals and researchers on the introduction of specific approaches within environmental and urban planning that consider the local specificities of settlements.

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“Los Ríos” in Colours: Colour Chart from the South of Chile

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ABSTRACT

The “Los Ríos” Region, in southern Chile, has an exceptional landscape from the Pacific Ocean to the Andes Mountains, with 63 rivers, 11 lakes, different types of vegetation, soils and skies that change color with the seasons, the weather and of course during the day. This extraordinary geography and landscape give the region a characteristic chromatic atmosphere, the result of the interaction of all its colors and lights. An interdisciplinary team of scientists and designers has been created, with the aim of investigating the color of the region, to create a color chart with its own identity. We have made trips throughout the region for a year, to collect and measure colors with a colorimeter and by visual comparison, with the NCS chart and the Munsell chart. We have documented each color in a database, with all its relevant information. We have also made watercolor sketches, as a subjective and artistic interpretation of reality. From the 208 colors obtained, we have created 40 color palettes based on relationships of harmonies and contrasts. The results of the project have been exhibited in an art gallery, on social networks and on a website, and 3 workshops have been held for children and adults, with the aim of introducing both the final color chart, the color palettes, and the entire process of collecting and cataloging samples. Finally, this color chart has been used in color excercises by design students and we hope that it will be a contribution to all those creative disciplines that work with the identity of a territory, since color is an unavoidable means of expression of creative work.

1. INTRODUCTION

Color is present in every aspect of our lives. We live in a world of color. Since color crosses many art and scientific practices and disciplines, it cannot be fully grasped from a single approach. Color is particularly relevant for creative works or projects as an unavoidable means of expression. This project aims at identifying the colors present in the natural landscapes of the Los Rios region. The Los Rios region has exceptional landscapes that span from the ocean to the mountains: 63 rivers, 11 lakes, different types of vegetation, soils, and skies that change their brightness even during one day. This extraordinary geography and landscapes endow the region with a typical chromatic atmosphere, resulting from the interplay among all its colors and lights. We have created a color chart for the Los Rios region based on the chromatic measurements of 208 of its natural elements, which were divided into two categories: i) Objects (soils, rocks, and vegetation; for example leaves and flowers); and ii) Atmospheres (skies, waters, and landscapes). Each color has its own specifications in multiple classification systems so users can find what they are looking for. This color chart and the palette built upon it can be used for creative design, architecture, craft, geography, and art projects, among others.

2. METHOD

The interdisciplinary team that works in this project is made up by Universidad Austral de Chile academics, professionals, and students. The Los Ríos region has a particular geography. The choice of the places where to look for the most representative natural samples of the region was made based on the knowledge of a forestry engineer expert in soils and native forests, and a geographer specialized in disasters (volcanoes, earthquakes). We made several trips through the Los Rios region during one year – from north to south and from the coast to the mountains – looking for and finding colors in soils, rocks, vegetation, skies, and waters. The trips were made covering all seasons of the year and the 12 communes of the region, from the Pacific Ocean to the Andes mountain range. We documented the trips with photographs, watercolors, and database logs with references to each color found.

2.1 Color Survey

To survey a color means to measure it with some sort of standardized means, ideally, with a color chart with national or international coverage (Friedell-Anter, 2001). In our case, we worked with the Natural Color System (NCS) and Munsell charts. Surveying through visual comparison is done by placing the color chart beside the observed object and looking at it until the same or at least the closest looking color is found (Cordero, 2019). In the case of the chromatic atmospheres, the chart is placed facing the landscape and – isolating the surroundings using a frame – the same procedure described below is followed (Figure 1).

Figure 1: How we measured the colors of the atmospheres, isolating the surroundings using a frame (the author, 2023).

Some colors where measured on site while others were measured in the lab through samples of field-collected objects, such as rocks and soils. We also used the NCS colorimeter, which is a tool to electronically measure a colored surface. How does it work? The device is located on the surface to be measured and a phone app is activated, showing the NSC code with its equivalences in other classification systems. This result must be corroborated visually with the actual chart because although the measurement is fast, it is fallible. We entered each of the 208 collected colors into a database that contains all the context information: location (with GPS), date, season of the year, common name, scientific name, photographs, and color codes according to the NCS, Munsell, CIELab, RGB, and CMYK systems. The conversion to the codes of a paint company will be available soon.

2.2 Watercolors

In this project, we used the watercolor technique to observe the landscape's chromatic atmosphere from a very subjective point of view. Each watercolor was made on site, sitting on a rock, on a pampas, or under an umbrella, sometimes in the cold, in the wind, and occasionally under the sun. These watercolors are not intended to be works of art or decorative objects, but only chromatic witnesses of the moment in which they were made (Cordero, 2023).

Figure 2: Aquarelle at the Riñihue lake (the author, 2023).

3. RESULTS AND DISCUSSION

3.1 The color chart

The 208 colors collected during one year in the Los Ríos Region were sorted into 9 color categories. We obtained 50 greens, 11 pinks, 19 yellows, 16 blues, 16 whites, 36 browns, 20 grays, 12 purples, 5 oranges, 10 blacks, and 13 reds. The colors were found in various objects and atmospheres, for example, the greens correspond to both plant objects, bodies of water and rocks, and the blues were found in flowers, skies and water. There are several green colors that are repeated more than once in the leaf measurements made with the NCS colorimeter, there is even one that is repeated 5 times (NCS s 7020-G30Y) and another that is repeated 10 times (NCS s 5540-G40Y). We assign a name to each color, based on the base color (green, blue, etc.), the object measured (flower, sky, river, etc.) and the name of the place where it was found. For example, the color NCS s 3020-B, has the name “Neltume lake blue”, where blue is the color, lake is the chromatic atmosphere measured and Neltume is the name of the lake. All the colors in the chart are available on the website (www.losriosencolores.cl).

3.2 The color palettes

From the general chart of 208 colors, we created a reduced and representative chart of only 48 colors. Building on it, we created 40 chromatic palettes of four colors, based on relations of harmonies and contrasts: achromatic harmonies, monochromatic harmonies, polychromatic harmony of analogous colors, polychromatic harmony of complementary colors, and hue, temperature, saturation and ratio contrasts.

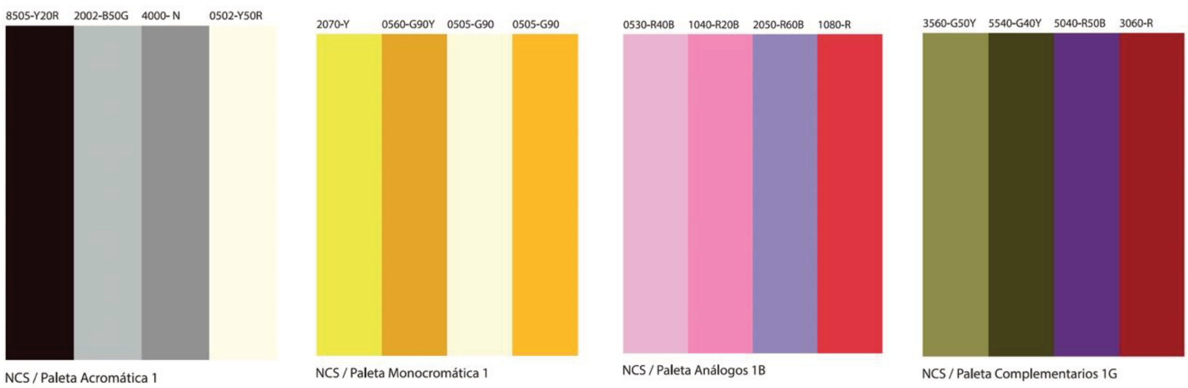

Figure 3: Four of the 40 palettes of the project (the author, 2023).

3.3 Project's outreach

In June 2024, we presented the project in an art gallery in the city of Valdivia, with the 208-color chart. We designed a map of the region, in a free and artistic interpretation, and a 2-meter-diameter mandala with the 208 colors, which we exhibited along with the 40 palettes, the complete chart, watercolors, rock samples, and other products, during the month of June 2024. In addition, we have held color workshops to present the chart and the palettes, and we participated in two conferences.

4. CONCLUSIONS

The project has not yet been completed, as there are still some activities to be carried out, and above all, the connection with a national paint company that would allow people to access the colors from the "Los Ríos en Colores" chart, in a store of prepared colors. The projections of this project are broad, and we have begun taking small steps through exercises with students within the university. We hope that it will be a contribution to all those creative disciplines that work with the identity of a territory, since color is an unavoidable means of expression of creative work.

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Color, Design, and Poison Dart Frogs

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ABSTRACT

The participating trailblazing color professionals embody a diverse group of international leaders in the field of color such as an Emmy award-winning production designer, a Harvard color conservationist, two Sikkens color prize winners, a preeminent color neuroscientist, an expert in design for colorblindness, a color data analyst using AI, a distinguished color forecaster, a premier indigo grower/artist, cutting-edge product designers, a kintsugi artist, the planetary scientist who created the camera that took the first color photographs in space, and others. Moreover, an interview with an expert on ectotherms outlines the many color strategies critical to the survival of poison dart frogs.

Discussion includes how and when color is used in stages of work and why color is important to the process and result. Color methodologies investigated include similarities and differences of color use by interviewed professionals and poison dart frogs. These methodologies include utilizing color to allure, protect, deceive, and evolve.

The paper elucidates ways in which color can be used with intention to creatively solve problems. The findings illustrate color's role in the creative process across many industries and demonstrate color's impact on cross-disciplinary decision making on a global level.

1. INTRODUCTION

In a 1929 paper, the astronomer Edwin Hubble announced a discovery that radically altered the way we see ourselves in the universe. He observed that wavelengths of light from the visible galaxies shifted toward the red end of the spectrum—proof that the cosmos began with the Big Bang. Notably, the breakthrough hinged on a property of color (European Space Agency, nd).

Moreover, a home seller wanting to earn more cash should paint the front door black. An easy color change raises an average home's sales price by $6,449 (House Beautiful, 2024).

Curiously, regardless of performance, the color purple makes athletes shine. Designers at the Stade de France for the summer Paris 2024 Olympics colored the innovative running track a mid-value, rather saturated purple. Olympic Broadcasting Services attested that the purple color "provides a better viewing experience." Research revealed that, for television viewers, the chosen purple highlights the athletes on a digital screen (Burgaud, 2024).

From doors to athletic stadiums to stars, color makes a difference. With this in mind, interviews with global experts were conducted to explore color methodologies that affect process, performance, and outcome in a variety of contemporary fields.

2. METHOD

Subjects were interviewed via phone, video, questionaire, or in person.

2.1 Interview Questions

A variety of questions were asked—evolving in a conversational style—where questions between interviewees varied based on evolution of the conversation. Questions included:

- Color plays roles of both seduction and protection in the lives of poison frogs. How does your use of color allure or attract? How does color act for protection in your work?
- Color forms part of a narrative with poison frogs (such as messaging "steer clear" or "I'm attractive.") What is the role of color and storytelling in your work?

- Color of frogs is made of three layers that combine together to make the color we see. Could you discuss the importance of layered color in your work?
- How would your work change if it were achromatic (say, if color was not a part of your toolkit)?
- Would you like to walk us through color development of a specific project you've done?
- What stage does color arrive in your design process?
- How does color inform your decisions?

The websites of the interviewees were also used for research.

2.2 Selection of Interview Sources for Discussion

The methodology included 18 interviews. For clarity, the paper focuses on four interviews. One interview featured scientist Juan Santos of St. John's University where discussion centered on the color strategies of aposemetic poison frogs. Subsequently, the interview with designer Christoph Bach of the firm Raw Color, the interview with architect Jacob van Rijs of the design studio MVRDV, and the interview with synthetic molecular biologist Tal Danino of Columbia University explored color methods to induce progress in their respective fields.

3. RESULTS AND DISCUSSION

The interview with scientist Santos revealed that poison frogs have strong colors to attract mates and to repel predators. Golden poison frogs are the most lethal frog (and likely the most lethal animal on the planet) – able to kill about 10 humans or 20,000 mice with the amount of poison available at one time (American Museum of Natural History, nd). As such, the saturated yellow color sends a warning message by strongly contrast in hue and value with a typical jungle floor habitat. For frogs with a less poisonous punch, a color may be bright lime green; the lime green warns predators with contrast and/or strong saturation level in certain contexts but can also deceive predators when the green blends with the foilage or spots of sun landing on the jungle floor. Furthermore, significant hue changes of poison frogs during the formation of the islands of Panama illustrates how frogs can evolve to survive in changing circumstances.

The conversation with architect van Rijs exemplifies his use of a glowing, translucent Tiffany Blue façade in an airport store to allure travellers into the shop. In his firm's self-designed MVRDV House, dark colored rooms discourage company leadership from inadvertently staying in their offices and, instead, encourage them to be out in the studio spaces interacting with the staff. This color application creates a positive contribution to company culture by integrating those at various levels of the organization. Additionally, clever cultural application of color in Radio Hotel contributes to the thoughtful and respectful evolution of a neighborhood in New York City.

Biologist Danino uses color in experiments on his path to cure cancer. Color dyes in experiments can highlight good bacteria (such as probiotics in the gut or in sauerkraut) and bad bacteria (such as E. coli) to help scientists learn to synthesize new bacteria to operate as problem-solving vehicles in the body. Importantly, Danino exhibits seductive chromatic imagery of his colored petri dish experiments in art shows to encourage interest in personal health, in the ongoing efforts to cure diseases, and in the bacteria science field at large.

Finally, designer Brach layers color in many of his works, causing a perceptual sensation similar to a frog's layered skin. His stacked hues of lines and grids in furniture design entice viewers into spaces and, at times, playfully trick viewers on spatial depth and actual color of materials. Just as Brach's complete rethinking of the design of the MINI car offers color as an experience enhancer, so, too, it ensures safety with color chosen in relation to ritual of navigating a fast moving car in city traffic.

The provocative interviews present tangible strategies for intentional color use to enhance experience, performance, health, and safety of those in our world.

4. CONCLUSIONS

The candid interview conversations in the paper elucidate ways in which color methodologies—including use of color to allure, protect, deceive, and evolve—can creatively solve problems. The paper suggests that, without color's presence, vital human accomplishments for connection and growth may not exist. Further exploration could continue to prove that clever and judicious use of color goes beyond creating visual impact to forge societal transformation on a more comprehensive scale. The remaining 14 interviews previously conducted will be analyzed. In addition, more interviews will take place to explore color's role in changing the world. The overall learnings from the interviews will be published in a book with the working title of *Hue, Chroma, and Poison Dart Frogs: How Color Changes Everything*.

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(Post)humans and Technology: Exploring Colour Stories of Metaverse Images by International Media Outlets

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RAL COLOURS

ABSTRACT

This paper analyses images from twelve international news websites and online magazines to explore how media outlets depict the Metaverse, an immersive world linking the physical and virtual. By comparing images from two different times periods and examining the respective themes and colour palettes, including contrasts, saturation, and tonal balance, the research aims to understand the evolving portrayal of the Metaverse and its possible impact on public perception. The paper employs insights from scholars such as Haraway and Hayles to frame the analysis within a posthuman context.

The findings reveal three main aspects of the human-technology relationship: VR headsets illustrate the integration of technology into daily life, AR headsets highlight the merging of physical and virtual realities, and depictions of cyborgs, robots, and AI emphasise the evolving boundaries between human and non-human entities. Specific colour choices reinforce these themes, influencing the emotional tone and aesthetic appeal.

Overall, the study shows that while certain themes and colour palettes remain consistent, the concept of the Metaverse is dynamic. Media images and their colour stories significantly shape public understanding and interaction with emerging technologies, contributing to a deeper comprehension of the human-technology relationship and potentially informing future technological and cultural developments.

1. INTRODUCTION

In a time of rapid technological advancements and increasing interconnectedness, media visualisations are significant as they provide a glimpse into the emerging Metaverse technology. The Metaverse, though not strictly defined, generally refers to an immersive world that bridges the physical and virtual, often accessed through VR and AR headsets (Dolata and Schwabe 2023, 4). As technology advances, humans spend more time in virtual worlds for work, social interaction, and recreation. In October 2021, Mark Zuckerberg rebranded Facebook as Meta, signalling a major investment in the Metaverse and sparking extensive media coverage. Dolata and Schwabe emphasize the importance of popular media in the reception of the Metaverse, noting that it significantly impacts collective understanding and adoption of technologies (2023, 2). The success of the Metaverse depends on how people perceive it through media consumption (Zhang et al. 2022, 1). Visualisations in news reports are crucial due to the Metaverse's visual and immersive nature. Images not only act as thought experiments of potential human transformations through technology, but provide concrete visual representations of these changes (Hauskeller et al. 2021, 4). Effective visual communication design relies on visual perception and cognitive organization, with colour and contrast playing a crucial role in capturing attention, creating an emotional atmosphere, and enhancing communication by drawing focus to key elements amidst a cluttered visual landscape (O'Connor 2020, 86).

2. METHOD

Posthuman philosophy serves as the theoretical framework to critically examine the transformative power of the Metaverse, using it as a lens to interpret both themes and colours stories within media images. The methodology involves a visual content analysis and a colour analysis using the RAL Design System plus to extract and analyse media images and their colour palettes as it offers a comprehensive colour space that allows for interdisciplinary compatibility through standardization.

2.1 Posthuman Lens

Posthumanism is a philosophical framework that challenges traditional humanist concepts by suggesting that the human is fluid and ever-changing in a world of unparalleled technological development (Braidotti 2013, 2). The (post)human-technology relationship increasingly challenges traditional notions of what it means to be human and explores possible transformations of what we are becoming (Deleuze and Guattari 1987, 260).

In her book *How we became posthuman*, Hayles identifies three waves of digital technology transforming human body and identity through the hybridization of the biological and technological: homeostasis (starting 1945), reflexivity (starting 1960), and virtuality (starting 1980). These waves of cybernetics highlight the evolving nature of human identity and embodiment, with the first wave focusing on the merging of human and machine, the second on the blending of the physical and the virtual, and the third on the integration of human and non-human with biotechnologies blurring species boundaries (1999, 8-9).

Haraway, in her work *A Cyborg Manifesto,* defines the concept of cyborg as “a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction” with a nonbinary, intersected, fluid and fractured identity (1991, 5, 16, 60). Almost synonymous with the posthuman, the cyborg highlights the transcendence of human boundaries through technology, blending human and machine in terms of body, embodiment and identity to challenge traditional binaries. Haraway’s concept of the cyborg and Hayles’ exploration of human-technology hybridization illustrates posthumanism’s relevance in analysing technological advancements such as the Metaverse.

2.2 Visual Content Analysis

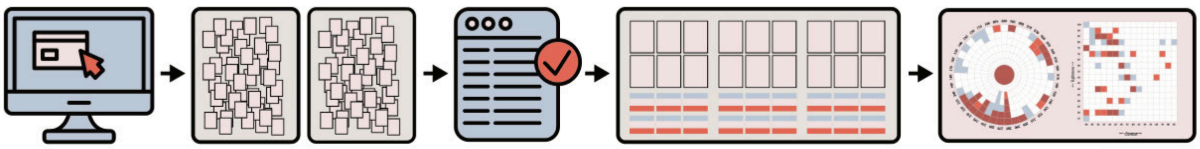

Figure 1: Flowchart illustrating the visual content analysis

This research conducts a visual content analysis of images (Figure 1) from twelve international news websites and online magazines published in English[1], focusing on sources with significant circulation and impact, covering a broad socio-political and geographic spectrum. The study examined images related to the Metaverse from two 90-day periods: after Facebook’s rebranding to Meta, ending January 26, 2022, and a year later, ending April 26, 2023. The aim is to identify shifts and trends in media images of the Metaverse.

Images were manually collected, excluding those featuring logos, Zuckerberg, or unrelated individuals. A combination of quantitative and qualitative visual content analysis identified recurring themes, grouped into what I call “clouds of images”. Using a coding list, images were categorized to break down complex ideas into smaller parts, uncovering important themes and focusing on three specific clouds that represent different aspects of humans interacting with technology. This process examines correlations and patterns to identify colour stories.

The next step is to extract the colour palettes from these clouds of images. For each image, three prevalent colours are identified. The RAL Design System *plus* is used to analyse these

[1] *The New York Times, Wall Street Journal, The Washington Post, WIRED, Forbes* (US); *The Guardian, The Economist* (UK); *The Rio Times* (Brazil), *China Daily* (China), *Times of India* (India)*, Sydney Morning Herald* (Australia)*, and The Daily Nation* (Kenya)

colours in terms of hue, lightness, and chroma, enabling an examination of colour grading, contrast, and overall tonal balance.

3. RESULTS AND DISCUSSION (250)

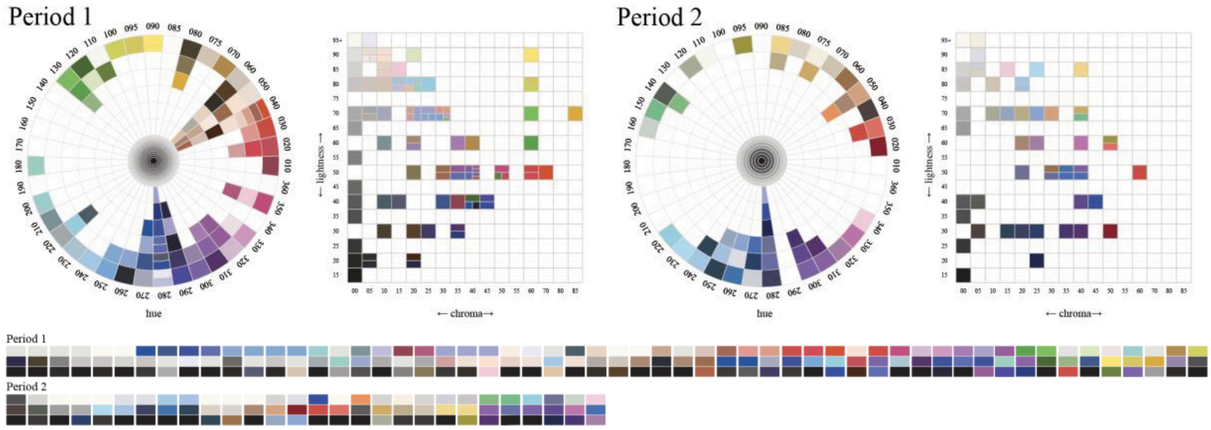

Figure 2: Colour Analysis of Cloud of Images 1 - Transgressing Human-Machine Boundaries

Images in the first cloud show humans wearing VR and AR headsets in physical environments. Applying Hayles' concept of homeostasis, individuals wearing VR headsets symbolizes the early posthuman stage, with the absence of explicit Metaverse references suggesting this integration is primarily an internal experience. This theme indicates a continuous transformation toward the posthuman, as the VR headsets act as an extension of the human body akin to the cyborg, expanding human capabilities and altering the perception of reality.

In terms of colours (Figure 2), the first period exhibits a pronounced red spectrum in all tints and shades; a pronounced blue spectrum reaching into greenish and violet nuances; quite some highly saturated yellows and greens, creating a sense of energy and artificiality, which might evoke feelings of excitement or intensity about the emerging Metaverse; a dominance of neutral greys and blacks could suggest a focus on the technological aspect, aligning with the futuristic and somewhat stark aesthetic of VR headsets. In the second period, the greens diminish and the different nuances of violets and reds decrease, creating a more subdued and balanced visual experience. Although blues remain prominent, these changes create a more balanced overall tonal distribution, with hue, lightness, and chroma more evenly spread across the spectrum. The changes suggest growing calmness and sophistication, potentially leading the public to view the Metaverse as more mature and refined, rather than chaotic.

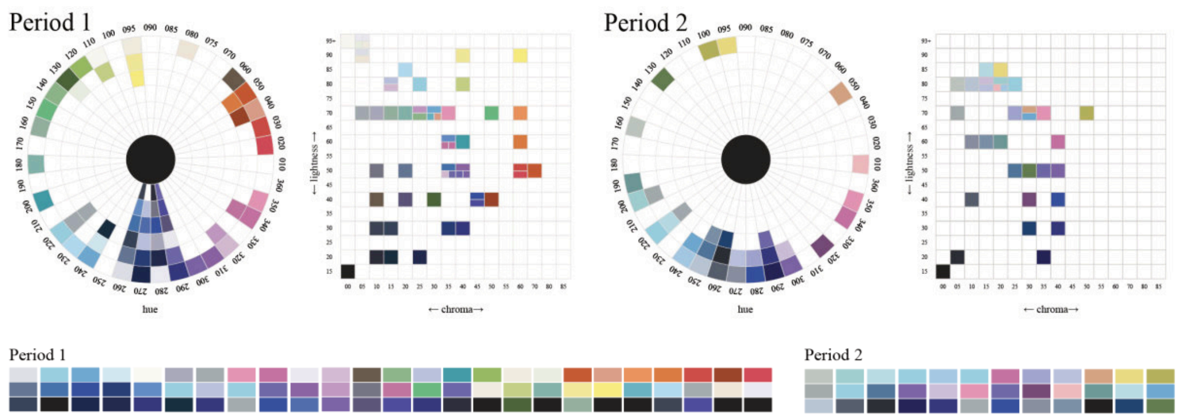

Figure 3: Colour Analysis of Cloud of Images 2 - Transgressing Physical-Virtual Boundaries

The previous cloud maintained an external perspective on the Metaverse, whereas this cloud visualizes a phygital world through AR headsets and augmented graphic elements, blending physical and virtual realms. These images align with Hayles' second wave, reflexivity, as they place humans in hybrid spaces, where the boundaries between physical and virtual worlds become increasingly indistinguishable. The images reflect the notion that the virtual realm becomes increasingly integrated into the physical world, thereby altering our perception of what is considered ‘real’ (Van der Merwe 2021, 5).

Similar to the first cloud, the colours of the first period of the second cloud feature high-saturated greens, yellows, and reds, alongside many strong light-dark contrasts (Figure 3). In the second period, these vibrant colours disappear, possibly showcasing less excitement about the Metaverse. Persistent blues and violets give the overall atmosphere a cooler tone that is often associated with technology. This shift towards a more subdued palette may be a deliberate effort to create a welcoming yet futuristic ambiance, moving away from the overly artificial greens, reds and yellows. However, the dominance of dark blues and vibrant violets undermines this intention.

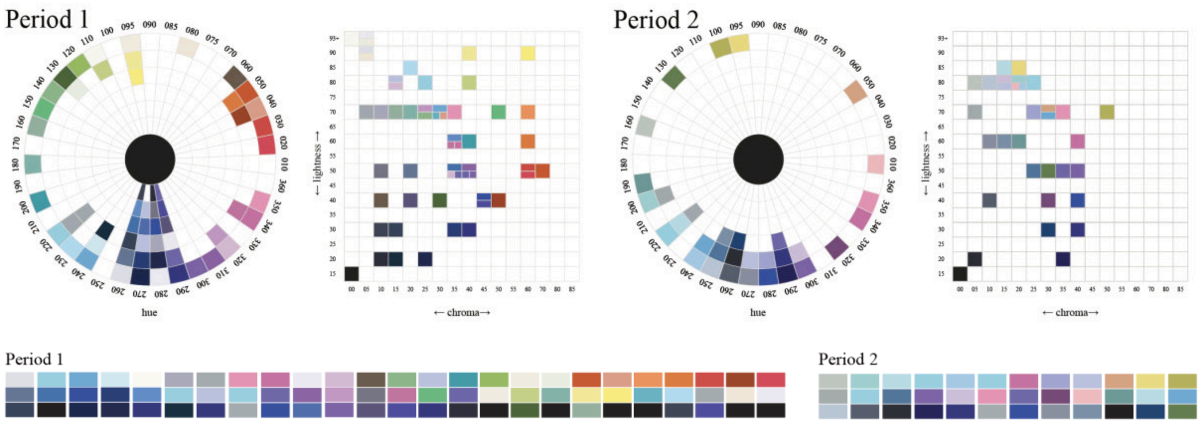

Figure 4: Colour Analysis of Cloud of Images 3 - Transgressing Human and Non-Human Boundaries

The third cloud features humans both alongside and as cyborgs, robots, and AI, highlighting the merging of human and non-human characteristics. The third cloud features humans both alongside and as cyborgs, robots, and AI, highlighting the merging of human and non-human characteristics. The images portray a future vision in which humans become cyborgs as catalysts for human evolution and transcendence into a higher-thinking, posthuman species (Konsa 2022, 2). As humans interact with and even physically incorporate technology, both undergo changes, profoundly impacting our self-perception of body and identity, and consequently, our understanding of what it means to be human (2022, 9). These depictions visualize Hayles’ concept of virtuality as they challenge conventional notions of embodiment and subjectivity by recognizing the equal significance of non-human bodies and identities.

In both periods, the colour palettes predominantly feature shades and tints of blue, with occasional pops of red and yellow, contributing to a sleek, futuristic, and technologically advanced aesthetic. However, the transition in the second period, where vibrant greens are eliminated and the tonal balance shifts away from mid-range colors, might suggest a deliberate move towards a cooler, more homogeneous visual style. This change could make the phygital world seem increasingly monotonous and less engaging. The reduced colour diversity and emphasis on cooler, darker tones may risk diminishing the perceived dynamism and emotional impact of the Metaverse, potentially leading to a more sterile and less inviting public image.

4. CONCLUSIONS

The three visual themes explored in this paper illustrate the transformation of humans into posthumans within the Metaverse. Applying a posthuman framework enhances the visual analysis by highlighting the intensifying relationship between humans and technology. This interconnected socio-technical phenomenon gradually dissolves boundaries between humans and technology, making the integration with technology a defining aspect of what it means to be human as it influences our perceptions, identity, and embodiment. The colour stories convey emotional tone, aesthetic appeal, and conceptual aspects, influencing human interaction with emerging technologies. Overall, the tonal balance in the images reflects a cold, impersonal world, characterised by the dominance of blues and greys. The use of high-saturated artificial colours - such as greens, violets, reds, and yellows - combined with stark light-dark contrasts create an atmosphere that feels unwelcoming and and not ideal for a habitat focused on regeneration and well-being, potentially challenging the Metaverse's success. Additionally, the shift to less saturated colours suggests that the initial excitement surrounding the Metaverse does not necessarily translate to widespread adoption of the technology. The three parallel storylines create multifaceted colour stories of the Metaverse in media outlets, raising a crucial question: Are we prepared to fully embrace these cyborg transformations associated with technology and accept ourselves as posthumans? Both media images and their colour stories shape public understanding and cognition of the Metaverse, affecting how humans perceive and engage with new technologies.

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Color in Cultural Landscape: Cross-cultural Differences in Strategies for Constructing Harmonious Color Combinations

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ABSTRACT

In cultural landscapes, we most often deal not with separate colors but with combinations. When choosing a color, we usually try to “fit” it into an already existing color context, making the new color combination harmonious. Yet are the “laws” of color harmony fundamental to our shared cognitive architecture, or are they cultural products that vary from country to country? To answer these questions, we conducted an experiment involving 2,247 participants aged 16-84 and coming from 52 countries. To create experimental stimuli, we used 10 color combinations composed by the Russian avant-garde artist Mikhail Matyushin and his disciples for the *Reference Book of Color* (1932) based on the shades typical of architectural design. We removed from each of the selected color triads the “intermediary” linking color, asking participants to adjust the color of this band according to their liking. Our analysis of 11,235 color choices enabled assessment of cross-cultural differences in: projections of color choices into the CIELCh color circle; the frequency and predominance of colors with specific attributes (hue, chroma, and lightness); and the “geometric” properties of the color triads plotted in the CIELAB color space. Our experiment showed that when choosing shades from a large number of possible options, participants from different countries tried to coordinate choices with the shades already present. Moreover, the chosen chroma correlated with lightness and hue. Another universal strategy was the choice of a color at approximately the same color difference from the existing two. Thus, in the 3D CIELAB space, the resulting triangles turned out to be isosceles or even equilateral. Along with universal patterns, we recorded noticeable cross-cultural differences in strategies for constructing harmonious color combinations. Color triads in different cultures were found to have a different “geometry” in CIELAB space. The most culturally specific are the ratios of angles and side lengths formed by given and selected shades,

as well as the areas and types of triangles determined by the color choices. A comparative analysis of color choices according to these parameters confirms the cultural conditioning of the mechanisms of perception, processing, and multimodal integration of color information.

1. INTRODUCTION

In cultural landscapes, we most often deal not with separate colors but with combinations. In art, architecture, and design, each individual shade belongs to a system of relationships: it is adjacent to other colors, and these colors define its boundaries. When choosing a color, we usually try to "fit" it into an already existing color context, making the new color combination harmonious (see for review O'Connor 2010; Westland et al. 2007). Yet are the "laws" of color harmony fundamental to our shared cognitive architecture, or are they cultural products that vary from country to country? To survey potential cross-cultural specifics in strategies for building harmonious color combinations, we conducted an online experiment. Our analysis of the resulting data enables assessment of cross-cultural differences in: (1) the projections of color choices into the CIELCh color circle; (2) the frequency and predominance of colors with specific attributes (hue angle (h°), chroma (C), and lightness (L*); (3) the "geometric" properties of the color triads plotted in the CIELAB color space.

2. METHOD

2.1 Participants

The experiment involved 2,247 participants aged 16-84 and coming from 52 countries. In the present paper, we analyse and discuss the data for 30 countries with at least 30 respondents: Algeria (MA = 27.9), Armenia (MA = 31.9), Austria (MA = 26.2), Belarus (MA = 21.1), Brazil (MA = 20.0), Canada (MA = 58.9), Chile (MA = 36.8), Croatia (MA = 41.4), Egypt (MA = 34.8), Greece (MA = 31.1), Iceland (MA = 50.1), Indonesia (MA = 22.5), Iran (MA = 34.7), Italy (MA = 30.2), Japan (MA = 25.3), Jordan (MA = 24.9), Mali (MA = 26.7), Mexico (MA = 22.1), Nigeria (MA = 35.6), Philippines (MA = 22.7), Russia (MA = 26.7), Saudi Arabia (MA = 25.5), Senegal (MA = 20.9), Serbia (MA = 26.3), Spain (MA = 34.8), Taiwan (MA = 24.3), Thailand (MA = 21.2), Turkey (MA = 23.9), USA (MA = 60.5), Zimbabwe (MA = 30.9).

2.2 Experimental Stimuli

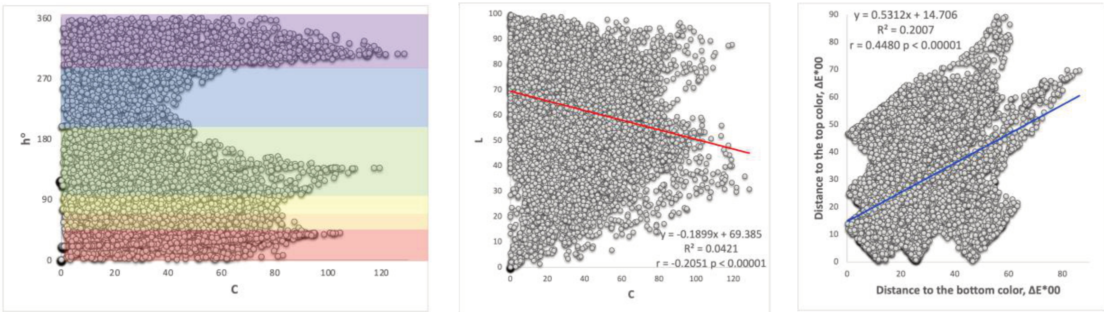
To create experimental stimuli, we used 10 color combinations composed by the Russian avant-garde artist Mikhail Matyushin and his disciples for the *Reference Book of Color* (Matyushin 2007/1932) based on the shades typical of architectural design. We removed from each of the selected color triads the "intermediary" linking color, asking participants to adjust the color of this band according to their liking (Figure 1) (see for more details: Griber et al. 2024).

(I) **(II)** **(III)** **(IV)** **(V)**

Figure 1: Experimental stimuli.

3. RESULTS AND DISCUSSION

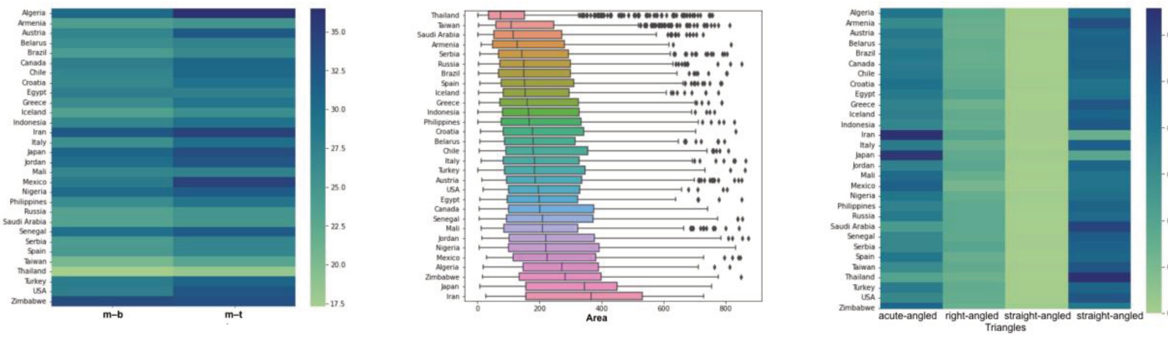
Our experiment showed that when choosing shades from an almost infinite number of possible options, participants from different countries tried to coordinate these choices with the shades already present. Moreover, the chroma (C) of the chosen colors correlated with their hue angle (h°) and lightness (L). Purples (mean C = 43.68), reddish (mean C = 31.57) and orange colors (mean C = 31.37) had greater chroma than yellows (mean C = 26.97) and greens (mean C = 26.22). Blue and blue-green colors had the lowest chroma (mean C = 21.37) (Figure 2-a). The higher the C-value, the lower the lightness (r = -0.2051 p < 0.00001) (Figure 2-b). Another universal strategy was the intuitive choice of a color at approximately the same distance in the color space from the two already given (r = 0.4480 p < 0.00001) (Figure 2-c). Thus, in the three-dimensional CIELAB space, the resulting triangles turned out to be isosceles or even equilateral.



(a) **(b)** **(c)**

*Figure 2: Universal patterns in strategies for constructing harmonious color combinations: (a) correlation of chroma (C) with the hue angle (h°) and (b) the lightness (L) of the colors chosen in different countries; (c) color differences CIEDE2000 (ΔE*00) between the vertices formed by the middle (chosen) and the bottom colors (x axis), the middle (chosen) and top colors (y axis).*

Along with universal patterns, we recorded noticeable cross-cultural differences in strategies for constructing harmonious color combinations. Color triads in different cultures have a different "geometry" in CIELAB color space. The most culturally specific are the ratios of side lengths formed by given and selected shades in the CIELAB color space (Figure 3-a), as well as the areas (Figure 3-b) and types of triangles determined by the color choices (Figure 3-c). A comparative analysis of color choices according to these parameters confirms the cultural conditioning of the mechanisms of perception, processing, and multimodal integration of color information.



(a) **(b)** **(c)**

*Figure 3: Cross-cultural differences in strategies for constructing harmonious color combinations: (a) mean color differences CIEDE2000 (ΔE*00) between the middle (chosen) color and the color of the bottom stripe (m–b), the middle (chosen) color and the color of the top stripe (m–t) in the CIELAB color space; (b) the areas and (c) types of triangles determined by the color choices.*

4. CONCLUSIONS

By mapping the color choices from the experiment database into CIELAB color space to identify their chromatic characteristics, we revealed universal and culture-specific patterns of color harmony. The results are significant in at least two major respects. The present study surpasses past design limitations by using an unconstrained color-picking method and by involving a great number of participants from different countries. The analysis presented in this paper will facilitate opportunities for architects, designers, and other color professionals to create culturally specific harmonic color combinations in urban environments. Research should be continued to describe gender and age influence on strategies for building harmonious color combinations in different cultures, as well as to expand the number of participating countries.

ACKNOWLEDGEMENTS

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The Role of Aesthetics and Color in Sustainable Textile Practices

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ABSTRACT

This paper investigates how color can enhance sustainability in textile and fashion design, based on the Sustainable Consumption and Production framework. It highlights the significance of extending product lifespans and deepening user attachment through strategic color use, which fosters emotional connectivity and promotes sustainable consumer behaviors. A qualitative analysis of four case studies from the Swedish School of Textiles demonstrates that integrating color enhances product appeal and supports environmental sustainability by influencing user behavior. These cases illustrate varied methods of incorporating color in design processes to improve product longevity and minimize environmental impact. The discussion points out that despite the industrial focus on speed and cost, using color strategically can extend textile durability and promote sustainable industry practices.

1. INTRODUCTION

The prevailing economic system, with its focus on mass production and low prices, significantly undermines sustainable practices by promoting short product lifespans. According to Bermejo (2014), consumers often overlook the environmental impact of their habits. Manzini (2009) proposes the Sustainable Consumption and Production approach, emphasizing the extension of product lifetimes and enhancing user attachment as essential for sustainable consumption. This approach advocates for designing longer-lasting products and fostering stronger connections between users and their products.

Mugge et al. (2008) state that products must hold special significance to delay replacement, as mere functionality doesn't foster emotional attachment. Deep connections with a product encourage care, repair, and prolonged use, enhancing user satisfaction and long-term relationships. Niinimäki (2010) highlights that product attachment is influenced not only by personal history but also by design styles, quality, and functionality. The aesthetic aging process of a product is crucial for its longevity, with materials like high-quality wool and leather aging well, thus increasing aesthetic appeal and product durability.

Harper (2018) argues that aesthetics and expressional durability in design are crucial for long-term satisfaction and product longevity. Enhancing the psychological and sensuous bond between users and products encourages longer retention and transcends traditional sustainability methods.

Color plays a significant role in shaping user perceptions and attachments to products. It can evoke emotions, convey meaning, and enhance the visual appeal of a product (Hirschler et al., 2022), contributing to its expressional durability. By carefully considering color in the design process, designers can create products that resonate more deeply with users, fostering stronger attachments and promoting longer product lifespans. This paper aims to explore the role of color in aesthetic design as a driver for enhancing product longevity and sustainability. By qualitatively analyzing four case studies from the textile design program at the Swedish School of Textiles, this study demonstrates how the strategic use of color can contribute to more sustainable and enduring user experiences. The investigation highlights the potential of color in fostering sustainable design practices that extend the functional and aesthetic life of textile products.

2. METHOD

2.1 Case 1: Maelis Ray's 'The Transformable Textile Interior'

In 2023, Maelis Ray designed a versatile textile that transitions from a teapot cover to a tablecloth, showcasing her commitment to sustainability and longevity. The teapot cover features soft pastel hues of blue, green, and yellow, while the tablecloth is a vivid dark purple with pastel accents, enhancing adaptability across different settings and styles. The design incorporates leaf patterns, adding a graceful and organic touch that promotes comfort, reduces eye strain, and enhances comfort during prolonged use. This choice of contrasting colors not only attracts attention but also increases engagement levels and complements various environments, emphasizing the textile's functional and aesthetic flexibility (Figure 1, left).

2.2 Case 2: Mia Lehtonen Madsen's 'The Sky is the Mirror'

In 2023, Mia Lehtonen Madsen launched a personalized collection of wearable textiles inspired by zodiac signs and their colors, enhancing users' connection to their garments and creating a sense of ownership. She uses the zodiac charts of two individuals to tailor unique color palettes aligned with the four elemental zodiac themes, incorporating universally resonant colors into simple geometric patterns like circles and narrow rectangles for stability and identity expression. Her piece, the 'SUN-MOON-ASCENDANT SKIRT' for Person A, showcases a reversible design with a bold green, black, and blue side featuring structured stripes and a calmer blue, white, and black side. Both sides offer aesthetic versatility and prolonged engagement. The top edge features a textured fringe, enhancing tactile engagement. Tunnels for ropes are integrated, serving both functional and decorative purposes, increasing user engagement and attachment (Figure 1, right).

Figure 1: Case 1 (left): a versatile textile transitioning from a pastel-hued teapot cover to a dark purple tablecloth. Case 2 (right): the skirt with reversible designs and distinct color palettes.

2.3 Case 3: Luna Gil's 'Seen-UnSeen'

In 2020, Luna Gil's collection of three textiles transcends mere decoration, embodying stories that evoke strong emotional reactions and address environmental concerns from human activities. These textiles portray the journey through the oceans and the effects of plastic pollution, using color and hand-drawn patterns to deepen user engagement. Each piece features organic fish shapes and seaweed patterns against a light blue backdrop, symbolizing an underwater scene. The textiles come alive under RGB lighting, shifting colors to convey trust, pollution awareness, or danger, depending on the light's hue. This interactive element increases user involvement, enhancing the narrative experience of the textiles (Figure 2, left).

2.4 Case 4: Emilie Palle Holm's 'OriOri'

In 2023, Emilie Palle Holm introduced a series of textile forms that dynamically change colors and patterns through lenticular effects and can be turned inside out to reveal new designs, encouraging deep interaction. These transformations foster a strong sense of curiosity and attachment. The featured piece, a three-dimensional woven origami structure, displays a circular, starburst pattern with radial symmetry and color transitions from deep blue to black, enhancing its tactile and visual appeal and evoking peace and calmness. Its side view is a cylindrical structure with a dark blue zigzag pattern at the top and a black zigzag pattern at the bottom, with white lines outlining the edges, creating contrast and emphasizing the geometric design. It creates a sense of stability and strength. Closing the piece from the weft direction reveals complex, tall accordion-like folds and contrasting zigzag patterns, creating a visually engaging, interactive experience that deepens users' emotional connections (Figure 2, right).

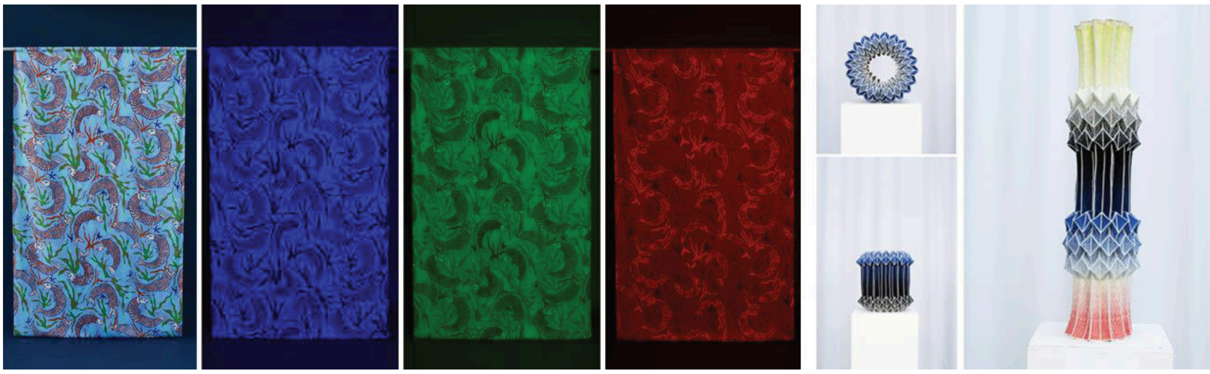

Figure 2: Case 3 (left): textiles shift colors under RGB lighting, enhancing user engagement. Case 4 (right): the piece transforms from a starburst pattern to a cylindrical structure, fostering curiosity and attachment.

3. DISCUSSION

In textile and fashion design, color communication often involves using standardized color systems like Pantone, alongside digital technologies, to ensure precise communication and quality control. This paper expands the discourse on color communication by exploring how colors can communicate concepts of sustainability and longevity in fashion and textile design. The prevailing economic system, focused on mass production, challenges sustainable design practices. Manzini's Sustainable Consumption and Production approach (Manzini, 2009) advocates for products designed for longer lifespans and deeper user attachments, as seen in the minimalist and personalized color palettes used by designers like Maelis Ray (2023) and Mia Lehtonen Madsen (2023).

Furthermore, Mugge et al. (2008) and Niinimäki (2010) have highlighted the role of emotional attachment and product longevity, suggesting that aesthetic qualities, such as those achieved through strategic color use, are crucial for enhancing user satisfaction and extending product life. This is apparent in the collections of Luna Gil and Emilie Palle Holm, which engage users emotionally through interactive storytelling and dynamic color integration.

Harper (2018) highlights the role of expressional durability in enhancing long-term product satisfaction. Our findings reveal that aesthetic expressions, influenced by color choices, are crucial for fostering attachment and extended use. Contrary to the belief that neutral colors promote sustainability, our case studies indicate that various color palettes, including pastel and highly saturated hues, support themes of longevity and sustainability. This suggests that the psychological effects of colors, combined with design elements like patterns, textures, and forms, can positively influence user behavior and attachment, encouraging extended usage.

The environmental impact of textile dyeing, including biodiversity loss from natural dye use, raises concerns. Strategic color use and educational campaigns to shape consumer perceptions can enhance sustainability and longevity. Future research should explore quantitative measures of user attachment and product lifespan in relation to color choices to substantiate these qualitative findings. Expanding this research to include diverse cultural contexts could uncover universal and culture-specific color strategies that enhance sustainable design practices globally.

4. CONCLUSIONS

In conclusion, this discussion underscores the critical role of color in textile design as a medium for emotional and sensory connectivity, which in turn promotes sustainability through longevity. By prioritizing aesthetic appeal and emotional resonance, designers can transcend conventional sustainability practices, offering solutions that encourage consumers to form lasting relationships with their products.

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Effectiveness of Real Appearance Images and Characteristics of Building Images that Alter Impressions

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ABSTRACT

The appearance of building surface colors changes depending on the surface characteristics and lighting conditions. Impression-evaluation experiments should be conducted using images representing the appearance of buildings in various lighting environments to reveal the impact of these visual changes on impressions. However, reproduction of the same luminance distribution as that in actual scenes is impossible because of limitations in monitor brightness and latitude.

The real appearance image (RAI)-based method proposed by Y. Nakamura has the capability to reproduce a realistic appearance by altering the image brightness while retaining contrast features in the distribution. Two experiments were conducted to assess the effectiveness of this method.

- Experiment 1: Changes in impression based on two significant alterations during RAI creation
- Experiment 2: Comparison of RAIs and on-site building impressions

The main results of the two experiments are as follows:

Experiment 1: Three factors were interpreted as the main contributors to changes in impressions.

1. Changes in the reflective characteristics of the wall surface associated with the overflow from the latitude of the monitor.
2. Changes in overall wall surface brightness.
3. Changes in the partial darkness of wall surfaces not exposed to direct sunlight.

Experiment 2: The differences in evaluations were significant, reaching approximately 2.0 in certain instances. Obtaining equivalent impression evaluations for on-site evaluations is challenging, even when using RAIs.

Significant features of the images with substantial evaluation differences are as follows:

1. Images depicting reflections on metallic wall surfaces or overall wall reflections appeared to receive higher on-site evaluations than those on RAIs for most impressions.
2. As regards images with subtle reflections on calm wall surfaces or with reflections of the sky, evaluations of vividness and brightness were higher as compared to on-site evaluations.

Additionally, scales representing impressions derived from overall perception, such as preferences, tranquility, and beauty, show a smaller disparity between on-site evaluations and RAIs as compared to the inherent characteristics of the building surface. This suggests that the evaluation process focuses on the building itself rather than its appearance.

1. INTRODUCTION

We conducted two experiments, as described in the abstract, to assess the substitutability of real appearance image (RAI) evaluations for on-site evaluations. Below, we describe the second experiment, which directly addressed the differences between the on-site evaluations and those conducted in the laboratory using real appearance images.

2. METHOD

2.1 On-site Building Impression Evaluation Experiment [On-site Experiment]

Considering factors such as the ability to view the entire building, the prevalence of buildings receiving full sunlight on sunny days, and the presence of buildings with diverse designs and materials, on-site evaluation experiments were conducted on buildings near Tachikawa Station and in the Harajuku/Omotesando area. For Tachikawa, a total of 21 locations (18 common on both sunny and cloudy days) and for Harajuku/Omotesando, 27 locations were selected. In Tachikawa, evaluations were conducted on a cloudy day (May 27, 2022) and a sunny day (October 21, 2022), while in Harajuku/Omotesando, evaluations were conducted on a sunny day (November 18, 2022). Both the sunny and cloudy days had variations in light conditions, with some clouds and partial sunlight.

Impression evaluations were conducted using 16 seven-point semantic differential (SD) scales focusing on aspects such as the material, appearance, and overall impression of specific parts of the buildings indicated such as “the entire wall surface exposed to light” and “the entire portion of the wall facing the road above the second floor.” Fourteen participants in Tachikawa and fifteen in Harajuku/Omotesando, all female university students aged 19-22, conducted the evaluations.

2.2 Impression Evaluation Experiment Using Real Appearance Images [Laboratory Experiment]

2.2.1 Creation of Image for the Experiment

Photographs for creating RAIs were also taken during the on-site experiment using a DSLR camera (Canon EOS 80D + Tamron SP 10-24mm), about 12 images were taken at EV1.0 intervals on each site, ensuring that the highest and lowest luminance parts (e.g., sky, sunlight reflections on glass) were captured within the camera's latitude.

The RAIs were created from the multiple photographs using an application “REALAPS-omni-color” by Visual Technology Laboratory Inc. After testing various combinations, images were created with settings of maximum luminance of 300 cd/m² and a compression factor of 0.5, which were perceived as closest to reality. However, for extremely varying brightness photos, multiple settings were used for comparison.

2.2.2 Experimental Procedure

Participants were called into a darkroom, where the experimental procedure was explained, and they were given 10 minutes to adapt to the lighting conditions. Subsequently, the specific parts of the buildings evaluated on-site were shown as text at first to notice the part to evaluate, and then selected RAIs were presented on a 27-inch monitor (EIZO CX271-CN, maximum luminance: 300 cd/m²) for impression evaluation using the same SD scale as the on-site experiment. The total number of images evaluated was 66.

One ceiling light was on in the darkroom, with a horizontal illuminance of 1lx at the participant's position. The dark adaptation in this room was intended to bring the brightness perception closer to the on-site conditions, since the maximum luminance of the monitor was insufficient to fully replicate daytime lighting conditions.

Thirty female university students aged 18-22 participated, with data equivalent to 20 participants collected as two-thirds of the participants rated each image.

3. RESULTS AND DISCUSSION

3.1 Comparison of Impression Evaluations between On-site and Laboratory Experiments

The average ratings for the 16 scales were calculated from both the on-site and laboratory experiments using RAIs, and the differences were used for the input data of cluster analysis. The results are shown in Figure 1 with images.

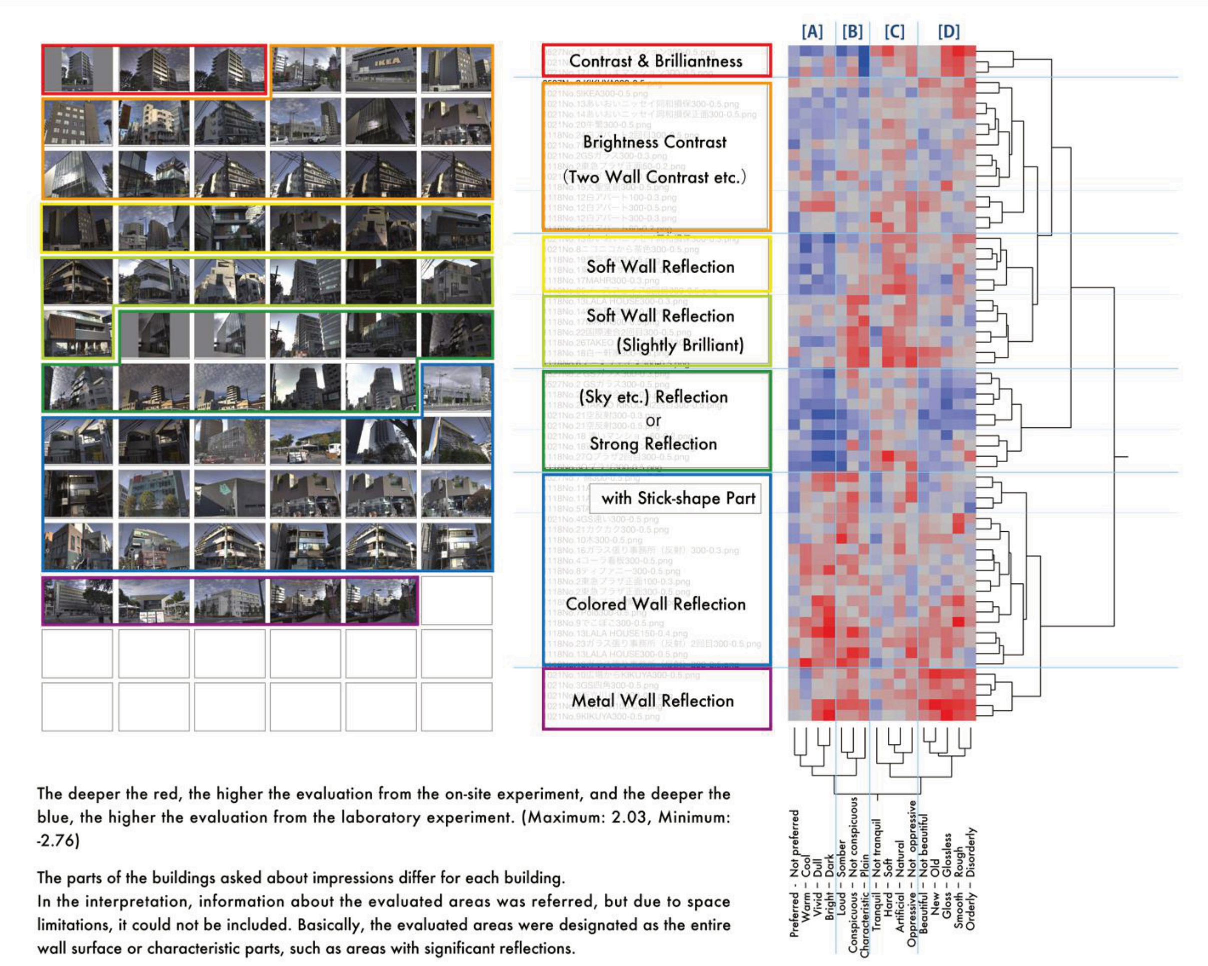

Figure 1: Results of the cluster analysis using the differences in average ratings between the on-site experiment and the laboratory experiment

For scale group [A] that includes vividness and brightness, the areas enclosed by purple and blue lines generally indicate higher ratings in the on-site evaluations. This is likely because vividness and brightness are more perceptible on-site when the wall surfaces reflect colored or metallic materials. Conversely, for the areas enclosed in green and yellow lines, which involve sky reflections or soft reflections, vividness and brightness were more strongly perceived in the RAIs, possibly due to the limitations of the dynamic range.

For scale group [B] that includes conspiciousness showed similar trends to [A]. However, differences in ratings for reflections and strong reflections (green) were smaller between on-site and RAIs. For the yellow-green areas with soft wall reflections, where contrasts with shadows or the evening sky were present, on-site evaluations had higher values.

For scale group [C], on-site evaluations were higher for the areas in yellow and yellow-green lines, indicating a greater perception of hardness and artificiality for smooth brightness changes on-site.

For scale group [D], on-site evaluations were higher for shiny and reflective surfaces (purple, some part of blue, and red), whereas RAIs showed higher values for green areas with sky reflections or strong reflections. Differences in glossiness perception are inferred to be involved.

Overall, for images, metallic surfaces with reflections, and overall reflective surfaces, on-site evaluations tended to be higher. Vividness, charactristic, artificial feeling, and glossiness were not sufficiently represented in images. Evaluations should be slightly adjusted for buildings with these characteristics. Sky reflections and strong reflections might require a slight decrease in brightness and glossiness evaluations. Soft reflective surfaces might need higher adjustments for charactristic and hardness.

Impressions that express feelings such as preference, tranquillity, and beauty, which are not related to the surface characteristics themselves but rather to the impressions they evoke, tend to have smaller differences between on-site and RAI evaluations.

4. CONCLUSIONS

Although it is not possible to obtain impression evaluation results equivalent to those from the on-site experiment using real appearance images, it has become clear that the difference tendencies in the evaluated impressions.

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The Communication of Colors in Interior Design: an Analysis of the Covers of The World of Interiors Magazine from the 1990s and 2000s

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ABSTRACT

This article seeks to establish a relationship between domestic interior design, the use of color in interior environments, and the communication of trends through the covers of specialized magazines. In this way, the time frame of the 1990s and 2000s was determined by analyzing the covers of The World of Interiors Magazine, from London, United Kingdom. To this end, it was possible to determine that although the time frame with the change of millennium occurred, the environments themselves did not undergo many changes, since the tones of beige, brown, and gray were present in the composition of the floor, ceiling, and walls, with the difference being the application of decorative elements with colors such as red, blue, and pink. In this way, it was possible to understand the behavior of these cores in the environment and their possible influences for the specialized professional and for the layman interested in the area.

1. INTRODUCTION

When talking about domestic interior design, analyzing its spatial composition and, in particular, its chromatic composition, it is necessary, first of all, to understand what this design that makes up the domestic environment would be. Therefore, according to Gomes Filho (2006), interior design determines:

> In a broader sense, it means the planning, organization, decoration and composition of the spatial layout of furniture, equipment, accessories, art objects, etc., arranged in internal living, work, cultural, leisure and other similar spaces, such as air, sea and land vehicles – planes, ships, trains, buses and automobiles, for example (Gomes Filho, 2006).

Therefore, it is clear that the spatial composition in the domestic environment is extremely relevant and that the elements present in it, through their colors and chromatic combinations, can determine the most varied sensations. However, it is still necessary to understand what color is and how it can influence the environments in which it is placed.

> The perceived color of an object results from the complex interaction between incident light and the object's material, which can reflect, absorb, or transmit light at different wavelengths (Jones, R., Chhilders, D.G., 2016).

At this point, it is possible to determine that color can be defined, physically, as a perception of the interaction between light and materials present in the observed space. Therefore, it is possible to state that color is not a property of objects, but rather an interpretation generated by the brain from the reflection of light, which can be absorbed or transmitted through objects.

After understanding the definition of interior design, inserted in the residential context, and of color, with its respective explanation of how its interpretation occurs through the use of the brain together with physical reactions, the relevance of specialized periodicals in the dissemination of trends for domestic interior spaces and their respective implications in spatial compositions is presented below.

In view of this, specialized periodicals become relevant, as they are a continuous update of trends, a means of disseminating new technologies, sharing case studies and inspiring projects, training and professional development, and encouraging discussion and critical reflection.

Interior design journals play a crucial role in keeping professionals up to date on the latest design trends, technologies, and techniques. They provide a medium for the exchange of ideas and creative inspiration, essential for the continued advancement of the profession and the education of future designers (Baker, R. & Bowers, C, 2013).

2. METHOD

The methods and methodologies that guide this work are directly related to the study and understanding of color in visual contexts, ensuring the quality, precision and reliability of the research. Therefore, it is clear that these methods are essential in demonstrating and analyzing the chromatic composition of the image in a way that allows the perception of its general color palette.

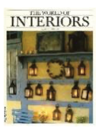
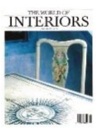
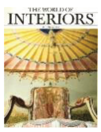
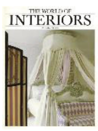
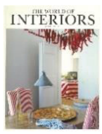
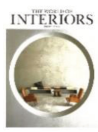
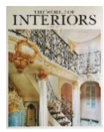
The application of rigorous methods and consistent methodologies is essential to ensure the accuracy and reproducibility of research results, allowing data to be analyzed and interpreted reliably (Gerring, J, 2007).

2.1 Sample Preparation

The covers of The World of Interiors Magazine will be analyzed taking into account the chromatic composition present in the floor, walls, ceiling and decorative elements, so that it is possible to make an individual analysis of each color palette and its general composition and, finally, create a color palette that represents these decades of analysis, which are 1990 and 2000. It is important to highlight that these decades were chosen because they determine a very considerable time frame with the change of millennium and, consequently, a change in mentality and behavior.

In addition to this point, it is necessary to state that the covers for the month of January of each year will be analyzed, since they generally demonstrate the trends expected for the following year and only the covers with images referring to interior spaces, the object of this research, will be taken into consideration. Therefore, figures from the covers of the 90s and their respective analysis are presented in a table:

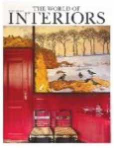
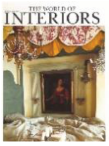
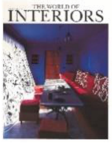
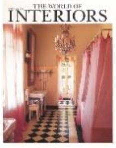
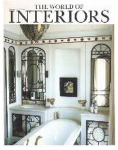
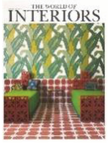
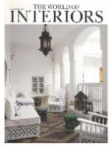
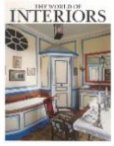
Table 1. Covers of The World of Interiors from the 90s with their color analysis

						
1990	1991	1993	1994	1996	1997	1998

Year	Floor	Wall	Roof	Decorative Elements	General Color Palette of the Cover
1990	-		-		
1991			-		
1993					
1994					
1996			-		
1997			-		
1998	-				

Therefore, in order to continue the study, below is the table for the year 2000 with the images of the magazine covers and their chromatic analysis:

Table 2. Covers of The World of Interiors from the 2000s with their color analysis

							
2002	2003	2004	2005	2006	2007	2008	2009

Year	Floor	Wall	Roof	Decorative Elements	General Color Palette of the Cover
2002			-		
2003	-		-		
2004					
2005					
2006					
2007					
2008					
2009					

3. RESULTS AND DISCUSSION

The results of the research conducted show that the 1990s are dominated by lighter tones, suggesting a sober palette with some touches of color. The flooring features shades of brown and gray, and occasionally dark blue. The walls and ceiling also feature lighter tones such as beige and brown. However, it is possible to see that the colors of the decorative elements include some colors, such as red and blue, to break up the monotony and create interest in the space and in the communication made through the magazine's image.

The 2000s also feature a predominance of lighter tones, following the same spatial composition line found on the covers of the 1990s, with shades of beige, brown and gray, and the decorative elements feature shades such as red and pink. These elements highlight certain spatial points and promote interest in the interaction between the environment and the reader, thus generating a connection between them, based on identification.

4. CONCLUSIONS

After an objective explanation of the theoretical basis containing the three guiding pillars of this article, interior design, color and communication of trends through specialized journals, explanation and application of methodology for subsequent analysis, it was possible to reach the conclusion that there were no significant changes regarding the spatial composition of the environment in the 90s and 2000s, as light tones, including beige, brown and gray, remained in its composition.

However, it is worth highlighting the presence of decorative elements in the spatial composition that allowed for greater dynamics in the environment, in addition to the presence of vibrant colors that draw the reader's attention and that can be applied with some ease in more sober environments. In this way, environments can indeed be affected by the images brought by specialized journals that aim to influence both the professional and the layman who will live in this environment.

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Chromatic Metaphors: Red as Green among Bahrain's Sunni and Shi'a Landscapes

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ABSTRACT

Based on remote fieldwork in urban/peri-urban areas across the Kingdom of Bahrain, the paper investigates the presence and perception of red and green among Shi'a and Sunni Muslim religious spaces. Proposing the concept of "chromatic metaphor," the paper argues that Sunni spaces seek to use red as a metaphor for green, an essential colour of Islam. In Bahrain, green is often associated more specifically to the majority Shi'a community and, by extension, to forms of resistance to the Sunni-led state. The paper examines this chromatic phenomenon, by collecting photographic material of Islamic spaces across Bahrain (from street-level and interior views to satellite imagery) and utilizing methods of colour analysis and classification to observe this situated association between red and green.

1. INTRODUCTION

In Bahrain, the definition of landscape is commonly perceived as the contrast between a constructed green against an arid indigenous environment (Doherty, 2017). As a small and self-contained city state encompassing a diversity of environments, of hues of green and perceptions of landscape, Bahrain becomes an intriguing place for investigating broader social, cultural, environmental, and political positionalities of colour. Green, perceived here as a synecdoche for landscape, is positively reinforced in the built environment in the form of urban greenery to address the country's aridity but also broader political and social intricacies. As a dense condition of histories shaped over the millennia, Bahrain has been long viewed as a green oasis amidst the beige landscapes of the Arabian or Persian Gulf. This reputation is influenced by the geography of Bahrain as the land of 'the Two Seas' (*al-Bahrain* in Arabic), referring to the Gulf that surrounds the archipelago and the major presence of underground springs that resist the persistent aridity of the land. This paper investigates color's capacity to convey broader social, cultural, environmental, and political positionalities and aspirations, and the ability of one color to adopt the meanings and significances of another. By identifying the presence and perceptions of the highly politicized colours of red and green in Shi'a and Sunni spaces, this research calls for a greater awareness of colour in the theory of landscape architecture, recognizing the broader implications and opportunities of colour for landscape and the built environment.

2. METHOD

To investigate this phenomenon of metaphorically perceiving and utilizing red as green, this research project focuses on spatial observations of Shi'a and Sunni religious spaces. The choice to investigate religious spaces rather than universally observing the built environment assumes that any differentiations of chromatic perceptions are more clearly defined and expressed in these spaces. Utilizing Bahrain's geography as a city-state, the research observes associations between red and green in diverse social and spatial contexts, from the dense urban conditions of Manama to the newer urban developments of Muharraq, the traditional agricultural lands of the northwest and the arid landscapes of the south. The paper utilises remote fieldwork, engaging in a multiscalar interplay of satellite imagery and eye-level perceptions. From a preliminary collection and curation of photographic material of Islamic spaces across Bahrain from aerial and street-level perspectives, the paper utilizes methods of colour analysis and classification to observe associations between red and green.

2.1 Preparation for Remote Fieldwork

In preparation for remote fieldwork focused on Shi'a and Sunni spaces, an important first step in the research was to rigorously record each space to shape a preliminary overview of the number and distribution of them across the country. Such documentation was conducted digitally within the environment of GIS (Geographic Information System), where each space was registered as a geospatial point within the map of Bahrain. A significant outcome of this preparatory work for the fieldwork was the creation of a dataset that spatially registered the majority of spaces of Islamic prayer across the country. A geospatial record of 1,873 religious spaces across the city-state laid the foundation for an expansive yet highly focused view of the points of interest from a chromatic standpoint. A map of Bahrain illustrating Shi'a and Sunni spaces (fig. 1) was utilized as an initial visual reference for observations at the national scale, with green circles representing Shi'a spaces and red squares for Sunni spaces. Each point is accompanied by a corresponding index number, which links its presence within the map to additional documentation (e.g., photographs, colour analysis, etc.). The spaces are overlaid on a layer of edited satellite imagery, which has isolated and emphasized areas that appear 'green' while lowering the opacity of all other areas. In addition to the index number for each Islamic space, the created GIS dataset includes information for the type of space (e.g. Mosque, Matam), waqf (Sunni, Jaffaria), status (whether it is further documented with additional materials as part of the research), source (of data for its presence), gov (respective Governorate of Bahrain), latitude/longitude coordinates, and j-index and site (applicable only to some Shia spaces: numbering system and corresponding online resource published by Jaffaria Waqf).

A significant resource for the geospatial and administrative features of Shi'a and Sunni spaces were the official government portals of the *Government of Bahrain*, in combination with more specialized data retrieved from the Islamic institutions of the *Sunni Waqf Directorate* (http://www.sunniwaqf.com) and the *Jaffaria Waqf Directorate* (https://www.jwd.gov.bh/ar/). While a combination of online institutional databases allowed for the geospatial documentation of most spaces, additional used-defined portals (e.g. Google Maps, OpenStreetMap) were also utilized to compensate for occasional inaccuracies or omissions of the official information sources.

The compilation of vector-based registrations of Islamic spaces in Bahrain was additionally enhanced by raster-based material of aerial imagery and street-level photographs. Formal resources of satellite imagery (e.g. Google Earth, NASA – Landsat 8) were utilized to "thicken" the registrations of the spaces from preliminary geospatial points on a map to richer documentations that include visual information on their contexts and spatial associations to green areas of parks, agricultural parcels and natural land plots. Planimetric top views of the spaces were collected and then then further observed in an interplay with human-scale exterior and interior views of the places of investigation. Collected visual material of mosques and ma'tams (community centers) was retrieved from both formal and informal sources, including photographs uploaded directly on online platforms of the Directorates, by individual users (e.g. Google Photos) and occasionally by social media accounts of the spaces themselves (e.g. on Instagram, Facebook).

3. RESULTS AND DISCUSSION

In the Capital governorate, the project's dataset has enlisted here 732 spaces, including 630 Shi'a and 102 Sunni mosques. The Southern Governorate is predominantly occupied by Sunni communities, since from the 244 religious spaces that have been registered 198 are associated to Sunni with only 46 associated to Shi'a. Within the governorate of Muharraq, the research has captured 296 Islamic spaces, including 66 Shi'a and 230 Sunni. We found a very clear distinction, as evidenced by Figure 1, where Sunni spaces are invariably red, and Shi'a spaces, invariably green.

The method of geographically registering spaces has allowed for an expansive visualization of the spatial distribution of them across the country, facilitating observations on the proximities of these spaces to larger green areas (e.g. agricultural lands, park spaces etc.). Here, the created dataset of Islamic spaces is overlaid on top of an analysis of satellite imagery focused on capturing green spaces across the country. For this analysis, the project uses NASA's Landsat 9 satellite imagery (captured on 09/28/2022) and applies the band combinations of 'natural color' (4-3-2), 'color infrared' (5-4-3) and 'short-wave infrared' (7-6-4) to capture clusters of green (primarily vegetation) in relationship to Islamic spaces.

Here, it is important to note that the selected methodology of remote fieldwork comes with certain limitations, as it is largely dependent upon the availability and accuracy of information found online. Aiming to find highly accurate and objective information, we selected official governmental and waqf datasets (Bahrain gov, Jaffaria Waqf, Sunni Waqf), to catalogue the geospatial location of each religious space across the country. However, in each of these formal resources, we encountered conflicting data in terms of the number of Shi'a and Sunni spaces across the country, their accurate geospatial location and, occasionally, their naming and/or additional documentation. From the aerial to the street-level, here the availability of visual material was also quite patchy. This is oftentimes related to the date or time that the available visual material is captured, where photographs from a few years back may not accurately depict more recent interventions, which could be chromatic. In addition, while many religious spaces have been extensively documented online with additional photographs and information related to their operations (such as the online platform of the Jaffaria Waqf), certain spaces lack this documentation and remain invisible in our fieldwork. Also, the methodology of the 'virtual walk' is largely dependent upon street-level footage such as Google Street View. In the case of Bahrain, such technologies remain quite limited for the moment as they haven't yet captured the majority of streetscapes and places across the country. Although some of these obstacles of remote fieldwork have posed challenges in our work, nevertheless it is clear for us that the constant use of diverse platforms of information from satellite imagery, governmental, individual user-uploaded materials and social media pages have allowed us to gain a clear view of the Bahraini Shi'a and Sunni spaces.

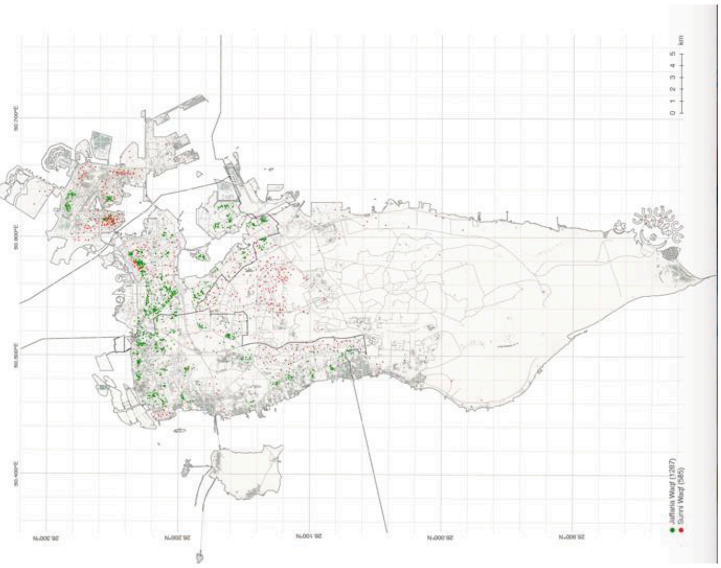

Figure 1: The chromatic distribution of mosques in Bahrain

Beyond the challenges of remote fieldwork in accurately depicting the appearance of Shi'a and Sunni spaces, certain questions can also emerge in the discussion of the accurate measurement of red and green from collected visual material. Referring here to Alex Byrne and David Hilbert and the notion that colour is intimately connected to its reflectance or light, measuring colour from visual material that is captured throughout the day in diverse moments of light and shadow challenges this rigidity of colour. For example, one mosque may be painted the same colour as another one, but the sampled colours of each may be quite different since the images used might've been captured in diverse moments of daytime and light/shadow conditions. In providing a solution to the complexity of light and shadow in readings of colour, here we've followed Byrne's and Hilbert's suggestion that we can perceive both the colours of the objects and their illumination, suggesting that the distinct colours of red and green can be distilled from a plurality of captured light conditions. Apart from the ephemerality of light, we've also observed a direct ephemerality of the application of colour. Following daily or annual patterns or responding to single calendar events, the colours of these religious spaces can occasionally change from the addition of a new carpet, a wall covering or fabric to the effect of coloured night lights, which have been observed to be in hues of yellow, green and even red. Such occasional or permanent chromatic changes can arguably challenge the rigidity of arguments on colour and the simplified associations of green to Shi'a and red to Sunni.

Apart from the ephemerality of colour, it would be important to also acknowledge that the chromatic paradox between red and green is oftentimes observed to be neutralized through the introduction of colours that remain common between Shi'a and Sunni. A common foundation or baseline in both tends to be beige, which appears as the predominant base coat or structural colour for both Islamic denominations. Gold, presented as an augmented version of beige, is also present in both denominations, appearing in architectural details within the spaces of both. Blue is also introduced, colouring the domes of Shi'a mosques, but also appearing as a decorated colour or in the form of carpeting in Sunni spaces.

4. CONCLUSIONS

Developing the concept of "chromatic metaphor", the paper argues that Sunni spaces seek to use red as a metaphor for green (an important colour of Islam), since green here is associated more specifically to Shi'a and, by extension, to forms of resistance to the Sunni-led state. Doherty (2025) shows that red is not only a complementary color to green but is often used as a metaphor for green, a "chromatic metaphor." A chromatic metaphor happens when one color, such as red, is substituted for another color, green, adopting many of green's uses and meanings. In Bahrain, green is often associated with resistance to the state, so the state promotes red instead of green. Examining this phenomenon throughout the four governorates of Bahrain, remote fieldwork and observations at the human-scale and the territorial demonstrate a peculiar association of green to Shi'a and red to Sunni spaces. The collection of photographic material of these spaces demonstrated a tendency of Shi'a spaces to embrace green in the various forms of 'applied colour', from the selection of carpeting colours to the night lights, while in Sunni spaces these built elements tend to be coloured in hues of red.

Acknowledging the political agency of red and green in the context of Bahrain, this research calls for a larger awareness within landscape architecture for the implications and opportunities for chromatic metaphors for the built environment. Recognizing the deep associations of green or 'greenery' to the field of landscape architecture, it becomes clear that metaphorical uses of red in the place of green can have significant implications on the perceptions and the role of landscape colors. Additional research and literature on the intimate connections of colour to landscape and to the political space of urban environments can allow for better informed interventions and provide additional design tools and opportunities in the practice of landscape architecture.

ACKNOWLEDGEMENTS

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Material and Color Mood Boards for Birth Space Designs

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ABSTRACT

In the last sixty years in Spain, obstetric care has changed from a model of home care to hospital care, making the birth process much more technical, but with a significant loss of warmth and intimacy. For this reason, there is interest in reversing part of the model, betting on improving the birth experience, prioritizing the mother, the child, and the professionals who participate in the process, from the perspective of gender, accessibility, and safety of care. In the field of architecture and interior design, there is evidence of the importance of the physical environment in childbirth, which is a unique and unrepeatable experience in the life of every woman, couple and family. Scientific literature highlights some physical features and sensory requirements that contribute to positive experiences and satisfaction, with particular attention to color and light in birth space design. Members of the "Global Birth Environment Design Network" (GBEDN) have developed interesting exploratory proposals for embodied birth environments. The objective of this communication is to show and discuss the preference for some material and color palettes to be implemented in birth spaces, particularly in labor-delivery-recovery-postpartum units (LDRP). The methodology used consisted of a i) study of the existing color recommendations for birth spaces, ii) the development of color mood boards, and iii) the evaluation by a panel of specialists with mothers, midwifes and architects. In general, experts opt for yellow-blue (NCS Y&B) and orange-turqueise combinatios (NCS Y30R & B30G) and are less in favor of those with red and green hues, what is coherent with previous findings in lactation rooms, in which warm colors (yellow and orange) tend to score well for coziness but red gets bad assessments. These color palettes aim to be adequate to communicate subjective connotations influencing childbirth experience and recurrent in literature, such as the physical security, privacy, calmness, confidence, cosines, etc.

1. INTRODUCTION

In the last sixty years in Spain, obstetric care has changed from a model of home care to hospital care, making the birth process much more technical, but with a significant loss of warmth and intimacy. For this reason, there is interest in reversing part of the model, betting on improving the birth experience, prioritizing what some authors name the *moving, feeling and dreaming body* of the mother (Lepori, Foureur, and Hastie 2008) the child, and the professionals who participate in the process, from the perspective of gender, accessibility, and safety of care. In the field of architecture and interior design, there is evidence of the importance of the physical environment in childbirth, which is a unique and unrepeatable experience in the life of every woman, couple and family (Dalke et al. 2006). Scientific literature highlights some physical features and sensory requirements that contribute to positive experiences and satisfaction (Bellini et al. 2023; Murray-Davis et al. 2023), with particular attention to color and light in birth space design (lit. rev. in Balabanoff 2023; Aroua and Hussein 2019). Members of the "Global Birth Environment Design Network" (GBEDN) have developed interesting exploratory proposals for embodied birth environments, together with other tools for the evaluation and proposition of new birth spaces (Balabanoff 2017).

The objective of this communication is to show and discuss the preference for some material and color palettes to be implemented in birth spaces, particularly in labor-delivery-recovery-postpartum units (LDRP) considering the recommendations extracted from the literature, the existing colors of a selection of LDRPs taken as case studies and the opinion of a panel of experts. These color palettes aim to be adequate to communicate subjective connotations influencing childbirth experience and recurrent in literature, such as the physical security, privacy, calmness, confidence, cosines, etc. (Kazemi, Beigi, and Najafabadi 2023; Nicoletta et al. 2022).

2. METHOD

The methodology used consisted of a 1) study of the existing color recommendations for birth spaces including: 1.1) a previous qualitative study with mothers and midwives, carried out by the The Biomechanics Institute of Valencia (IBV), in the facilities of the La Plana Hospital in Vila Real in Castellón; 1.2) the study of relevant cases developed by architectural studios such as Parra-Müller (Müller and Parra Casado 2015); 1.3) indications collected in scientific literature, with particular mention to papers by specialists from the GBEDN; 2) the development of 6 color moodboards were for the evaluation of possible color combinations in birth spaces, particularlly an LDR and a hospital bedroom, and 3) the evaluation by a panel of specialists composed of 7 mothers, 7 midwives, and 6 architecture and interior designers, under the supervision of the IBV.

2.1 Existing color recommendations for birth spaces

Previous studies demonstrate that, in birth spaces, the presence of artwork in an LDR reduces the request for epidural analgesia 7% (Duncan, 2011), and non-monochromatic schemes are associated with positive effects (Aroua & Hussein, 2019). The color composition for hospitals usually uses colour-coded for wayfinding and visual contrast, like in the Central Manchester hospital (Haller 2017: 339-41) and pursue a sense of domesticity in birth spaces. Some design features that promote domesticity include walls painted in soft earthy colors, textile curtains, birth tubs, comfortable furniture, and soft rugs and ottomans (Lit rev. in Nilsson et al. 2020: 229). Following the colour associations related with the different Chakras, Lepori et al. (2008) suggested the use of red for its association with "home, security, sense of self survival and trust," but in studies of color associations in lactation rooms, red was the color with the worst assessment and had negative scores for "coziness" and "safety"(López-Tarruella et al. 2019).

Figure 1: The six mood boards with suggested colors and materials for birth spaces

2.2 Color moodboards

Each of the six moodboards consistid on a grey cardboard with the dimensions of 841×594 (DIN A2), and the disposition of physical color and material samples glued on the surface. The colors were chosen according to the Natural Color System (NCS) with perceptual opposite hues on the color wheel: 1) two neutral colors, with low blackness and chromaticity, which would occupy most of the interior surfaces such as floors, ceilings or walls (NCS 0505/0510 nuance);

2) two dominant colors, somewhat more chromatic, that would occupy intermediate surfaces of the room such as a wall, a closet, etc. (NCS 0540/1040); and 3) two accent colors, very chromatic, that would occupy small surfaces such as a chair, a textile, a lamp, etc. (NCS 1060/2060). The materials of the moodboards included original color samples from NCS, high pressure laminated wood by Formica, and materials from the RAL Colour Feeling Trendbox 2025+ (https://www.ral-farben.de/en/trendreport-2025) including metal, carpet and textile samples from Covestro, TIGER Coatings, Object Carpet and Gabriel.

2.3 Evaluation by a panel of experts

Each of the six color moodboards was evaluated by every member of the panel of experts using a likert scale with five steps from 1 (completely disagree) to 5 (completely agree), with 8 terms related with the birth space requirements highlighted by Bellini et al. (2023) and the final question: Would I like to find this aesthetic in my labour and delivery room?.

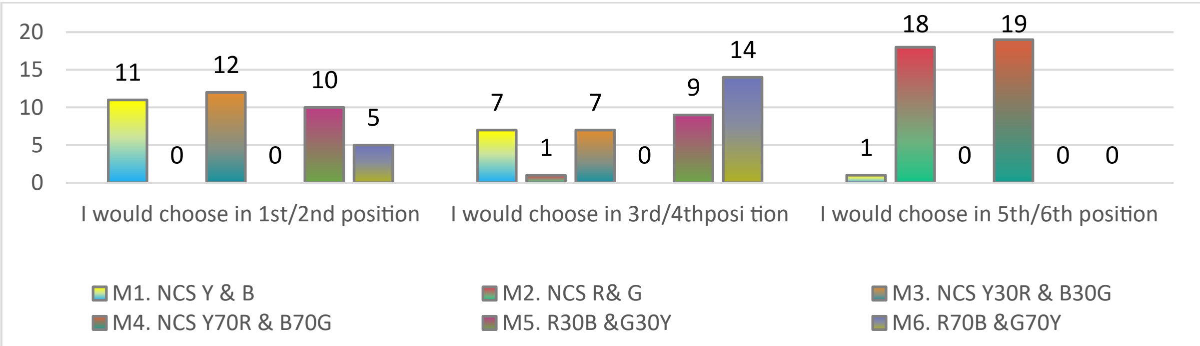

Figure 2: Preference for the 6 color mood boards for birth spaces

3. RESULTS AND DISCUSSION

The assessment of the color options presents high consensus among the groups. The color options chosen by the majority are proposal 1 (NCS Y & B) and 3 (NCS Y30R & B30G), followed by 5 (R30B & G30Y) and 6 (R70B & G70Y), being 2 (NCS R & G) and 4 (NCS Y70R & B70G) the least prefered. In general, experts opt for yellow-blue and orange-turqueise combinatios and are less in favor of those with red and green hues, what is coherent with previous findings in lactation rooms, in which warm colors (yellow and orange) tended to score well for coziness but red got negative assessments. (López-Tarruella et al., 2019)

4. CONCLUSIONS

In a study of color preferences for birth spaces (LDRs and a hospital bedroom), with the assessment of a group of mothers, midwives, and architecture and interior designers (20 members), the most preferred color combinations were NCS Y & B and Y30R & B30G, while those with green and red hues R & G and Y70R & B70G were the least preferred.

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Chromatic Survey Methodology: Case Study of the Planalto by João Artacho Jurado

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ABSTRACT

The article discusses a methodology for a chromatic survey of claddings applied to mainly ceramic tiles in buildings. It focuses on the case study of the Planalto, which is a Brazilian mid-twentieth-century architectural landmark signed by João Artacho Jurado. Planalto building stands out for the colorful emblematic and innovative tiles in its facades that are a few examples of objects of criticism to Artacho's ahead-of-time aesthetics. It also aims to identify the colors originally used in the Planalto's facades. Such a challenge exists because it was not common at the time to do chromatic registration of the claddings used. Without original color information, the local architects face challenges with the maintenance, preservation, and restoration of the building. Firstly, bibliographical research and several field inspections were made using Nix Color Sensor Mini 2 equipment for the chromatic survey. Such equipment digitally encodes surfaces and relates them to chromatic notation systems. Lastly, the data collected was transferred to a spreadsheet to allow adequate analysis of the current state of the facade's colors and compare it to the ones perceived in the location. The chromatic survey was able to determine the color scheme Artacho proposed in its current state, as well as some older chromatic information that could be dated from when construction was finished. Plus, the survey is relevant for discussing optimal methods of chromatic perceptions in a building covered mainly by ceramic tiles. Due to the great variation in hue and saturation caused by the material's nature, technological differences in production, and the chromatic variations of nonidentical batches at different times, the number of measurements taken was proven insufficient. Thus, it is paramount to increase sampling to achieve more trustworthy results that might be able to better guide restorations of the building's facades. Final considerations also highlight surprising chromatic and design discoveries during the research process, such as the existence of original painted concrete elements, removed before the building was listed, and the partitive synthesis effect found in some colors of the main facades.

1. INTRODUCTION

This paper is part of research conducted at the University of São Paulo through the Research Group (CNPq): *Cor, Arquitetura e Cidade*. Its objectives are to explore methodologies for studying color in architecture and urban environments, contribute to the restoration process of buildings and urban spaces, and enhance color education in architecture and urban planning programs.

The relationship between color and architecture is closely intertwined with the materials used. Although extensive research has been conducted on additive and subtractive color processes in this field, there remains a significant opportunity for further investigation into partitioned colors. According to Chevreul, partitioned color mixing involves the superimposition of pigment colors (Alvarez, 2021: 249). These colors can be represented in architectural contexts through specific materials, such as bricks, tiles, and ceramics.

These materials have been extensively utilized in architecture, as exemplified by the works of Peter Behrens (Technical Administration Building Hoechst AG, 1924), Alvar Aalto (Muuratsalo House, 1954), and João Artacho Jurado (Planalto, 1956). Given their widespread application and the associated challenges related to maintenance and reproduction, there is a pressing need to develop a method for assessing and documenting this type of color.

Architect João Artacho Jurado was born to Spanish immigrant parents in São Paulo (1907). In the mid-1940s, he concentrated on building projects for the emerging middle class in a city undergoing vertical expansion (Franco, 2008). His developments were highly successful and continue to be in high demand today. The case study, the Planalto, is a residential building with commercial spaces on the ground floor. It incorporates a range of cladding materials. Inspired by a trip to Rio de Janeiro, Jurado employed glazed tiles in multiple colors. There is a clear and significant relationship between the chromaticity and the form of the building (César, 2010: 5).

2. METHOD

2.1 Bibliographic and iconographic research

Firstly, information about the building and its designer was collected. Relevant books and articles were used as research sources. In addition, iconographic research was carried out to understand the building's chromatic aspects over time. The information collected allowed an understanding of the building and Jurado's work.

2.2 Technical visits and chromatic survey

Several external and internal technical visits to the building were carried out, allowing visualization of the facade and an understanding of the general characteristics of its architecture and surroundings. The color survey was conducted in the afternoon on two winter days in 2023 under similar weather conditions. Wherever possible, samples were collected, which became a means of querying material outside the building. Figure 1 exemplifies the material used on the facades.

Figure 1: View the Planalto facade and marking scheme of places with colors surveyed. Source: the authors.

3. RESULTS AND DISCUSSION

The systematized chromatic survey (Table 1) is presented below. It is noteworthy that in places where the existence of original tiles under layers of paint was verified, their colors were also measured when these were accessible. This is the case with the blue tiles on the 25th floor and the purple tiles on the 26th floor. The chosen color coding system was the Natural Color System due to its characteristic of considering human color perception.

Table 1. Chromatic survey of the Planalto Building. Source: the authors.

CHROMATIC SURVEY - PLANALTO BUILDING									
ITEM			**NCS**	**RGB**			**HEX**	**MUNSELL**	**COLOR (hex)**
Location	*Material*	*Ident.*		*R*	*G*	*B*			
1. GROUND FLOOR									
Pillar	square tiles	1. dark	NCS S 8010-Y30R	66	43	0	#422b00	2.5Y 2/4	
		2. medium	NCS S 5030-Y10R	136	106	44	#886a2c	2.5Y 4/6	
		3. light	NCS S 3005-Y	172	167	147	#aca793	2.5GY 7/2	
		4. red spots	NCS S 8505-R	31	6	1	#1f0601	2.5YR 1/2	
Floor - indoor garden	square tiles		NCS S 4010-G90Y	153	146	123	#99927b	10Y 6/2	
2. 8th FLOOR									
2.1. Balcony 1 (Santo Amaro Street)									
Wall	square tiles	1. dark	NCS S 4040-R	144	80	81	#905051	5R 4/6	
		2. medium	NCS S 4030-Y90R	159	108	102	#9f6c66	10R 5/4	
		3. light	NCS S 4020-Y80R	161	123	114	#a17b72	2.5YR 5/4	
	dark ceramic tiles		NCS S 8010-G10Y	0	31	0	#001f00	7.5GY 1/4	
	bricks	1.	NCS S 5030-Y10R	151	116	62	#97743e	2.5Y 5/6	
		2.	NCS S 5020-Y30R	140	105	67	#8c6943	10YR 5/4	
		3.	NCS S 5020-Y20R	150	120	82	#967852	2.5Y 5/4	
		4.	NCS S 4020-Y10R	157	133	96	#9d8560	2.5Y 6/4	
2.2. Balcony 2 (Maria Paula Street)									
Baseboard	rectangular tiles		NCS S 5010-Y70R	135	112	100	#877064	10YR 5/2	
Floor	hexagonal tiles	1. pink	NCS S 4020-Y60R	166	132	116	#a68474	5YR 6/4	
		2. white	NCS S 4010-Y30R	166	149	125	#a6957d	5Y 6/2	
3. 10th FLOOR									
Wall	square tiles	1. dark	NCS S 5010-G50Y	122	128	104	#7a8068	5GY 5/2	
		2. medium	NCS S 5010-G70Y	140	142	119	#8c8e77	5GY 6/2	
		3. light	NCS S 5010-G50Y	134	139	119	#868b77	5GY 6/2	
Wall - below partition	square tiles	1.	NCS S 3010-Y	193	184	160	#c1b8a0	10Y 7/2	
		2.	NCS S 3005-Y20R	183	176	164	#b7b0a4	7.5Y 7/2	
4. 25th FLOOR									
Bannister	paint		NCS S 5030-B	16	87	116	#105774	5B 3/4	
Wall - below partition	square tiles		NCS S 4020-Y	161	142	99	#a18e63	5Y 6/4	
Pillar	rectangular tiles		NCS S 2502-Y20R	195	193	187	#c3c1bb	5GY 8/2	
Casement	paint		NCS S 1502-Y	215	213	202	#d7d5ca	5GY 8/2	
Wall and ceiling	original square tiles		NCS S 3040-B	53	127	156	#357f9c	5B 5/6	
5. 26th FLOOR									
Wall	paint		NCS S 2010-B	178	199	210	#b2c7d2	10BG 8/2	
Wall	paint		NCS S 4010-R50B	149	143	152	#958f98	7.5PB 6/2	

When viewed from a greater distance, the tiles' colors cause a solid color effect, as if they were a grouping of tiny pixels. This effect is called "partitive colors" and was widely used by Jurado in the Planalto, with 2x2cm tiles, and in other buildings he authored.

One of the colors that stood out most during the color survey was blue – present on the 25th and 26th floors in tiles and guardrails in concrete and paint. The original tile could be accessed from the roof area, and a sizeable chromatic divergence was noticed: the original tile has a considerably higher luminosity of blue than the current color. Blue was also present in the concrete *brise soleil* that was demolished before the building was listed.

Seen up close, the places covered in colored tiles – such as the pink and green tiles on the balconies and the tiles on the pillars on the ground floor – present a tremendous chromatic variation, even if initially considered subtle. It cannot be confirmed whether the chromatic variation was a specification choice or whether it is a result of the degradation suffered by the material or its quality. Faced with this problem and for the viability of the chromatic survey, the decision was made to choose gradual dominant tones – a more saturated tone, one or two medium tones, and a less saturated tone according to human perception. This pattern was reproduced, adapting to the number of colored tiles in dominant tones that the researchers could perceive.

4. CONCLUSIONS

Initially, the walls appeared to be a uniform color from a distance. During our site visits and chromatic survey, partitioned colors were observed. Alongside this type of color effect in architecture, the interaction of the facade colors was also noted. The same cladding material was used in two different locations, but the one surrounded by a darker frame appeared to be a much lighter shade. Nowadays, the building faces restoration challenges, such as the detachment of ceramic tiles and the unavailability of the materials in the colors used. Planalto's management chose to apply paint over the tiles to preserve the original tiles. Alongside that, without original color documentation, some chromatic information may be lost. Given these factors, further research and a more detailed chromatic survey of the colored tiles are necessary.

ACKNOWLEDGEMENTS

We would like to thank the current manager of the Planalto Building, José Ricardo, for accompanying us on the many visits and allowing us to carry out the survey. And to the residents who opened the doors of their homes and shared images and stories of the Planalto. We hope that the research can contribute to the preservation of the building.

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Color in Architecture in the 21st Century, and the Manifestos and Programs of Architects in the 20th Century

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> "We don't want to build anymore colorless houses, or see them built, and want to give the building owner and resident courage to stand up for the joy of color on the inside and outside the house, through this united confession (…) Color is joy of living and since we have but small means to provide it, we must insist on it, especially during this times of need today, in all buildings that must be executed." (Taut, B. 1919, in Brenne, W. 2008)

ABSTRACT

This text aims, based on some manifestos and programs of architects, written in the 20th century and, based on premises of the current century, such as the advancement of material technologies, project development software that allows an almost photographic visualization of the work and even Artificial Intelligence, and the atmosphere architecture, establish parameters that could constitute a new way of approaching and thinking about color in architecture.

1. DISCUSSION

One of the most important manifestos, in defence of a modern, rational and functionalist architecture, in which color is seen as a mere ornament, was written by Hannes Meyer in 1928, then director of the Bauhaus. The position defended by him, represents how it is still being approached today in many architecture courses, responsible for training professionals who end up repeating patterns, understandable at that historical moment, but which today deserve to be reviewed.

> "Color to us is merely a means for intentional psychological influence or a means of orientation. Color is never a false copy of various kinds of material. We loathe variegate color, we consider paint to be a protective coating, where we think color to be psychically indispensable, we include in our calculation the amount of light reflection it offers, we avoid using a purely white finish on the house. We consider the body of the house to be an accumulator of the sun's warmth"…and the architect? ... he was an artist and now becomes a specialist in organization!" (Meyer in Conrad 1971)

The Bauhaus, initially, had a strong influence from artists and architects who argued that colours should have a prominent position not only in the design of architectural projects, but in the training of students. The Work Council for Art, group composed of architects such as Gropius, Taut, Poelzig among others, signed a manifesto in favor of a greater presence of the arts in the training of architects in 1918 and 1919, which Gropius would retract years later, adopting a more radical stance, where colour no longer has space.

> "In the forefront stands the guiding principles:
> Art and people must form a unity.
> Art shall no longer be the enjoyment of the few but the life and happiness of the masses.
> The aim is alliance of the arts under the wing of a great architecture." (Work Council of Art, in Conrads 1971)

Em 1920 Naun Gabo e Antoine Pevsner wrote in Moscow, Basic Principles of Constructivism:

> "3. We reject decorative color as painterly element for the building in three-dimensional construction. We demand that the concrete material shall be employed as a painterly element." (Gabo, N Pevsner, A. in Conrad 1971)

Other important architects will position themselves against this new trend defended by the Bauhaus, closer to the initial concepts, such as Otto Haesler, Frank Loyd Wright, among others.

> "Oh yes young man, consider well that a house is a machine in which to live, but by the same token a heart is a suction pump. Sentient man begins where that concepts of a heart ends." (Wright in Conrad 1971)

Just like Le Corbusier:

> "Polychromy is as a powerful an architectural tool as the plan and section"(Corbusier in Porter 2009)

Em 1923 De Stijl Manifesto V:

> "III. We have examined the laws of color in space and time and have stablished the mutual harmonization of these elements produces a new and positive unity." (De Stijl, in Conrad 1971)

And in 1924 Theo van Doesburg in Towards Plastic Architecture:

> "14. Color. The new architecture has done away with painting as a separate and imaginary expression of harmony, secondarily as representation, primarily of colored surface.
>
> The new architecture permits color organically as direct means of expressing its relationships within space and time. Without color these relationships are not real but invisible. The balance of organic relationship acquires visible reality only by means of color. The modern painter's tasks consist in creating with the aid of color a harmonious whole in the new four-dimensional realm of space and time – not a surface in two dimensions. In a further phase of development color may also be replaced by denaturalized material possessing its own specific color (a problem for the chemist) by only if practical needs demand this material.
>
> 15. The new architecture is anti-decorative. Color (and this is something that color-shy must try to grasp) is not a decorative part of architecture, but its organic medium of expression." (Doesburg, in Conrad 1971)

In 1960, the painter Hundertwasser, in the Mould Manifesto Against Rationalism in architecture, defends the idea that "A man in an apartment house must have the possibility of leaning out of his window and scraping off the mansion for as far as his hand reaches. And he must be allowed to paint everything around pink as far as he can reach with a long brush, so that people can see from far away, from the street a man lives there who differs from his neighbors." (Hundertwasser in Conrad 1971)

Although there were many demonstrations for or against a more conscious use of color, in countries like Brazil, positions such as that of the architect Max Bil, professor at the Ulm School, in a lecture at the USP School of Architecture in 1953 reinforced the idea of a rational and functionalist architecture, on which architecture courses will be based: "Architecture is an art when all its elements – function, construction, form – are in perfect harmony." (Bill in Xavier 2003)

Mastering the use of color in architecture does not necessarily mean applying a variety of saturated hues, or as Meyer wrote that he hated chromatic variations, but controlling its contrasts, variations depending on the light, the three-dimensionality of the project and the relationships with surroundings. Achromatics, if they do not carry the weight of the symbolic factors of hues, can reinforce contrasts and consequently alter the perception of volume. It is possible to specify the color without, as some claim, losing the potential for internationalization of an aesthetic in architecture, since shades can be loaded with cultural, symbolic and consequently regional aspects.

Color no longer has the function of falsifying coverings and construction materials, as the modernists condemned, since not all materials have a unique color that characterizes them. Concrete can be pigmented, paints, as Meyer recommended, do have the function of coating and protection, but not only that, as the project can also be characterized through colors.

Rem Koolhass wrote in 2001 on the trends in materials and information that surround people in the 21st century relating to architecture:

> "It is only logical that, with the incredible sensorial onslaught that bombards us every day and the artificial intensities that we encounter in the virtual world, the nature of color should change, no longer a thin layer of change, but something that genuinely alters perception.
> In this sense the future of colors is looking bright." (Koolhass 2001)

The 21st century is also characterized by architecture that focuses on the environment and the atmosphere, as advocated by Peter Zunthor, not only on the walls, but on the perceptive processes of space and its multisensory experiences that define its essence. In this sense, color and light, as visual elements, are largely responsible for human reactions. Despite the many resources that technology may have, allowing simulations of environments, it is the sensitivity and experience of the architect that will allow some control over the expected results. Experience and sensitivity that can be improved through studies, research and design experiences.

2. CONCLUSIONS

> "God gave us everything: life, earth, wind and sun.
> And all of them have a common value, a marvellous value:
> Everything was given with colour.
> Without it the world wouldn't exist,
> Our life would be an unbearable monotony.
> Color is the base of our life,
> Of our happiness and sorrows,
> It is the symbol of our emotions.
> Color is… life!
> It is not a complement, it is a fundamental element.
> Therefore I shout and shout again:
> Viva el color" (Legorreta in Porter 2009)

The 21st century brought technologies for developing projects and materials that considerably reduce the limitations that existed until then. It is necessary to deepen research, disseminate studies and works, develop teaching methodologies that encourage experience and overturn dogmas originating from design positions of the last century, valuing color as an element that makes up architecture and the city, including perceptive, technological aspects, sustainability, the environment and why not, the aesthetic. We need to give color a chance if we really want to build a better world.

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Immersive Space of Colored Light

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ABSTRACT

Coloured light has a great impact to the appearance and feeling of interior architecture. Nevertheless, the specific role of colour and light as a source of well-being has only limited implementations in design practice, and is especially relevant in medical institutions. The research project *Skylight* aims to reduce stress and states of arousal in the context of psychiatric environments with the use of multicolored light. The systematic research approach and the evaluation of empirical data resulted in the design of an evidence-based prototype. A testing phase was carried out in a Swiss psychiatric hospital, where positive effects on well-being, using coloured light as a spatial feature, can be demonstrated.

1. INTRODUCTION

Through the course of the research implementation, the project combined the lighting concept with a personal and adjustable spatial solution. The spatial installation integrates a modular curtain system that can be installed around various sizes of beds within the psychiatric hospital, enclosing the occupant and framing the lighting effect (Figure 1).

Figure 1: Modular system of a curtain-structure + movable lamp 'Skylight'.

The movable floor lamp *Skylight* consists of a large disk that has both a direct and indirect light configuration; the direct light illuminates the disk, and the indirect light shines onto the walls and ceiling. Using the newest LED technology, different light settings were created, from warm to cold daylight and a variation of multicolored scenes, enabling the patients to adjust the atmosphere of the space according to their needs. The preconfigured multicoloured light settings create colour gradients in the space, as seen during sunrise or sunset. Natural light situations are used as a reference to program the light settings, and patients can use an app to choose atmospheric moods like *early morning*, *mild evening*, or *warm moonlight* (Figure 2).

An essential feature of the final design was its flexibility and the potential to change the configuration of the prototype by the patients until the effect of the self-perceived stress reduction was registered.

Figure 2: Preconfigured natural light scenarios as installed on site.

2. METHOD

In a participatory process with caregivers, patients, doctors, therapists, and researchers, a distinct spatial installation was developed as a place for patients to retreat into. The prototype was developed and tested over several months (2019-2022). The development of the floorlamp *Skylight* is part of the research project, which aimed to create a modular and movable solution using coloured light together with different spatial configurations within a patients room.

2.1 Evidence based Prototyping

The creation of the prototype *Skylight* is based on the evidence-based design principles (Ulrich 1984) and its process is divided into four phases: (1) Site inspections, observation, and measurement of the actual state, (2) Co-creations and Co-Designs with the relevant stakeholders, (3) Data analysis, derivation of concept ideas, and construction of prototype and (4) Implementation of prototype and testing in a controlled environment, in this case the psychiatric clinic.

2.2 Light as a therapeutic Instrument

The effects of light on the well-being are widely recognized. Especially in scandinavian countries, light is a common therapy to maintain the psychological state of mind. The city of Umeå in Sweden for example offers free light therapy on over 30 bus stops to overcome the winter depression with artificial daylight.

In chromotherapy the patient is irradiated with color or colored light to heal or prevent physical and mental illnesses. However, it is still a young field of research, and it cannot always be scientifically substantiated how the effect of light and color on the body and mental well-being functions.

The american artist James Turrell, who had studied psychology and astronomy is since his early career in the 1960s has been active in developing the relationship between light and space in the artistic and spatial design fields. In his artwork series *Skyspaces*, he creates spaces in which viewers can sit on seats along the walls and where an opening in the ceiling allows a framed view of the sky. Turrell is looking for ways to create situations in which *indeterminable space* could be perceived (Covan, Kim 2013). In many of his installations he creates chambers within which individual viewers could experience the *Ganzfeld effect*[1], a completely homogeneous visual field. These immersive art spaces provide situations in which an introspective spatial experience can lead to a subtle form of meditation. Similar to the ganzfeld experience the lamp *Skylight* creates a zone around the patient's bed, which fascilitates them to drift into a state of relaxation by fading out the existing spatial reality.

[1] The Ganzfeld effect (from German for "complete field"), or perceptual deprivation, is a phenomenon of perception caused by exposure to an unstructured, uniform stimulation field. The effect is the result of the brain amplifying neutral noise in order to look for the missing visual signals, which can lead to hallucinations. https://en.wikipedia.org/wiki/Ganzfeld_effect

2.3 Skylight

The mobile floor lamp *Skylight* was developed with both ‘biological’ and ‘emotional’ lighting functions. The biological daylight-like lighting is automated and largely escapes the visual perception of users but can help to regulate *circadian rhythms*[1], ensuring a regular sleep-wake cycle. The emotional light allows patients to either setup individual-coloured light situations or for them to choose from 12 preset atmospheric nature scenes, which also have corresponding names to convey this atmosphere. These dual-coloured light situations create an immersive space of color, comparable to the light installations by James Turrell.

The therapeutic light effects are self-controlled via an app, which has been developed during the research project (Figure 3). Its interface design and navigation have been simplified to be as easy to understand as possible. The app makes sure that there are not too many options and that patients are not overwhelmed. During the testing period the preset natural scenes became the most preferred light settings by the patients (Figure 4).

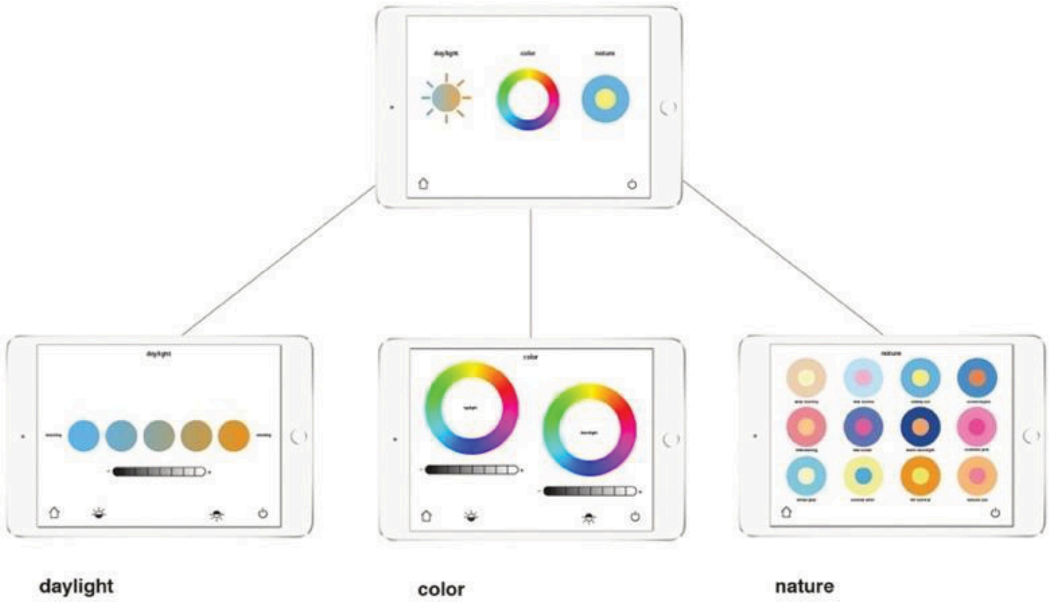

Figure 3: Interface of the app with biological and emotional light settings.

Figure 4: Dual-coloured light settings viewed from the bed.

3. RESULTS AND DISCUSSION

The empirical data collected clearly presents that self-organized design enables patients to self-regulate their stress and actively impact their own well-being. Through the controllable light settings more self-determination can be created in the patient’s room. Patients can take responsibility for themselves, which actively supports the healing process.

The evaluation demonstrates that stress-reducing effects can be presented at different levels by almost all testing patients, especially through the possibilities to self-organize the design parameters like the spatial curtain structure and the coloured light. Patients reported, among

[1] Circadian rhythms are the physical, mental, and behavioral changes an organism experiences over a 24-hour cycle. Circadian lighting follows the natural sleep/wake cycles of the human body and changes between warm and cold light throughout the day.

other things, a feeling of security, a more quiet and improved sleep, an increased ability to imagine, a lower need for stress-related medicines, and a better re-orientation after nightmares (Ziegler, Hartmann 2022). The preconfigured emotional light which refers to light situations most closely recreating those seen in nature have a strong spatial and emotional impact and became the preferred light setting by the patients during the testing period. The naming of the light setting, such as *mild evening* is also significant, and supports an imaginative world beyond the clinical setting. The so created indeterminable space can create positive feelings, like a view into a serene and picturesque landscape.

4. CONCLUSIONS

From the scientific perspective, the individually usable control is an essential component that contributes to increasing well-being. The selection of natural lighting scenes is also an important component that contributes to patients having a tool with which they can control or influence their environment. This is not usually the case in the hospital and clinic context. Coloured light is an element to change an existing architectural situation from a neutral to a multisensory experience. Especially in healthcare institution where the physical contact to nature may be reduced, multicolored light can temporarily be a substitute for a real-world situation – such as a sunset walk along the beach – by turning a neutral room into an immersive world of colour.

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Dorothy Draper: a Brazilian Chromatic Palette – Case Study of the Quitandinha Hotel

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ABSTRACT

This research is dedicated to the production of Dorothy Tuckerman Draper, considered the precursor of the interior decoration profession in the United States, at the beginning of the 20th century. Her office, established in New York City in 1925, continues to operate till today, being one of the oldest offices in the world. A fan of extravagant environments and the use of color, she was recognized for creating a style called "modern baroque". She has published two books, "Decorating is Fun!" (1939) and "Entertaining is Fun! (1941) and both mentioned the issue of color application to interiors. Dorothy Draper was invited by Joaquim Rolla, an influential Brazilian businessman, to design the interiors of the Quitandinha hotel in Petrópolis, in the mountainous region of Rio de Janeiro, in Brazil. The first contacts took place at the beginning of 1942 and the project was developed in her office in New York, but carried out by Brazilian artisans, having been opened in 1944. The hotel, which is still in operation today, was a landmark in decoration for the society at the time and preserves a relevant sample of the history of interior design. This work analyzes the chromatic scheme chosen by the American decorator, based on national and foreign literature, a technical visit to the site and a chromatic survey of the environments. According to some authors, the forms of Brazilian Baroque architecture and the colorful flora served as a reference for the project. The literature suggests that Draper, in some way, had his work influenced by the experiences she had during his time in Brazil. Later, Draper started to sign a line of openly Brazilian-inspired products, such as cheerfully printed chintz fabrics and accessories. Considering the possibility of still having access to Draper's legacy, this research visits her production in an attempt to identify chromatic references from a palette that may provide evidence of a Brazilian chromatic identity.

1. INTRODUCTION

Despite the crisis brought about by the Second World War, the effervescent search for casinos has become a curious phenomenon in Brazil. This context fueled the audacious plan of Joaquim Rolla, a Brazilian businessman, to build the largest hotel and casino complex in Latin America, the Quitandinha casino hotel, located in Petrópolis, in the mountainous region of Rio de Janeiro.

In 1942, Dorothy Draper was hired to develop the interior decoration of the Brazilian enterprise. Exuberant colors occupied the 50,000 square meters, in the Draper style. Despite being foreign, she appropriated a language that can be considered a first sketch of a Brazilian identity in interior decoration.

Focusing specifically on the chromatic work of the American decorator Dorothy Draper, this research aims to investigate the chromatic palette used in the Quitandinha hotel, seeking to identify a Brazilian chromatic identity. Draper's work, still present, drew new contours for the history of Brazilian interior design.

2. METHOD

This research was developed in three stages. In the first, the available literature was surveyed, having access to national and foreign books with reports on the historical context of the time, the intricacies of the building's construction, the implementation of Dorothy Draper's project and the developments of the Quitandinha hotel after the ban on casinos in Brazil. The second stage took place on site, through an exploratory visit to the old hotel's facilities with a chromatic survey of the environments accessible to the public. For the chromatic survey, the *Colourpin Pro* color reader from NCS (Natural Color System) was used. The predominant colors of the floors, walls and ceilings were systematically selected. The third and final stage of the research involved interviews with former employees and monitors responsible for visits to the old hotel, which now houses a cultural center. At this stage it was possible to access old photographs, plans and illustrations.

2.1 Dorothy Tuckerman Draper (1889-1969)

Dorothy Draper occupies a place of a precursor of professional decoration in the history of interior design. She was born in 1889 into a high-society New York family and set up his own business in 1925. She broke with the historicism of the time, when she began to design spaces that transcended its history. For Lee (2019, p. 70) "she was an unbridled maximalist, and it didn't take long to establish her own style defined by boldness, graphic patterns and lots of strong colors – generally, all at the same time." For Draper, color was a fundamental element in space planning, a tool capable of causing emotions. It is possible to say that the success of his work lies in her chromatic compositions.

Dorothy Draper had the "Draper Touch" as her trademark, of which it is possible to mention: the use of *"chita"* fabrics with exaggerated prints, white painted plaster elements contrasting with the colored walls, black and white checkered floors, wallpapers and paintings with wide stripes, indirect lighting incorporated into the architecture, and saturated colors in a diversity of hues. The unexpected was key to her aesthetic. Regarding the application of her style in the interiors of Quitandinha, Roiter (2011: 129) describes that,

> [...] she created an allegory that mixed Brazilian Baroque architecture and Art Deco geometry, using the colors of tropical flora. On screens, fabrics and wallpapers: stripes, lots of stripes! On the floor, geometric designs created a counterpoint with the volutes of the trim, the Hollywood chandeliers and the portentous plaster and white stucco columns. The entire project, as well as its details, came from Dorothy Draper's drawing board in her office in New York, being carried out exclusively by Brazilian artisans" (ROITER, 2011, p. 129)

For this project, Draper adopted Baroque elements and motifs, and colors inspired by Brazilian flora. Dorothy insisted on using wood and materials of Brazilian origin and that the pieces were made in Brazil by local artisans. According to Dantas (2015: 110) it was commented that, "there are several things that only a Brazilian can understand. A Brazilian and Dorothy Draper."

2.2 Chromatic examination of the Quitandinha hotel

Part of the Quitandinha hotel's colors have stood the test of time, preserving Dorothy Draper's cheerful and theatrical interiors. The diversity of colors in his projects is in line with the cultural background of Brazilians, resulting from a mixture of people from different corners of the world. For Mahnke (1996: 16),

> Greeks find all colors to be equally refined, while Swedes consider saturated color to be more vulgar than unsaturated ones. The Japanese respond deeply to the gentle colors of water, sky, and wood; whereas Indian arts and crafts have a common theme of vivid color. Although cultural differences are evident, we know that many reactions to color are universal and cross cultural boundaries. It's often natural to look for difference rather than commonality, but in trying to understand human reaction to color, the basic similarities are of importance, especially when it comes to the design of the human habitat.

Some regions and even countries have a very well-defined chromatic identity, which in part reflects on their legacy and consequently on their interiors. It is possible to mention the strength of the saturated hues of Guatemala, Mexico and India, the minimalism of the tones used in

Nordic design and traditional Japanese architecture, the colorful patterns of some African countries, and the stunning color of ancient cities in the East. However, it is possible to ask:

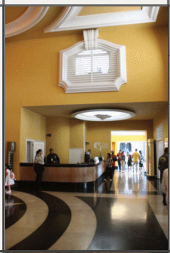
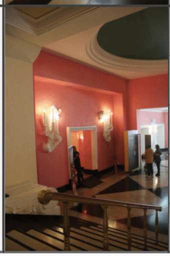
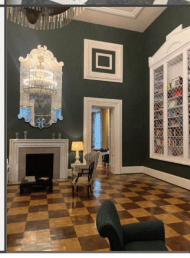
Which color palette would represent a Brazilian color identity?

3. RESULTS AND DISCUSSION

For the purposes of this article, the chromatic survey of Hotel Quitandinha was synthesized in four environments representing the chromatic diversity of the complex. The environments chosen were the two main entrances of the hotel, the gallery areas and the library.

The table below shows images and chromatic notation codes for the floor (nº 1 and 2), walls (nº3), ceiling (nº4) and skirting boards (nº5) of the rooms.

Table 1. Quitandinha hotel's chromatic examination

TABLE 1: QUITANDINHA HOTEL'S CHROMATIC EXAMINATION									
SPACE		CHROMATIC DATA			SPACE		CHROMATIC DATA		
Name	Picture	Nº	Hue	NCS	Name	Picture	Nº	Hue	NCS
CENTRAL HALL		1		NCS S 8010-Y70R	GALLERY		1		NCS S 8505-B20G
		2		NCS S 3020-Y60R			2		NCS S 2005-G20Y
		3		NCS S 2060-Y10R			3		NCS S 2020-B10G
		4		NCS S 2060-Y10R			4		NCS S 2020-B10G
		5		NCS S 8010-Y70R			5		NCS S 8505-B20G
SECONDARY HALL		1		NCS S 8010-Y70R	LIBRARY		1		NCS S 5040-Y60R
		2		NCS S 1505-Y40R			2		NCS S 7020-R
		3		NCS S 1030-R10B			3		NCS S 6020-G30Y
		4		NCS S 2005-G20Y			4		NCS S 0500-N
		5		NCS S 8010-Y70R			5		NCS S 0500-N

It is possible to see that there is a great chromatic diversity in Draper's project, as each space presents a specific chromatic palette, however, the colors are integrated by the white elements, such as the wall decorations and ceiling, as well as the foliage-shaped lamps. The most frequented areas of the hotel have two-tone marble floors (*damier*), while for the more restricted spaces the floor is made of two-tone wood (Ivorywood and ipê, or Pau-Brasil). The flooring of the galleries consists of an arabesque layout, made in black and white marble mosaic. The skirting boards used two patterns: either made in black stone or in white painted wood.

At a time when the use of colors still had limitations and instabilities compared to today, Dorothy Draper made a difference by designing exuberant and happy spaces, using colors strategically to positively influence people. Her creative legacy inevitably consists of unlikely combinations.

4. CONCLUSIONS

Dorothy Draper's work in Brazil left a legacy for interior design. In addition to the ability to choose unexpected colors and create exuberant spaces, Draper adopted the purest essence of Brazilian identity in the design for the decoration of the Quitandinha casino hotel. Translated through the sinuosity of its shapes, its fauna and flora that became the backdrop of the project.

Draper probably realized that a Brazilian palette could not be purist or minimalist, but rather, it should be diverse and cheerful, in line with the diversity that contributed to the formation of Brazil, coming from immigrants from different parts of the world.

In an attempt to design a national identity, other designers and artists later adopted Draper's strategies, which corroborates the fact that an attentive American sketched in the decoration the essence of the Brazilian identity, materialized through its colors. She was a pioneer in the search for our own Brazilianness.

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Color Studies in Trauma-Informed Design

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ABSTRACT

In a time of societal reconstruction for social justice and diversity, the focus on mental health has become paramount for every institution educating young people. This research project aims to show the potential benefits of trauma-informed design strategies on mental health in university settings. It explores how the framework of biophilic design and the role of color within could reduce instances that trigger Trauma in the built environment, offering hope for a healthier and more supportive environment and as a characterization of our collective efforts to design a sound future for all.

1. INTRODUCTION

This research project, which builds upon experimental color workshops and studies the role of spatial color application in addressing mental health, is essential. It has become a focus area for every institution educating young people and a focus on university settings for Indigenous peoples**.**

> As the divide among cultures shrinks, designers must consider the cultural differences among clients when preparing color solutions for projects. Color and design shape our behavior and attitudes, behavior shapes our culture and sense of collective and individual identity, and culture ultimately shapes how we design. (Ron Reed, pp. 22+23)

This research aims not to present a theoretical analysis of Indigenous culture and its relationship with Color studies, nor is it to contribute to the ongoing discussion about the various pedagogical approaches discussed herein. Instead, it is a modest yet visionary collection of student-color exercises contributing to our understanding of multiple approaches to color meaning and perception cited herein. It examines the practical value of color as a trigger, tool, and concept in creative practices, with equal attention to indigenous cultures, as a trigger in the practice of color education, and as a characterization of our collective efforts to design a sound future for all.

2. METHOD

The research is conducted within the framework of the Interior Architecture course 'Color Theory and Application in the Built Environment' at the University of Oregon. This course aims to understand the fundamentals of color studies and integrate color into processes that enhance human well-being and experience. It covers the use of color in culture and the environment, including principal color systems, methods of color harmony, effects of visual phenomena, and various psychological, cultural, and historical implications. The research team, comprising two Caucasian immigrants and one Navajo/Chicana Peoples member, brings diverse perspectives to the study. Building upon the authors' professional and lived experiences, they investigate the impact of color in trauma-informed design strategies on mental health in the context of campus life and examine if and how the framework of biophilic design could reduce instances that trigger Trauma in the built environment and the role color plays within. Mahlum Architects, RALcolor, Prof. Timo Rieke, University for Applied Science and Arts (HAWK) students, and guest lectures conducted the interdisciplinary workshops[1].

[1] Prof Dr. Axel Buether, *Introduction to Color Psychology* (2023) RAL color Germany: Markus Frentrop, and Laura Kilian (2023); Lina Schmidt (2024).

The phrase indigenous peoples refer broadly to the first peoples of North America, in the lands we call the United States, Canada, and Mexico. Indigenous culture's understanding of color and its meaning shows how everyday life is closely connected and focused on a human-scaled living environment regardless of specialization. It is more relevant today than ever. References on color for indigenous cultures included original artifacts mostly found in craft and references to Color Symbolism. The use of color and forms are qualities to distinguish the separation between tribal groups, thousand-year-old traditions, often a few basic principles, creations of lines, secondary layers, and symmetrical units, usually relatively flexible in their organization. The sources were observed, examined, and assessed, and the analysis results served as a basis for studying spatial color application. This might present a possible shift towards a more public profile and the need for understanding trauma-informed design, and this workshop focused on creating a more significant awareness for the students. Its place in the broader cultural context of spatial justice and diversity received recognition beyond conventional aesthetic responses in Human-Centered Design (HCD) as it describes an approach of design strategies that focus on being valuable and appropriate for the user.

> John Paul Jones sees 'Color Symbolism and Beauty' in the 'Human World' and its design and architecture for the environment, tradition, and culture of Indigenous Native American people. Human-centric environments consider people's prosperity, satisfaction, and well-being while celebrating sustainability, resilience, and diversity in the built and natural environment at all scales. (Environmental Design Research Association EDRA55 conference in Portland, Oregon, June 2024)

2.1 Understanding Trauma

The Western medical understanding of Trauma says: The permanent haunting of an individual by an initial crisis or series of events which becomes an overwhelming stressor that prevents the individual from coping with the daily demands of life and results in lasting adverse effects on the individual's social, physiological, physical, and emotional well-being.[1] Trauma-informed design goals focus on Avoiding or recovering from triggers. How can the built environment preempt and limit a triggering encounter? What spaces are likely to trigger? Can color/design prevent or dampen some of these sensory disturbances? What can the built environment do to compensate/address the activated response? The typical responses to how people respond to a "trigger" in the environment fall into the fight, flight, freeze, and fawn mode: (1) Every stimulus can be overwhelming for people who go into 'flight mode,' so a safe place, offers a release and can ease fear. (2) Flight mode needs spaces that allow retreat by seeking refuge without isolating themselves. (3) Freeze mode needs excitement and stimulation to ease people. (4) People who fawn can benefit from clear physical boundaries and welcoming social interactions. Interactions between colors and the possible harmonization between them are known principles of color space effects: for example, repetitions of complex images with a characteristic selection of colors and patterns, color sequences of near and far effects, progressive brightening/shadowing, directional positional relationships of colors, and progressive size changes.

2.2 Understanding Trauma for Indigenous People

Indigenous peoples and Native American worldviews balance holistic "wellness" quadrants and how these concepts and qualities are taught in the culture. The repeating series cycle of fours, such as the four elements of nature: Earth, Water, Fire, and Air. Elements like the four directions, East, South, West, and North, connect with stages of life, such as birth, youth, adulthood, and then old age and death, and with the seasons of spring, summer, fall, and winter. There are various cultures; for example, the East is the direction of birth. It is about light. It is about new beginnings. South is the direction of youth, so that's the midday. The west is the direction of adulthood, representing dusk; in the north, it represents old age and night. The typical response to how people respond to Trauma is through Community. People come

[1] Architectural Principles in the Service of Trauma-Informed Design (2021) Shopworks Architecture, University of Denver Center for Housing and Homelessness, and Group 14 Engineering.

together to support each other in their culture, including language, ceremony, and tradition. It is important to pass down tradition, have pride in heritage, and retain cultural connection. Colors are of the highest importance in creating identity Culture. What is Trauma specifically for Indigenous people?[1] (1) Historical Trauma is a collective experience that includes genocide, forced relocation, and assimilation. The events of the past can directly connect to the occurrences of today. (2) Intergenerational Trauma: In a few generations, profound changes occurred, including the loss of language, cultural practices, and proximity to ancestral lands. It's a continual process that lingers with each generation. (3) Geographical Trauma: Leaving family, Community, and losing cultural touchstones. Federally recognized reservations are not necessarily aligned with traditional lands. (4) Cultural Trauma recognizes we're all on native land, and erasing that in many ways is deeply dissonant. Encountering Indigenous cultures respectfully in the visual landscape is tremendously important and can significantly impact how we navigate the shared space. Color plays an important role, and the process focuses on creating a problem awareness of colors with the students and promoting a differentiated perception of color. This involves different levels on which people experience the effect of color, for example, unconscious to conscious, self-experiencing and reflecting, spontaneous or associative, comprehending and/or organizing, depending on purpose and/or symbolism.

3. RESULTS AND DISCUSSION

Biophilic design is about designing for people as biological organisms and respecting the mind-body systems as indicators of health and well-being. The studies are structured to get a shared understanding of what Trauma means, then as a sub-category, the meaning of color in Indigenous people's worldview, and then the knowledge around biophilia to connect us back to our inner selves and respond to intrusions we have, deep back throughout our evolution basically from 100,000 years ago. Biophilia views all people as biological organisms holistically. It serves as the framework to propose a solution to Trauma and support the impact of the Indigenous worldview, as it brings us back to where we all started.

Biophilia is designed for people as biological organisms who have innate responses to specific environments, including natural settings with dynamic and diffuse light, Leveraging "varying intensities of light and shadow that change over time to create conditions that occur in nature;" (Cacique, Shen, Sheng-jung 14(9)5605). Elements, materials, and colors as found in nature visually connect with the visible features of the area to create a distinct sense of place; Biomorphic forms and patterns, i.e., non-rhythmic sensory stimuli. Colors and forms are distractions, mainly with symbolic references to the Community and the surroundings.

4. CONCLUSIONS

The color-redesign of selected university spaces helped to portray the present situation; the search for social justice gives rise to a spiritual current for something genuinely new, a spirit of optimism, or even the will to redefine boundaries. This requires an inner attitude, in the sense that we question our color perception and aesthetic preferences, to create a mindset in which the whole of society expresses itself. The potential of the biophilic design approach, which is more legible overall than other design principles, is a compelling reason for its scientific examination. Its unique potential to foster a sense of connection and unity, surpassing other design principles, is a crucial argument for its inclusion in Color Education. Despite its near-forgotten status, its resurgence in contemporary design discussion is a testament to its relevance and makes a strong case for its inclusion in Color Education. Our heritage is immortal and anchored in us. With an – for now – unconventional approach to color design and its relationships to life and with an understanding of a systematic approach to sensitizing, raising awareness, and balancing out the deficits we experience, color may be accessible to a broad public – across borders.

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Urbanisms of Color: Exploring Communicative Roles and Evolutionary Trends

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ABSTRACT

Color is used for expression and communication in various forms in art, architecture, interior and product design. Likewise, in landscape architecture, color can be considered a semiotic resource that undertakes communicational functions while reflecting social development. Historically, colorhas not received much attention in landscape architecture perhaps because it is often a subordinate concern, with most colors being regarded as inherent in materials. Apart from some vivid-colored flowers and plants, landscape architectural materials are usually neutrals and earth tones, with colour primarily serving an ornamental role to create a natural and harmonious scenery. To this end, color theory, especially color's communicative function, has been notably absent from landscape architectural literature and curriculums. Despite the historical underestimation of color, its application in designed landscapes has been developing over time, influenced by ongoing social and cultural shifts.

1. INTRODUCTION

Projects by the Brazilian landscape architect, Roberto Burle Marx, serve as a good example to demonstrate the changes of color in landscape architecture. Burle Marx's color design in landscape, informed and refined by his training in painting, reflects new attitudes and experiments in color and advancements in color study at the time, showing more independence of representation. In a lecture, "The Garden is a Form of Art," Burle Marx acknowledged that "the successful use of color is one of the most difficult things in the world" and goes on to recognize the relationality of colors, "And a color will follow itself throughout a design; a color is never isolated, never alone" (Burle Marx, 2018, 113-114). Inspired by his artworks and art movement at his time, Burle Marx introduced intense colors and abstract patterns through the conscious arrangement of plants and hardscape materials, expressing his ideas on art, regional culture, and political agendas. In his landscapes, despite still being presented through natural materials, colour emerged as an independent design element, on par with form and composition. Marx's approach detached color from being merely an inherent feature of the landscape while enhancing its distinctiveness for expression.

Burle Marx's works demonstrate a shift in the use of color in landscape design around the mid-20th century. However, the concept of color as a distinct element in landscapes did not gain widespread attention until recent decades. Traditionally, most literature on color and environmental color design has predominantly assessed its impact in terms of aesthetic and functional aspects (e.g., McLachlan, 2012; Mahnke, 1996). These conventional approaches seem inadequate to explain the dramatic changes in urban landscape coloration, marked by an increase in expressive hues.

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In recent years, more diverse and vibrant color expressions have appeared across various landscapes, from traditional parks and gardens to urban public spaces, streetscapes, and plazas. Color has become more actively involved in urban transformations. Rather than isolated cases, this diverse and expressive color application has emerged as a global trend, creating a notable phenomenon in urban environments. This dramatic change has made the discussion about color in urban settings unavoidable, necessitating an examination of its association with and impact on urban environments.

2. METHOD

To bring the issue of color into the discussion of landscapes and urbanism and address the social dimensions of color, Gareth Doherty introduced the concept of "urbanisms of color" (Doherty, 2011). Doherty emphasized color as an integral part of the city, urging consideration of color in relation to its influence and connections to urban dynamics. Extending from this foundational concept, Beichen further developed this idea. She argues that color shares crucial interrelationships with urbanism, meaning it can not only actively contribute to the progression of the city but also be influenced and shaped by events and changes occurring in urban environments. Therefore, she proposes to interpret colors in urban landscapes from a social semiotic perspective, where the use of color in design is consistently shaped by social demands to fulfill different communication functions. The concept of urbanisms of color is introduced to emphasize that color can interact with urbanism at different levels; while being a mode of communication, the usage of color is constantly shaped by various social motivations.

The intention of introducing urbanisms of color in this paper is to provide a lens and framework for analyzing the dramatic shifts in color design in landscape architecture. Marked by the pervasive use of saturated colors, a new norm of color design seems to be emerging in contemporary landscapes. Previously, bright colors with distinct hues were not typically part of the toolkit for most designers when considering urban spaces and landscapes. Vibrant colors were traditionally introduced to landscape design for their functional benefits, such as wayfinding, enhancing visual effects, or creating specific ambiance. They were also used to establish landmarks, as seen in Parc de la Villette, or as a signature style of unconventional designers like Martha Schwartz. Since the new millennium, unlike the previous conservative attitudes toward color, designers have begun to embrace saturated colors, using them more expressively and frequently in various urban and landscape design scenarios. Previous color theories focused on color's deep roots in social and cultural traditions or expected functions of color and were less responsive in explaining why the usage of color changes.

3. RESULTS AND DISCUSSION

This research argues that urbanism of color can provide a perspective to understand the dramatic changes in color usage in urban landscapes. The new features of color can be interpreted from a social semiotics perspective to identify the motivations behind these changes. Beichen's previous research collected nearly 700 landscape projects from 2000 to 2019, distinguished by their use of saturated colors. The majority of these projects share similar key features of color design. They use contrasting pairs to attract attention and increase visibility, and their color schemes have an emphasis on perspicuity and legibility. Most saturated hues are painted or coated in a plain manner without additional details, making the colors flat and low-modulated. Combining these features in design makes color effective for communication and expression. The key characteristics of color identified in these landscape designs closely resemble those in advertising. In such designs, vibrant and eye-catching hues stand out as a distinct element in the landscape, actively serving the role of communication in urban environments.

In this new phenomenon, emerging saturated colors are increasingly found in promotion and branding activities, including promotions for products and private companies, urban space and city promotions, and cultural and social events. Saturated and distinct colors are deliberately used to create photogenic places that attract visitors and convey intended messages. With the prevalence of social media and the increasing need for self-expression, unique and eye-catching colorful spots in urban spaces have become popular destinations, often accompanied by widely shared photos and videos online. The information conveyed through color in landscape design, such as the new identity of a place or city (e.g., Lightpath in Auckland), social and political ideas (e.g., Pink Balls in Quebec), and associated brands and products (e.g., Pigalle Basketball Court), is promoted through pictures and videos. Saturated color, with its easy adaptability in urban spaces, offers significant advantages in meeting the communication demands of our highly visual era, which consistently seeks new stimuli.

Figure 1: Lightpath in Auckland in Pink as a way to brand the uniqueness of the city. (https://en.wikipedia.org/wiki/File:Nelson_Street_Cycleway_030.JPG)

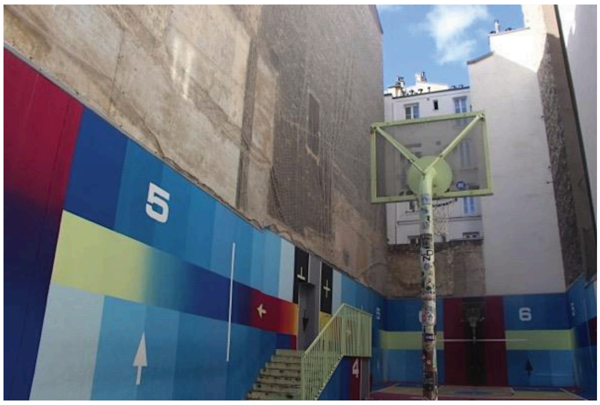

Figure 2: Colors in Pigalle Basketball to convey information about fashion and sport. Photography by Beichen Yu

4. CONCLUSIONS

This paper argues that color in landscape design, as a semiotic resource, is shaped by social motivations and significantly influenced by urban development, including the availability of materials and social and cultural activities. In contemporary urban spaces, color serves as an active communication tool, provoking responses and actions and triggering further changes. Dynamic interrelationships between color and urbanism result in the constant evolution of color use.

However, the current focus on advertising and promotion has led to a lack of consideration for the contextual use of color in landscapes. Color design in landscape should involve various considerations, such as materials, patterns, and textures. Landscape design should be mindful of its social, urban, and historical contexts rather than merely driven by commercial needs. Designers should also recognize the reinforced power of color in communication and its impact on social issues under today's urbanism of color. By building a thoughtful language of color in landscape design, color can better serve urban development and enhance communication in urban spaces.

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The Role of Color in Adaptive Building Facades

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ABSTRACT

In contemporary architecture, responsive and adaptive building skins have become essential for enhancing sustainability, energy efficiency, and aesthetic appeal within the built environment. These innovative structures are often implemented on tall buildings, serving as experimental platforms for technologies aimed at regulating solar radiation and improving indoor comfort. A critical question arises: what is the optimal color for these adaptive building skins? Furthermore, understanding how the color of dynamic components interacts with environmental stimuli is vital, particularly within urban contexts. The main goal of this research is to explore the selection and significance of color in adaptive facades, emphasizing its strategic role in shaping architectural and urban design quality, as well as environmental integrity. A key aspect of this analysis is the dynamics of facade components, which can modify both the color and texture of the facade, thereby influencing the perception of urban spaces. It is well recognized that the color of architectural surfaces significantly affects the experiences of occupants, especially concerning urban heat islands (UHIs) and the overall quality of urban environments. This paper will discuss findings from an initial study on the current state of the art in this area, highlighting that the color of adaptive facades is a complex design consideration.

The research identified a notable gap in the exploration of color design for adaptive facades. Most applications focus on facade performance concerning indoor well-being and achieving environmental sustainability certifications. Nevertheless, there is a lack of studies on external performance of the facades, particularly regarding color, perception, livability, orientation, and their effects on urban heat islands. Thus, it is crucial to expand research to establish guidelines for adaptive facade design and develop certification protocols for their chromatic and material aspects.

1. INTRODUCTION

The chromatic composition of urban buildings significantly influences the quality of urban spaces and the well-being of citizens across perceptual, psychological, and physical dimensions. Environments rich in color and light can lead to visual chaos and disorientation. Numerous studies highlight the importance of color design in architectural and urban contexts, emphasizing the need to consider environmental, cultural, social, and ergonomic factors (Taha et al., 1988; Qi et al., 2019; Zennaro, 2017). For instance, soft or light colors have been shown to positively impact urban orientation and climate, helping to mitigate urban heat island effects. The absorption and reflection of solar energy by facades contribute to increasing ambient temperatures, especially from artificial surfaces like concrete and asphalt (Synnefa et al., 2007). Tall buildings in urban peripheries serve as testing grounds for innovative technologies that manage solar radiation and improve indoor comfort, with adaptive facades being a key outcome. Often, facade colors are chosen without considering their environmental context, focusing instead on aesthetics and technology. Some research has explored how colored facades affect urban identity and their impact on surrounding environments, including urban heat islands (Synnefa et al., 2007; Chao Hong et al., 2022). However, the role of adaptive, kinetic colored surfaces on environmental perception remains underexplored. Adaptive facades represent a relatively new application area, with research primarily analyzing their potential and construction characteristics for indoor well-being and energy savings. The COST TU1403 Adaptive Facade Network (2014-2018) is notably comprehensive in this regard (Favoino et al., 2018). Nonetheless, a gap exists in understanding how these kinetic surfaces affect urban environmental quality in relation to well-being and perception performances. This study aims to address this gap, focusing on the chromatic reflection of dynamic components and incorporating findings into ongoing research at the University of Sassari (Italy) on adaptive facades.

2. THE CHROMATIC ADAPTABILITY OF URBAN SPACE

The European COST action TU1403 defines adaptive facades as building envelopes that adjust to changing environmental conditions, such as weather variations and seasonal patterns (Attia, 2020). Within the interaction between adaptive facades and urban spaces, two levels of adaptability emerge: the adaptability of facade components, which respond to environmental parameters, and the adaptability of urban space to instantaneous color variations. The perception of color in open spaces is influenced by environmental and climatic conditions; for example, colors appear more saturated and bright under sunlight (Gorzaldini, 2016). Also, the visual and thermal effects of adaptive facades on urban areas depend on attributes such as hue, brightness, surface texture (matte or glossy), and the movement of facade components. These factors, along with variables like the viewer's distance and angle, reflections, and shadows, impact environmental quality, color perception, and thermal effects. A key aspect of this research is that facade components can be oriented differently throughout the day, reflecting absorbed colors in various directions, creating a dynamic effect. Even achromatic claddings (gray or white) can evoke color play, reflecting the non-monochromatic surrounding landscape. Studying the solar reflectance and emissivity of adaptive facades is crucial for understanding color perception and controlling urban heat islands in relation to material, texture, and color. Materials typically reflect between 5-10% of light, but metals can reflect or absorb light without penetration (Premier, 2024). Under sunlight or artificial light, certain metals (e.g., aluminum, stainless steel) can exhibit golden reflections with reddish sunlight and vibrant colors with artificial light, enhancing the visual and thermal performance of adaptive facades and contributing to urban thermal management.

3. METHOD

The research method employed is descriptive and analytical. Data collection is based on research from international databases and scientific journals by keywords (adaptive color facades, adaptive architecture, heat island and adaptive facades, adaptive facades and urban perception). The projects were subjected to analysis in accordance with the established criteria, and the findings were compared in a synoptic table. The findings indicate that in the adaptive facades, the color is regarded as a mere inconsequential detail and facade components are frequently applied with a preference for the inherent color of the material. Accordingly, here an analysis of the impact of color in adaptive facades within an urban setting was deemed unnecessary, as it was decided not to focus on cataloging color gradations (hue). Instead, with regard to adaptive facades, it would be worthwhile to examine the impact of light and dark, reflection, and refraction in open spaces in relation to the movement of facade components and their surface texture (matt/glossy).

3.1 Case studies selection and analysis

The case studies analyzed were constructed between 2000 and 2020 and their selection was based on the following criteria: international building built in the 21st century that feature facades with adaptive characteristics in accordance with the previously mentioned definitions. Kinetic facades that are activated by only mechanical or manual systems were excluded from the analysis. The sample of case studies (25) was analyzed and compared according to common parameters with the aim of investigating the project type, the constructive characteristics of the facade, and the technologies related to adaptability, as well as the types of cladding materials, color, and texture of the components (Table 1).

Table 1. Summary of the main criteria for analysis

Purpose/goal	Building Use	Colors	Texture	Facade System	Adaptive System type
Indoor Comfort Appearance Energy generation Energy Management	Office School Museum Pavilion Housing	Hue Neutral Natural	Matt Glossy	Double Skin Brise Soleil Overcladding Panel System	Active Technology (technology responce) Passive Technology (material responce)

4. RESULTS AND DISCUSSION

The analysis revealed that 52% of the facades are constructed with metal components and almost all of these facades are used in their natural color (original or entropic). The majority of these facades have a glossy finish, which results in high reflectivity. Such surfaces serve as expansive reflective surfaces, absorbing the chromatic nuances of their surrounding environment, including the hues of edifices, asphalt, foliage, the firmament, and bodies of water (Premier, 2012). This phenomenon is observed in the case of static surfaces or when the adaptive facade is fully covering and stationary. In the comprehensive color analysis (Figure 1), facades with colored surfaces represent only 16% of the total, while facades with the natural color of the material account for approximately half (48%). With regard to texture, over half of the cladding is opaque (56%). A total of three case studies feature facades that are classified as "filtering," which allows sunlight to pass through (e.g., glass components with PV cells). 24% of the case studies can be considered "smart" or "material responsive" due to their adaptability is material-based (Matin and Eydgahi, 2019). The implication of this information is that adaptive facades constructed with passive technologies exhibit a more gradual rate of state change (adaptability) in comparison to those constructed with active technologies (76%). This element, therefore, exerts an influence on the variation in color perception and reflection on public grounds in relation to the time-perception relationship.

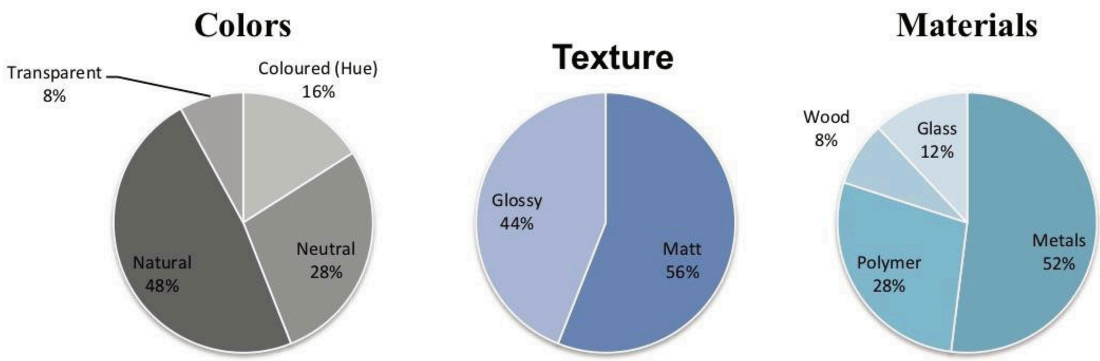

Figure 1: Summary of the results of the comparative analysis.

5. CONCLUSIONS

Research on adaptive facades is continuously evolving, currently focusing on their performance concerning indoor well-being and environmental sustainability certifications. The research confirm that there is a significant lack of studies addressing the external performance of facades, especially regarding color, perception, livability, orientation, and their impact on urban heat islands. The color of materials is crucial in adaptive facades, as their functional characteristics lead to constant changes in reactions and effects throughout the day. Typically constructed from metal in natural or white hues, these facades influence the reflection of surrounding colors and heat, shaping the perception of the urban environment. Recent studies (Synnefa et al. 2007) show increasing interest in the relationship between coating color and solar reflectance and emittance values, although the focus remains primarily on indoor well-being. The research suggests that using facade materials with low thermal inertia can help reduce heat island intensity. Therefore, it is essential to further investigate this area to establish design guidelines for adaptive facades and develop certification protocols for the chromatic and material design of building cladding.

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Colors and Meaning Making: a Rhetorical Perspective

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ABSTRACT

This paper is a part of a larger project which focuses on colors and rhetoric and hopes to provide a nuanced and rich way to understand the communicative role of colors in their context. It uses the theoretical framework of argumentation and suggests thinking of distinct color pallets as forms of arguments. To this end, it rhetorically analyses discourses surrounding two different urban environments in Israel: an ultraorthodox neighborhood characterized by a monochromatic palette and a renovated area in the culturally and religiously mixed city of Jaffa where the palette is colorful and saturated. The palettes used were found to correspond with the worldview in the areas (traditional and binary vs eccentric and inclusive). Color choices made by the planners and residents in these areas are not arbitrary and serve as arguments rather than mere affective agents or tools of persuasion.

1. INTRODUCTION

In traditional landscapes, colors were derived from local materials, but due to the current availability of artificial colors, they are no longer chosen only according to their accessibility. This paper suggests thinking about color choices as having a communicative, cultural and even an ideological role. To examine color choices, analysis was conducted to compare two paradigmatic cases studies: neighborhoods characterized by markedly different demographics and color choices albeit their geographical proximity.

The theoretical framework chosen is that of rhetoric and more specifically that of the visual argument. Argumentation provides a lens through which to read colors within context and to read the layered way in which colors are understood by communities. While color choice is often understood as arbitrary or as motivated by persuasion and marketing considerations, this lens helps us understand the deeper meaning in which colors reflect and shape worldviews and ideologies, on top of being affective agents which reinforce mindsets. In other words, arguments explicate the connections between colors, culture, ideology, and emotions.

2. THEORY

2.1 Rhetoric, Colors and the Body

When thinking about communication and rhetoric, researchers have traditionally looked at aspects of language, structure, symbolism and myths. While the body has been the subject of a great many studies that focused on race and gender, not many explored the ways in which messages influence the body itself and consequently participate in the construction of said cultural symbolism.

Colors are especially interesting in that regard as they link the physiological and the rhetorical-cultural: they call our attention instinctively and shape our perception immediately, but their uses can be deliberately planned and constructed to achieve desired outcomes. An increasing number of studies showed colors to induce emotions and the importance of skilled use of colors in therapeutic and other settings (Valdez and Meherabian, 1994). Colors were accordingly used to create a sense of identity and place (Xu, 2017), yet the meaning of specific colors choices was not deeply explored.

To understand the nuanced use of colors in the urban environment which begins with the body and continues with ideology, this paper focuses on the missing link and focuses on rhetoric and the theoretical framework of the visual argument. Attempts to draw the line between a rational argument to manipulations and logical fallacies are as ancient as the study of rhetoric itself and date back to Ancient Greece. Plato is especially known to have ridiculed the art of rhetoric which focuses on emotions and manipulations and compared it to cosmetics. Instead, he favored philosophy which he associated with logic and truth claims about the world (Georgias). Difficulties to distill rational arguments and distinguish them from other forms of persuasion have become even more pronounced once the focus of communication has shifted to the visual.

2.2 Visual Arguments

The possibility of visual arguments and the ways in which they could be teased from other forms of expression or from verbal arguments was dealt with in depth in a special issue dedicated to the topic (Birdsell and Goarke, 1996). In an interesting article from the issue, Blair tried to separate visual persuasion from argumentation. It is true, he claimed, that certain causal properties are supervenient on certain visual properties, which thus affect their viewers in predictable ways. For example, colors invoke feelings of warmth (reds, oranges) or coolness (blues, greens); photographs of young animals (puppies, kittens, children) evoke tender-heartedness; and certain scenery (the open desert, the mountains, the seashore, hills and forests) evoke feelings of freedom and escape in their viewers. However, while such properties can be and are exploited affectively to cause feelings and attitudes and to evoke responses (for example, in advertising), that does *not* imply that the visual images to which they attach are languages in any literal sense and they do not necessarily serve as arguments.

After analyzing ads as well as architecture from churches, Blair reached the conclusion that visual arguments can indeed be found and convey grammar that is richer than the mere evocation of feelings, affect or comparison by association. According to him, a visual argument must have all, or some, of the salient properties of arguments and they should also be non-verbal visual communication. In other words, visual arguments are to be understood as propositional arguments in which the propositions and their argumentative function and roles are expressed visually (e.g., through gestures, cartoons, animation, videos.). An example, given by Blair is of sculptures at the entrance to medieval churches: one describes the harm that befalls the sinners on judgment day. Another illustrates the benefits bestowed on the righteous in heaven. Both can be read as propositions and can be understood by church goers within the cultural-religious context in which they are displayed. The conclusion drawn from these visual propositions is clear to the churchgoers as it implies the importance of devotion and right conduct.

The working definition of visual argument in this paper relies therefore on O'keefe's concept of argument (1982) which was also used by Birdstell and Goarkee in the special issue mentioned above (1996) as well as Blair's insights. According to this definition, arguments make claims, there are explicable reasons for the claims, there is an attempt to communicate the claim and reason(s), the argument has author(s), and the argument has an intended recipient. For the visual to be considered a form of argument rather than persuasion it needs to be a form of enthymeme where the claims are deductively drawn from the visual propositions. Importantly, it must be linked to socially or culturally agreed upon conventions that audience members can identify, as they insert their own knowledge and experience to 'fill in the blanks'.

Reading *colors* as argument helps us gain a deeper understanding of their impact provided the audience can identify the propositions and insert the knowledge missing according to the cultural context. Since colors link It can link the affective and sensory (e.g., earth tones for warmth) to the cultural and rhetorical (e.g., green for health stores, saturated pallets for inclusivity), this paper believes them to be less arbitrary and ambiguous than other forms of visual images and even words. In relation to the urban environment, focusing on colors as arguments helps us understand their role in creating an experience and shaping a worldview.

3. ANALYSIS

3.1 Method

The analysis focused on rhetorical analysis of color palettes used in the architecture, street art, but also the fashion worn by those visiting and living in the area. Research on the worldview held by people living there was conducted through interviews and the reading of relevant cultural and religious texts. Interviews have further shed light on the ways in which people understand the color palettes as arguments.

3.2. Place and People

The research focused on two neighborhoods in Israel and although they are less than 10km apart, their demographic and cultural make-up, architecture and color pallets are remarkably different. One is in Bney-Brak, a city composed of predominantly ultra-orthodox Jews. This sector tends to be extremely religious and adherently follows the scriptures and its religious leaders. Very little room is given for personal expression and judgment even on matters pertaining to one's outfit or household and violation of the rules of conduct conquers consequences. The city is poor, dense and the architecture is monochromatic- mainly gray. The ultra-orthodox wear black and white suits and their dress code in strict eve in relation to details such as the number of buttons in the collar, or the length of the socks.

Jaffa, on the other hand, is an ancient city and now a part of the municipality of Tel-Aviv. The population living there is ethnically and religiously mixed and is composed of many religions and ethnic groups. The research focuses on an area surrounding the flea market which was successfully renovated fifteen years ago and has become more affluent than other parts of the city. The architecture is renovated and ancient sprinkled by contemporary residential buildings, restaurants and stores can be found. In the past decades, the color palette has changed from its traditionally white stone as colorful murals and walls and art were. The outfits worn by those living in the area are also varied in terms of style, textures, lengths and colors.

4. FINDINGS

Correspondence easily arose between the color palettes and ideologies and individuals from both communities were aware of the deeper meaning conveyed by colors. For the ultra-orthodox, the black and white palette matched their formal, severe and dignified approach to life as well as the importance of observing the rules. Participants talked about the homogenous look and the necessity to dig deeper if one were to express one's individuality. Moreover, black and white was homologous with the dualistic and religious approach: sacred vs the profane, "merit" vs "sin," Jew vs "the Other." The propositions here therefore relate to monochromatic palette as tradition, conformity, dignity and duality. The conclusion reinforces this worldview as important and even inevitable.

Shop owners and residents of Jaffa have also read the color pallet in according with their world views. They had a need to express their individuality, and they discussed the importance of inclusivity. While some sectors in that area were religious, the varied makeup of the neighborhood made them appreciate and desire acceptance. For artists and others who moved to the neighborhood, the colors signaled creativity, eccentricity and the possibilities of coexistence. In other words, more liberal values. Despite cultural and religious tensions, all loved the colorful architecture that according to them beautified the area and made them feel a part of it.

This approach corresponds with the notion of the "fabulous" coined by Madison Moore (2017). Moore identifies the rise of the eccentric and fabulous in recent decades which is visually expressed through mixed textures and bright colors. The book does not investigate architecture but focuses on other case studies such as fashion and nightlife, but its conclusions are relevant here. Moore concludes that the fabulous expresses inclusivity and rebellion mainstream culture. When examining colors as arguments in Jaffa, the proposition links color with eccentricity and individual expression and the conclusions relates to the importance of inclusivity.

5. CONCLUSION

Propositions pertaining to color pallets were identified in both cities as relating to the importance of formality and obedience, versus individuality and inclusivity. Individuals from both communities did not always know if the colors have a deeper meaning when asked about it. However, they expressed affinity with the aspects they associated with them and were able to "add in the blanks".

The color pallets had an affective resonance with those living in Jaffa noting that the colors are convivial and uplifting. I therefore believe that although color palettes correspond with a certain ideology and shape a similar mind-set, their affective resonance can override the ideology. Unlike fashion, which is strictly monitored in that area, varied and saturated palettes can be applied in designated places such as schools and gardens without causing terror.

On a deeper level, this paper illustrates that visual argument is a useful lens for analyzing color choice in the urban environment and beyond. Even when color choice appears arbitrary, it is often informed by an ideology as well as by physiology which is not separate from these worldviews. Colors encode ideology due to their affective impact and their use molds a corresponding (body) mindset.

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The Color Chart of Jalpan de Serra, Querétaro (Mexico)

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ABSTRACT

Jalpan de Serra is the municipal seat and the most important economic center of the Sierra Gorda region, a protected natural area that is part of the Biosphere Reserves, located in the state of Querétaro, in central Mexico. This town was included in the "Magical Towns" program in 2010 by the Ministry of Tourism of the Government of Mexico because it integrates historical, cultural, and architectural heritage with the richness of the surrounding natural environment distinguishing it among unique landscapes. Among this heritage is the mission of Santiago de Jalpan, inscribed on the UNESCO World Heritage List in 2003, of which the stuccoed polychrome of the Mexican baroque style of its façade stands out.

This paper tries to identify the color palette present in the municipality of Jalpan de Serra and its surroundings, carried out within the framework of a two-month research stay with the aim of studying the polychromy of the façade in the mission of Santiago de Jalpan. During this period, it was observed how color manifests itself in architecture, influenced by its own natural and material environment, as well as in everything that its society adds to everyday life to transmit certain cultural values, that characterize the identity of a people.

One of the main pillars during the course of this work was a detailed study of historical and social bibliographic sources, complemented by fieldwork that included graphic representation and a photographic report of the elements characterizing the architecture and environment. A survey was also conducted among residents to obtain information on customs, ways of life, and the use of color.

With all this, a series of conclusions have been obtained on the importance of color in the built environment of this town as an intrinsic, representative, and integrating part of its intangible heritage.

Keywords: *color, heritage, culture, Jalpan de Serra, Querétaro.*

1. INTRODUCTION

The city of Jalpan de Serra is located on a plain surrounded by the Sierra Gorda mountains, a protected natural area that is part of the Biosphere Reserves, creating landscapes that combine the urban image with the tropical forest vegetation and that characterize this region of warm subhumid climate.

The Jalpan River flows through the city in a northeast-southeast direction until it reaches the Jalpan Dam which has been identified as a Ramsar site (The Ramsar Convention) within the Sierra Gorda Biosphere Reserve since 2004. This wetland, of international significance, serves as a crucial refuge for birds migrating from the United States and Canada to Central and South America, as well as for endemic species.

In 1744 the city of Jalpan was founded and in 1750 the construction of the mission of Santiago de Jalpan began, with the aim of gathering and evangelizing the inhabitants. Since then, urban development in the historic center "has remained through time, offering a clear reading of the foundational trace; with the religious complex as the ordering center, the square in front of the atrium, and the blocks arranged around the perimeter of this center" (Gobierno del Estado de Querétaro 2003, 119) (Figure 1).

The façade of the mission, in the Mexican baroque style, stands out from the religious complex, for its stuccoed artistic elements and polychromy, it is “the product of creativity, of the joint work between the Franciscan friars and the inhabitants of the region” (Gobierno del Estado de Querétaro 2008, 17). The mission of Santiago de Jalpan was inscribed on the UNESCO World Heritage List in 2003 along with four other missions that are located in the Sierra Gorda region.

Figure 1: Aereal view of Jalpan de Serra’s City Center. 2019. Ochoa, A. Source: www.iStock.com

2. OBJECTIVE

This research is based on the interest in the relationship that cities and color have as a connection and influence between the social and the cultural aspects that build the identity of a town, with which the objective of identifying the color palette present in the municipality of Jalpan de Serra in the Mexican state of Querétaro.

3. METHOD

To achieve the aforementioned objective, a visual chromatic analysis of the environment was carried out, observing how color manifests itself in architecture influenced by its own natural and material environment. The study presented has been limited to the two blocks where the mission of Santiago de Jalpan and the main garden are located because it is an important area of the city with influence on urban development and the lifestyle of the inhabitants (Figure 2).

The study was carried out within the framework of the Conservation and Restoration Work on the façade of the Santiago de Jalpan mission led by the Directorate of Sitios y Monumentos de la Secretaría de Desarrollo Urbano y Obras Públicas del Estado de Querétaro during the months of November and December 2023.

To identify the color of Jalpan, several tours were made in the study area. Observations from the visual analysis of the urban environment, architecture, colors, and lifestyle of the population were recorded in a work log. A photographic survey documented the architectural typology, construction details, chromatic range, and the relationship between the urban space and the natural environment. Finally, surveys were conducted with local residents to complement the visual analysis with the inhabitants' perceptions of color.


Figures 2 and 3: Aerial view of the study area. 2024. Source: Google Earth, and a collage of the architecture of the study area. 2023.

4. RESULTS

The buildings located around the block of the mission and the main garden in the historic center of Jalpan predominantly exhibit a two-story architectural typology, featuring decorative ironwork details and "pigeon's chest" finishes that top the façades (Figure 3).

The study confirmed a strong relationship between the polychromy of the mission's façade and the chromatic palette observed on the surrounding buildings. These façades showcase a range of ochre tones, both intense and light, which contrast with the reddish hues used for door and window frames, as well as the black ironwork (Figure 4).

The green color was frequently observed during the site tours as a prominent color in the natural landscape, creating a contrast with the ochre tones and highlighting the interaction between the natural environment and the architecture.

Interestingly, while the visual chromatic analysis emphasized ochre and reddish-brown tones, the survey results indicated that the inhabitants perceive green as the most predominant color in the study area, followed by ochre and orange tones. The presence of ochre and green was expected; however, the prominence of orange was surprising, as a more rust-red shade was observed, suggesting an influence from the colors present in the mission (Table 1).

Figure 4: Elevation of standard facades in the study area. 2024. Image edited from a plan drawn by the Secretaría de Desarrollo Urbano y Obras Públicas del Estado de Querétaro.

Table 1. The color chart of Jalpan de Serra.

Color	light ochre	medium ochre	medium orange	dark orange	brown	light green	medium green

5. CONCLUSIONS

The city of Jalpan is perceived as a warm city, due to the ochre, orange, and green colors present in the natural environment, in the architecture, and in the culture that characterizes this town.

On a day-to-day basis, color can go unnoticed, however, it is a key element in our society, and in the formation of our cities, it is intimately related to the urban context, architecture, and the identity of its inhabitants.

ACKNOWLEDGEMENTS

We express our gratitude to the Secretaría de Desarrollo Urbano y Obras Públicas del Poder Ejecutivo del Estado de Querétaro for their support and for providing the necessary facilities to conduct this research stay. We also extend our thanks to the team that makes up the Grupo de Investigación del Color en Arquitectura del Instituto de Restauración at UPV for sharing their experience and knowledge, which greatly contributed to this study.

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Color in between Art, Technoscience and Politics: the Vantablack Controversy

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ABSTRACT

This article studies a controversy in contemporary art, involving the development of Vantablack nanotechnology by Surrey NanoSystems. After its artistic use exclusivity by artist Anish Kapoor, artist Stuart Semple developed an alternative superblack, raising important questions about color. To study these issues, we use theories of STS studies, like actor-network approach, material culture contributions and the study of technical media by Friedrich Kittler. We do a mapping, as suggested by Tomaso Venturini, identifying the main actors and the main controversies, writing an analytic description. In this process we identify how in color studies there are many naturalizations and hidden conflicts, controversies about its conception, materialities and meanings. These disputes also show us that it is impossible to understand color in disciplinary approaches. The history of the material must be looked through a multidisciplinary lens, involving contemporary art, journalistic media, social networks, nanotechnology, industry, activism, democracy, and so on. The controversies that we identified influence the trajectory of the product by interventions and disputes of the other actors, who also change because of their interactions to each other and the material. Therefore, we conclude that the study of the controversies around Vantablack brings fundamental insights on how we can understand color in contemporary world, in a multidisciplinary way, combining the inseparable dimensions of poetics, technoscience and politics, which are in fact co-produced.

1. INTRODUCTION

This article studies a dispute in contemporary art, involving the development of Vantablack nanotechnology, a coating that has the optical effect of being non reflective to light. British company Surrey NanoSystems sold to artist Anish Kapoor its exclusive rights for artistic use, triggering a response from the art world, which criticized this monopoly. British artist Stuart Semple became the leading voice of discontent. He created his own art supplies company, Culture Hustle, and an alternative superblack material, a paint called Black 3.0, made from acrylic base, also accessible to everyone (except Anish Kapoor) and non-toxic.

This debate raised questions about how color is controlled and the importance of its materialities. The political implications of this dispute let to a sociotechnical controversy in which Surrey NanoSystems considers Vantablack not as a color, but a "material"[1], reinstating the scientific debate about the nature and concept of color in general and about the place of black in the chromatic world.

Such controversies bring light to many hidden conflicts and naturalizations in color studies. Mainly, these controversies show us that it is impossible to understand color in disciplinary approaches only. All actor's frameworks enact at the same time elements of technology, politics and aesthetics. To speak of Vantablack is to speak of contemporary art, journalistic media, social networks, nanotechnology, industry, activism, industrial property, democracy, and so on.

2. METHOD

Our conception of technology follows Science, Technology and Society (STS) studies, understanding technology as non neutral and intertwined with social elements, such as ethical

[1] In 2016, Surrey NanoSystems posted on their twitter account: "To clarify - #Vantablack is not a colour, it's the complete absence of all colour". (Breitenbach, 2016).

values. STS perspective sees technology inside human relations, worrying about its impacts but without fetishistic or deterministic biases.

To study a sociotechnical controversy, we use the methodology proposed by Tommazo Venturini (2010) and Bruno Latour: a cartography. This mapping focuses on identifying main actors and debates, organizing their relationships and visualizing its key elements, assuming its historical aspects, symmetry between human and non-human actors, as well as the complexity of sociotechnical phenomenon.

Diagrams redistribute temporal flows and spacial orders, revealing aspects that before were invisible. According to Latour (2017), a diagram is at the same time a construction, a discovery, an invention and a convention, allowing to link realities that from an empirical dimension would probably be unrelated.

Our methodology does not depart from pre-established conceptions of nature, humanity, culture and society, but from actions that create concrete bonds. Social is not a domain of reality, but is constructed in movement and it is in a net of interactions.

Our cartography uses sources from news websites, social networks from the actors, visual representations, commercial websites, exhibitions and interviews. These sources are mediated by interests of self-promotion, what can lead to certain biases if not looked critically. However, these manifestations are representations that tell a lot about conceptions, practices and relationships between actors, because they allow us to see their frameworks.

The main actors we find are showcased in Figure 1. Product Vantablack, nanotechnology company Surrey NanoSystems, Indian-british artist Anish Kapoor, british artist Stuart Semple, his ink company Culture Hustle and products Pinkest Pink and Black 3.0. We also include the generic term "artistic community", which influences actions.

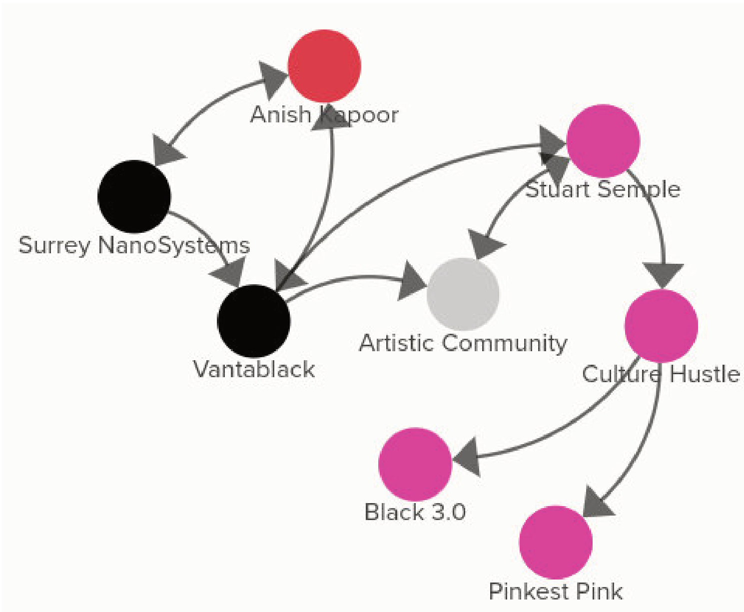

Figure 1: Flowchart illustrating the main actors of the controversy.

Every sociotechnical controversy envolves many other controversies, in different fields of knowledge and human practices. Their key desagreement is political: how can someone own a color? This issue of access enacts a response from the actors. In order to defend its position, Surrey NanoSystems argues that Vantablack is not a color but a material, followed by Anish Kapoor's claims about Vantablack's technical complexity and expenditure.

This arguments lead to important repercutions in color theory, about the relations between color and materialities. If color can be owned and monopolized, then what is color after all? Actors also question: Do we have access to all colors?

From these considerations, we can derive other issues: does our perception of color depents on its industrial production, juridical property and technological constitution? How our access to color is mediated by technology and property? What this dispute on control can explain about the co-production of technoscience and politics (Jassanoff)?

From the artist point of view, which is also our own, what does these debates impplies to research and practice in art? How does the lack of access to color influences artistic poetics? And how the artist articulate technological and political aspects in their practice?

All of these questions are related to disputes that take place in other corelated areas, such as nanotechnology, law, philosophy, and color theory in general. Therefore, in Figure 2, we produced a visual map of all of these disagreements, put together in relation on a tree of desagreement, folowing Venturini's proposal (2010).

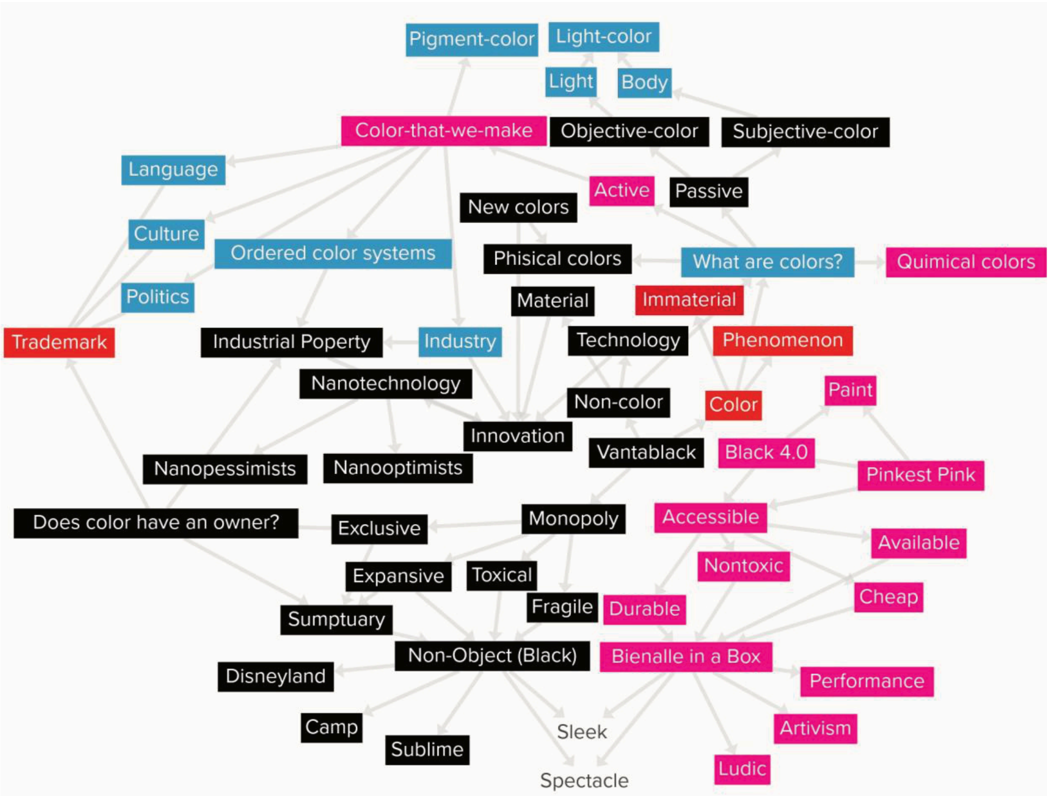

Figure 2: Tree of Desagreement

3. CONCLUSIONS

After identifying main actors and debates, this research found the following elements: the key feature of Vantablack is its aesthetic experience as a 'superblack'; Surrey NanoSystems frames Vantablack as a luxury good, extraordinary and of high technology; nanotechnology conflicts influences the polarization between actors and the engagement with the public.

Besides its descriptive dimension, we can infer analytical remarks: Vantablack's framing as great technological innovation, its enactment as extraordinary and its commercial quality as luxury good are part of a conception of technology dominated by neutrality and determinism, as well as embedded in progress ideology.

This controversy has important implications for color theory. We highlight how industry has a fundamental role in the way we relate to the chromatic phenomenon, what shakes established knowledge of its conception, control and access, as well as the artistic ideals that accompany it. Color materialities, which are technical, political and economic, allow them to be controlled and also disputed.

Vantablack controversy emphasizes how there are still many uncertainties about the chromatic phenomenon, which is multifaceted, helps to produce subjectivities and is inserted in the social relations of visual expression, market and technology.

The conflictual but codependent relationship with regard to superblacks and their poetic uses also reveals a more abstract point: poetics cannot escape either technoscience or politics. Semple's political opposition to Kapoor's monopoly is necessarily a counterposition that is also poetic, technological, scientific, industrial, economic, mediatic and discursive.

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Contemporary Landscape Color Design and Its Origin in the Work of Roberto Burle Marx

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ABSTRACT

Color in landscape design is an aesthetic and affective matter that carries a potent social, commercial, and political agency. Over the past three centuries, landscape designers have experimented with color and lighting effects toward many ends – conceal undesirables, accentuate desirable elements, display social status, enhance the perception of space, produce moods, surprise, joy, and humor, create place identity, forge attachment to place, and critique stereotypes about color. More recently, immersive experience, politics of identity, branding, and digital culture have had their upper hand in shaping landscape color. Contemporary cities and gardens teem with vast, brightly colored and glowing light surfaces that compete on social media. In this paper I argue that today's landscape color affinities owe much to the work of the Brazilian painter and landscape designer, Roberto Burle Marx. I focus on the conceptual, technological, and cultural ingredients that shaped Burle Marx's landscape color designs and trace to his work defining landscape color and light principles in prominent postmodern and contemporary landscape architectural works.

1. INTRODUCTION

Color and light are basic considerations in landscape architectural design. Since the late 18th-century, landscape designers have written about and experimented with color and light toward different ends. As I show in my recent book *Landscape Design in Color* (Engler 2023), the color palettes used overtime depended on four variables: (1) the position on color by related professions, especially art and architecture, (2) cultural stereotypes and consumerism, (3) landscape material technology in which color is conceived, represented, and conveyed, and (4) the most endemic to landscape design is the discipline's changing affinity to nature and ecology, on the one hand, and to art and culture, on the other. The closer it was to the arts, the more contrasting the color it used, thus highlighting human handicraft; the closer it was to nature, the more it blended colors with nature.

The late 18th century English Humphry Repton, the first landscape gardener to have written about color, used nature as a model and privileged shades of green and earthy autumn golden hues of popular landscape paintings at the time. Fresh and bright blossom colors were relegated to the kitchen garden, for fear they interfere with the visual composition. Repton's mid 19th century counterpart, The English J. C. Loudon was drawn instead to polychrome and focused on seasonal change. Loudon's gardenesque style highlighted landscape as human handicraft and catered to the growing suburbanite appetite for bright complimentary-contrast flower bedding patterns enabled by colorful imports. Loudon's work was rejected by the late 19th-century work of the English William Robinson and Gertrude Jekyll, who found kinship in Impressionist and post-Impressionist paintings and favored inter-grouping of calming spectrum-adjacent harmonies. Conversely, early modernist Europeans allied with one of two architectural modernist positions: (1) primary colors, seen in the Viennese Secessionist Joseph Maria Olbrich's "Garden of Colors" in Darmstadt, Germany (1905), and (2) achromatic palette of white, gray, and the intrinsic colors of new industrial material against green, represented by the Austrian Josef Hoffmann's Stoclet Palace, Brussels (1905).

The work of the modernist American Garett Eckbo, who like the Brazilian Roberto Burle Marx began his careers in the 1930s, rejected pure colors lest they interfere with spatial and compositional perception. His approach dominated landscape architecture through the 1970s.

In contrast, Burle Marx used color profusely as an essential compositional and affective element, becoming model to postmodern and contemporary landscape work.

2. ROBERT BURLE MARX'S LANDSCAPE DESIGN

Born in Recife, Pernambuco, Brazil, to parents of German-Jewish and Portuguese origins, Burle Marx (1909–94) moved with his family and grew up on a farm in Leme, Rio de Janeiro. Trained as both a vocalist and a painter, he added landscape design to his multimedia palette. In over six decades of practice (1932-1994) he completed more than 2000 private and public projects on three continents with his Rio office and partner, Haruyoshi Ono. His residence and nursery outside Rio, known as Sítio, preserve his legacy. A key signature in his landscape design are two interdependent contrasting tendencies: (1) permanence, a fixed and coherent formal color composition, and (2) contingency, ephemeral color-light effects. Four of his distinct color principles have proven to be long-lasting – the dramatization of color through vast landscape surface and mass, the production of color events and light performances, artificial illumination, and display of regional and national identity.

Figure 1: Roberto Burle Marx, Ministry of Education Roof Garden, Rio de Janeiro (1939).

2.1 Dramatization of Color through Vast Landscape surface and Mass

Burle Marx's treated the landscape ground plane as painted canvas (Figure 1). He used large and contrasting built material patterns and clusters of single plant species, repeating them throughout. His diverse formal and chromatic choices derived from the local landscape, theatrical and musical insights, and the palettes of both European and Latin American modern artists and traditional artisans. His abstract gouache drawings present fixed formal composition that allow for changing seasonal colors. To resolve the contingency of plant-scapes and produce a coherent mosaic of color patches, he amassed each specie, thus amplifying the character of each, as in the Civic Center square of Curitiba, São Paulo (1953) (Figure 2) and the Cavanelas Residence, Petrópolis (1954). To enrich the plant material palette with new textures and colors, like new pigments for his canvas, he incorporated native and hybrid plants, which he discovered in plant expeditions and hybridized in his nursery.

Burle Marx's bold, colorful treatment of the floor plane was absent in the landscape architectural scene through the 1970s, where the traditional perspective view and colors of gray, brown, and green dominated. With the turn to postmodernism and the rise of consumerism the achromatic urban and landscape hegemony was disrupted. Landscape architects searched for grand gestures and, like Burle Marx, turned the floor into a carpet. We saw this first in the work of the American Peter Walker, and later his apprentices. Walker's projects featured floor patterns with repetitive arrangements of objects, innovative water and steam fountains, and artificial materials. However, neither plants, nor color, were his focus. It was Martha Schwartz who was the first to brake with the modern landscape achromatic code and inaugurate the color phase in postmodern landscape design.

Beginning in the 1980s Schwartz's landscapes teem with color, relying mostly on paint and colored material, though not on plants. Her bold ground patterns derived their inspiration from contemporary art sources, like minimalist, land, and pop art, and her colors followed Pantone and RBG digital systems, as in the Moscone Center Competition (1990) (Figure 2).

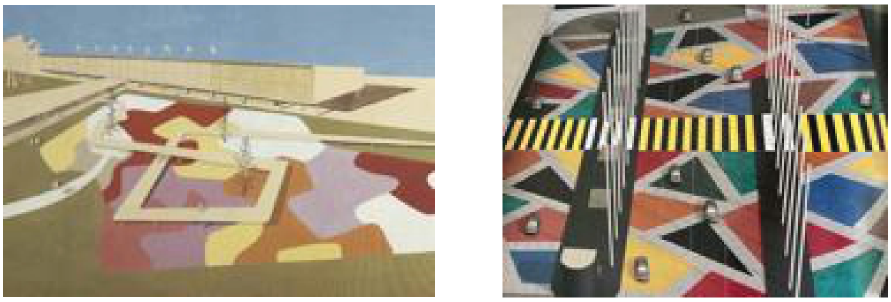

Figure 2: Roberto Burle Marx, Civic Center Square of Curitiba, São Paulo (1953) (left); Martha Schwartz, Moscone Center Competition (1990) (right).

Schwartz's followers from the late 1990s onward, the Canadian Claude Cormier and German Martin Rein-Cano of TOPOTEK1 who practiced with her, developed their own distinct bold ground floor color signatures, as seen in Cormier's l'esplanade du Palais des congrès, Montréal (2007) and in TOPOTEK 1's Superkilen, Copenhagen (2007–12). They advanced the critical role of color played in digital culture, social media, and instagrammable appeal.

2.2 Production of Landscape Color Events and Light Performances

Burle Marx produced color events and dramatized color through sun light and seasonal blossom. He worked with light to unleash its performative quality. Guided by his penchant for theatrical lighting design, he choreographed the movement of sunlight on plants and artifacts in the garden, much like a spotlight following the actors on stage. Thus, the lighting spectacle he produced at Fazenda Vargem Grande, Areias, near São Paulo (1979) framed, sequenced, and juxtaposed plants, water, and minerals in changing daylight. We see this tendency to create theatrical effects in Schwartz's work, in the Davis Residence Garden in El Paso, Texas (1996) and in the interior and garden design of the Dutch Petra Blaisse's work, in the Swamp Garden in Almere, the Netherlands (2007), among other projects.

2.3. Artificial Illumination

Burle Marx lamented the failure of landscape architects to see the potential of artificial illumination at night beyond the practical safety consideration of lighting. He was inspired by the new aesthetic possibilities created by neon signs, advertising posters, even traffic lights and parkway lighting and was riveted by reflections and light effects on water. In Ibirapuera Park, an unrealized project for the Civic Center square of Curitiba, São Paulo (1953), he illuminated the space with soft light from above and used low, bright spotlights to illuminate high waterjets sequentially and intensely, creating multiple diffractions, reflections, and refractions on the water column. Peter Walker continued this passion, and so did Schwartz in her many projects, including Jacob Javits Plaza, New York (1997) and Grand Canal Square, Dublin (2017). Color illuminated fountain displays are now common spectacles in cities across the world.

2.4. Display of Regional and National Identity

Burle Marx's understood the meaning of color and its role in creating identity, both regional and national. He celebrated the brilliant colors of Brazil's native flora and fauna and vernacular art and craft. The region's immense variety of brightly colored birds, insects, and plants found their way into Burle Marx's chromatic schemes and became expressions of the tropics. He selected intense plant colors that were not washed out by the tropics' strong light.

He also embraced the contradictions of "tropical" and "modern," Brazilian traditional art with European vanguard. It was a political act; defiance of the colonial cast of Brazil as exotic primitivism within the context of the emerging modern national identity movement, called variably "Pau-Brazil" and "*brasilidade*." Pre-Columbian art and Portuguese craft inspired the forms, colors, and techniques featured in his gardens' free-standing wall ensembles and glazed ceramics, called *azulejos*. Mosaic pavement, known as *calçada portuguesa*, offered an opportunity to lay out huge horizontal paintings on city floors, as in Largo da Carioca (1981) and the famous Copacabana Beach (1969–70) (Figure 3).


Figure 3: Roberto Burle Marx, Copacabana Beach promenade (1969) (left); Martha Schwartz, King County Jailhouse Garden, Seattle, Washington (1987) (right).

Similarly, color as a political statement and social identity designator was used in Schwartz's many projects, including King County Jailhouse Garden, Seattle (1987) (Figure 3), in Cormier's Pink Balls, Tornoto (2011), and in other contemporary works.

3. CONCLUSIONS

Burle Marx used the agency of light and color in the construction of an idiosyncratic modern Brazilian landscape identity. Celebrated by design professions and high-art institutions worldwide and appreciated by the ordinary citizens of Rio and São Paulo, Burle Marx's landscape oeuvre has been far-reaching and lasting.

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Exploring in-Car Lighting Design: A Data-Driven and Evidence-Based Analysis of Color Choices and Driver Safety

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ABSTRACT

Ambient lighting inside a vehicle plays a significant role in influencing a driver's mood and attentiveness, both of which are crucial for safe driving. Therefore, investigating in-car lighting color schemes is essential. This study, grounded in *data-driven* and *evidence-based design* approaches, explores prevalent color choices in car interior lighting using a dataset of images sourced from the internet. We systematically compared our findings with existing color psychology research to scrutinize the rationale and impact behind specific lighting color selections within vehicles. Using the Fatkun image downloader, we collected 174 images, carefully filtering out irrelevant material to maintain the focus and integrity of our analysis. We employed the K-means clustering algorithm to identify and quantify the 10 most dominant colors in our dataset. The analysis revealed a range of dominant colors, including blue, cyan, purple, pink, red, and yellow, in car interiors. While blue and cyan are known to enhance alertness and reduce drowsiness, the effects of purple, pink, and yellow on driver's mood and attentiveness remain less understood, indicating a need for further exploration. However, it is important to note that the use of K-means clustering to extract colors from images may not accurately represent the exact colors used in real-world applications but rather provides a general indication of the color trends in the design context. This research contributes to the broader discourse on automotive interior design, particularly concerning night driving safety. By highlighting current trends in vehicle lighting color selection and their potential psychological impacts, our study lays the groundwork for further investigations into how strategic color design in vehicles can enhance both driving safety and overall passenger experience.

Keywords: *car interior lighting, K-means clustering, driver attention, evidence-based design, data-driven design*

1. INTRODUCTION

Driving at night poses greater challenges and risks compared to daytime driving, primarily due to reduced visibility and the necessity for heightened attention and quick reaction times. Although modern cars reduce physical exertion through assistive systems, the demand for mental focus remains significant, and even with (semi-)automated driving, drivers will still need to manage various situations and take control when necessary (Giorgi et al., 2023). In vehicle design, the use of light supplementation has proven to be an effective approach to combat sleepiness and boost alertness (Lin and Westland, 2020). Research specifically points out that additional in-cabin lighting can mitigate drowsiness during night time driving and in low-light scenarios such as dawn and twilight (Popp et al., 2024). Although the concept of using color and light to influence product and environmental design is not new, the challenge of how to optimally apply specific colors and colored light remains relevant (Xia et al., 2023). This area of inquiry is particularly crucial in vehicle design, where appropriate lighting can greatly enhance driver alertness and safety.

In addressing this challenge, integrating data-driven and evidence-based design approaches provides a structured methodology for this study, guiding the use of algorithmic analysis to identify dominant color schemes. A notable method is the K-means clustering algorithm, which is widely recognized for its effectiveness in categorizing and analyzing large datasets of color information. The K-means algorithm works by partitioning the dataset into k clusters, where each cluster represents a group of similar data points – such as colors in this context. The algorithm begins by selecting k initial centroids, representing the centers of the clusters. Each data point, or in this case, each pixel's color, is then assigned to the nearest centroid based on the Euclidean distance, defined as:

$$\text{Assign } x_i \text{ to cluster } j\text{:}\ j=\text{argmin}_j \|x_i-\mu_j\|^2$$

Here, the $\|x_i-\mu_j\|^2$ represents the squared Euclidean distance between the data point x_i:and the centroid μ_j. After assignment, the centroids are recalculated by finding the mean of all data points in each cluster, using the formula:

$$\mu_j=\frac{1}{|C_j|}\sum_{x_i \in C_j} x_i$$

This iterative process continues until the centroids stabilize, ensuring that the clusters accurately reflect the dominant colors within the dataset. By systematically grouping similar colors into clusters, K-means enables the identification of dominant color schemes within digital images of environments, such as a vehicle's interior. This process is essential for understanding how color is used in real-world design contexts, particularly in assessing whether design implementations consider psychological factors alongside aesthetics. In this study, prevalent color choices in car interior lighting were explored by analyzing a corpus of images sourced from the internet. Observations were systematically compared against established principles of color psychology to scrutinize the rationale and impact behind specific lighting color choices in vehicles.

2. METHOD

A total of 174 digital images of car interiors were collected using the Fatkun image downloader from various online sources, including Behance, Pinterest, and Google Images. Following a thorough review, irrelevant, low-quality images, as well as those taken under daylight conditions, were filtered out to ensure the dataset accurately represented a comprehensive range of ambient lighting choices in vehicles. To identify dominant color schemes, the K-means clustering algorithm was applied, grouping similar colors into 10 clusters. The images were first converted to the CIELAB color space to better reflect human color perception, as this space is designed to be perceptually uniform. The decision to use 10 clusters was guided by two key considerations: the Elbow Method, which indicated that this number provided an optimal balance between within-cluster variance and simplicity, and the principle of dimensionality and perception, which suggests that 10 clusters effectively capture the most relevant color differences while remaining interpretable in the context of human visual perception. The K-means algorithm categorized pixels into clusters, with each cluster representing a dominant color in the dataset. This approach allowed for the quantification of the prevalence of specific colors across all images. The identified color trends were then compared with existing research to assess whether the lighting choices in car interiors align with psychological principles of color, particularly those related to mood, alertness, and well-being.

3. RESULTS AND DISCUSSION

Figure 1 presents the dominant interior light colors extracted by K-means clustering, showcasing a range of hues that are commonly used in vehicle interiors. The identified colors include shades of yellow, cyan, blue, purple, pink, and red. The impact of these colors on drivers has been the subject of varying levels of research, with some colors being well-studied and others requiring further investigation. Research has shown that **blue** and **cyan** hues can have a calming effect and are associated with increased alertness, which is beneficial for night driving (Lin and Westland, 2020). These colors are known to reduce drowsiness and improve concentration, making them ideal for use in vehicle interiors where maintaining driver alertness is critical. The **red** hue, while less frequently used for ambient lighting, is generally associated with heightened alertness and arousal. However, excessive exposure to red light can also increase stress and anxiety, potentially compromising driver comfort (Boyce et al., 2003). Therefore, while red can be effective in short bursts, its prolonged use may not be ideal for maintaining a relaxed driving environment. **Purple** and **pink** colors are less frequently discussed in the context of automotive lighting. While purple is sometimes linked to creativity and calmness, there is limited research on its specific impact on drivers. Pink, often associated with relaxation and reduced aggression, also lacks substantial evidence in the context of vehicle interiors. These colors may present opportunities for further research to determine their effectiveness in promoting driver well-being. **Yellow** light is associated with warmth and positivity but can also be straining on the eyes over prolonged periods (Mahnke, 1996). Its use in vehicle interiors should be carefully considered, balancing its potential to create a welcoming atmosphere with the need to avoid visual discomfort. While some colors, such as blue and red, have been extensively studied, others like purple, pink, and yellow warrant further exploration. The psychological impacts of these colors in the specific context of automotive lighting are not well-documented, suggesting an opportunity for future research. Understanding how these colors influence driver mood, comfort, and alertness could provide valuable insights for optimizing interior lighting designs.

Figure 1. Dominant interior light colors extracted by K-means clustering.

4. CONCLUSIONS

This study employs a design thinking approach that integrates data-driven design with evidence-based design to analyze ambient lighting in car interiors. The originality of this research lies in its innovative use of algorithmic analysis to identify dominant color schemes, which are then evaluated against existing studies to assess their potential impact on driver mood, alertness, and well-being. However, a key limitation of this study is its reliance on digital images for analysis, which may not fully capture the complexities of real-world lighting conditions. This suggests that while the results offer valuable insights, they should be applied with caution when designing actual vehicle interiors. Future research should aim to validate these findings in real-world settings, further exploring the relationship between color usage and psychological outcomes to refine design strategies that prioritize driver well-being based on empirical evidence.

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Evolution of the Methodology 'Under New Direction: Performative Runway': Exploring the Neutrality of Gray in Design, Art and Fashion

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ABSTRACT

In this article, we explore the evolution of the methodology "Under New Direction: Performative Runway," originally introduced in my doctoral thesis, which investigates the confluence between design, art, and fashion. Our innovative focus lies in examining the impact of color, with particular attention to the neutrality provided by the color gray. The theories of Johannes Itten on color harmony and contrast, along with Joseph Albers' analysis of chromatic interaction, serve as the foundation for our study on the influence of color (or its absence) on perception and emotion within the context of design and fashion.

We adopt a perspective that aligns with Massimo Canevacci's "maximal design," which questions the boundaries between technology, art, and culture, proposing that the simplicity found in gray can result in unexpected expressive complexity. Complementarily, Edgar Morin's complexity theory serves as the theoretical context for understanding the choice of this shade as an expression of interconnections and ambiguities in the design field.

Our method develops through the digital manipulation of original images from the doctoral experiment involving kimonos previously addressed in the thesis, altering the color palettes for this study. The proposal is an on-site experiment that complements our analysis by capturing audience reactions to variations and their perceptions. With this, we seek to reveal the influence of color on the reception of pieces, challenging conventional patterns in fashion and design.

We conclude that this study not only advances the understanding of the role of color (or its absence) in artistic creation and fashion design but also paves the way for future research on the exploration of other shades using the methodology developed here. This work aims to expand the boundaries of design, art, and fashion, reconsidering the use and meaning of colors in their practices.

1. INTRODUCTION

This article aims to explore Josef Albers' theory, particularly his perspective on the relationship between light and color, and how these influences shape the creation and perception of objects through colors. The investigation presented here emerges from a broader project initially developed as a doctoral thesis that included three experiments using gray kimonos. The choice of this color aimed to neutralize visual elements while enhancing actions during performances.

Color is an essential element in human perception, playing a crucial role in understanding phenomena. It has the power to evoke emotions and reveal people's innermost feelings. Its nature is mutable and enigmatic, often appearing incomprehensible. This complexity makes color a fascinating subject of study. In the pursuit of understanding and expressing it, there is an interaction between the personal and the collective, the objective and the subjective, the rational and the irrational. Explaining or reducing color to concrete concepts involves choices that reflect the specific values of a society.

The research is based on pre-existing work related to the runway, understood not only as the physical space of fashion shows but also as the act of crossing, of positioning oneself. During the Congress, we propose conducting an experiment similar to the one conducted at the Rio

Grande do Sul Biennial. It will consist of providing a rack with various kimonos and a QR code that will guide participants to interact with these pieces, exploring how colors affect the performative act.

Unlike previous experiments, in this article, we intend to discuss how colors influence the performance using the same element—the kimono—and the same action proposal. However, we do not seek to present conclusive results, as these will depend on the data collected during the Congress from participants' spontaneous performances.

The installation will feature a rack positioned at the entrance of the AIC 2024 Congress, allowing visitors to choose and use the kimonos to parade individually or in groups. Participants will be encouraged to record their performances and share their testimonials on the official research page, feeding an archive that will later be analyzed and incorporated into the existing material on the feed of that page. Thus, we intend not only to reflect on the impact of colors on performances but also to open space for new interpretations and ongoing collaborations in the areas of art, fashion, and design.

2. METHODOLOGY

The methodology proposed for the AIC 2024 Congress is therefore a natural evolution of previous practices, such as those carried out at the Textile Biennial, where the Performative Runway stood out for its ability to generate creative and meaningful interactions. The act of digitally manipulating the images of the kimonos and observing the audience's reactions will allow for the exploration of new dimensions of the color gray, integrating Morin and Canevacci's theoretical perspectives with a creative practice that continues to challenge the boundaries between design, art, and fashion. This approach will reflect the essence of the Performative Runway: a space of improvisation and continuous transformation where design becomes an open and fluid process capable of dialoguing with the complexities of human experience and artistic expression. By doing so, the Performative Runway at AIC 2024 reaffirms itself as a project that not only explores but also expands the possibilities of contemporary design.

The markers previously used to delineate the initial space of the runway are now arranged around the suspended kimonos and take on the connotation of being in flux on the Runway. Each of the kimonos received a tag with access to a video from the designer, suggesting that the participants wear the cape and register through the QR Code. Besides the AIC 2024 visitors, the attendees of the place where the runway will be set up, completing the universe of ESPMSP, can equally participate in the Performative Runway. In this case, it is requested that, if they feel comfortable, they could post photos or videos on Instagram while wearing the kimonos, tagging the performance's networks #performativerunway @performativerunway, in addition to the AIC 2024 Congress' networks.

These reflections arose even before the practical experience, generating an anticipated sensation of what the real experience of wearing the cape and turning the passage through the AIC 2024 Congress into a life runway would be. This provides a unique visibility experience and encouraged participants to record every moment with their cell phones as if there were no tomorrow. In this way, new possibilities of transformation and fulfillment emerged.

The AIC 2024 Experience will elevate the research to a new level, making it more organic and alive. It revisits and deepens the analysis of the influence that the environment exerts on individuals and how society is formed by a network of interpersonal relationships that mutually affect each other. This dynamic intertwining of relationships becomes evident in the Performative Runway, where culture, language, and the representativeness of each individual are manifested through interpersonal interactions. These factors are constantly renewed by the system that drives the runway, creating new connections between thought and action and are driven by subjective and creative manifestations.

3. THEORETICAL CONTEXT

This connection between the previously developed methodology with gray kimonos and the impact that the introduction of color has on this methodological process. By replacing the gray kimono with colored kimonos, we seek to understand how this change affects the research, observing people's reactions when using the same piece with the same format as the original research but now with different colors. It is an experiment conceived within the context of complex systems, reflecting the understanding of a method that manifests itself in the act of dressing and parading.

The fact that the Performative Runway experiments are conceived as complex systems reflects the understanding that the method develops in a continuous process of formation and transformation occurring in parallel with the investigation itself. It is not a process that precedes the practice with defined and preconceived stages. What is necessary is an initial design that encompasses a general structure and foresees various stimuli. In this way, spaces are created for the manifestation of creativity, balancing design, art, and fashion in this expression event.

Color plays a crucial role as a parameter for understanding the senses and valuing intuition as a fundamental element in scientific activity. The meanings attributed to color in works of art reveal the historicity of cultural manifestations, and the changing nature of perception demands a re-evaluation of human experience, evidencing the dependence on contexts in the construction of meanings. This imposes on the scientist the need to maintain a constant critical attitude, recognizing their own personal involvement in the process.

Our research emphasizes constructive actions that seek to restore confidence in rationality, not simply adopting it uncritically but revisiting and questioning it. As it transforms over time, color reveals its inherently multidisciplinary nature. To understand the many variables of color and highlight them together – as demonstrated in Albers' works – it is necessary to understand the successive stages of its formation until visual perception occurs in the brain. Josef Albers (2021), throughout his career, developed a unique and profound approach to color, always seeking to explore its purity and intensity. In his early works, especially with glass, Albers dedicated himself to finding the most luminous color possible, treating it as a source of light itself rather than a mere reflection of ambient light. This incessant pursuit of luminosity accompanied him throughout his life, even when he shifted his focus to painting, especially during his North American phase.

At the Bauhaus, where Albers deepened his mastery of artistic techniques, he continued to investigate color, always with the goal of transforming the pictorial plane into a true light emitter. Even when he moved away from glass, Albers maintained his commitment to the moral principle of economy, where he sought to achieve the best visual effect with the least number of means. This principle was clearly manifested in his most famous works, the Homages to the Square, where Albers managed to create an intense luminosity effect by applying a very thin layer of oil paint on an extremely white and absorbent base. This method allowed the colors to become translucent, functioning as filters that, instead of obscuring light, intensified and directed it towards the observer. Albers' approach to color was not limited to mere technical improvement; it reflected a broader philosophy about the role of the artist and craftsman in the modern world. He believed that luminosity, especially when extracted from less ideal materials like paint instead of glass, had the power to illuminate the "darkened world" of human experience. He saw his mission as bringing light and clarity to this environment, using color to create a deeper connection between the material and the spiritual.

This philosophy, which emphasizes the economy of means and the pursuit of maximum luminosity, serves as a direct inspiration for the choice of colors for the kimonos in the "Performative Runway under new direction." Just as Albers sought to transform the material and human environment with his vibrant colors and precise application techniques, the selection of colors for the kimonos aims to transform the perception of participants and the audience. Color here is not merely decorative but an active element that interacts with the performative space and the individuals who inhabit it. In the "Performative Runway under new direction," the kimonos are more than just garments. They are instruments of expression carefully chosen to explore how color can influence perception and action in the context of performance. Just as in Albers' works, where color is used to challenge visual perception and create an engaging and luminous experience, the colorful kimonos are designed to provoke a reaction in the audience and performers, establishing a dynamic connection between color, movement, and space.

4. CONCLUSIONS

The study on the impact of gray color in the Performative Runway offers significant contributions to the understanding of the role of color or its absence in design, art, and fashion. The developed methodology, which integrates aspects of maximal design and complexity, allowed for an innovative exploration of perception and interaction with the gray color, challenging conventions and expanding the dialogue between creator and spectator.

For future research, it is recommended to explore other colors and their variants, investigating how different shades influence perception and interaction in similar contexts. The analysis of colors beyond gray, such as red or blue, may reveal new aspects of the dynamics between color and emotion. Additionally, incorporating interactive and digital technologies may offer new dimensions for the exploration of color and performance, enabling a deeper analysis of participants' reactions and the visual and emotional transformations during the performance.

The methodology can also be applied to different socio-cultural contexts to investigate how perceptions and interactions with color vary in diverse environments. This will allow for a broader understanding of how cultural and social factors influence the reception and impact of colors in design and art. In short, the Performative Runway offers a fertile field for the continuous exploration of the role of color and aesthetic experience, expanding the boundaries of research and artistic practice, and promising new discoveries and insights for the future.

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The Subconscious of Color in the Senso Book Case Study: A Methodological Process of Fashion Event Production

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ABSTRACT

The article, to be presented in poster format, explores the synergy between the fashion event production methodology outlined by Antônio Carlos Rabàdan Cimadevila in “Senso” and Johannes Itten’s color theory. The integration of these approaches provides a deep understanding of how color can be used as a unifying and communicative element in the fashion design projects of ESPM students, presented to the market through the @senso.livro project on Instagram. Cimadevila emphasizes the importance of rigorous methodology in organizing fashion events, highlighting the role of design and aesthetics in creating memorable experiences.

Complementarily, Johannes Itten teaches us that “color has a powerful subconscious effect on the viewer” and that “color is a force that directly influences the soul.” These words resonate deeply with the mission of the Senso project, which aims not only to showcase fashion creations but also to communicate the essence and narrative behind each piece, using color as a narrative link that connects various projects into a cohesive experience.

The poster will illustrate how ESPM students applied these principles in practice, using color to differentiate and highlight the individual themes of their projects while maintaining a visual unity that reflects the collectivity and collaboration of the semester.

We will examine specific cases where color was strategically employed to signal different phases of the creative process, emphasizing how these chromatic choices contributed to the understanding and appreciation of the works.

Through this study, the poster will argue that color is not just an aesthetic component but an essential tool of communication and expression in fashion design, capable of transcending visual barriers and connecting various projects into a unified visual narrative. This focus not only aligns with the philosophy of the color congress but also highlights the innovation and creativity of ESPM students, projecting them into the contemporary fashion market.

1. INTRODUCTION

This article aims to be more than just a diary of fashion events linked to higher education at ESPM in the Design course from 2015 to 2021. It intends to draw a parallel with Johannes Itten’s theory on color perception and the influence of visual context, which is relevant to understanding how the design developed and how participants experience and interpret the colors of each edition of SENSO can emphasize the complexity present in each edition.

It is a source of research and study of active practices so often discussed but rarely used in the daily life of the designer in the fashion line. These are empirical processes that have gained form and robustness throughout their trajectories in each of the 10 editions of Senso. These practices contributed to a methodological construction developed over ten editions, which remains alive and self-adjustable to the needs of the moment. This investigative process is part of my research, which has in the doctoral thesis the theoretical deepening of this self-generative and ecosystemic methodology that arises from three pillars: Design, Art, and Fashion.

The study consists of deepening the understanding of the Senso Project, an authorial initiative by Professor Antonio Rabàdan, who throughout his career has dedicated himself to exploring the relationship between spectacle and spectacularization in fashion shows. The Senso Project seeks to uncover how elements of form and color directly influence the perception and absorption of sensory experiences within the performative space. This article intends to expand this analysis by incorporating Johannes Itten's chromatic interaction theory, investigating how the principles established by Itten can be observed and reinterpreted in the context of the runway narratives of the Senso Project.

The original project generated a book (@senso.livro) of event processes that gradually expanded and was altered into a new and invigorated format, consistent with its time and space, using the academic practices already experienced in the Design course at ESPM Porto Alegre, where it originated. There was a need in the fashion line to present the academic results of the students to the community, and thus the first edition of Senso, called Senso Fashion Day, emerged. The event was truly special, a unique opportunity for students to present and test their knowledge, built and designed for the local community. This structure is based on some principles from which the design field itself originates, involving planning, processuality, and verification of everything that is being created. We find this structural practice originally in the Bauhaus school, where students conducted practical workshops and developed happenings to test their creations with the community. Senso is understood as a historical revival of these teaching processes in which active practices were applied.

2. METHODOLOGY

The Senso project follows the same path – articulating various areas of knowledge to construct a fashion show or event that allows working with more than one field of knowledge and articulating such information to broaden the possibilities of growth and deepening of the practices of construction and realization of fashion events. For the first edition, the path began with the need to explore the visibility of Design students in an initial process within the fashion production discipline, which gained strength with the inclusion theme raised in the classroom. With the process of constructing a more inclusive fashion show, new agents and more instinctive and less planned construction possibilities were incorporated along the way, which may be mistaken for a more careless approach. However, despite the apparent simplicity, the production is extremely careful. Some adjustments were necessary and required those involved to seek flexibility in processes and their understandings, keeping the project always alive and alert. All these steps represent the records of practical action based on a prior theory that gradually solidifies and contributes to the choices that emerge. Construction is necessary as it generates a multitude of experiences and concreteness for the new.

When we talk about the Senso project, we are talking about performative runway and conceptual shows. For this, we need to understand that this path is directly linked to the act of performance in the visual arts and that the place of rupture and questioning used on the runway comes from this aspect. As in the 1st edition of Senso, this rupture is very present, and it is necessary to understand what performance means and what the bodies of dancers on a runway signify. Of course, this foundation was built from a more careful look at the practices developed here, and the paths constructed are two-way, where the journey works in both directions between the artist and the creation.

3. THEORETICAL CONTEXT

We begin by thinking of the body as the vehicle of expression that carries the designers' creations and concerns and is the driving force behind the Senso performance. Considering the body as a vehicle of expression must reflect on its more formal structure from an anatomical point of view, and for this, I use the perspective of (Castilho; Galvão 2002 p. 66) to understand what body we are talking about and what the differences are between the anatomical-morphological body and the symbolic-semantic body. For if we realize that each individual differentiates themselves by what they do to their body, it is important to understand how we consider an anatomically adornment-free body and do not morphologically present any natural embellishment characteristics in different situations. In this way, we can think of the body as a quick path of possibility that the individual can take to differentiate themselves and build new narratives that will appear in conceptual fashion shows. Following this thought, we realize that a well-reflected action can be the basis for the construction of a thought that is used differently depending on the artist's language to present themselves.

As a basis for the creative process, the designer presenting their proposal via performative show uses the body as a foundation for their creation, and this alone is already a living work. It is as if we were placing arteries or heartbeats in the work that the designer is presenting, and often the artist builds their work as a simulacrum of their own body and what this body is capable of enduring to conform to the social standards in which it is inserted. When we approach performances, we consider the possibility that the body present there is being used from its structures to its organs, which even when internal, contribute to the visibility and dissemination of this body in space. Thus, the existing limits in other art practices are extrapolated, making the performative act intense enough to provoke a range of reactions in people – in a brief scenic passage before the work and its author.

Fashion is nothing more than responsible for the aesthetic presentation of the body, the machine that sculpts time in bodies (Mesquita 2004). It is from its material, semiotic, and social components that apparatuses such as fabrics, clothing, accessories, and shoes are produced for the presentation of bodies in the world. Returning a bit to the Bauhaus school, which used academic experiments involving the local community, we see in Schlemmer's experiments in his ballet that they were dressed in possible geometric fashion and communicated the artist's thinking. He used them as a fundamental structure to discuss his ideas, where the body was prevented from performing usual movements, creating a completely different gesturality for the ballet to happen.

This space that we are unveiling throughout the Senso editions allows for the development of a fraction of fashion, a fragment responsible for the conceptual and not for its more popular part: the one in which we seek numbers, sales, and the rampant copying of clothing pieces as the rules that govern this market. The objective here is different – to develop critical thinking in our students, establishing knowledge within design processes and building in each of them a style that references a specific cultural group. Students come to understand how to better develop commercial practices, which are also part of their world as designers. Through research and creative processes full of successes and failures, the designer, as a catalyst for the aspirations of a society, decodes their vision of that society into clothing for specific groups.

The idea of interdisciplinarity or even multidisciplinarity is one of the pillars that has been guiding Senso fashion shows and attempts to articulate a path to Total Art, in our case, a total runway that is built through integration. It presents a plastic result that supports the proposal of the work as a "Babel" of fashion. It does not originate from the migration of designers/artists without space in their languages; on the contrary, it originates from the intense search for space that allows integration. A total art that escapes the delimitations of disciplines (Cohen 1989).

The project gained strength mainly because it was a proposal that sought inclusion. The idea of a sensory and inclusive fashion show aimed to stimulate all senses to explore and satisfy them, promising full satiety of smell, taste, touch, sight, and hearing so that everyone could feel fashion. The organizing team brought a differentiated concept to the production: a show for everyone. During the research and development process of this project, a roadmap of needs emerged that allowed us to develop a differentiated fashion event and that each new event could self-adjust to the needs of the group leading the edition.

With each new edition, the word Senso was complemented and re-signified, just as the methodological process originally designed was also re-signified.

4. CONCLUSIONS

This project is about continued education based on study and research processes and represents a methodological construction of Design practices in fashion events. It is impossible not to draw a parallel to today, when Senso itself had to reinvent itself and become digital, like much of humanity. In order to preserve itself, it needed to withdraw, to protect itself, but without abandoning the construction of knowledge and the reinvention of presentation and verification spaces. This task follows the market itself, connecting with everything that is produced within ESPM. Senso has become a possible path of investigation and exchange on digital platforms, especially on Instagram, the feasible space at the moment. The page's profile was completely remodeled by our students, becoming more affectionate and allowing us to exchange our knowledge with others.

The Senso project was born from a group of close, dreaming students who always hoped for better days, who believed that together we could build a better, closer, and also more humane society. At that initial moment, we could walk together, exchange conversations, and build everything in person in large, small, and medium groups – groups necessary for the construction of events that could handle everything being created in the ESPM Porto Alegre laboratories. Now, this stage ends in the 10th edition, reinventing itself for the upcoming moments of our society in hybrid spaces and with the same hope and belief in a closer future, even if through digital means. It is necessary to take advantage of everything that a difficult moment can bring to creative design, striving to create future scenarios in which society can develop in the best possible way.

With so many challenges as a professor, constructing a publication of this magnitude, involving academic processes of knowledge development, is a fundamental step to stimulate learning. Initially, it is an empirical experimentation material with which I was able to develop and improve my own knowledge regarding my area of expertise and my doctoral research on performative runways. This research maintains the pillars of DESIGN, ART, AND FASHION. In such scarce times of teaching and learning, when everything is in constant re-signification, describing the living history of Senso events, feeding back into each project, is a privilege. More importantly, it is to count on the support of an educational institution that believes in interdisciplinary, transdisciplinary projects and that allows itself to constantly investigate knowledge – that is even rarer. I leave here my many thanks to ESPM and the students who built the knowledge of Senso.

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The Role of Colors for Digital Three-dimensional Materials: Using Colors as a Parameterization Tool to Obtain Advanced Shaders

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ABSTRACT

Creating materials and shaders in 3D software is complex and requires technical knowledge and artistic skills. These materials are generally simulations of how specific physical properties can be perceived – for example, how a digital 3D model might be perceived as being made of metal, glass, etc. This article investigates using colors as an interface for parametrizing materials and shaders in modeling and rendering 3D software. Such parameters have various implications for complex properties like reflection, refraction, texture, shading, and resource optimization for interactive applications.

This study's data come from using different color parametrization paradigms in complex projects between 2020 and 2023. We highlight the Turku 1827 project and MetAmazonia, both of which were carried out in collaboration with the Finnish studio ZOAN Oy.

As the main result of using colors as an interface for parametrizing materials and shaders in modeling and rendering 3D software, we obtained high-quality interactive experiences that took advantage of the cutting-edge resources of platforms like Unreal Engine 5. We validated and discarded various production processes, which aroused the interest of other museums and European institutions. Processes and images are detailed throughout this article, which is a material of relevant consultation for designers, artists, and other digital developers.

1. INTRODUCTION

Colors, with their diverse uses, play a fundamental role in creating digital audiovisual works. They serve as stylistic elements to enhance various atmospheres, from the gloomy and dark aspect of an abandoned cottage in a dense forest to the sterile hermeticism of a spaceship interior in a high-tech future. They can also be used to emphasize the bucolic nature of a landscape. Color patterns allow us to approximate specific artistic movements, such as the nuances of the Renaissance period or the simplicity of the so-called flat design, widely used in app and website interfaces, connecting us to art history.

In the case of more figurative images, the goal is generally to recreate or simulate the appearance of things in a way that achieves verisimilitude. Can we tell what the material of an object depicted in a digital painting is? Is the object made of metal, wood, or leather? What is its primary color? Is the object clean, dirty, or scratched? What is its finishing? Is it polished, matte, rough, or wet?

These characteristics result from how we represent – or simulate – these objects in their interactions with surrounding lighting; the apparent color of the object is just one parameter in this complex composition of properties. Interactive digital three-dimensional environments employ sophisticated computational techniques to handle this information in highly effective, yet not always intuitive, ways for artists.

In this context, colors take on new roles in controlling properties and become powerful tools for parameterization. These solutions have been widely used in games, films, simulations, and XR applications, among many other possible applications, giving artists a sense of empowerment and control over their creations.

2. METHOD

This study analyzes the primary parameterization method used in creating shaders and digital materials, the Physically Based Rendering (PBR) technology. It considers the primary structuring of this type of shader and its use in the Turku 1827 and MetAmazonia projects carried out between 2020 and 2023 by the Finnish studio ZOAN Oy.

Turku 1827 was an interactive digital 3D reconstruction of Finland's first capital at the request of the Museum of History and the Future. Based on the meticulous research by Panu Savolainen, a professor at the School of History, Culture, and Art Studies at the University of Turku, we were able to recreate with unparalleled precision the houses, squares, bridges, castle, temple, and theater, among many other urban landscapes of the city, with the setting of 1827 – the year of the great fire that devastated the old capital.

The MetAmazonia project was a high-fidelity prototype of an interactive three-dimensional environment. Made at the request of Amagroup, the project aimed to engage users in the preservation of the Amazon forest and the economic development of local communities around the municipality of Manicoré – Brazillian Amazon. The proposal was to faithfully reproduce the village of Jatuarana so that software users could experience a virtual presence in the location, learning about the environment and the main local productions (Brazil nuts and açaí) and interacting with other users.

Both projects utilized PBR technology throughout their development, and the parameterization processes enabled the creation of materials with high quality and significant graphical optimization in their creation processes within design software and the Unreal game engine.

3. RESULTS AND DISCUSSION

Digital 3D materials generally follow two main processes: They can use numerical instructions assigned directly to the available channels in the material's composition; we call these materials procedural materials. For an object to be interpreted by the program as red, it must receive numerical instructions (in RGB) in the main color channel. Depending on the software, this color-dedicated channel can have various names, such as base color, albedo, color, or diffuse. Thus, we would use the instruction R = 255; G = 0; B = 0 in the base color channel, which tells the program that there is 100% red information but no information in the material's green and blue components, making the material entirely red on its surface. The other process uses a pixel map to assign the same information (RGB) but with possible variations across the surface. Digital images like JPG or PNG consist of RGB information assigned to each pixel individually, allowing us to control the amount of this information across the entire object's surface. Since they are pixel maps, the information's location on the object is fixed by the UV mapping determined by the 3D artist[1].

Procedural strategies rely on various algorithms of complex patterns that can be calculated sequentially, resulting in sophisticated textures that are difficult to achieve with traditional digital painting methods. However, they are considered non-destructive strategies because they can be adjusted and altered at any point in the material's development. On the other hand, strategies that use pixel maps (images) have a more fixed nature, depending much more on the image creator's performance, whether a digital artist or a painter, or even depending on the image capture – in the case of photographs or scans. Materials that use maps that require significant alterations need to be manipulated in image editing software and brought back to the 3D software – and sometimes, they need to be entirely redone; it's not just a matter of adjusting the procedural parameters of an algorithm.

[1] UV mapping is a technique used by digital 3D modelers to determine the location of texture instructions projected onto a three-dimensional object. It is achieved by flattening the object's polygons to create an image—in pixels—that represents the entire surface of the model in two dimensions.

In this context, we can better explore the intriguing PBR technology. PBR can be considered a powerful shader that instructs the 3D program on how to calculate the material's interactions with the lighting and other objects in the digital scene. Its parameters may vary from software to software, but generally, it uses a common structure composed of a channel responsible for the object's apparent colors, the base color channel. There is a channel responsible for light scattering or absorption according to simulations of metals or dielectric materials[1], the metallic channel. We also have the channel responsible for the surface's polish or roughness, the roughness channel. And, to complete the group of crucial channels for shader formation, we have the normal map channel, which captures lighting information from the X, Y, and Z axes and compresses it into an image capable of making the lighting of a flat surface behave in very complex ways.

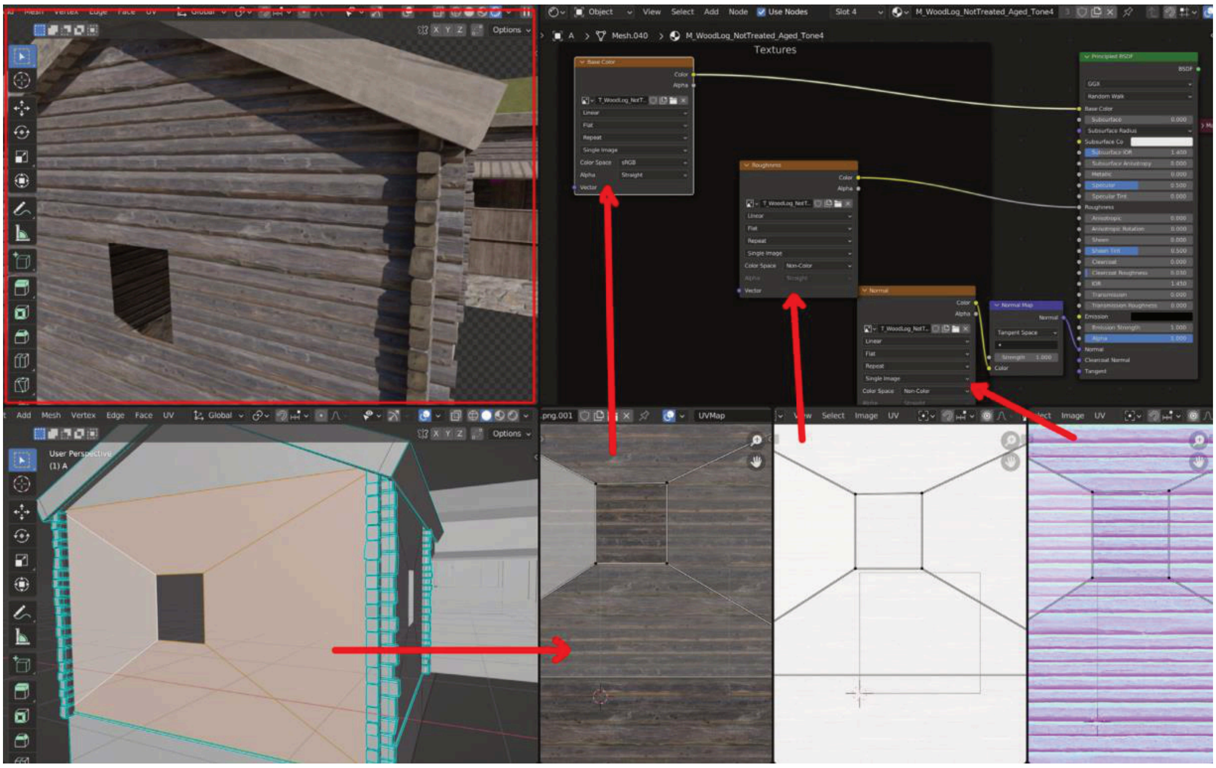

Figure 1: PBR map assembling sample from Turku 1827 project.

4. CONCLUSIONS

In conclusion, the exploration of color as a parameterization tool within the domain of digital three-dimensional materials underscores its pivotal role in enhancing the creation of advanced shaders. The strategic use of color in the process of shader development is not just a tool but a key to achieving visual accuracy and a deeper level of control over the physical properties of digital materials. The projects analyzed, such as Turku 1827 and MetAmazonia, demonstrate that integrating color-driven parameterization strategies within Physically Based Rendering (PBR) technology leads to highly optimized, visually stunning results that meet the specific needs of interactive applications.

Moreover, the insights gained from these case studies underscore the broader implications of this approach for the future of digital media. Color parameterization simplifies complex processes by providing a more intuitive interface for material creation, making high-end production techniques more accessible to a broader range of creators. This advancement empowers artists and pushes the boundaries of what can be achieved in digital environments, promising richer, more immersive experiences across various platforms, from games to virtual

[1] https://www.eletrica.ufpr.br/mehl/materiais/aulas/te337-aula-7-dieletricos.pdf

reality to educational simulations. As the field continues to evolve, the strategic use of colors in shader creation will likely become essential, driving innovation and excellence in digital artistry.

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The Effect of Colors on Quiet Luxury Consumption: the Role of Uniqueness and Xenocentrism

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ABSTRACT

Quiet luxury, characterized by subtle elegance, represents a refined level of consumer goods, particularly in apparel, appealing to the middle-class demographic. This trend of discreet sophistication has led to niche brands focusing on clothing as a form of individual expression and identity construction. The preference for monochromatic color schemes, associated with exclusivity and sophistication, is evident across product categories. Scholarly research in this area is limited. This study uses color psychology and social identity theories to examine the impact of color schemes on quiet luxury perceptions through three experimental studies with 401 Brazilian consumers. The first study compares black-and-white versus colorful presentations in shaping luxury perceptions. The second investigates perceived uniqueness as a mediating factor in the color-uniqueness relationship. The third explores xenocentrism's moderating effect through moderated-mediation analysis. Results indicate that monochromatic color schemes significantly enhance luxury perceptions, partially mediated by perceived product or brand uniqueness. Xenocentrism strengthens this effect, especially among consumers with lower-middle xenocentric attitudes. These findings contribute to color theory literature, highlighting color scheme impact on luxury perception in the clothing industry. The study offers practical insights for luxury brands and suggests directions for future research.

1. INTRODUCTION

The colour palette of the creative design in luxury fashion is emblematic of luxury's uneasy relationship with prevailing economic, social and cultural conditions. Following the contractions and disruptions caused by the global pandemic, luxury has entered a 'quiet' phase which is characterised by muted colours and pastel shades. This stands in stark contrast to the brash, shouty tones and hues which typified luxury's sortie du temple - its departure from the 'temple' of exquisiteness, exclusivity and scarcity – as it reached out to global, mass, young and new consumer markets. Despite the growing interest in colours, particularly in the fashion market, their interplay has not received sufficient attention. An unanswered question persists regarding the influence of colorus on quiet luxury consumption. This study aims to address this gap through three experimental studies.

2. METHOD

Three experimental studies were employed. Experiment 1 (S1) explores the argument that (H1) the absence of colour (*vs* the presence of colour) elicits a greater perception of luxuriousness in quiet luxury fashion. Experiment 2 (S2) investigates the assuption that (H2) product uniqueness mediates the influence of colour scheme on the perception of luxuriousness. Finally, experiment 3 (S3) addresses the hypothesis that (H3) xenocentrism may enhance the relationship of quiet clothing colour scheme with product uniqueness.

2.1 Sample Preparation and Research Design

A total of 401 Brazilian consumers participated in the three studies. Respondents were recruited via online social media platforms and invited to partake in a study involving an unidentified clothing brand. They were subsequently assigned to the specific experimental conditions of each study. Participants were exposed to stimuli featuring either monochromatic or colorful clothing, after which a research instrument was administered to gather their opinions. Perceived luxuriousness was measured following the framework established by Hagtvedt and Patrick (2008). The construct of product uniqueness was assessed based on the work of Park et al. (2020). Xenocentrism, employed as a moderating variable, was measured in accordance with Cucato et al (2023). Figure 1 depicts the experimental studies design.

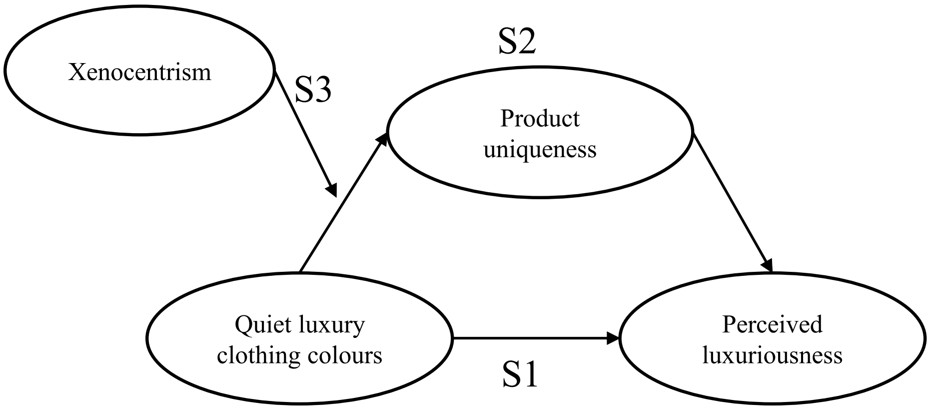

Figure 1: Framework illustrating the research design.

2.2 Experiment Argument

The role of colors in brand attitude is a critical aspect of consumer psychology and branding. Colors evoke emotional and cognitive responses. Taking the perspective of social psychological distance, as the absence of color (*vs* presence of color) is related to sociallly distant events, increasing the perception of exclusivity by the absence of colors. Existing knowledge also endeavors to understand the various aspects that regulate luxury perception. Togawa and Sugitani (2022) found that the zooming effect increases the perpection of luxury.

By exploring the moderating effects on luxury aspects, we are able to better exert control on the phenomenon. Uniqueness is the characteristic of a singular product, among other products perceived as regular ones. In this way, uniqueness are perceived as a distinction aspect of products regarded as high in quality, superior in performance, that elicits social superior social status. In this way, uniqueness are very similar to foreign brands (as opposed to local ones) in several studies in developing countries). As xenocentrism exert a controlling effect over global brand preference, we expect the same pattern for product perceived as high in uniqueness. Xenocentrism is particularly salient in cultures were economic and social development are still under way, provocating a preference for foreign products, despite the duality of consumers found in some regions (Cucato et al. 2022). Figure 2 presents the studies' stimulus.

Figure 2: The experimental stimulus.

3. RESULTS AND DISCUSSION

The model proved to be significantly adequate (R^2 = 28.7%), with evidence effects of the clothing colour scheme (effect = 0.810, t = 4.215, CI [0.431;1.1189], p<5%), and uniqueness (effect = 0.266, t = 4.086, CI [0.138;0.394], p<5%) on perceived luxuriousness. We also identified a significant effect of the colour scheme on uniqueness (effect = - 3.301, t = -7.720, CI [-4.560; -2.458], p<5%). The indirect, mediating effect, was also significant, confirming H2 (effect = -0.626, $CI_{bootstrapped}$ [- 0.926; -0.323], p<5%, for xenocentrism = 1.5, effect = -0.374, $CI_{bootstrapped}$ [- 0.536; -0.209], p<5%, for xenocentrism = 3.0, but effect = -0.095, $CI_{bootstrapped}$ [-0.232; 0.048], p<5%, for xenocentrism = 4.67). The index of moderated-mediation was significant (effect = 0.168, $CI_{bootstrapped}$ [0.067; 0.283], p<5%). Finally, H3 was also confirmed, as the positive moderation of xenocentrism was achieved, with a Jonhson-Neyman point at 4.479 of the xenocentrism inclination (effect = 0.631, t = 5.013, CI [0.067; 0.283], p<5%). Figure 3 provides a nuanced view on the moderating effect.

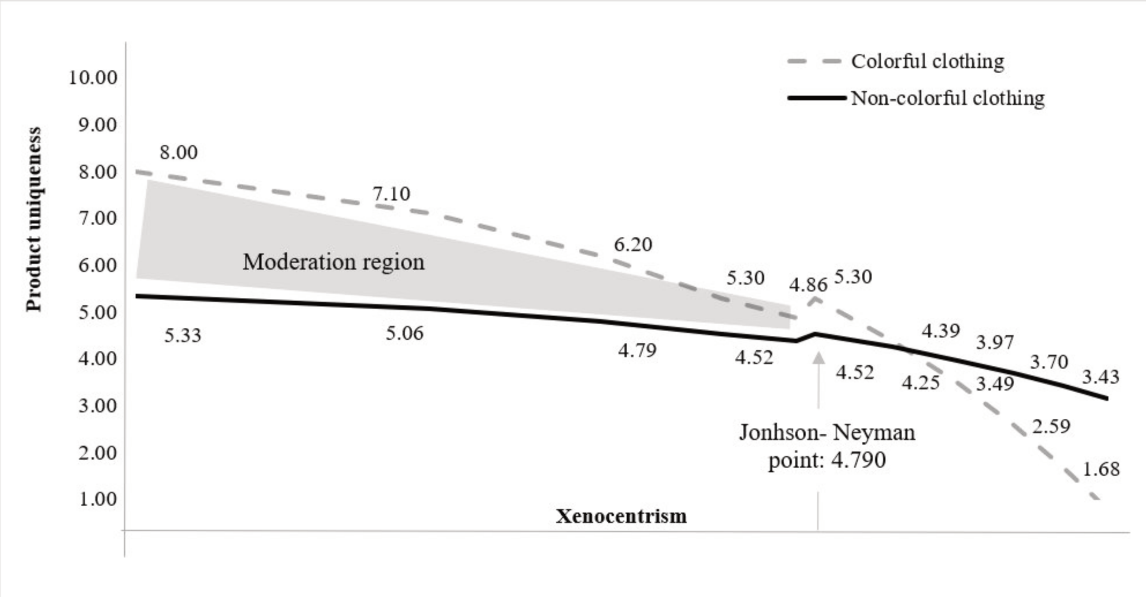

Figure 3: Moderating effect

These results indicated that at low levels of xenocentrism, product uniqueness is greater for colorful quiet luxury clothing. As xenocentrism increases, this effect tend to a reversion, with non-colorful schemes becoming progressively as unique as colorful schemes, until a level of 4.79 of xenocentrism. After this level, xenocentrism no longer affects the relationship of color with product uniqueness in our moderated-mediation model.

4. CONCLUSIONS

The first study (S1) establishes that color absence serves as a significant cue for sophistication, with perceived luxuriousness as an indicator of quiet luxury. This aligns with literature on color's role in conveying brand-product congruence. However, the mechanisms underlying color's influence on luxuriousness remain under explored. The second study (S2) addresses this gap, empirically validating that uniqueness mediates the impact of clothing color scheme on perceived luxury. It also reveals a paradox: while less colorful clothing enhances luxuriousness, more colorful attire increases perceived uniqueness, suggesting that distinctiveness may be more about being different than exclusive. The final study (S3) confirms this mechanism through a moderated-mediation model, highlighting xenocentrism as a moderating factor. Collectively, these studies integrate the role of color, uniqueness, and xenocentrism, offering a comprehensive framework that deepens our understanding of how aesthetic elements as color shape luxury perceptions in fashion.

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The Age Influence on the Color Perception and Judgment: a Color Meaning Study with Mouthwash Packaging

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ABSTRACT

Color is a visual feature used in packaging design to capture attention and communicate the qualities of the product and brand messages. Therefore, color impacts the users' perception and engagement with a product. In this context, it is known that the aging process modifies the human perceptual and cognitive dimensions, creating generational differences. However, there is a lack of scientific literature pointing out the influence of age on the color perception and semantic judgment of packages. Adopting a generational path, this study aimed to evaluate the influence of age on the perception and meaning of three models of mouthwash packaging in different colors. The study has an experimental and transversal approach. One hundred and twenty participants from female and male genders distributed into two age groups (18-29 and 30-55 years old) evaluated three mouthwash packaging in green, red, and blue hues. Thus, the participants were exposed to nine stimuli conditions during the experiment. We conducted a color-meaning experiment in a laboratory environment using a semantic differential questionnaire with twelve pairs of design attributes from functional, aesthetic, and symbolic dimensions. To avoid cognitive biases, we randomized the order and polarity of the attributes, elaborating nine questionnaires. The questionnaire application sequence was randomized. The results indicated statistically significant differences ($p \leq 0.05$) between the age groups in eleven design attributes, signaling generational differences. The pairwise comparisons showed four design attributes appearing in five or more stimuli conditions. These attributes are all from the symbolic dimension. Based on the findings, we suggest that age is a relevant variable in color perception and semantic judgment related to the colors of mouthwash packaging. In this sense, designers and other human-centered practitioners should consider generational influence as a relevant interaction variable for users' comprehension and engagement with the product, going beyond biomechanics and vision issues. The present study may contribute to further research in Color language, Design, and Ergonomics.

1. INTRODUCTION

Color is an abstraction created by the cognitive processes in the brain cortex (Henderson and Hollingworth, 1999), a human idea conception impregnated with mental constructs and psychophysiological effects. Throughout history, mental constructs have supported color meaning and language. However, the color meaning can be modified over time (Pater, 2016) and depends on the individual's experiences and knowledge (Ng and Chan, 2018), the cultural context (Pater, 2016) and the product itself, such as clothing, packaging, etc. (Alves et al., 2022). Besides, diseases of the visual and neurological systems and aging can modify color perception (Barbur and Carmona, 2015) and so, the color cognitive processing and interpretation. Previous studies analysed the color effect on the meaning of mouthwash (Won and Westland, 2018) and on the risk perception of chemical household packaging (Buchmüller et al., 2022), and the gender effect on color-concept association (Ng and Chan, 2018). Nonetheless, none verified the age influence or generational differences. Therefore, adopting a generational approach, this study aimed to evaluate the age influence on the perception and meaning judgment of mouthwash packaging.

2. METHOD

2.1 Sample size and Sampling

One hundred and twenty participants between 18-29 years (younger adult) and 30-55 years (middle-aged adult) participated voluntarily, selected by convenience sampling. The age stratification considered the findings of neurological studies (West et al., 2012). We distributed the sample into four groups to perform the judgment tests: 30 female younger adults (*Me*=21.67, *SD*±1.79 years) and 30 middle-aged adults (*Me*=38.47, *SD*±6.90 years), and 30 male younger adults (*Me*=23.70, *SD*±2.18 years) and another 30 middle-aged adults (*Me*=41.87, *SD*±8.56 years). For Serdar et al. (2021), some statistical models calculate 30 participants as a critical sample size. To characterize the sample's frequency of use, we asked the participants, *"How often do you use mouthwash?"* being able to answer *daily*, *occasionally*, or *never*. Among the younger group, 16 (26.67%) reported using daily, 38 (63.34%) occasionally, and six never (10%). On the other side, 25 (41.67%) middle-aged participants indicated using daily, 31 (51.67%) occasionally, and four (6.67%) never. The data about gender and frequency of use were collected only to characterize the study sample, not as variables in the experimental design. Anyone who indicated pathologies in the visual or nervous system that could alter color vision (e.g., color blindness) was excluded from the study. This color-meaning study followed the Declaration of Helsinki.

2.2 Stimuli conditions

The experiment incorporated three different mouthwash packaging models (A, B, and C) (Figure 1) in green (#d8dd96), red (#c91b00), and blue (#087bcc). It was essential to test different shapes and colors to ensure the participants' assessment was not associated with a particular color or packaging model to their previous use experience. We adopted material transparency as a criterion for selecting mouthwash packaging so the participant could quickly see the color. All packages were presented without the label.

Figure 1: Mouthwash packaging in the colors evaluated in this study.

2.3 Measure and Procedure

We applied a Semantic Differential (SD) questionnaire created with 12 pairs of bipolar adjectives separated by a Likert scale with seven anchors. The SD included the functional (ergonomic/uncomfortable-V1, resistant/fragile-V2, small/large-V3, light/heavy-V4), symbolic (hygienic/unhygienic-V5, modern/traditional-V6, unusual/common-V7, simple/complex-V8), and aesthetic (pleasant/unpleasant-V9, beautiful/ugly-V10, shiny/frosted-V11, proportional/disproportionate-V12) dimensions of product design. We selected the adjectives from the terms most used to describe the mouthwashes in catalogs, websites, and advertising material. We randomized the order in which the pairs of adjectives were presented and the terms' polarity, so there were no positive or negative characteristics on only one side of the scale. Thus, we applied nine questionnaires and randomized their application sequence (random.org) to minimize bias and learning effect.

The procedure can be divided into two stages. Firstly, the participant visually interacted with one of the packages, looking at it for 30 seconds. Then, after reading the instructions, the participant answered the SD questionnaire. This procedure was repeated for each package. During the test, participants could consult a table contextualizing the adjective meanings to clarify doubts without our interference, avoiding noise in the data. The experiment was run in a controlled room with white walls, a lighting color of 6000K, and a luminance of 290 cd/m2. We eliminated any colored points that could capture participant attention or compete with the packaging color. The packaging was positioned in the center of the table and at 110cm from the chair seat (Figure 2). Due to the data's non-parametric nature, we performed Mann-Whitney test using the Jamovi (version 2.3.0.0) software.

Figure 2: Demonstration of the visual interaction stage.

3. RESULTS AND DISCUSSION

The summary of the results with statistical differences ($p \leq .05$) can be seen in Table 1.

Table 1. Summary of the results. Gray cells indicate $p \leq .05$ and which age group had higher median (1 – Younger group; 2 – Middle-aged group).

		V1	V2	V4	V5	V6	V7	V8	V9	V10	V11	V12
Model A	Green				2	1	1	2	2			2
	Red				2	1	1	2				2
	Blue						1	2				2
Model B	Green	2			2	2			2	2	1	
	Red	2		2	2	2			2	2	1	
	Blue	2	2			2				2		
Model C	Green				2	1					1	
	Red				2	1	1	2				
	Blue						1	2			1	

The results indicated that mainly Model B presented significant differences ($p \leq .05$) in the aesthetic dimension. Thus, it is difficult to state that there is a generational aesthetic preference. In addition, only Model B had statistical differences ($p \leq .05$) in the functional dimension. The hypothesis is that the results may be related to the participants' previous use experience or some particularity of the packaging design. On the other hand, the results from the symbolic dimension concentrated the statistical differences ($p \leq .05$), pointing to generational influence and color-meaning association inconsistency between the younger and middle-aged adult groups. These findings are supported by those of Alves et al. (2022). Moreover, it was noticed that the middle-aged group evaluated more positively compared to the ratings of the younger group. Lastly, the results showed a predominance of significant differences ($p \leq .05$) in the packaging with green and red, colors known as a highly contrasting complementary color pair.

4. CONCLUSIONS

The current study aimed to evaluate the age influence on the perception and meaning judgment of mouthwash packaging through a generational approach. The results indicate significant differences between generations concerning color meaning in mouthwash packaging, especially in green and red packages, and design attributes from the symbolic dimension. Designers and other practitioners should consider generational influence on a product's comprehension and engagement. This study starts to fill a research gap in the literature and may contribute to future studies in Color language, Design, and Ergonomics.

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Visual Elements in Organic Products Communication: The Impact of Yogurt Packaging Material and Color on Consumer Perception

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ABSTRACT

In recent years, health issues have increased with special focus on consumption and food habits, which created an opportunity for the expansion of the organic food market and the creation of new organic product lines by retailers. Therefore, organic product consumption has been increasing, especially due to the promotion of healthy lifestyles. However, it is difficult for these brands to differentiate their products since they lack information about which package elements should be used, besides the organic claims and labels. The purpose of this study is to contribute to this literature gap, by analyzing the impact of packaging materials and colors on consumers' environmentally friendly perceptions, product attractiveness and purchase intention. We conducted a quantitative experimental study (n = 372), with the aim of analyzing organic packaging elements, namely, color and material. Accordingly, a yogurt packaging was created for the purpose of this study, using Adobe Photoshop for image manipulation. The color was compared in three different levels: green, blue and white/black, with the latter being used as a control condition. Also, two different packaging materials – recycled plastic and recycled glass - were used as variants. The packaging essentially contains one of the colors under study, along with an image of a cow and brief information stating, "Organic Yogurt", as well as "100% Grass-Fed Cows". For the scope of this research, only changes in hue were made. Results indicate that material impacts attractiveness and environmentally friendly perceptions, color impacts attractiveness, while purchase intention is not affected by any of these elements. This research contributes to the current literature on color packaging and consumer behavior. Therefore, it is expected that our findings will assist marketers in clarifying communication patterns, and helping them to adopt more suitable and sustainable materials in their production processes. These modifications should not be carried out by law imposition only but mostly because consumers are more aware of the environmental issues and are changing their habits and consumption patterns accordingly.

1. INTRODUCTION

Research on consumption and food habits has been increasing in the past recent years. According to Eurostat (2019), organic production has increased significantly, achieving 7% of the total cultivated area in 2017, doubling the value when comparing to 2005. Also, retail sales increased 10%, demonstrating the consumers' concerns regarding their consumption patterns. The organic market appeared as a different option for consumers and implies an extra effort from managers to draw product attention and consumer attraction, especially to acquire new targets and increase their purchase intentions. In particular, it is important to acknowledge that consumers nowadays are more concerned with the environment, and consequently pay more attention to the product package and their main elements when going shopping (Lindh et al, 2016; Steenis et al., 2017). Consequently, packaging with all its characteristics provides a useful tool for marketers to differentiate their brands, by being able to engage consumers while, at the same time, helping to increase environmental sustainability (Lindh et al., 2016; Magnier and Schoormans, 2017). However, organic food information is more focused on organic claims and nutrition labels, instead of focusing on other characteristics equally important. As a result, in the existing literature, there is a gap in organic packaging characterization and main package elements to bet on to enhance their communication. Therefore, the main objective of this study is to help managers to acquire more insights about consumers' opinions and habits related to organic products consumption and to understand which are the efforts and strategies they should apply for organic brands, to improve their communication and market positioning. The dairy category (and organic yogurt) were chosen as green and blue colors are usually found in this type of product. In addition, literature about the organic dairy category and, in particular, organic yogurt, is scarce, which emphasizes the importance of this study (Van Loo et al., 2013). From this perspective, the research hypotheses were defined as following:

H1*: A packaging made of recycled plastic will increase the environmentally friendly perceptions of consumers when compared to the same packaging made of recycled glass.*

H2: *A packaging made of recycled plastic will score higher in purchase intention and attractiveness when compared with a recycled glass packaging.*

H3*: A blue packaging will increase the attraction towards the product and purchase intention among consumers when compared with a green packaging.*

2. METHOD

A quantitative approach was applied through an online questionnaire, using a between-subjects experimental design: 3 (green vs. blue vs. white/black) × 2 (recycled plastic vs. recycled glass), resulting in six different conditions. The participants were randomly assigned to one of the six conditions created and had to answer questions concerning the presented product. The questionnaires were created in Qualtrics platform and distributed through Facebook. Two-way ANOVA and *t*-test for independent samples were used to test the research hypotheses, using SPSS Statistics 24.

2.1 Stimulus and Procedure

As seen in a study conducted by van Rompay et al. (2016), blue and green hues were used in yogurt packaging and were perceived as healthier than the other tested color condition, reinforcing the connection with this product category. Therefore, for the purpose of this study, a yogurt package was created using Adobe Photoshop for image manipulation. For the purposes of this study, only color changes were made. Two different packaging materials – recycled plastic and recycled glass – were also used as variants (Figure 1).

Figure 1: Recycled Plastic Yogurt (above) – Control condition, Blue and Green; and Recycled Glass Yogurt (below) – Control condition, Blue and Green.

2.2 Measures

As the aim of this study is to analyze which visual elements could improve the communication of organic products on the market, the colors (with three categories: green, blue and white/black) and materials (with two categories: recycled plastic and recycled glass) used in the packaging of organic products are analyzed as independent variables. In addition to three dependent variables: (i) environmentally friendly perceptions, using a 7-point Likert type scale (1 = very unfriendly, 7 = very friendly), an adapted version of Haws et al. (2014); (ii) product attractiveness, using an 11-point Likert scale (0 = very unattractive, 10 = very attractive), according Page and Herr (2002); (iii) consumer purchase intention using a 5-point Likert type scale (1 = definitely will not buy, 5 = definitely will buy), modified to avoid biasing consumers' decisions by considering the order of items on the previously presented scales (Mullet & Karson, 1985).

2.2 Sample

A total of 372 responses were received (evenly and randomly distributed to ensure that each of the six conditions studied had an equal number of responses). The survey was distributed only to Portuguese people, with a predominance of the female gender (60.75%), as opposed to the male gender (38.98%) and other genders (0.27%). The age of the participants ranges from 15 to 74 years, with a prevalence of people between 20 and 24 years old (59.68%), giving a mean of 26.9 and a SD of 11.31. The majority of participants have a level of education equal to or higher than a bachelor's degree (63.71%) and 55.91% are currently working.

3. RESULTS AND DISCUSSION

As mentioned above, two-way ANOVA and *t*-test for independent samples were used to validate the research hypotheses. It should be noted that these tests have some requirements in terms of implementation (normality and homogeneity of variances). As the means of the subpopulations were tested, although these requirements were not met due to the size of each sample subgroup ($n > 30$), it was considered feasible to proceed with its implementation. Although conclusions must be drawn with caution, this test is more robust than the alternative of using non-parametric tests. Analyzing the environmentally friendly perceptions, the results showed that there is an isolated effect of the package material ($F(1,366) = 23.825$; $p \approx 0.000$), representing significant differences between recycled plastic ($M = 4.84$; $SD = 1.72$) and recycled glass ($M = 5.60$; $SD = 1.236$). It is interesting to verify that color has a marginal effect, with no significant differences (at the 5% level of significance) between pairwise comparisons when the Tukey test was applied ($F(2,366) = 2.367$; $p \approx .095$). Therefore, hypothesis H1 cannot be confirmed. For attractiveness, the results showed that color ($F(2,366) = 4.374$; p ≈ .013) and material ($F(1,366) = 6.676$; $p \approx .01$) have a significant impact (at the 5% level of significance) on the variable. To understand which were the differences between the packaging colors, Tukey post-hoc tests were performed. A significant difference (at the 5% level of significance) between the blue packaging ($M = 5.86$; $SD = 2.217$) and the control condition packaging ($M = 4.98$; $SD = 2.647$), was observed, with . Additionally, the blue packaging has a higher mean than the green packaging ($M = 5.35$; $SD = 2.219$), although this difference is not statistically significant ($p \approx .271$). Regarding material, recycled glass ($M = 5.72$; $SD = 2.306$) scored higher than recycled plastic ($M = 5.08$, $SD = 2.443$). As a result, hypothesis H2 cannot be confirmed by the observed results. Finally, considering purchase intention, none of the independent variables has an effect on the dependent variable (color: $F(2,366) = 0.862$; $p \approx 0.423$); material: $F(1,366) = 0.692$; $p \approx 0.406$), although consumers gave higher scores to recycled glass packaging ($M = 3.03$; $SD = 0.897$) and blue packaging ($M = 3.07$; $SD = 0.876$). Regarding H3, despite both the attractiveness and purchase intention have higher means for blue, these differences are not statistically significant when compared to green, leading to the rejection of this hypothesis.

Considering the results of this research, some conclusions can be made. In our first hypothesis, consumers rated recycled glass packaging as being friendlier to the environment than recycled plastic packaging, which is contrary to what Steenis et al. (2017) found. However, in the Lindh et al. (2016) study, glass was rated as more environmentally friendly than plastic, which is in line with our conclusions, now extended to recycled materials. These results could be explained by the media coverage and attention given to the consequences of high plastic use worldwide. Consumers may therefore perceive recycled glass packaging as more environmentally friendly than recycled plastic packaging. Regarding H2, contrary to the hypothesis formulated, consumers think that glass packaging is more attractive than plastic packaging. These results could be explained by consumers' values and beliefs, as today's consumers continue to analyze their food choices, not only in terms of production processes, but especially in terms of the impact of their environmental footprint. As mentioned above, environmental concerns are one of the main drivers of organic food consumption (Hughner et al., 2007). Consequently, consumers may be more attracted to a more environmentally friendly option than a more harmful one. In H3, no significant effect of color was found. This is in line with what some authors have said, defending that blue and green have the same effect in health perception (Huang and Lu, 2015; Seo and Scammon, 2017; Sundar and Kellaris, 2015). However, the use of blue in packaging is predominant in the dairy category and is also commonly associated with low-fat and healthier products, which could mislead consumers and explain some difference.

4. CONCLUSIONS

Packaging is one of the first components of a product to be evaluated by consumers in a shopping environment. It should be noted that most of the competition between brands takes place on the shelves of retail spaces, where visual elements are crucial in attracting consumers' attention and leading to a product purchase. In this study, no significant differences were found between blue and green conditions for both attractiveness and purchase intention, leading to the conclusion that Sundar and Kellaris' (2015) findings do not extend to these two variables. This research has made a clear contribution to the current literature, and it is therefore expected that this information will help and influence companies to use other materials in their production processes, not only because of legislation, but mainly because consumers are more aware of environmental issues and are changing their habits and consumption patterns accordingly.

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The Use of Colors as an Element of Customization of the Surface of Myoelectric Upper Limb Prostheses

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ABSTRACT

This article aims to investigate the use of color as an element of customization of the surface of myoelectric upper limb prostheses to increase the acceptance rate of this kind of device by the user. The traumatic loss of a limb causes physical and psychological damages to the individual. The use of a functional prosthesis with customizable aesthetics allows the treatment of these traumas, being able not only to recover the lost manual ability, but also to enable the treatment of psychological trauma and to increase the user's self-esteem. So, we assumed that defining the surface of the prosthesis through the choice of colors will allow greater identification between the user and the upper limb prostheses. Considering that 3D printing is nowadays an accessible technology and, taking that the surfaces that cover the prostheses are capable of being materialized by additive technology, it is admitted that the variability and the selection of colors ensure different customization possibilities by the user. The additive 3D manufacturing process supported by Fused Deposition Modeling (FDM) and Stereolithography (SLA) guarantees respectively the definition of the color of the plastic filaments and resins that will make up the prosthesis' covering material. For each covering models which will be printed in 3D, the user will have autonomy in defining the characteristics of the prosthetic surface. Firstly, in general, the concept of customization will be discussed in the context of assistive technologies for the upper limb. Secondly, it will be examined how colors can be used to define the visual configuration of upper limb prosthetic surfaces. Thirdly, a case study of customizable 3D printed upper limb prostheses will be presented, which explore different strategies for the user's choice of colors, pointing out this device as an object of belonging and uniqueness.

1. INTRODUCTION

An assistive product is any external product (devices, equipment, instruments or software) that aims to ensure the user's functioning and independence (Priority Assistive Products List 2016: 1). Upper limb prostheses are an example of assistive product. In addition to the functionality, most prosthetic models do not yet incorporate aesthetic characteristics. The attributes that make these prostheses more attractive rely on the exploration of available colors, shapes, and textures. There are still few prostheses that allow customization. This article intends to focus on surface coverings of prostheses, in which the use of color, as a means of customization, favors the identification of the object with the user, by promoting their self-esteem.

2. CUSTOMIZATION IN THE CONTEXT OF UPPER LIMB PROSTHESES

Prosthetic models are basically divided into two categories. The first one focuses on the functionality of the prosthesis, and it can be moved by electrical motors, which are controlled by muscles' bio signals (myoelectric prostheses). The second one, cosmetics, are built to resemble the lost limb, visually reproducing its colors and textures, but with no functionality.

The additive manufacturing, also called rapid prototyping, allows the production of prosthetics at a lower cost. The materialization of prostheses through additive technology favors customization possibilities, as it ensures the incorporation of aesthetic demands through the definition of colors and shapes. The mass customization paradigm has been widely adopted in manufacturing to improve the user's satisfaction, allowing them to participate in the product design process (Brandão, Paio, Whitelaw 2017). In mass customization, creators develop the basic architecture and the options of the product, and make them available to users who will select them to enable the definition and/or assembly of the product. Flexible and reconfigurable manufacturing systems are used to create variety in the final assembly (Hu 2013).

3. COLOR IN THE DEFINITION OF UPPER LIMB PROSTHESES SURFACES

In the context of myoelectric prostheses, there are few 3D printed models that are capable of customization. The prostheses from the Limbitless Solutions organization are examples among these models. Limbitless Arm prostheses guarantee users' self-expression through the choice of the type of surface covering and the combination of colors. For the customization, different surface coverings ensure different styles which, in turn, can reveal specific user's ways of life. According to Kester (2019: 29-35), surface models are divided into four categories to represent different personalities (Ethereal, Warrior, Shadow and Serenity). For each one, a color palette is suggested, reinforcing the user's identity. Through interaction on a digital platform, he/she is invited to choose a style that represents him/her. Manero et al. (2023: 172) highlights that, to produce the surfaces of these prostheses, FDM 3D printing technology is used: precise positive molds are generated to be thermoformed in plastic.

Therefore, the use of color guarantees greater identification of the user with this type of prostheses, as its visual configuration is due to his/her participation in attributing aesthetic singularities. To explore the possibilities of aesthetic composition using color and different materials that 3D printing technologies allowed, the authors of this paper carried out experiments to define the surfaces of upper limb prostheses, which will be presented below.

4. CASE STUDY

In this case study, we will present the design of surface coverings for an upper limb myoelectric prosthesis. Four models of covering were developed (Plain Cylindrical, Antiprism, Voronoi and Truchet) which, in turn, allow variations in aesthetic configuration due to the choice of color for each section of the prostheses. This selection will be implemented in a future phase through a digital user access platform. Customization, therefore, will be proposed by him/her when choosing a certain design system that defines the configuration of the prosthesis surface covering and its respective color palette.

This case study assumes that these sections allow customization possibilities due to the variability of combinations between models and color palette. Once the four surface models were defined, two 3D printing alternatives were explored. The first one used thermoplastic filament as an input for FDM technology and the second one used resin as an input for SLA technology. In the first experiment, the printing cost was lower, the sections were lighter, but it was not possible to maintain reliability to any color system. There are limited choices of color of the filaments, without the possibility of mixing colors in their pure state.

In the second alternative, the SLA 3D printing technology was used. Here, the color refers to the pigmentation of the chosen resin. As a starting point, the 12 colors corresponding to the color wheel of the RYB system were used. The set of colors included the primary colors (blue, red and yellow), the secondary colors (green, purple and orange) and the tertiary colors (yellow-orange, yellow-green, blue-green, blue-purple, red-purple, and red-orange). In this way, a defined set was established, according to the RYB color system, allowing us to propose and evaluate different color combinations. For each one of the four covering models, a specific color combination scheme was used as a basis to obtain a harmonious color set. Variability was also favored, as the prosthesis structure is divided into four different sections (A, B, C and D). For each of these sections, a specific color. Regarding section D, more than one color options were assigned to increase the possibility of combination, as shown in Figures 1, 2, 3 and 4.

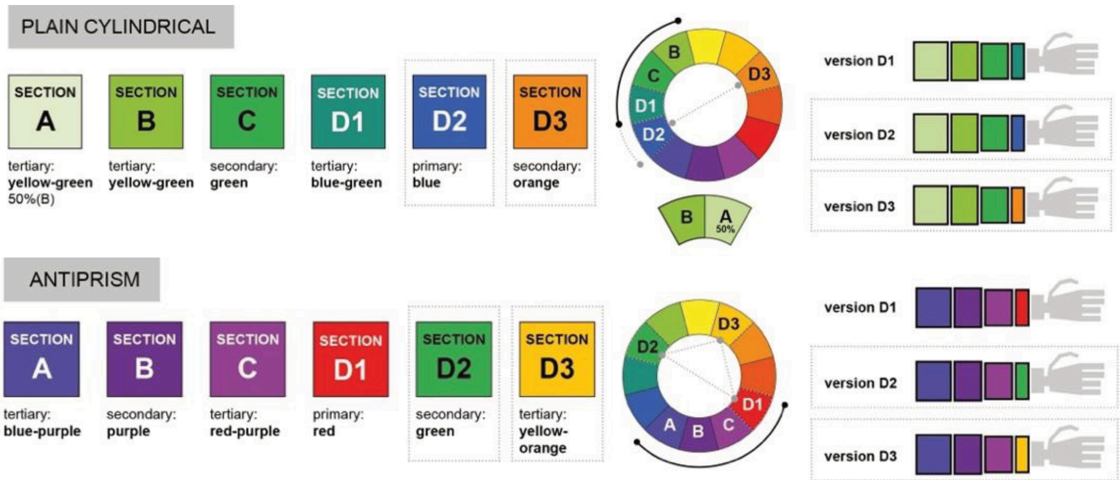

Figure 1: Scheme 1 / Scheme 2

In scheme 1 (Figure 1), a customization proposal was made based on the combination of three analogous colors (B, C and D1) contiguous to the primary blue (D2) and a fourth color (A), which is part of the set of analogous and is equivalent to 50% saturation of the color of section B. The D1 color of D section can be replaced with the D2 or the D3 colors, which are the primary blue (D2), as an extension of the analogous set, and the secondary color orange (D3), the complementary color of the primary blue (D2). In scheme 2 (Figure 1), the customization took place through the combination of the primary red (D1) and its three analogous colors (A, B and C). It is possible to vary the color of D section, replacing the D1 color with the D2 or the D3 colors which, in relation to the primary red (D1) form a right-angled triangle. Thus, one can choose for the combination of A, B, and C with the secondary green (D2), which is the complementary of the primary red (D1), or even the yellow orange (D3), which is a tertiary color, situated in a right-angled of the triangle.

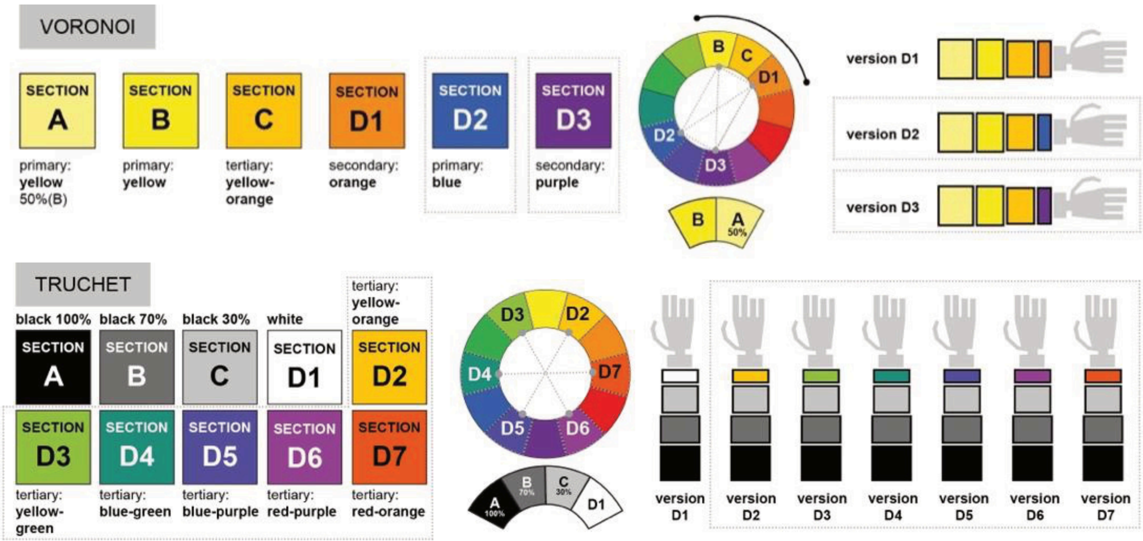

Figure 2: Scheme 3 / Scheme 4

In scheme 3 (Figure 2), the customization was done by combining the primary yellow (B), its two analogous colors (D1 and C) and a fourth color (A), which is part of the set of analogous and is equivalent to 50% saturation of the color of section B. The color of D section can change, by replacing the D1 color with the primary blue (D2) or the secondary purple (D3), which are, respectively, complementary to the secondary orange (D1) and the primary yellow (B), forming a rectangle set. In scheme 4 (Figure 2), the customization proposal is based on the combination of black saturation variations (A, B and C) combined with either white (D1), or the tertiary colors: the yellow-orange (D2); or its complementary, the blue-purple (D5); or the yellow-green (D3); or its complementary, the red purple (D6); or the blue-green (D4); or its complementary, the red-orange (D7).

The customization proposals presented here show a possibility in combining the three color groups of the RYB system, respecting the harmony of colors. By the end of this project, the possibilities of combining colors will be made available to the user so that he/she can make customizations with autonomy and self-expression.

5. CONCLUSIONS

This article intended to highlight possibilities for using color as a customizable element in defining the surfaces of upper limb prostheses. It is understood that the user's participation in the process of customizing their own prosthesis can increase identification with the assistive product used, contributing to improving the acceptance rate. The attribution of singularities using color combinations allows self-expression and increases the user's self-esteem. Propositions that allow variability in choices of chromatic attributes promote the right of users with motor loss to make decisions freely when configuring their prosthesis.

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A Board Game for the Education of Young Hair Colorists

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ABSTRACT

Color education is a fundamental pillar on which all traditional art disciplines are based, and likewise all those crafts that use color in everyday practice, such as hair coloring. Although color is a key item in the hair dressing market, especially for women, the level of basic education on the theoretical foundations of this vast and complex subject is extremely simplified and anchored in rules – or worse, precepts – nowadays outdated and supplanted by the evolution of color science. In order to try to bridge the gap between the training of young hair color professionals and what is requested of them in actual, daily practice, we propose a board game on the educational basics of hair coloring.

The game is based on a dedicated color space consisting of a beginner-friendly reinterpretation of the more traditional hue-saturation-lightness color space. Actually, with due analogies and modifications in place, hair coloring products marketed by all major brands worldwide are already loosely based on this well-coded color attribute triad. This fact, however, goes largely unnoticed – or underappreciated at best – by hair colorists. And in any case, the lack of standardization of hair coloring products and naming is both widespread and concerning. The game is intended to introduce – firmly yet gently – the general concept of color space, well known to colorimetry, and to convey the idea that a more mindful color practice should precisely be based on considering color as a space within which to move.

The game is not, therefore, an exhaustive compendium of all available products, nor does it aim to describe how to use them in practice; an operation, this, that would require an insurmountable amount of information unsuitable for the context for which the game was designed, i.e., ideally a school, or a training center. Instead, its purpose is primarily educational, specifically aimed at recognizing the hair color of hypothetical clients in the form of hair color cards; characterizing them in terms of the profession-specific color attributes; and finally, framing them in terms of the overall concept of color space.

The recreational aspect, while not the strict focus of the game, is intended to offer professors or professional mentors a teaching method complementary to a classic frontal lesson, which is on average based on ill-informed premises in any case, and to encourage reasoning, the sharing of the learning process, and the formation of critical thought through the exchange of opinions and a closer analysis of the theoretical framework on which a conscious exercise of the profession should be based.

1. INTRODUCTION

When thinking of color education, artistic disciplines immediately come to mind. Along a substantial level of practice, color theory forms the basis of an artist's knowledge and craft, and when color theory is involved, almost inevitably color wheels are also introduced. Among these, Itten's color wheel is widely employed despite its anachronism and its many shortcomings (Briggs 2013): for instance, the potential primary vermilion, when used as an actual paint in mixes, will produce vibrant oranges but very drab purples coming nowhere close to those depicted in the hue circle. Most notably, however, this color wheel is one-dimensional, and because of this it conflates and obfuscates vital color attributes.

This issue only seems to worsen when color-related crafts are involved. For instance, hair coloring, at least as it is taught in Italian vocational training centers, heavily relies on the so-called Ostwald Star (‘*Stella di Ostwald*’), an even more simplified form of Itten’s color wheel having only six colors, to which an equal amount of hair color shades are assigned. This set up is a gross oversimplification of Ostwald’s color order system first and foremost, and all but negates the concept of color space, which is vital to a professional understanding and use of color. In order to try and compensate for this lack of a theoretical framework, an educational board game on hair color is proposed that is briefly described in this paper.

2. THE ATTRIBUTES OF HAIR COLOR SPACE

Unknown to the vast majority of hair colorists around the world, hair color products are intrinsically designed and labelled to fit into a color space loosely based on the color attributes hue, lightness, and saturation. Let us consider, for instance, a hair product labelled 7.334, a numerical short-hand for *intense golden copper blonde*[1]. The digit to the left of the dot marks one out of ten *levels* representing a likewise number of steps on a hair lightness scale, ranging from 1 (*black*) up to 10 (*platinum blonde*). Individual digits to the right are instead *tones*: .1 is *ash*, or blue[2]; .2 is *irisé*, or violet; .3 is *golden*, or yellow; .4 is *copper*, or orange; .6 is *red*; and finally, .7 is *matte*, or green[3] (and thus are the six colors in Ostwald’s star accounted for). Finally, when any tone digit is doubled (or tripled) an increase in *intensity* is signaled relative to it. Therefore, 7.334 is *intense golden* (-.33-) *copper* (-.--4) *blonde* (7.---), as mentioned. The order of tone-related digits matters: 8.64 is *red* (-.6-) *copper* (-.-4) *light blonde* (8.--), suggesting a slight prevalence of red over orange; 8.46 is *copper* (-.4-) *red* (-.-6) *light blonde* (8.--), implying the opposite hierarchy.

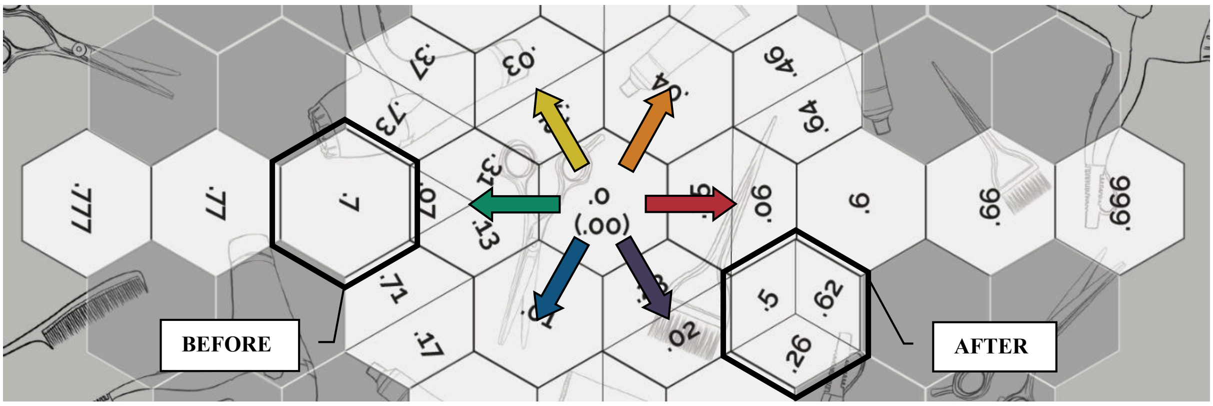

Figure 1. Portion of the game board. Every numbered hexagonal cells represents a combination of tone and intensity. Greyed out hexagons represent more sophisticated nuances, here left as empty tiles allowing for pure movement for the sake of simplicity.

Levels and intensities are completely lost to the oversimplification imposed by the structure of Ostwald’star, where only the six main tones are accounted for that also suggest a basic form of complementarity (as per the much overstated and equally inaccurate rules of traditional color theory: yellow-violet, orange-blue, red-green). Bearing in mind that no color space can ever be

[1] Technical terms related to the hair coloring domain will be italicized hereinafter in this paragraph.
[2] This is misleading: ash is tied to blue because blue pigment is used during the formulation phase. However, as the name would suggest, ash colors appear gray, which has technically no place on the outer edge of a hue circle. This should not come as a surprise, since an appropriate blue will somewhat neutralize the natural yellow to orange residual pigment within the hair shaft. To the best of the authors’ knowledge, the distinction between color formulation and color appearance goes mostly unnoticed to hair colorists.
[3] In this context, the term *matte* bears no relevance to surface finish. Also, its association to the hue green is somewhat feeble, as .7 is very much subject to marketing whims. Still, .7-matte-green appears to be the most widely recognized and accepted combination worldwide.

properly represented on a planar surface, such as a game board, the core element of the game is what authors deemed the most appropriate compromise between a formal color space and Ostwald's star, which is – and will be for the foreseeable future – the cornerstone of hair color education and real-world market. The resulting color 'space' is twofold: a simple scale accounting for levels; and an expanded version of Ostwald's star in the form of a star of hexagons (Figure 1) where tones and intensities are laid out, with intense version of the six basic tones being placed on the outer edge and converging to the most neutral version of human hair, i.e.: *natural*, marked as .0 (5.0, for instance, is *natural light brown*). Compound tones are placed accordingly between the six main branching arms.

This setup has at least three main advantages related to color education. First, it is made apparent that colors must be described with three separate attributes. Second, that colors are related by means of these attributes: for instance, some hues are contiguous, while others are opposite, but a path of changing saturation can be traced between them. And finally, precisely because of these relationships, that it is possible to move between colors. Conveniently, because colors are associated with tiles on a game board, it is strongly suggested that this path be followed stepwise from a starting point to a desired ending point.

3. GAMEPLAY

The evaluation of the starting and ending point within the color space is exactly the first task players are assigned each round. To begin with, players must draw two cards from a shuffled deck where colored hair are depicted: the first card being the hair color of a hypothetical client entering the salon; the second card being their desired color. On a purely educational basis, judging and then naming a hair color based on level, tone(s), and intensity is a well-accepted practice in hair color teaching and mentoring. Within the game context, players are prompted to visualize these color attribute as squares (hexagons) on the board, at first only with their mind's eye so as not to give away their hypothesis.

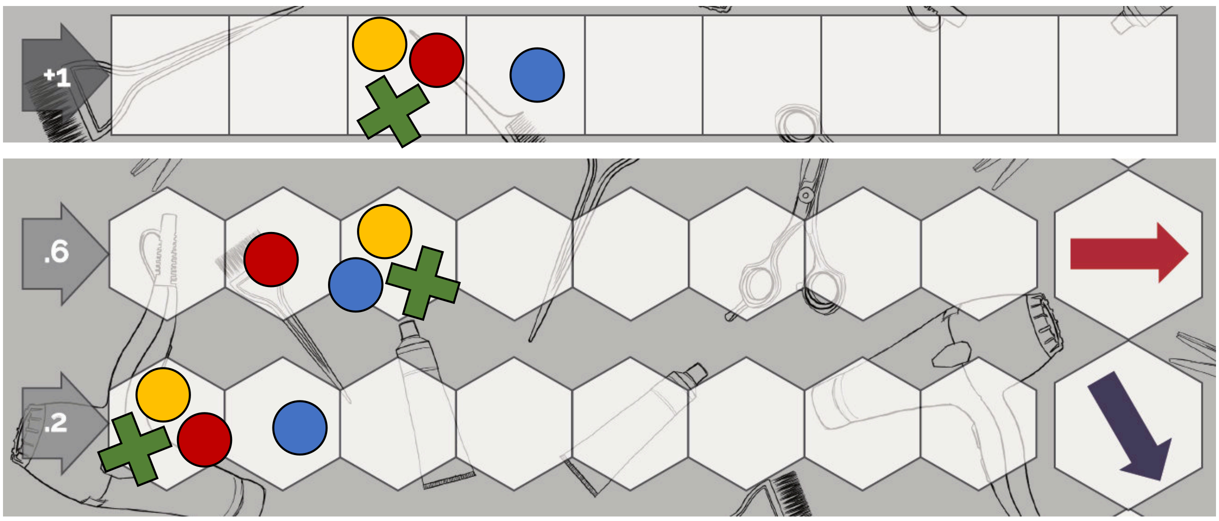

Figure 2. Simulation of players' paths (round tokens) and the correct path (green crosses). Players performance is scored by counting the distance from the tokens to the crosses.

Suppose for instance 6.7 (*matte dark blonde*) was identified as the color of the client, and 9.26 (*irisé red very light blonde*) as their desire. Then, the player would mentally mark squares 6 and 9 on the level scale (not shown for space constraints), and hexagons .7 and .26 on the tone/intensity plate (Figure 1: .7 is BEFORE, .26 is AFTER). Once both landmarks are in place, the shortest course must be traced that connects the first to the second. This is done by moving colored tokens along a maximum of three (one plus two) out of a total of eight allotted paths: one for increasing the level, or for decreasing it; and then a maximum of two out of six, one for each cardinal direction represented by a tone family (two directions at most are needed to reach everywhere). In this case, three steps are required to move from level 6 to level 9; as for the combination of tone and intensity, three steps are required towards direction .6, and one step towards direction .2 (see again Figure 1 for reference, and Figure 2). Players can move tokens a maximum of two squares for each turn and are required to turn them upside down to signal their intent to end movement along a specific direction. The round ends when every player is done moving tokens, at which point the solution sheet is perused, correct hair colors are established, and so is the path between them. Based on the total distance between players' answers and the correct answer, an error score is computed, and a winner is identified each round until the criterion is met for ending the game.

4. CONCLUSIONS

A board game for teaching the concept of color space in the context of hair coloring was briefly detailed. We deem it a valid alternative – or better yet a complement – to traditional teaching approaches, usually fraught with anachronisms (which should equally be amended). Hopefully, young professionals will benefit from the involvement required due to the gamification of the topic, and appreciate the subtleties of color from the onset of their career.

ACKNOWLEDGMENTS

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Visual Grouping: A Study on Preponderances of Color or Shape in Match-Three Games

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ABSTRACT

A category of entertainment that stands out for its popularity is the Match-three electronic game (Coutinho 2014), in which the player needs to form groups of, at least, three similar objects to score points. Thus, the study of how players perceive visual groupings becomes an important tool for future developments.

This research investigated color and shape relationships in Match-three games, looking for preponderances in the visual grouping of color or shape in the psycho and neurological response. For this, a bibliographic and empirical research were carried out. A beta and a final version of two match-three games were created and applied to a sample of 64 subjects. One of the games had black and white shapes (circle, triangle, square and lozenge), and the other one had only colored circles (red, green, blue and yellow).

Results of the visual language and psychologic bibliographic research indicated that color and form belong to the similarity aspect of visual groupings, without showing any preponderances between them. The neuroscience literature showed that the visual grouping of color and shape are perceived in different ways depending on the context in which they are inserted. Some experiments present that color and form are perceived without prominence, others show that for lower exhibition rates, color is perceived before orientation.

The empirical research showed that, for the category of games studied, visual groupings of color are perceived more quickly and more easily than groupings of form.

1. INTRODUCTION

A type of entertainment that grew with the spread of smartphones (Coutinho 2014) were digital mobile games (Gualà et al. 2014), and the popularization of the category of match-three games stands out in the world (Coelho 2014).

For people with normal vision, the perception of visual groupings is the most important part to be observed in the mechanics of this type of game, as its dynamics is based on making groupings of at least three similar icons by color or shape to score (Jull 2010).

In Psychology and Visual Language, Arnheim (2008), Dondis (2007) and Kepes (1995) place color and shape as characteristics belonging to the same type of visual grouping, which is similarity. Thus, they don't suggest any differences on perception of those groups.

As for neuroscience, depending on the interaction, difference in perception between the two types of groups will be noticed. This occurs because they will be processed differently paths (parallel or serial) and in different brain locations (Aymoz and Viviani 2001).

In Aymoz and Viviani (2001) experiments, color and shape were perceived almost simultaneous. But in Moutoussis and Zeki experiment (1997 apud Rentzeperis et al. 2014), colors were perceived approximately 63 milliseconds before orientation. Clifford et al. (2003 apud Rentzeperis et al. 2014) corroborates with that, since it was found that for faster presentation rates, color and orientation were perceived at the same time, but in lower frequency (1 Hz presentatio), color perception preceded orientation in 50 milliseconds.

In this context, this present study aimed to understand response in visual groupings of color and shape and visual comfort in the specific match-three games scenario.

2. METHOD

To understand the preponderances in visual groupings of color and shape in match-three games, two games and a qualitative questionnaire were developed by the authors to test the speed with which players group similar sets.

One of the games made was black and white, with the shapes: square, circle, rhombus and triangle. The other was polychromatic (multiple hues), with only one shape (circle) of pure RGB hues (pure yellow, blue, red and green), with the same brightness and saturation.

The game and the questionnaire were applied to a sample of 52 people, between 18 and 30 years old and attended higher education at ESPM College in São Paulo, Brazil. Female and male individuals were tested, equally divided into groups of 26. The selected subjects claimed not to have color blindness or any other visual compromising pathology. Before the final tests, a beta test was carried out to detect aspects that could be improved, with 12 people, 6 males and 6 females.

The tests were applied on half of the tested people started playing the first, the other half the second, so the learning of mechanics wouldn't influence the speed of grouping.

At the beginning of the tests, a brief explanation of how the tests work was given. Then, at the end, the qualitative questionnaire was presented on Google Forms. Was asked the name (further anonymized), age, biological sex and the following questions:

- Which one of the two games, black and white or color, did you find it easier to group? Why?
- Which of the two games did you find most pleasing to see? Why?
- Did you notice anything different in the way you perceived the groupings in the two games?
- Do you have any observations or suggestions? If so, which one?

3. THE DEVELOPMENT OF THE MATCH-THREE GAMES

The games were developed in "Unity 3D" and "Adobe Illustrator", with the code of Gkanatsios (2015). A programmer (Mario S. A. Junior) was hired to code the games. Both games had the same code and a 30-second timer (see Figure 1), indicating the time remaining to match as many combinations as possible. At the end of each, the program generated a report with the number of groupings made. The groupings considered were those of moves made manually, the cascade occurrences weren't counted.

The authors also intended to create greater contrast between figure and background. Therefore, it was decided to use in both games 100% brightness on items and a black background (R = 0, G = 0, B = 0; #000000). For the black and white game, the square was reduced in height compared to the other shapes to guarantee the perception of individuality when close to other squares.

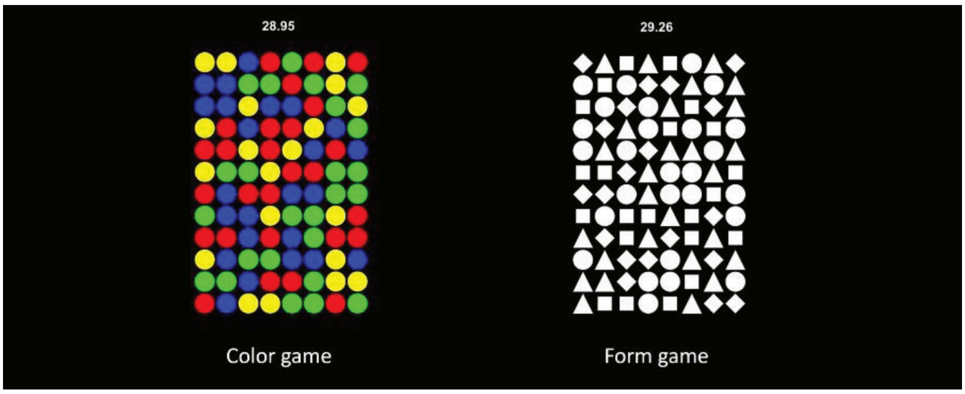

Figure 1: Printscreen of the color and form games designed by the authors.

4. RESULTS

The tests showed that visual color groups were perceived more quickly by players, since the programs accounted for a total of 644 color groups and 435 form groups made by the participants. Furthermore 47 people (90%) made more color groups, 3 females and 1 male (8%) made more shape groups, and 1 female (2%) made equal combinations in games.

In the color game, male respondents made 333 combinations, while female 311. In black and white, males made 221 combinations and females 214. It may be concluded that the preponderance in combinations of the colorful game is perceived, in both sexes.

The qualitative questionnaire based on the players perception also demonstrated greater facility and comfort to make colored groups. For the question: “Which one of the two games, black and white or color, did you find it easier to group? Why?”, 90% of respondents (47 people) replied that they preferred colored groups, 8% shaped ones (4 people) and 2% (1 person) presented an incongruous answer.

For people who responded that preferred the colored game, the following aspects were highlighted: the groups were more visible, ease to grouping, more attractive, and greater emphasis in perception. Although, the people who responded to preferred shape groupings usually related that dislike the strong/saturated hues used on the colored game.

For the question: “Which one of the two games did you find most pleasing to the eye? Why?”, 79% of those surveyed (41 people) replied that they preferred the colored game, 21% the form game (11 people).

It was highlighted for the color test: less effort to group, easily identify the colors, more alive and happy, was more intuitive, more attractive, with shapes everything seems mixed. For the black and white, they said: caused relaxation and made the test less intense, personal preference for black and white, the colored game was too saturated, more pleasing.

For the last question: “Did you notice anything different in the way you perceived the groupings in the two games?” and “Do you have any observations or suggestions? If so, which one?”, not all participants had observations to make, but was highlighted:

In the black and white game: The need of greater concentration to make groups, a person made combinations from the tips of the shapes and thinks that didn’t make many combinations with circles, everything is perceived as a unique visual mass, it took a player time to "understand" the shapes. As for the color game: equal colors were more natural than thinking about equal shapes, one managed to form “color paths” that facilitated the game.

5. CONCLUSION

Although the visual language and psychology studies used on this paper don’t suggests difference on perception of groups of color or form, the neurologic study of Clifford et al. (2003 apud Rentzeperis et al. 2014) shows that in lower rates color is perceived before form.

The results of this paper corroborates with this affirmative since the factor that facilitates the speed of grouping in the developed match-three game was the use of different colors (hues). Therefore, it demonstrates that for visual groupings of color and shape in match-three games, color is predominantly seen as a factor of better, faster and more comfortable visualization of groupings.

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Color Vision Deficiency in Video Games

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ABSTRACT

The videogame industry is currently comparable to the cinema industry in terms of number of products, audience and wealth of the sector. This industry has proven to be attentive to an audience that can be perceived as a niche audience but which is actually numerically very important: Color Vision Deficiency (CVD), which involves the reduced capacity or impossibility of perceiving specific colors. This genetic anomaly manifests as incomplete color perception and consequent reduced chromatic distinction capacity. CVD incidence is not negligible; about 8.5% of men and 0.5% of women suffer from it. In this work we present some characteristics of color deficiency and how the video game industry deals with it.

1. INTRODUCTION

The video game industry can be identified within the tertiary and quaternary sectors of the entertainment industry. A report (Urbanemujoe, 2022) by the Entertainment Software Association (ESA) indicates that aided by the lockdown resulting from the COVID-19 pandemic, the total revenue of the video game sector in the United States alone reached $61.4 billion in 2021, demonstrating that it is no longer merely a niche market. According to an independent report (Steam, 2024), in 2023, on the Steam digital distribution service alone, 14.445 titles were released, an increase of 1.922 compared to 2022.

Video game development, ranging from indie productions to major software houses, heavily relies on color for interfaces and gameplay dynamics. This practice is understandable because color, besides being a powerful expressive tool to guide the game narrative (Joosten et al., 2010), is also a quick means to direct players to use the graphical interface efficiently. For example, designing the interface to distinguish factions using different colors in a team-based game is undoubtedly effective and easy to implement.

Color Vision Deficiency (CVD), the reduced capacity or impossibility of perceiving specific colors, is a genetic anomaly that leads to incomplete color perception and consequent reduced chromatic distinction capacity. The incidence of CVD is not negligible; about 8.5% of men and 0.5% of women suffer from it.

In the case of highly successful titles such as Minecraft, published in 2009 by Mojang Studios, the player base consists of approximately 140 million unique connections per month (with peaks of 11.9 million players connected simultaneously; assuming an equal distribution between genders, this equates to nearly 6.000.000 players with Color Vision Deficiency every month.

Despite this, the fast-paced market rhythms, the economic volume invested, and the need to meet deadlines often lead developers to overlook, or at least underestimate, this aspect of accessibility to video game products. There is no official list (PCGamingWiki, 2024) of computer or console products developed that implement specific settings for people with color vision deficiency. However, numerous developers have tackled the issue with results ranging from excellent to detrimental.

2. A NOVEL APPROACH TO COLOR DEFICIENCIES

Literature describes color vision deficiencies exclusively from the retinal point of view. The three types of anomaly are in fact described according to the class of cones affected. There are three main types of CVD: protanopia, deuteranopia, and, much rarer, tritanopia, according to the relative class of cones involved. If the anomaly is milder and the class of cones partly functions, it is called protanomaly, deuteranomaly, or tritanomaly. In addition to these six conditions, there is a much rarer one called achromatopsia, which entirely prevents color perception ("grayscale vision"). However, science has already established for almost a century that color vision is not only the result of the work of the retina but also of the brain. The processing of the brain is as well at the base of adjustment mechanisms that make the visual system much more robust to unpredictable variations of the scene. These mechanisms are present also in color-deficient observers. We do not want to explore these aspects in this paper, the interested reader can find more information here (Eschbach et al., 2014; Rizzi et al., 2014, Eschbach et al., 2022; Plutino et al., 2023). We mention these mechanisms to explain that context-based compensation mechanisms can help color-deficient observers partially compensate for the lack of information. If on the one hand this helps the color deficient observer on the other it makes the job a little more difficult for those who try to model color deficiency or more simply to help color deficient players. With this in mind, we present some of the strategies that are usually used to allow color-deficient gamers to enjoy video games

3. THE ISSUE

This article is not intended to be a complete list of the solutions currently used to solve the problem of the Color Vision Deficiency (CVD) problem. However, we will present some examples of how developers have addressed the issue. The gaming issues related to this visual deficit can sometimes prevent the completion of essential tasks entirely. In team games where different groups are differentiated by using colors (in most cases, red for the opposing team and blue or green for one's team), a person suffering from e.g. Deuteranopia cannot distinguish between their teammates and opponents. The issue often extends to the interface (specific actions to perform, the player's health level, etc.), puzzles (connecting elements of the same color, finding an object in a different color context), the crosshair, or necessary game effects (e.g., the red glow at the edges of the screen to indicate that damage is being taken). Additionally, color is often used as a narrative tool; particular visual effects are employed to change the atmosphere of a scene from "normal" to "dangerous" through the use of red light or to induce a sense of "unease" or "dread" using green or cerulean. All these nuances do not achieve the same effect for atypical trichromats. At the same time, they are entirely invisible for those with a total deficit in one of the three types of cones. The problem is even more severe in e-sports, where the game's competitive aspect is central, and the disadvantage arising from this type of problem is critical. The anomaly affecting the cones in CVD not only prevents the perception of a specific color but also confuses the perception of the other colors that the visual system would typically be equipped to handle. This peculiarity makes it unthinkable to solve the issue simply by removing a specific color from the interface design. Chromatic confusion and color perception in context represent the main reasons why many adjustments made in simulations by some developers are ineffective in providing visually impaired people with satisfactory gaming experiences. The issue has been known for a long time and involves so many people that it is not negligible when related to the gaming sector.

4. COMMON APPROACHES

Many game developers have tried to address the problem by developing filters that modify the color scheme in the game so that people with CVD perceive the game scenario with enhanced contrast regarding their specific pathology. Real-time correction filters, however, cannot compensate for the disadvantage of CVD people and sometimes do not provide any benefit. Beyond some blatantly incorrect filters, such as the famous one in Bethesda's Doom, where the filter simulated the type of visual deficit instead of creating a color scheme to counteract it, other widely popular games like Blizzard's World of Warcraft, Bungie's Destiny 2, and Ubisoft's Assassin's Creed, to name a few, while not making specific errors in filter implementation, allow choosing the type of visual deficit (Protanopia, Deuteranopia, and

Tritanopia) with few or no other options to correct any imperfections. Many of these solutions, however, focus more on color correction performed pixel by pixel, not considering that vision is a phenomenon strongly influenced by the entire visual field. Different levels of luminance in the scene, phenomena like color opponency or simultaneous contrast, which can invalidate real-time filters even in people with a partial deficit, are not considered. There is no actual index of how the various deficits affect the spectrum as a whole because deficit conditions are not always complete. In the case of a partial deficit, the intensity of the problem results in a non-linearity of the correction applied by the filter.

5. THINKING OUT OF THE BOX

What solution could be better to ensure a more equitable gaming experience for CVD players? A straightforward and cheap solution that seems to work in many cases is to give distinguishable elements blue and orange colors instead of the typical red and green. When tested with various CVD simulators, these colors appear to be the most discriminable color pair across the various visual deficits. Another safe solution that should be implemented not at the end of the design process but from the early stages of the game development is to avoid creating critical gameplay and narrative passages solely based on color. Always add graphic elements (geometries, patterns, or animations that are easily perceivable even by people with CVD). Use other elements like sound to compensate for what might be lacking in color. Regarding the possibility of including CVD options in graphic settings instead of just hypothesizing correction filters, integrate the graphic options with the ability to choose colors for different game elements (allies, enemies, health kits, explosive elements, powerups, etc.). An example of this type of implementation is Blizzard Entertainment's Overwatch 2, where, after a false start with only three filters strongly criticized by the CVD player community, the game was also updated to include the possibility of selecting colors; another perfect example is Electronic Arts' Battlefield 1, where it is possible to modify the outline of the various teams through a true color picker based on Hue-Saturation-Value.

Among the various hypothesized approaches, a more particular one follows the opposite path; this system is plausibly more sensible in e-sports where the competitive component is higher. Instead of developing a system to improve the performance of CVD players, the proposed system involves implementing a visual impediment system for players with normal vision. Applying this penalty covers the inevitable gap that still occurs using improvement interventions, ensuring fairer competition among the various players.

6. CONCLUSION

The design of an optimal system to address the issue of the perception gap between players with normal vision and CVD cannot be conceived as a simple filter to be applied as an overlay on the gaming experience. It is necessary to study additional complements (not necessarily related to vision) and collaborate with experts and individuals who suffer from the condition during the development phase. The number of discriminating elements that can arise in a broad and variable-rich context, such as that of a video game (which remains a highly visual medium), is such that a single solution cannot exist; each case must be tailored to the specific product. Furthermore, more tests with feedback from real CVD players (not simulations) should be conducted to evaluate those typical visual phenomena (color constancy, contrast, background interference, to name a few) that compromise the linearity of perception and undermine simpler and cheaper solutions such as correction filters, which have been commonly (and inefficiently) used in the video game industry to date.

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Board Games for Early Screening of Limited Color Vision in Italian Primary Schools

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ABSTRACT

The term “Limited color vision” refers to a condition where a class of cones in the retina functions abnormally, causing the individual to confuse and perceive certain colors in a limited way. Approximately 8.5% of European men and 0.5% of European women suffer from this condition, while in Italy, the number of color deficient individuals is estimated to be around 2.2-2.5 million. Color deficiency is a condition linked to genetic transmission and is therefore present from birth, but often in Italy, it is diagnosed only after adolescence. This study aims to explore the possibility of diagnosing this condition in childhood in a playful manner, using board games, to provide teachers and any potential tutors or educators with tools and techniques for classroom assessment. The paper presents a research project funded by the Italian Ministry of Education, named Game4CED, Gamification for color blindness early detection. The project aims to develop a series of board games as educational tools for early detection of color deficiency, to raise awareness about color deficiency among people, and to enhance the accessibility of board games for color deficient individuals. Additionally, the project seeks to provide new tools for teachers and educators to promote a more inclusive school practice for all children.

1. INTRODUCTION

Color vision deficiency is a genetic condition which, in a percentage of individuals, causes the hypofunction of a class of cones which makes it difficult to perceive and distinguish some colors. About 8.5% of European men and 0.5% of European women are affected. In Italy, the number of color- deficient individuals is around 2.2-2.5 million (Wright and Martin 1946), (Birch 2012), but the diagnosis is often made only after adolescence. Currently the most used methods for testing color deficiency are the Ishihara Test and the Farnsworth-Munsell Test (Birch and McKeever, 1993), (Cole 2007), which can be associated with alternative clinical tests such as the Nagel anomaloscope or the CAD test. Color deficiency diagnostic tests are carried out mainly for the purpose of issuing authorizations to drive vehicles (e.g. driving license) and for carrying out specific tasks. For this reason, many color deficiency diagnoses are made in adulthood, especially in cases of mild color deficiency, or in subjects for whom color deficiency was masked by other types of visual dysfunctions. Furthermore, diagnostic tests for color deficiency require trained and specialized personnel, as well as high levels of attention from patients. This makes many tests difficult for children or individuals with attention deficits (Armellin, Plutino, and Rizzi 2022).

Early diagnosis of color deficiency is essential for adequate management of any problems associated with this condition, especially at school. Untrained teaching staff, and lack of knowledge of this phenomenon, could cause stress, exclusion or discrimination of color-deficient children, as well as slowing down their learning pace.

In this context, proper teacher training, associated with some specific board games as tools, could be a solution. Using board games as an early diagnostic tool has numerous benefits. Games are a playful and engaging method that allows you to test children’s ability to recognize colors in a fun way, without creating stress and without affecting their motivation. Furthermore, games are an easily accessible and low-cost method, suitable for varying age groups and contexts, such as school.

2. GAME4CED

Game4Ced is a research project funded by the Italian Ministry of University and Research, from December 2023 to November 2025.Game4Ced has three main objectives:

1. Analyze and improve accessibility standards for color deficient people in the world of board games;
2. Development of a board game as an educational tool for the early detection of color vision deficiency increasing people's awareness of color deficiency;
3. Provide teachers, educators and parents of school-age children with tools and knowledge useful for using the board game as an accessible aggregation tool.

The project is structured into various sub-goals. The first is the definition of a tool capable of analyzing and evaluating the color-deficient accessibility of modern board games. During this phase it will be important to explore the state of the art of accessibility policies and, above all, their actual mechanisms by comparing their use by color-deficient and non-color-deficient players. There are mainly two objectives. The first is to correctly frame the problem and understand the level of attention and awareness of the industry today. The second is to be aware in the subsequent work phases of designing games that respect these standards by applying them correctly.

Then the main goal will be the design, development and play testing of a set of board games based on color information, that can be used to execute an initial screening of young players.

Together with other board games, Color-Fit, will constitute the first set of instruments for an early but effective detection of color vision deficiencies. The games will then be brought to real contexts, mainly schools and board game fairs, where they will also be a tool for disseminating problems related to color deficiency. Educators and teachers in school will therefore assume fundamental importance given that they will be trained on the use of games in order to be able to organize game sessions that have the dual purpose of transmitting the gaming culture in schools and creating a relaxed and favorable environment for carrying out of initial screening of subjects suffering from color deficiency.

Then, aim of the project is to develop an educational toolkit composed of videos, booklets and educational materials that can guide educators and children in creating a more accessible environment. The material has the aim of training educators on issues relating to color deficiency and allowing an autonomous use of Color-Fit and other playful tools to carry out an initial screening of young students affected by color deficiency at school.

3. VISUAL ACCESSIBILITY IN MODERN BOARD GAMES

In modern board games the usage of colors to communicate a specific information to the players is very common. This approach is an accepted and recognized standard for most players, but it can be a problem for all players with altered or limited color perception. E.g. in several games the color feature is used to identify all the components that belongs to a specific player. These components usually differ from each other only for this feature so, if these colors aren't chosen specifically from a suitable color palette, a player with limited color vision can run into multiple problems. These problems can lead to increase the processing time necessary to make moves in the game, making unwanted mistakes and feeling frustration and anger. However, there are some strategies that can be applied during the design of the components of a board games that can be used to minimize these problems:

1. Use colors suitable for the various types of color deficiencies
2. Do not use color to convey information regarding game mechanics
3. Every time a color is used to identify a specific information it must be associated with a specific symbol or texture.

4. METHOD TO ANALYZE THE VISUAL ACCESSIBILITY OF A BOARD GAME

The team of Game4CED has defined a procedure made by three different analyses to evaluate the visual accessibility of a board game:

1. Colorimetric analysis
2. Qualitative analysis of the gaming experience
3. Playtest and debriefing with limited color vision players

The colorimetric analysis is based on the use of spectrophotometer and colorimeter to analyze the colors of game components such as boards, cards and pawns. Through this analysis it is possible to trace the colors that fall on the same lines of confusion, that is, which are likely perceived similar by color-deficient players based, of course, on the specific type of color deficiencies.

With the qualitative analysis instead the impact of the use of non-color-deficient friendly colors on the gaming experience is observed. This analysis divides games into risk categories trying to identify how much and how the incomplete understanding of the colors of the game components impacts the gaming experience. In this second step we try to understand how much the gaming experience at the table is affected by the incorrect use of the colors analyzed in phase 1.

Playtests with color-deficient players are our final test. In this phase we try to verify if the assumptions made during the first two phases are correct.

5. COLOR-FIT

Color-Fit is the first game designed for the Game4CED project with the main objective to become an easy "print and play" tool to perform an early screening for color deficiency in primary schools. It is as an abstract game for two or three players lasting around 15 minutes per match.

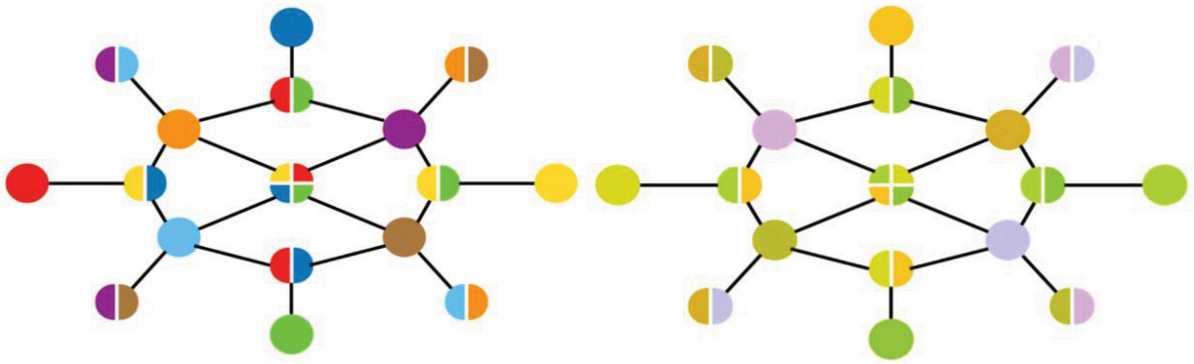

Fig. 1 – A standard board of Color-Fit (Left) and a hard to distinguish version (Right)

For the download and the rules visit https://game4ced.di.unimi.it/.

An outside observer, by looking the players and the timing of their moves, can easily spot a difficulty in recognizing colors. These difficulties will however have to be investigated in a more appropriate place since Color-Fit does not aim to replace official medical tests. The main objective of this game in fact is to find these difficulties more easily and as soon as possible.

6. CONCLUSIONS

This research project is therefore interesting from several points of view. The possibility of designing and disseminating free and print-and-play board games with the same characteristics as Color-Fit would allow individual schools to carry out tests and game sessions independently and more regularly. The analysis of the visual accessibility standards in board games could bring to an improvement for the Limited color vision players as well as leading us to learn more about the peculiarities of these players and their condition. The early diagnosis of color deficiency through board games represents a useful step forward for the prevention of any discomfort associated with a color vision deficiency. Thanks to the use of games, individuals with difficulties in color perception can be identified quickly and effectively.

Furthermore, it is presumably that through the spreading of this project the understanding of color deficiencies and their functioning will be more widespread in the school personnel. This can be an extremely important factor in providing support and tools to people affected by this condition.

ACKNOWLEDGMENTS

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Fun Educational Programs to Promote Understanding of Colors and Color Vision Diversity

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ABSTRACT

The concept of color vision diversity describes the inherent variation in human color vision. The Genetics Society of Japan introduced the concept in Japan in 2017 as "color vision variation." However, prejudice toward people with color vision deficiency remains, and the condition has negative effects on school education. Color vision deficient students easily lose interest in their studies and lack confidence in color usage and recognition. The purpose of this study was to develop several inclusive educational programs to increase the understanding of color vision diversity from both majority and minority perspectives through fun experiences with color science. The key concept was the development of a condition in which participants with any type of color vision engage in activities in a "color world" different from their usual world. To realize the key concept, we used a three-step process: 1. scientific color experiments, 2. design of the program contents and the educational scenario, and 3. use of repeated demonstrations to confirm the effectiveness of the program and improve it by using participant feedback from a questionnaire and interview survey. We developed two programs: "The color detective" (a color detection game) and "What color is this pigment!?" (a painting workshop). Participants' responses indicated that the programs were enjoyable for both people with trichromacy and those with color vision deficiency. Moreover, the results showed that child participants were able to understand that color vision was diverse and that each different type of color vision had its own color world. We suggest that increasing the understanding of color vision diversity could help to change social attitudes to indivdiual differences in color vision. As a first step toward this goal, we plan to collaborate with schoolteachers in desiging and implementing future studies to examine how these programs can be adapted to real educational settings in schools.

1. INTRODUCTION

The concept of color vision diversity is used to describe the inherent variation in human color vision. This concept was introduced in Japan in 2017 by the Genetics Society of Japan as "color vision variation" (Genetics Society of Japan 2017). However, prejudice toward people with color vision deficiency remains, even in schools. Many color deficient students have had traumatic experiences of having their "wrong" color usage or recognition pointed out by friends or teachers (Tsuji et al. 2020). A few programs have been developed to increase awareness of differences in color perception between people with color vision deficiency and those without (who are assumed to have "normal" vision). However, these programs have promoted a unidirectional understanding, in which the experience of people with color vision deficiency (a minority) is considered only from the perspective of people with normal color vision (the majority). This unilateral approach applies a superiority vs. inferiority categorization of color vision diversity. This is a widespread "common sense" assumption, and hinders a deeper understanding of color vision diversity (Kawabata 2020).

The purpose of this study was to develop several educational programs to increase understanding of color vision diversity from both majority and minority perspectives through fun experiences with color science. We initially reviewed previous literature (Kawabata 2020, Muraya and Sunaga 2023, Yanagida 2003, Muraya et al. 2022) on color vision diversity and identified five important points that informed program development (Table 1). We developed several educational programs that included all five points. Here, we discuss two of the programs: “The color detective” and “What color is this pigment!?” The aim of the programs was to generate simple but effective content that was appropriate for fourth-grade elementary school students. We used several demonstrations to validate the programs.

Table 1. Points for understanding color vision diversity.

A	Objectivity of color recognition	the belief that there are “correct” colors because of the assumption that color is fixed to an object.
B	Subjectivity of color recognition	an understanding that the color of a particularobject may be perceived differently by different observers, because color vision is a personal experience.
C	Color vision diversity	the notion that no two people have the same color vision, because color vision involves inherent variation that is distributed on the spectral curve.
D	Each person’scolor vision ability is characterized by both strengths and weaknesses	the notion that under particular conditions, people with color vision deficiency have a superior ability to differentiate colors compared with peoplewith normal color vision.
E	Every person’sc olor vision is valuable	the notion that people do not differ in the superiority or inferiority of their color vision, and that each person’scolor world has value.

2. DEVELOPMENT OF EDUCATIONAL PROGRAMS

The key concept for creating the programs was the development of conditions in which participants with any type of color vision engaged in activities in a “color world” different from their usual world. We used colored goggles as a simple but scientific and effective way to change participants’ color world and used a three-step process to design the programs.

2.1 “The Color Detective”

“The color detective” is a game for five or six teammates. The aim is to promote the understanding that color vision ability is diverse through direct experience (points A to C, Table 1). Participants wear differently colored goggles and engage in team discussions to identify the color of a given card. Teammates look at the same card at the same time but they are unable to agree upon the color of the card because they are wearing differently colored goggles. The point of the discussion is to make these differences apparent to participants.

In the first step of program development, we selected a combination of colored films to attach to the goggles. We chose a color card by calculating the CIE 1931 xy chromaticity coordinates of the cards from the spectral power distribution of the illumination, the spectral transmittance of the films, and the spectral reflectance of the cards, in addition to visual observations. We used the following criteria: we selected those film colors that enabled participants to easily name different colors with differently colored goggles, and scattered the xy chromaticities of the cards. The chosen colors of the films and cards were as follows: five colored goggles (film no. 21 [red], 43 [yellow], 59 [green], 63 [light blue], 71 [deep blue], and 81 [purple]) (Polycolor, Tokyo Butai Showmei), with the v7 color card (PCCS yellow vivid tone) and the BK color card (black) as a control (size: 12 cm × 8.8 cm, Japan Color Enterprise Co., Ltd) (Muraya et al. 2022).

In the second step, we created the game scenario and content. We also created illustrated slides to facilitate participants’ understanding of the explanation of points A to C and the game instructions. In the third step, we demonstrated this program six times (from December 12, 2021) with an approximate total of 150 participants (age range: from elementary school pupils to people over 60 years) include 10 people with color vision deficiency, and improved the program in response to feedback from 79 participants. The procedure of the latest version of the program is as follows. After the introduction (referring to points A to C), participants are asked to wear the differently colored goggles. The BK card is shown first, followed by the v7 card. Participants are instructed to decide on one color name by discussing the color of the card with their teammates. They are asked to write their answers down on paper at the end of each round. Finally, participants are asked to exchange their goggles with their teammates and confirm the color of the given card, which now looks totally different from when they wore the first goggles. In the last part of the workshop we summarize points A to C in a way that is linked to participants' experiences during the game.

2.2 "What Color Is This Pigment!?"

"What color is this pigment!?" is a painting workshop. The program aim is to promote the understanding that differences in color vision do not imply superiority/inferiority, and that each person's color world is valid (points A to C, and E, Table 1). In this workshop, all teammates have to paint a picture wearing color goggles to prevent them from recognizing the colors of the paints. We selected suitable color films (Polycolor, Tokyo Butai Showmei Co. Ltd.) for attaching to the goggles according to the criteria that the variance of the CIE 1931 xy chromaticity coordinates of the 18 acrylic paints viewed through each color film was large. We also used visual observations to ensure that the paint colors when viewed through the goggles would be perceived as substantially different from the colors when viewed without the goggles. We selected four colored films for each group: film no. 26 (red), no. 33 (orange), 53 (yellowish green), and 58 (green) for Group 1, and film no. 57 (bluish green), 81 (purple), 84 (bluish purple), and 780 (blue) for Group 2 (Muraya et al. 2022).

In the second step, we created the painting workshop scenario and content and generated illustrated slides to facilitate participants' understanding. In the third step, we demonstrated the program four times (from August 8, 2022) with approximately 120 participants (age range: preschool to 50s) include 8 people with color vision deficiency, and improved the program in response to feedback from 49 adult people (include child participants' family) and 68 child participants. The procedure of the latest version of the program is as follows. After the introduction (referring to points A to C), participants attended the painting workshop and wore colored goggles. After this experience of painting in a color world different from their usual one, participants were asked to look at their artwork, first wearing their goggles, then without the goggles, and finally by exchanging goggles with their teammates. The aim was to promote an appreciation of differences in the perceptions of the artworks. We tried the way of using drawing papers for each one instead of using big canvas for the fourth demonstration for 17 university students, and that was suitable for the class.

3. DISCUSSION

Participants' responses indicated that the programs were enjoyable for both people with trichromacy and those with color vision deficiency. Moreover, the results showed that even fourth-grade elementary school pupils were able to understand that color vision is diverse and that each different type of color vision has its own color world. A review by an expert on color vision diversity indicated that the two programs were effective in teaching participants about color vision systems, particularly that colors are not determined by objects, but by the eyes, the brain, and the spectral distribution of light. Of course, these two programs cannot directly reduce prejudice against people with color deficiency. However, we believe that if most people understood the concept of color vision diversity, it may help to reduce the current trichromat bias in social attitudes to color and increase social awareness of color vision diversity. To help create such change, we are planning future studies to collaborate with schoolteachers to examine how these programs can be adapted to real educational settings in schools. This will be a first step to changing social attitudes to color vision.

4. CONCLUSIONS

We developed the programs "The color detective" and "What color is this pigment!?" to educate people about color vision diversity. The results indicated that our programs may be useful in increasing people's understanding of the inherent variation in the properties of human color vision. We hope that such understanding of color vision diversity will help to change social attitudes. In future studies, we plan to collaborate with schoolteachers to examine how these programs can be adapted to real educational settings in schools.

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Color Harmonies and Playful Interactions: a Quantitative Analysis of the Impact of Colors on the Design and Behavior of the Game Trine 4 The Nightmare Prince

poster

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ABSTRACT

Colors influence emotions in a profound and shared way in digital environments such as electronic games (Joosten et al., 2012). The objective of this work is to investigate whether there are emotional differences in the visualization of the violet tones present in greater numbers in this genre of electronic game, which are possibly associated with the playful, happy and magical environment (Heller, 2012). The methodology adopted is quantitative, involving people over 18 years old, video game players and non-players. The association of violet with inspiration and spirituality showed a substantial effect in elevating the spirit and fostering optimism, although less than the impact of green. Furthermore, violet has demonstrated superior effectiveness in inducing a sense of inner peace compared to many warm colors. Violet's connection to the supernatural and the unknown was also significant, highlighting its ability to promote contemplative peace and evoke feelings of magic and fantasy.

Key words: Electronic Games; Colors, Emotions; Design.

1. INTRODUCTION

Electronic games, an integral part of popular culture for decades, have evolved significantly with technological advances and the Internet, offering improved emotions, graphics and storylines (Pereira, 2022). Colors influence these emotions in profound and shared ways (Joosten et al., 2012). This study examines the video game Trine 4, by developer Frozenbyte, which is set in a world of magic and fantasy. The objective is to investigate whether there are emotional differences in the visualization of the violet tones present in greater numbers in this genre of electronic game, which are possibly associated with the playful, happy and magical environment (Heller, 2012).

2. METHODOLOGY

The methodology adopted is quantitative, involving people over 18 years old, video game players and non-players. Using Heller's work Psychology of Colors (2014) as a theoretical basis, questions relating colors and emotions were created: Passion-red, Joy-orange, Optimism-yellow, Tranquility-green, Peace-blue, Mystery-indigo, Magic-violet . To measure participants' emotions in relation to the chromatic palette of seven scenes from the game Trine 4, a five-item Likert scale was used on the QuestionPro platform. Data were analyzed with JAMOVI software. Seven static scenes from the game, each with different backgrounds, characters, colors and lighting, were presented to participants. The Color Summarizer software analyzed the scenes to determine the concentration of pixels within the RGB space:

- scene 1 – 26% violet and 17.5% blue;
- scene 2 – 34.4% yellow/brown and 25.7% orange;
- scene 3 – 36.6% violet and 21.6% indigo;
- scene 4 – 38.3% green/brown and 3.57% violet;
- scene 5 – 41.8% dark blue/brown and 7.1% dark blue;
- scene 6 – 37.2% brown and 6.59% orange;
- scene 7 – 29% dark green and 26.57% light green.

The repetition of pixels in violet tones was observed, possibly associated with the playful environment (Heller, 2012).

3. RESULTS AND DISCUSSIONS

In total we had 52 participants. An ANOVA test was performed for the feeling variables versus the colors of the game scenes. The result for each table is displayed:

ANOVA a um fator (Welch)

	F	gl1	gl2	p
paixão	13,72	6	159	< ,001
alegria	12,3	6	159	< ,001
otimismo	12,91	6	159	< ,001
tranquilidade	17,7	6	158	< ,001
paz	11,05	6	159	< ,001
mistério	11,25	6	158	< ,001
magia	1,86	6	159	0,09

Figure 1: ANOVA test

Research Hypotheses

H1: Violet is often associated with lust and creativity, which can intensify passionate feelings more than Green, which is associated with calm and nature. Confirmed, because although there is a significant difference for green, in favor of green, the difference is still significant in relation to yellow, blue and red, in favor of violet (M=2.94 and M+3.98).

H2: The color Violet is more significantly and more effective in intensifying the feeling of Joy compared to warmer colors. Confirmed, because although there is a significant difference for green, in favor of green, the difference is still significant in relation to yellow, blue and red, in favor of violet (M=2.94 and M+3.98).

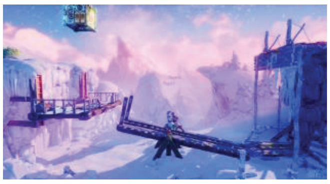
H3: Violet is often associated with inspiration and spirituality, which can uplift the spirit and foster optimism. Partially confirmed, as violet had a greater effect (M=3.38 and M3=3.65) than blue (M=2.58), it did not have a greater effect than green (M=3.88), colors associated with optimism.

H4: Violet, with its association with meditation and spirituality, can induce a deeper sense of inner peace than warm colors. Partially confirmed, as the violet has more effect M=3.75 and M=3.65) than blue (M=2.62), orange (M=2.58), red (M=3.02) and yellow (M=3 .54), but not greater than green (M=4.17).

H5: Violet, with its connotations of spirituality and introspection, can promote a deeper, more contemplative peace than warm colors. Partially confirmed, as violet had a greater effect (M=3.42 and M=3.48) than orange (M=2.37), red (M=2.79), and the same effect as yellow (M =3.44) and less effect than green (M=3.94).

H6: Violet is often associated with the supernatural and the unknown, while warm colors more with the everyday. Partially confirmed, as violet had a greater effect (M=3.60 and M=3.98) than green (M=3.29) and yellow (M=3.58), but not more effect than blue (M=4.58).

H7: Violet is often associated with the supernatural and the unknown, while warm colors are more with vivacity. Not confirmed, as all colors did not show significant differences for violet.



Scene 1

Scene 2

Scene 3

Scene 4

Scene 5

Scene 6

Scene 7

Descritivas de Grupo

	CENA	N	Média	Desvio-padrão	Erro-padrão	Cores
paixão	1	52	2,94	1.056	0,1464	violeta
	2	52	2,33	1.184	0,1641	laranja
	3	52	3,98	1.163	0,1613	violeta-escuro
	4	52	3,69	1.147	0,159	verde
	5	52	2,5	1.245	0,1726	azul
	6	52	2,73	1.239	0,1718	vermelho
	7	52	2,88	1.166	0,1617	amarelo
alegria	1	52	3,17	1.080	0,1497	violeta
	2	52	2,5	1.146	0,1589	laranja
	3	52	3,58	1.126	0,1562	violeta-escuro
	4	52	3,94	0,958	0,1329	verde
	5	52	2,56	1.243	0,1724	azul
	6	52	2,94	1.145	0,1587	vermelho
	7	52	3,44	1.092	0,1514	amarelo
otimismo	1	52	3,38	1.087	0,1508	violeta
	2	52	2,56	0,998	0,1384	laranja
	3	52	3,65	0,968	0,1342	violeta-escuro
	4	52	3,88	1.078	0,1495	verde
	5	52	2,58	1.109	0,1538	azul
	6	52	3	1.120	0,1553	vermelho
	7	52	3,58	1.109	0,1538	amarelo
tranquilidade	1	52	3,75	1.219	0,169	violeta
	2	52	2,38	1.174	0,1628	laranja
	3	52	3,62	1.087	0,1508	violeta-escurc
	4	52	4,17	0,923	0,128	verde
	5	52	2,62	1.255	0,174	azul
	6	52	3,02	1.146	0,1589	vermelho
	7	52	3,54	1.146	0,1589	amarelo
paz	1	52	3,48	1.291	0,179	violeta
	2	52	2,37	1.205	0,1671	laranja
	3	52	3,42	1.177	0,1633	violeta-escurc
	4	52	3,94	1.092	0,1514	verde
	5	52	2,73	1.402	0,1944	azul
	6	52	2,79	1.177	0,1632	vermelho
	7	52	3,44	1.178	0,1634	amarelo
mistério	1	52	3,6	1.225	0,1699	violeta
	2	52	4,02	0,98	0,1359	laranja
	3	52	3,98	0,98	0,1359	violeta-escurc
	4	52	3,29	1.210	0,1678	verde
	5	52	4,58	0,696	0,0965	azul
	6	52	4,29	0,893	0,1238	vermelho
	7	52	3,58	1.242	0,1723	amarelo
magia	1	52	4,31	1.058	0,1467	violeta
	2	52	4,1	1.034	0,1434	laranja
	3	52	4,15	1.036	0,1437	violeta-escuro
	4	52	3,92	1.064	0,1475	verde
	5	52	4,5	0,96	0,1331	azul
	6	52	4,23	1.002	0,139	vermelho
	7	52	4	1.120	0,1553	amarelo

4. CONCLUSIONS

The findings of this study elucidate the pre-eminence of the color violet in the intensification of various emotions, partially corroborating the theoretical postulates of the work Psychology of Colors by Heller (2012). Violet, often associated with lust and creativity, has been observed to intensify passionate feelings more effectively than yellow, blue and red, although green still prevails in evoking calm and nature. Furthermore, violet was significantly more effective in promoting feelings of joy when compared to warmer colors. The association of violet with inspiration and spirituality revealed a substantial effect in elevating the spirit and encouraging optimism, although inferior to the impact of green. When it comes to inducing a feeling of inner peace, violet demonstrated superior effectiveness compared to several warm colors, but was once again surpassed by green. Violet's connection with the supernatural and the unknown was also manifested, presenting a more pronounced effect than green and yellow, but less effective than blue. In short, the results partially confirm violet's ability to promote deep, contemplative peace and evoke feelings related to the supernatural, magic and fantasy. In this way, the relevance of the color violet in the design of electronic games is reaffirmed, not only as an aesthetic component, but as a psychological element that enriches the emotional and immersive experience of players. The color violet, with its playful, magical and fantasy connotations, transcends mere visuals and promotes an environment of enchantment and mysticism, essential elements in creating engaging and imaginative narratives in electronic games. We were unable to compare the results in relation to those who play video games and those who do not play video games because we have a small sample of participants.

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Fresh Appearance and Color in Green Vegetables

poster

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ABSTRACT

After harvesting, vegetables undergo an accelerated senescence (vegetable stress). Cutting the plant results in the disruption of the supply of water, hormones and other nutrients, which together with the lack of light, interrupts the development of photosynthesis. In the case of green vegetables, this decline generates a modification in the absorption spectrum of chlorophyll pigments. That is why, a change in the plant green color is observed. In the early stages of senescence, discoloration is accompanied by shine loss and changes in texture, typical of the dehydration. Although there would be no nutritional or taste change at this stage, the decrease in the vegetable marketing possibilities is noticeable.

There are different tools to delay the effects of this aging (post-harvest treatments): refrigerating and hydrating the product, chemical methods to preserve the visual appearance and experimental procedures based on light. The latter uses LED light pulses as a means of keeping active the chlorophyll pigments.

In order to analyze the color changes caused by post-harvest stress, the reflection spectra of four green vegetables were studied. The experiment was performed using green vegetables that are usually consumed without cooking: lettuce (Lactuca sativa), arugula (Eruca vesicaria), cucumber (Cucumis sativus), kale (Brassica oleracea) and spinach (Spinacia oleracea). For the plant in a "fresh" state (acquired at the beginning of its marketing chain) and after variable periods of senescence, spectrum measurements were performed.

In the tests, a light source simulating an illuminant A, with a continuous spectrum increasing towards the red zone, was used. The light reflected by the plant, in a wavelengths range practically coincident with the visible range (400 – 800 nm) was captured with an Avantes spectrometer, which also allowed obtaining the color parameters of the sample for this light source. A Diffuse Reflectance Standard were used as reference in order to obtain the vegetable reflexion.

Lettuce was the experimented sample with the most noticeable and rapid changes. A loss of spectral absorption in the 600 – 700 nm zone was observed, together with an increase above 700 nm. From the point of view of an observer, the changes in the spectrum generate a yellowing or redness, which can be quantified with a movement of the color point on the CIE color diagram. The modifications were similar, but of lesser magnitude in arugula and spinach, while cucumber was more complex to evaluate due to the appearance on its surface of areas with different degrees of senescence. In any case, the overall phenomenon was the same: the changes were minimal for wavelengths less than 600 nm. Changes in absorption as a product of vegetable stress, were found above 600 nm.

In practical terms, the results of the study suggest that light sources with a high red content (e.g., illuminant A used in the experiment) visually enhance yellowing. On the other hand, the use of LEDs, especially those commercially known as “cold”, because they have a decreasing spectrum above 550 nm, would somehow minimize color change. In addition, and taking into account studies on post-harvest conservation, these same types of spectra could help keep some of the chlorophyll pigments active, prolonging the fresh appearance of the plant.

1. INTRODUCTION

The objective of this study was to evaluate the spectrum of light reflected by fresh vegetables and follow changes in the senescence process. Our initial hypothesis was that color changes, which are minimal in the first days of storage and become noticeable at the end of the process, should manifest as spectral reflection changes. Since the senescence process involves the loss of chlorophyll pigment activity (Barry 2004, Koukounaras 2008), and these pigments have clearly defined spectral regions, changes in reflection should primarily occur in these areas. Identifying these changes will help determine the most suitable light source to highlight freshness during display and sale.

1.1 Experiment description

Fresh state reference was taken from vegetables purchased at a grocery store in the morning, approximately two hours after their arrival from the distribution center. Initial measurements were performed within two hours of vegetables acquisition. After the initial measurement, the samples were placed on trays to initiate a natural senescence process. This process was carried out in a controlled environment room without refrigeration (22 ± 2 ºC, RH between 70 and 90 %). Subsequent measurements were taken every two days until the samples showed noticeable deterioration. For lettuce, arugula and spinach, yellowing was quickly notable, making the product unusable after five or six days. For cucumber and kale, the process was slower. In these cases the experiment was limited to seven days, when vegetables showed spots or excessive dryness. Figure 1a shows two species of lettuce in their “fresh” state.

An Avantes spectrometer (Avantes 2024) was used to measure the reflected spectrum, covering a range similar to the visible spectrum, between 400 nm and 800 nm. A small integrating sphere was used as a collector, allowing measurement of both direct and diffuse reflected light (Figure 1b). The light output of the sphere (observer in Figure 1b) was connected with an optical fiber to the spectrometer’s collector.

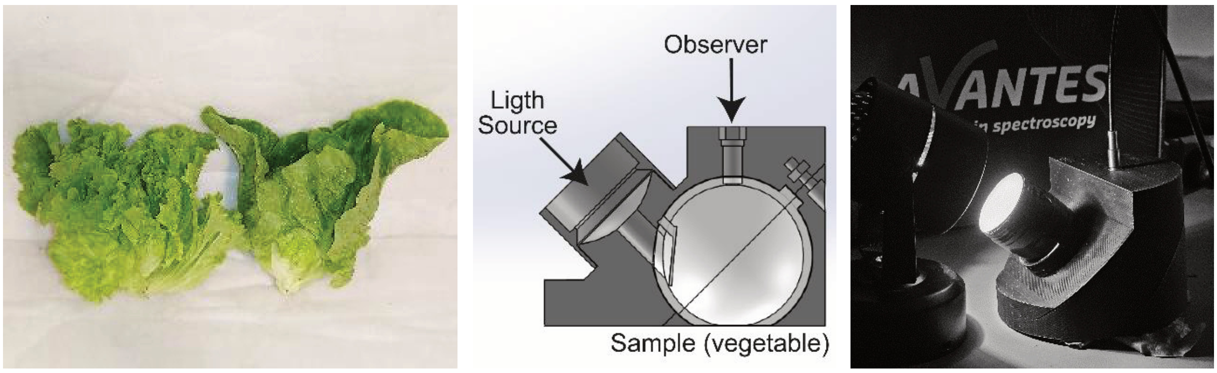

Figure 1: (a) two species of fresh lettuce, (b) integrator scheme and measurement aspect

The used light source was an incandescent lamp, simulating a CIE A type standard illuminant (CIE 2018). Before measuring the vegetable samples, the system was calibrated by using a white standard reflectance (Labsphere 2024). The standard reflectance was located in the integrator aperture (instead of the plant sample). The obtained spectrum (corresponding to the diffuse reflection of the reference lamp) was later used as a reference for the plant measurements. In this way, the reflectance obtained for the samples were referred to the standard reference (spectrally flat) and independent of the light source spectrum.

For leafy vegetables (except kale), initial degradation was more noticeable on the edges opposite the stem. Subsequent measurements were taken on the central part of the leaf to obtain averaged information. In the case of fruits (cucumbers), discoloration occurred in specific areas. In this case, the surfaces showing color change were selected as witnesses of senescence.

2. RESULTS

In general, the green color of the vegetables studied is characterized by a pronounced reflection lobe centered at 550 nm. On both sides, reflection decreases, with minimum values in the 450-500 nm regions and (more pronounced and sharper) in the 660-680 nm region. Reflection increases rapidly towards the infrared. Although it is challenging to qualitatively analyze the reflection curves, in dark green samples (kale, cucumber), the 550 nm lobe is more pronounced. In lighter vegetables (lettuce, arugula), we find relatively more components in areas near 500 and 600 nm (the lobe is wider). With their particular nuances, the reflection valleys coincide with the absorption peaks studied for the main chlorophyll pigments.

The senescence process shows a tendency to "flatten" the reflection curve. In lettuce, for example (Figure 2a), a noticeable increase in reflection is observed at 650-670 nm and a decrease above 700 nm. The curve also loses selectivity in the blues, but the change is smoother. The yellowing, which is comparable to a loss of freshness, is mainly caused by changes occurring above 650 nm, even in the region above 750 nm, at the limits of the visible zone for humans.

In kale (Figure 2b), the effect is similar. In all studied samples, the curve flattens with senescence, but here the change is smaller for wavelengths below 550 nm. Relatively, the change is much more significant in the red region of the spectrum.

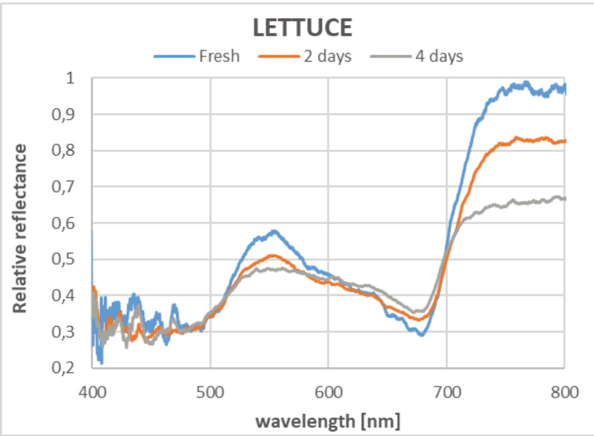

Figure 2a Senescence in lettuce.

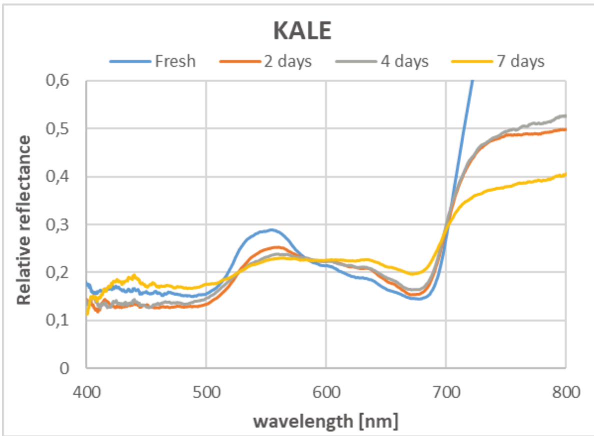

Figure 2b Senescence in kale

3. DISCUSSION

The results obtained indicate that the visual change attributable to the "loss of freshness" is linked to the decrease in chlorophyll b activity, especially the pigments that absorb light in the red region. This result is consistent with post-harvest studies (Sun 2024, Pintos 2023) that use light in this range to prolong the shelf life of harvested produce by trying to increase the activity of these pigments. Our inference is that the fresh appearance could be maintained longer if, at display and sale points, light sources with limited red emissions are used to minimize the visual changes resulting from senescence. It is emphasized that at these stages, the product still retains its flavor and nutritional potential, with only a change in appearance that may hinder its commercialization. Finally, the proposed change contrasts with entrenched design practices. In effect, in markets or major commercial centers, more intimate spaces are reserved for products such as wines and spirits or fruits and vegetables. This effect is achieved using warm lights (with more red content). Our proposal would be to use LED sources (inherently with limited red content) with neutral or cool light. Based on the results of this experiment, applying these light sources would lead to maintaining the fresh appearance of leafy vegetables and green fruits for a longer time when consumed raw.

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Colors, Ideologies and Meanings in the 2022 Brazilian Elections

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ABSTRACT

This study analyzed graphic artifacts from the campaign of the two main candidates in the 2022 Brazilian presidential elections – Lula da Silva and Jair Bolsonaro – with the aim of understanding the symbolic use of colors in this conjuncture. A qualitative investigation was carried out in two stages: (1) bibliographic research and (2) visual analysis. Visual observation supported by the Image Color Summarizer (ICS) tool was used. The qualitative analysis verified the articulation of the colors with the other signs (iconic, plastic and linguistic) in the construction of a discourse inserted in the Brazilian social and political context. The analysis shows that, in Lula's campaign, red and white identify the left and reinforce the image of the 'proletarian', 'strong' and also 'peacemaker' man. Blue, yellow and green signal the different political forces gathered around Lula's candidacy and refer to the Brazilian nation idea. In the Bolsonaro's campaign, green and yellow refer to the concepts of 'military', 'patriot' and 'good citizen'. White and blue represent the idea of a religious and 'uncorrupted' man. It is concluded that: in Bolsonaro's campaign, the exclusive use of national colors directs communication to conservative and religious groups; while in Lula's campaign the greater variety of colors signals a broad coalition of forces, suggesting coexistence with diversity, 'inclusion' and union.

1. INTRODUCTION

Historically, the representation of political identities through colorful symbols has been observed in the context of a polarized world, divided by opposing ideologies (Ridolfi 2015b). Aggravated by the rise of ideologically divided masses, political polarization has intensified globally in recent decades, undermining the pursuit of a common good (Gu and Wang 2022).

Colors acquire meanings and influence our responses within a social system or related to a context (Fine et al. 1998). In the political field, they are used as symbols to represent parties and ideologies, becoming central pieces in communication strategies. Colors, as well as clothes and objects, signal political positions and make it possible to manifest adhesion or opposition (Ridolfi 2015a).

In Brazil, the division between left and right has been marked by a chromatic division, in which the color red is adopted by the progressive camp, while the official national colors (green, yellow, blue, and white) are used by the right and extreme right (Pereira, França and Freitas 2024). In this context, colors indicate belonging to opposite sides and are widely used by voters, political parties, and in communication design.

This study aims to understand the symbolic use of colors in the context of the 2022 Brazilian presidential elections. In the first phase of this research, the graphic artifacts of candidate Jair Bolsonaro's campaign were studied (see Pereira, França and Freitas 2024). In the second phase, the graphic pieces of Lula da Silva's campaign were investigated. This paper presents a comparative analysis of the two sets.

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2. METHOD

A qualitative investigation of an applied nature was carried out in two stages: (1) bibliographic research and (2) visual analysis. The bibliographic study synthesized data on the meaning of colors and their use in the political field, especially in the electoral campaign for president of Brazil. The comparative analysis considered two sets of graphic artifacts: the candidate Lula da Silva's campaign material (Set A) and the Jair Bolsonaro's material (Set B) (Figure 2), available for download on the official websites of the campaigns in October 2022 (https://partidoliberal.org.br/downloads/?categoria=material-de-campanha and https://lula.com.br/materiais-de-campanha).

Based on a method for identifying the meaning of colors that we used in a previous study (Pereira 2011), the following analysis guiding principles (Figure 1) were considered: (1) the use of colors is intentional and serves certain objectives (to provide visibility, to convey objective information, to convey a positive image); (2) the color meanings are related to other signs (iconic signs such as photographs, drawings; plastic signs such as colors, shapes, composition; and linguistic signs); (3) the color meanings are based on the shared semantic repertoire (cultural system, context). The articulation of colors with the other signs was observed in the construction of a discourse inserted in the Brazilian social and political context of the 2022 elections.

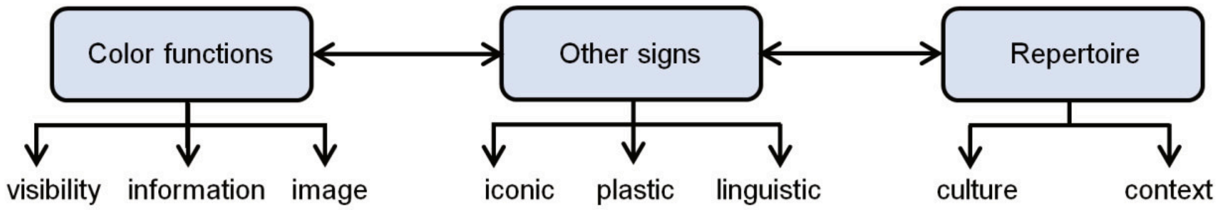

Figure 1: Guiding principles of color analysis.

To determine the predominant colors of the two sets, visual observation supported by the Image Color Summarizer (ICS) tool was used. The ICS tool (disponível em: http://mkweb.bcgsc.ca/color-summarizer/) identified the most representative shades of the sets based on the following parameters: html, 5 color clusters, space, vhigh 200 px.

3. RESULTS AND DISCUSSION

38 graphic pieces were obtained: 10 from Lula da Silva's campaign (Set A) and 28 items from Jair Bolsonaro's campaign (Set B). The analysis performed by the ICS tool for both sets identified the color distribution shown in Figure 2.

3.1 Lula's colors

In the graphic pieces of Lula da Silva's campaign, blue and red predominate, combined with white, green and yellow (Figure 2). Red – a color historically associated with social struggles and workers' movements around the world (Pastoureau, 2016) – represents the Partido dos Trabalhadores, founded by Lula, and highlights the candidate's name presented in white. At the age of 77, Lula – the worker and trade unionist who governed the country in two previous terms – positioned himself in the campaign as an conciliatory politician, opposing the intolerant, armamentist and anti-democratic discourse of the extreme right. In this context, red and white identify the left and reinforce the Lula's image of the 'proletarian', 'strong' and also 'peace-maker' man.

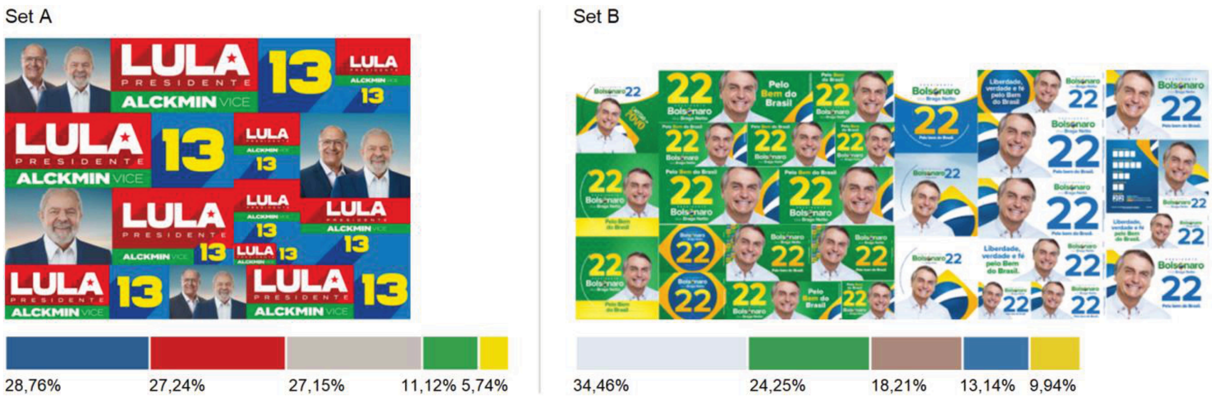

Figure 2: The two sets analyzed and their color distribution (by the ICS tool).

The use of blue as one of the predominant colors, the image and the name of the vice-presidential candidate (a centrist politician) next to Lula da Silva, and the inclusion of green and yellow in the pieces signal the different forces of the political spectrum gathered around Lula's candidacy – a coalition of seven political parties entitled ‘Let’s Go Together For Brazil’ – and at the same time refer to the idea of the Brazilian nation.

3.2 Bolsonaro’s colors

In Jair Bolsonaro’s campaign, the results show an exclusive use of Brazilian national colors divided into two subsets of artifacts: green background (B1), with a predominance of green and yellow; and white background (B2), with a predominance of white and blue (Figure 2). In the recent Brazilian political context, the green-yellow was appropriated by the articulation of right-wing groups with the media to legitimize the President Dilma Rousseff’s mandate revocation, which took place in 2016 (Becker et al. 2017) and Jair Bolsonaro encourages the use of national symbols by his supporters.

In the campaign material, the use of national flag’s colors and graphics associated with the texts ‘Captain of the People’ and ‘For the Good of Brazil’ allude to the candidate’s military origin and their supposed patriotism. These signs also refer to the idea of the ‘good citizen’, an expression related to moral values that seeks to distinguish itself from the “leftist” people who would promote the customs “disorder” (Medina et al. 2022). This distinction is reinforced by the total absence of red in the material, a color historically associated with communism – or the “red peril”, as it has been called by the anti-communists (Pastoureau, 2016). In addition, the use of national colors contributes to legitimizing the candidate’s image as an ‘official representative of Brazilians’.

On the white background artifacts, the slogan ‘Freedom, truth and faith for the good of Brazil’ emphasizes the image of a candidate whose political performance is supported by religion and linked to a certain “messianism” (see Sanchez and Arruda 2020). For Christians, white has positive connotations, symbolizing baptism, conversion, the Jesus resurrection, glory, and eternal life (Pastoureau 2000). White and blue reinforce the imagery of the ‘messiah’, contributing to the intended public perception of a religious and ‘uncorrupted’ man.

4. CONCLUSIONS

In societies around the world, political polarization has been a disruptive force that undermines the pursuit of a common good (Gu and Wang 2022). The 2022 Brazilian elections were marked, on the one hand, by polarization and political violence, and on the other, by an attempt at a pro-democracy coalition, the result of which – the victory of President Lula, obtained with a small difference in votes – confirmed a division process of the country (Singer 2023).

In this context, the exclusive use of national colors in Bolsonaro's campaign reinforces ideological polarization, directing communication only to conservative and religious groups, excluding sectors of society with divergent thinking. In this sense, the banning of the color red in graphic pieces indicates a total distancing from the left and progressive agendas. In Lula's campaign, in turn, the greater variety of colors and the use of red and blue as predominant colors signals a broad coalition of forces, suggesting 'composition', coexistence with diversity, 'inclusion' and a search for the union of Brazilian society.

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Calibracor: A Novel Free Software for Digital Image Color Calibration

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ABSTRACT

This study introduces *Calibracor*, a free web application that identifies the X-Rite ColorChecker in digital images and automates the color calibration process using grayscale samples from the color reference target. The approach adopted in this project is based on segmenting the color chart and then applying image processing, the calibration itself. As a result, *Calibracor* has reduced the average ΔE from 31.4 to 6.5 between the original and the treated images. Emphasizing accessibility, automation and reliability, this research addresses challenges posed by color distortions in digital images and contributes for the improvement of color improvement representation.

Keywords: colorimetry, color control, neural network, image processing, free software

1. INTRODUCTION

The widespread integration of high-resolution cameras in smartphones and advanced computational processing has revolutionized image capture. Some color distortions occur during the capturing and significantly affect the accurate representation of the real colors in critical applications (Kim et al., 2017). The color calibration process is often intricate, requiring user expertise (Cardoso, 2016) and it is used to deal with color distortions that can happen during the capture process, significantly affecting the precise representation of true colors in critical applications. These distortions significantly impact the accurate representation of colors in applications such as fine arts reproduction, restoration process of historical objects and many other purposes (Leão and Westland, 2019).

Calibracor[1] employs neural networks to identify the position and orientation of a color chart in an image and utilizes its grayscale samples to enable automated calibration. Since these grayscale samples, though neutral, contain RGB values, they are effective for performing color calibration. Once the color chart has been identified, the software applies white balance and contrast curve correction operations over the image.

This article is organized with this introduction followed by the methodology section in which are detailed the steps for i) how to isolate the color chart within the image and the ii) color calibration process; the section results and discussion shows the outcomes and a evaluating of the color distortion of some images before and after the automated color calibration and the conclusion shows the advantages of our software as a facilitator of processes for individuals interested in calibrating images and future works.

2. METHOD

The approach adopted in this project is based on segmenting the 24-color ColorChecker chart from X-Rite and then applying image processing, the calibration itself.

For the chart detection a image dataset was created to train a neural network to segment the images. The training dataset is composed by: i) real-world photographs with the X-Rite

[1] Calibracor is a software developed at the Scientific Imaging Documentation Laboratory (iLAB) - School of Fine Arts - UFMG available online for free at https://ilab.eba.ufmg.br/calibracor.

ColorChecker and ii) procedurally generated images, rendered with Blender[1]. The final dataset consisted of 700 images, each of which was manually annotated using the VGG Image Annotator (Dutta et al., 2016). These annotated images were then used to train the U-Net (Ronnemberger et al, 2015).

The train and test datasets were split in an 80 to 20 ratio, and an average IoU (Intersection over Union) of 0.93 was obtained in the train dataset and 0.96 in the test dataset, indicating that the program is able to accurately determine a color chart's position. However, the program provides a manual adjustment step to be used when the automatic detection is not accurate enough.

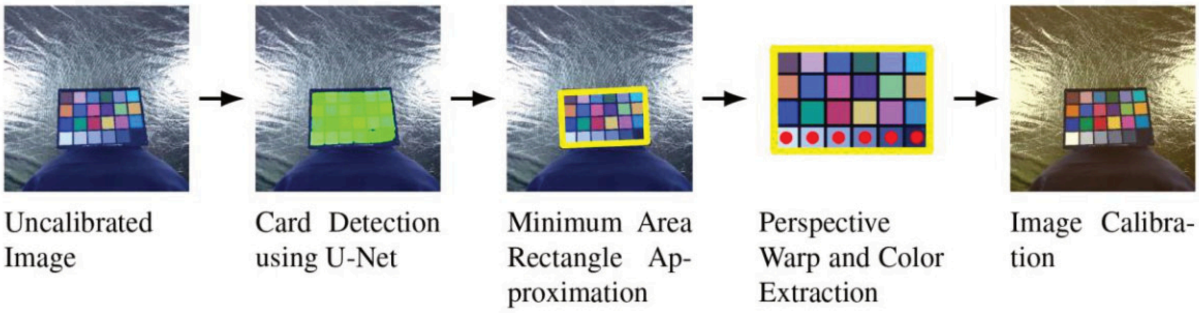


Figure 1: Calibration Process

Color Information Extraction: With a minimum area rectangle detection over the segmented area, the chart is mapped into a template by using perspective warping, exemplified in Figure 1. This template provides known positions for each color sample, enabling the extraction of the data necessary for calibration. Both minimum area rectangle approximation and perspective warping algorithms were provided by the OpenCV Python Library.

Image Processing: The image calibration process is done with white balance correction and contrast curve adjustment, both based on the grayscale tones present in the color chart. Specifically, white balance correction ensures that neutral tones appear truly neutral by adjusting the colors accordingly while contrast curve adjustment improves the image's exposure and tonal range by optimizing the contrast between light and dark areas.

Experiments

The following experiments are conducted to test the color correction efficiency of *Calibracor* and measure the accuracy of this correction using ΔE exemplified in (Mokrzycki et al., 2011). Photographs were captured under various camera configurations, measuring the color distance between the images and the original object's colors before and after calibration.

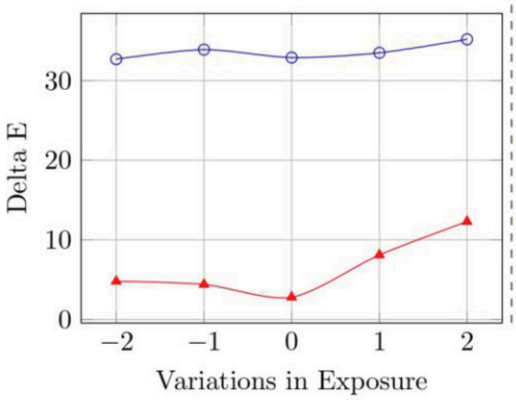
The experiment employed a set of photographs captured by a Xiaomi Poco X3 Pro smartphone, equipped with Android 11 RKQ.200826.002 while being illuminated by a 5500K LED from FloodLight (Model LDV-FL-50AM). The images were captured in DNG and JPEG formats, with the latter being used for analysis. In total, 17 photographs of the color chart were captured. Variations in Exposure (EV) and White Balance (WB) settings were explored to create different conditions in the sampled images.

Five photos were taken with different EV settings (-2, -1, 0, +1, +2), all using automatic white balance. Additionally, seven more photos were captured with white balance adjusted across Kelvin color temperatures (2000K, 3000K, 4000K, 5000K, 6000K, 7000K). Another set of five photos varied white balance settings across predefined modes.

The colors of the ColorChecker chart were measured using the X-Rite i1Publish Pro 3 spectrophotometer. For the colors within the photos, a custom Python program was developed

[1] Blender, a powerful 3D modeling and rendering software, was employed to generate a series of images of the color chart across various backgrounds and positions.

to automate the data annotation process for the measurements. This automation was important due to the complexity of annotating the three CIELAB components (L*, a*, and b*) for each of the six grayscale colors across 17 different images, both before and after calibration, resulting in a total of 612 values. Using the collected data, we calculated the mean difference in ΔE between the image after and before *Calibracor*. The follow diagram resumes the process.



Figures 2: EV versus ΔE.

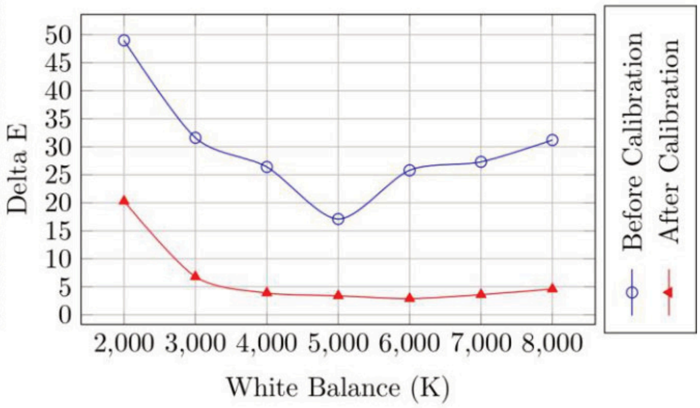


Figure 3: WB versus ΔE.

3. RESULTS AND DISCUSSION

The experimental results, summarized in the Graphics 1 and 2, reveal a significant reduction in the color deviation of images compared to the color data from Colorchecker. This reduction is evident across all test images, resulting in a ΔE ranging between 2.8 and 49. The Graphic 1 "EV versus ΔE" shows the ΔE before calibration (mean 33.7) and after calibration (mean 6.5), which result in a reduction of 27.2 ΔE. The exposure "0" generates the best result 2.8 and exposure "2" the worst result 35.2. The Graphic 2 "WB versus ΔE" shows the ΔE before calibration (mean 29.8) and after calibration (mean 6.5), which result in a reduction of 23.3 ΔE. The WB 6000K generated the best result 2.9 and WB 2000K the worst result 49.

Many factors can modify the color quality in the images, like the file format, the sensor quality, the bayer filter, the light source quality and others. It means that this research can be improved to solve those variables.

4. CONCLUSIONS

Based on these tests, it is possible to affirm that the proposed tool works as a useful tool for interested users, reducing the color distortion in images by a significant amount. This software has been made available to the public by the Fine Arts School Information Technology team as a web application at the address "https://ilab.eba.ufmg.br/calibracor".

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The Role of Colour in the Visual Narrative of Video Games

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ABSTRACT

In recent years, studies have focused on exploring the use of colour in audio-visual language, which has mainly been approached from the context of cinematography. However, research related to colour as a communicative element in the visual narrative of video games is not yet consolidated, and there is a shortage of bibliographies related to this subject. This research investigated the identification of strategies for applying colour as a communicative and interactive element in the visual narrative of video games. The starting point was recognizing the role of colour in audio-visual language from various authors related to film studies, and the identification of main visual narrative strategies related to colour in cinematography. Then, using these strategies, an analysis was carried out on ten case studies of selected video games, in which colour is a fundamental element in the art direction. In each video game, the scenario, characters, and mechanics were analysed. The main results of the research indicated a general coherence between the ways of using colour as a communicative element in both media, cinema, and video games, through the identification of different applied techniques. However, the interactive nature of the video game differentiates it from cinema and implies additional complexities and possibilities for colour as a communicative resource, which can play a relevant role in the interaction with the player and the development of the narrative and plot.

1. INTRODUCTION

Visual narrative or visual storytelling is the use of visual elements such as layout, textures, light, shadow, and colour, to communicate visually and tell stories. Visual narrative is a resource commonly implemented in different graphic and audio-visual media such as films, comics, and interactive games, among others (Caputo et al., 2003). Colour is a fundamental element of visual narrative and has been studied mainly in the field of cinema, where several attempts have been made to define the role of the chromatic aspect in the presentation of the plot, the description of the characters in the story, and other aspects of the film's communication to the spectator. However, in the field of video games, the study of visual narrative has received less attention, resulting in a scarcity of studies on the role of colour, especially in terms of its contribution as a powerful communicative resource. Additionally, in this audio-visual medium, the unique component of interactivity of the user or "player" within the game, could present interesting challenges and opportunities for colour as a narrative resource, broadening the horizons of visual storytelling of other mainly receptive media such as cinema. On the other hand, in the case of video games, the aspects of narrative and storytelling have generally been related mainly to the "adventure games" typology, which requires the player to engage in activities such as reflection, discovery and association of plot elements, which will build the story presented (Egenfeldt-Nielsen et al., 2016). This research sought to identify the main strategies through which colour is applied in the visual narrative of video games, starting from a comparison with the communicative uses of colour in cinema, and identifying elements that are innovative and/or belong to the video game medium. The research focused on case study analysis of ten video games, selected because of their particular use of colour, and by putting special emphasis on how colour supports the creation of the interactive experience of the game, facilitates the player's understanding of the dynamics and enhances the player's immersion in the scenario and the plot in which the game unfolds. The purpose of this study is to provide a reference frame for designers, game developers and art directors, which promotes a greater inclusion and more conscious application of colour in the visual narrative of this interactive medium.

2. METHODOLOGY

This study employs qualitative research methods and two main research tools: case study analysis and comparative visual analysis.

2.1. Sample selection criteria

The main requirements established for selecting the video games to analyse:

a. Novelty: the selected games were all released in the last 15 years (from 2009 to 2024).
b. Adventure type: all games are classified as "adventure type", as this typology considers most elements of visual narrative and, at the same time, they stand out for their stories, which highly influence their visuality.
c. Quality: most games have been awarded for their art direction or aesthetics, to ensure the quality of their visual design. Games nominated and awarded during the last 15 years by the *BAFTA Game Awards* institution, or the *Independent Games Festival* were selected.

The final selection of games is as follows: *Oxenfree* (released by Nightschool Studio in 2016); *Inside* (released by Playdead Studio in 2017); *Gris* (released by Nomada Studio in 2019); *Journey* (released by Thatgamecompany in 2012); *Gorogoa* (released by Buried Signal in 2017); *Hellblade: Senua's Sacrifice* (released by Ninja Theory in 2017); *The Artful Escape* (released by Beethoven and Dinosaur Studio in 2021); *Hyper Light Drifter* (released by Heart Machine in 2016); *Ori and the Blind Forest* (released by Moon Studios in 2016); and, *Night in the Woods* (released by Infinite Fall in 2017).

2.2. Creation of a matrix for case studies analysis

Based on a systematic literature review, the main sources from film studies were identified to facilitate the construction of an analysis matrix, relevant for the categorisation of communicative uses of colour in film. On the other hand, game theory and video game sources contributed to the identification of the key elements to be analysed in any video game. Seven possible communicative uses of colour were identified (Table 1), and three key elements of each video game were analysed: scenario, characters, and the game mechanics i.e., the rules and systems that make up video games (Labrador, 2020).

2.3. The comparative visual analysis

The selected video games were analysed through actual gameplay, *cutscenes* and walkthrough videos. During this process, videos and images were captured whenever the use of colours in the three key elements analysed was considered important and relevant according to the seven chromatic uses. The changing environmental design, the characters' attitude towards the player's actions, and several interactive objects (such as treasure chests, rewards, collectables, etc.) were particularly relevant in this analysis phase, as most of them are only existent in the video game language (and not in films). Additionally, notes were taken, and the information obtained was then organised and categorised in the analysis matrix. Finally, a cross-review of the matrices was carried out, analysing, and comparing the results obtained among the video games, to identify patterns and draw conclusions.

Table 1. The seven communicative uses of colour in video games

Time-based	Visual demonstration of the passage of time, illustration of a specific era or time, dividing scenes into past-present-future, using colour
Identifying	Differentiation of the key elements of the game using different colours, e.g., spaces, characters, interacting objects, using colour
Symbolic	Representation of symbolic, non-verbal information, using colour
Associative	Use of colour to provide intuitive information about the story, facts, plot, clues
Transitive	Representation of transitions or evolution of the plot, events, or characters in the story, that are not time-based, using colour
Emotive	Evocation of emotional reactions in the player, such as anxiety, happiness, fear, peace, etc. using colour
Aesthetic	Use of a general chromatic palette with a mainly aesthetic purpose, use of exaggerated colours, not real colours, out of the ordinary, etc.

3. MAIN FINDINGS

Time-based colour use: different shades of grey are usually used in scenarios and environmental design, to represent the past. Also, a sudden change of the colour palette is usually used to contrast between different eras. The colours of characters are usually changed, added, or removed to differentiate a past moment from the present. No specific colour strategies were recognised in the case of mechanics.

Colour as an identifier: in scenarios, usually navigation and map areas are divided by colour, and changes in saturation are used to highlight and contrast zones. Colour is generally used to identify climates or atmospheres, and symbols of different colours help to differentiate specific zones or areas. Different predominant colours are used to identify the characters. Also, dialogue bubbles and other elements are coloured according to the character's hue. Additionally, colour is used to identify various interacting elements of the game's mechanics.

Symbolic colour use: colour is applied to elements of the scenario to warn the players of certain situations, such as an approaching danger or something about to happen. Specific colours are added to the characters' appearance to represent their emotions and provide information about their different personalities. Regarding the mechanics, colour is used to symbolize elements such as good and evil, hope or danger.

Associative colour use: colour is used through repetitive patterns in certain elements to support players in a learning process. Repeated colours also help them associate and create connections between characters, scenarios, mechanics, and situations, to understand the development of the story.

Transitive colour use: in the scenarios, colour is used to represent changes in the environment, devastation, disasters, and the return to normality. Also, colour is usually used to represent the evolution of the characters' state of mind, illness, evil possession and healing processes, becoming ghosts, or passing to the afterlife. Regarding the mechanics, colour changes denote improvements, new abilities, more functions, and game rules.

Emotive colour use: in the scenarios, dark colours are used to limit the player's vision, raise the challenge, and cause tension. Red is also used to cause a reaction in the players, such as anxiety. Warm colours create cosy environments, cold colours are used to evoke uncomfortable environments. Adding or removing colours to the characters' appearance can also provoke emotional responses in the players, evoking empathy, or fear, among others. In the mechanics, coloured lights are often used to provoke awe and call for the player's attention to some specific elements of the game.

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Aesthetic colour use: in general, real colours are used to represent real-life scenarios, characters, and mechanics. When colour is purposely changed to unreal high or low saturation or high or low lightness, it is usually used to describe imaginary, dystopian, fantastic and/or dreamlike aspects of the game.

4. CONCLUSIONS

Most of the colour strategies mainly used in film are found in video game design, but they are strongly adapted to the interactive nature of the video game. The use of colour in this interactive means is mainly focused on supporting players in their intuitive experience, for understanding the plot, getting acquainted with the environment, and learning how to follow the game dynamics by developing skills. This also confirms statements made by authors such as Niedenthal (2013) and Labrador (2020), that colour can be key to differentiating temporal, emotional, environmental, and conceptual elements of the video game, while aiding to comprehend the game's progression. Although the mechanics are usually less related to the colour's communicative uses, it stands out as the most auspicious element for colour to improve communication with the player and provide an interactive experience. This study is a contribution to the colour decision-making of designers and art directors in the video game creation process while highlighting the role of colour and its communicative possibilities in current and future audio-visual media.

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poster

Color in the City: An Analysis of Chromatic Interventions in Urban Space Paving

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ABSTRACT

In the last two decades, colors have become a more expressive part of the urban environment worldwide (Yu, Bell, and Ponzo, 2021), contributing to the city's identity and the quality of life of its users. Currently, many urban-scale color interventions use street paving art as a tool for requalifying urban spaces. These interventions involve designs and colors applied to sidewalks and/or roadways, coloring the landscape and attracting users, transforming the city, and improving previously neglected spaces. Many of these chromatic projects focus on humanizing and visually enhancing city environments, aiming to attract users, reinforce local identity, promote the use of spaces, and provide new meanings to them. Others, in addition to impacting the street's aesthetics, modify the road layout of a region and/or create new areas for pedestrians, thus prioritizing pedestrian use in the city. In this context, considering the various ways to use color in paving, this work analyzes chromatic interventions in public paving to develop a typological categorization to understand the possibilities of using color in this urban component. The study methodology was developed in two stages. In the first stage, websites and guides on color actions in urban spaces were consulted; in the second stage, 115 projects were selected and investigated. As a result, a classification was developed based on two aspects: the function performed by the color in the intervention and the infrastructure involved. Regarding the function of color in paving, two possibilities were identified: aesthetic function and space redesign function; both involving two types of art: sparse art and mural art. As for the typology determined by the infrastructure involved in the project, the two identified possibilities are: road art and pedestrian space art, a classification derived from the Asphalt Art guide (2019). From the study, it was possible to verify that, despite the different objectives behind chromatic interventions in city paving, they all share a common goal: the pursuit of more welcoming, attractive, safe cities focused on the well-being of their users.

1. INTRODUCTION

Colors, in addition to influencing the aesthetics and visual identity of spaces, can be used to distinguish urban functions, providing individuals with territorial control and mental organization; factors that positively impact human comfort and well-being (Almeida and Gomes, 2018). Thus, well-planned colorful spaces, in addition to being visually attractive, facilitate the understanding and appropriation of the city by its inhabitants.

Although the colorful image of the landscape is generally associated with buildings, urban chromatics involves other elements of the space, such as furniture, vegetation, and paving – the latter being an urban component that has gained prominence in recent years.

Currently, various chromatic interventions in paving incorporate artistic elements, such as mural paintings, to enhance and transform underutilized or neglected urban areas. Research conducted by Zena O'Connor (2020) indicates that qualifying chromatic actions applied at a micro-scale of the city represent an accessible approach to implementing significant and effective changes in a short period. In this context, the possibilities for using color are diverse.

However, despite the significant number of practical examples of this type of chromatic action, there is little educational material available on these initiatives. Based on this, this research aims to study the use of color in public paving to develop a typological categorization for the possibilities of chromatic interventions in this urban component.

2. METHOD

The work was developed in two stages. In the first stage, websites, manuals, and guides on urban interventions with colors were consulted and analyzed in search of chromatic action projects in paving. The selected sources were: the Asphalt Art guide (i), including the website of the same organization responsible for the material, the Asphalt Art Initiative (ii); the *Piazze Aperte: Un programma per lo spazio pubblico di Milano* guide (iii); the Designing Streets for Kids manual (iv); the Street Plans website (v); and the book *Urbanismo Ciudadano en América Latina* (vi). In addition to these sources, other websites with more varied projects were investigated. Based on the information obtained in the first stage, the projects were then selected and analyzed. Both procedures were carried out through the observation of images and the information present in the reference materials.

The selection of 115 projects, out of more than 200 examples, was based on three criteria: the projects had to necessarily include the use of colors in the paving of public city spaces; the "amount" of color applied in the intervention had to be significant, meaning only projects with a substantial use of colors were selected; and the projects needed to have sufficient educational and methodological information for analysis. In cases of doubt, such as the location of the intervention or the type of design, other sources were consulted, including artists' websites, municipal websites, and the Google Maps platform.

3. RESULTS AND DISCUSSION

As a result of the analysis, two ways to classify the projects involving color in paving were identified: regarding the function that color performs in the intervention and regarding the infrastructure involved in the intervention. In both situations, the chromatic initiatives aim to improve urban environments by promoting humanized spaces, strengthening local identity, encouraging people to appropriate the city, and assigning new meanings to spaces.

3.1 Typology determined by the function of color

Two main functions for using color in paving intervention projects were identified: aesthetic function and space redesign function. For the **aesthetic function**, the type of art adopted should be observed to classify the projects (Figure 1). In the case of loose, not necessarily interconnected designs, and "scattered" across the paving, sparse art is used. The other possibility is murals, or mural art; "compact" or concentrated designs, where the paving is conceived as if it were a canvas or decorative screen on which everything is painted.

Figure 1: On the left, sparse art in the Czech Republic; on the right mural in Columbus, IN, USA.

Figure 2: On the left, road redesign in Houston, TX, USA. On the right, urban redesign in Santiago, Chile; former vehicle lane transformed into a pedestrian space.

In addition to the aesthetic function, there is the function of **space redesign**, where colors are used to prioritize pedestrians in the city. In this case, the redesign can be of two types: road and urban (Figure 2). Road redesign refers to projects with traffic calming objectives and actions, where color is used as a tool to modify the city's road structure; examples include curb extensions, alterations to crosswalks, and the addition of refuge islands. In these situations, color is predominantly found on the roadway.

Urban redesign aims to transform spaces through new uses; in this case, color is generally used to "design" new pedestrian areas in the city. Thus, environments previously used for one purpose are repurposed for another; for example, outdoor parking lots are converted into open plazas through the use of color in their paving. In the case of vehicle lanes transformed into pedestrian spaces, such as promenades and squares, both types of redesign are present.

3.2 Typology determined by the infrastructure involved

In addition to function, another way to categorize color interventions in paving is based on the type of infrastructure involved in the project. The two possibilities in this case are: art in the roadway and art in pedestrian space (Figure 3). This classification derives from the Asphalt Art guide (Associates, 2019: 11).

Art in the roadway occurs when projects are developed in paved and active areas accessible to motorized vehicles. The types of this action can be: intersection/crossing mural – located at street intersections; mural/sparse art on crosswalks; and mural/sparse art on roadways – located along the extent of the streets. **Art in pedestrian space** describes projects carried out in areas inaccessible to motorized vehicles, such as sidewalks, and on various surfaces that are transformed into plazas. This type of intervention includes cases of curb extensions and projects where parking lots and unused city spaces are converted into open plazas.

Figure 3: On the left, art in the roadway and, on the right, art in pedestrian space; both in a project in London, England.

4. CONCLUSIONS

In summary, there are two ways to classify chromatic interventions in paving: based on the function performed by the color, and based on the colored infrastructure. In the first case, the function can be aesthetic or space redesign, each with its own subcategories. In the second case, the two possibilities for categorization are: road art and pedestrian space art.

Despite the various objectives and ways to use color in public paving, all actions aim to requalify the space and enhance the user experience in the city. Additionally, it is observed that prioritizing pedestrians in urban spaces is a key objective of chromatic actions in paving, as the majority of projects are designed to be enjoyed by those traveling on foot or at low speeds.

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Color, Environment, and Sustainability: Faculty of Law, University of Lisbon

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ABSTRACT

Since its genesis with the architect Porfírio Pardal Monteiro and the visual interventions of Almada Negreiros, two references in Portuguese architecture and visual arts, the Faculty of Law of the University of Lisbon has always had a series of interventions that highlight its cultural value in architectural, artistic and sustainable terms, where color plays an important role. The faculty's building was later expanded in two phases that predominantly favor the visual arts represented by the glazed tiles of Andreas Stöcklein and interventions by students and professors of the Lisbon School of Fine Arts, and the color of the green patios. From tile panels and paintings to garden areas, the aim is to explore the importance of the relationship between color, environment, and sustainability through artistic, architectural, and environmental contextualization concerns that address this issue in contemporary times. We, therefore, analyzed the chromatic and environmental aspects of art and architecture, and how sustainability was an essential factor in their development. The integration of these factors into the building has as reference not only the time and quality of the interventions but also to the spirit of time, and the author's position as the holder of knowledge and sensitivity. These are the stages in which color is present, being a determinant that allows us to identify the interactive process between subjects, matter, and light. It is a way of transmitting sensations through a phenomenology of the spirit that humanizes the space, making it pleasant and facilitating study and reflection. Green roofs are areas of physical and visual enjoyment, not only for library users and staff but also for the professors' offices on the higher floors. They present themselves as rational paintings with temporal chromatic variations, meeting energy targets. The value of the building is explored now through the color of the green and flowery areas of its roofs and patios.

1. INTRODUCTION

Knowing how to add is part of understanding the aesthetic, cultural, environmental, and sustainability value. These factors integration into the building refers not only to the time and quality of the interventions but also to the spirit of the time, and the sensitivity of the author as the depository of knowledge, of the cultural legacy, of the authenticity of the heritage. These are stages in which color is present, being a determinant that allows us to identify the interactive process between subjects, matter, and light. It is a way of transmitting sensations through a phenomenology of the spirit that humanizes the space, making it pleasant and facilitating study and reflection.

Faculty of Law of the University of Lisbon was chosen as a study case as it always had a series of interventions that accentuate its cultural value in architectural, artistic, and sustainability terms, where color plays an important role.

Porfírio Pardal Monteiro, the architect who designed the first building in 1957, which is now a National Heritage Site, explored the colorful and textural artistic qualities of stone materials combined with greenish marble on the round pillars and the translucence of glass concrete in a masterful spatial distribution shaped by scale and natural light. The principle of combining the three arts – architecture, painting, and sculpture – was part of the spirit of the times, as there was an interest in fitting works of art into architecture. It was in this context that Pardal Monteiro chose the artist Almada Negreiros to create the bas-reliefs at the entrance to the

Faculty, maintaining the materiality of the limestone he used throughout the building, now with hints of color (Figure 1).

Figure 1: Entrance to the Faculty of Law with bas-reliefs by Almada Negreiros. Photos: RBD.APP 2024.

In 1994, it has been a public competition to expand the building and equip it with a new library, theaters, auditorium, teachers' offices, and support staff. In this extension, completed in 2001, the artistic impact was essentially based on interventions with tile panels, fulfilling the wish of the architect Pardal Monteiro, who could not do so at the beginning of the project (Pardal Monteiro 2013). The integration of tiles into architecture is part of Portugal's cultural heritage and a Mediterranean tradition. The colors and themes of the tiles create surfaces that make the eye wander and vibrate under the sun. Imagination that goes beyond logic and simultaneously *allows us to separate what amuses to uncover effective psychological roots* (Bachelard 1993).

Later, in the Rehabilitation of the old building and extension in 2012, was reached an agreement between the Faculty of Law and the Lisbon School of Fine Arts to use artistic interventions by professors and students to bring art into classrooms, amphitheaters and circulation spaces.

A new extension to the library was inaugurated in 2022, incorporating green roofs. The species now play the role of artistic interventions with the naturalistic and sustainable color of nature.

2. METHOD

From the beginning, the aim was to create a dialog between art, architecture, and users. The first stage corresponds to Almada Negreiros' artistic proposal for Pardal Monteiro's building – the following phases, designed by RBD.APP correspond to successive extensions to the Library and the rehabilitation of the spaces. The visual interventions combine color with architecture and take advantage of the traditional materiality of the tiles. Andreas Stöcklein's tile panel near the new entrance to the Faculty (Figure 2 – right) also involved the economic aspect. It benefited from a law that allowed artistic interventions on buildings at zero cost, up to 1% of the total construction cost.

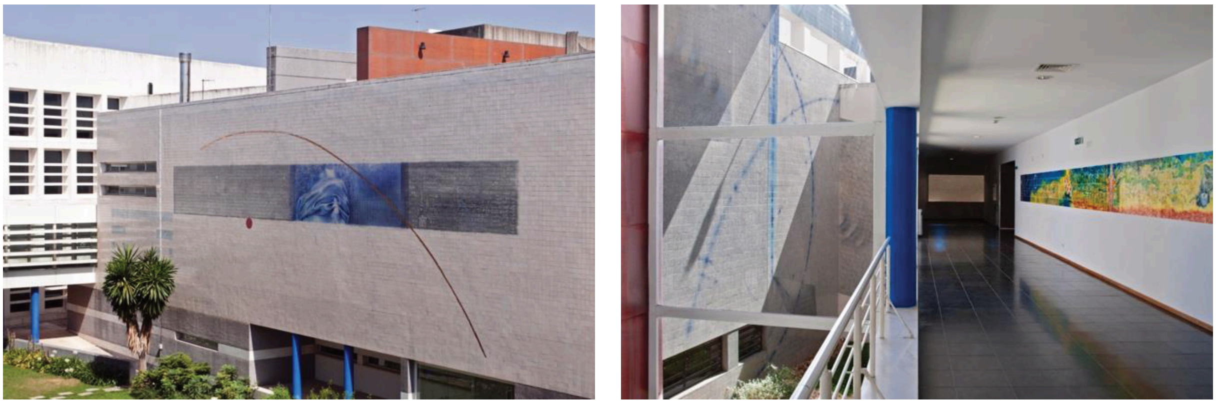

Figure 2: Jorge Colaço Tiles Prize 2000, Andreas Stöcklein (left). Panel by Andreas Stöcklein and Panel of the Faculty of Fine Arts of Lisbon (right). Photos: RBD.APP 2023.

The theme of the intervention dialogued with the artist, defined geometry as the major reference point for the building's expansion, a principle that was developed freely by the author. In addition, the visual field on the panel takes advantage of the view of the whole, its visualization by fragments, and explores unfolding images of proximity. This intervention methodology gives the building an identity and sensitive visual material. The aim is to reinforce the symbolic, humanist and aesthetic aspects of the complex, continuing the principle used in the original building.

A new tile panel was later applied to a wall related to the gallery that connects the old building with the Library and is visible from the inner patio. This panel won the Jorge Colaço Azulejaria 2000 Prize, the exponent of Portuguese tiles, awarded by the Lisbon City Council (Figure 2 – left).

> The tile always plays an active role in the ambiance of a space – through the accentuated rhythm of its weave, the glistening relief of its surface, the chosen colors and themes, the change in the light it generates, and even by modifying the sound of the environment (Andreas Stöcklein 2007).

Figure 3: East patio. View from the ground floor (Left). View from inside the second floor of the existing library (right). Photos: RBD.APP 2023.

The latest expansion of the Library has integrated color into the geometric patterns of the ecological roofs that are developed in two levels, creating visual fields of aesthetic decompression and chromatic enhancement that change with the seasons and are dependent on the type of plant species used (Figure 3).

The glass on the north and east façades reflect and extend the green space of the patio, anonymizing the building. The current spirit of the time has redefined the artistic incidence of the previous interventions. Currently, the building's integrated art relates to the color of nature. The use of red in the plants and furniture references the color of the Faculty.

3. RESULTS AND DISCUSSION

Results have been tested by students who feel comfortable and encouraged to use the library space, which expands into the garden areas with colorful plantings. The relationship with the subject focuses on creating pleasant environments, creating the conditions for mental availability that open up perspectives on the multiplicity of variables inherent in the qualities of what we see. This is the role of art, with architecture as its support, which in turn combines with nature to explore its qualities and beauty. Looking and seeing, seeing and noticing, are conditions that lead to discernment that involves the integrated law that governs life.

The discussion focuses on the importance of integrating architecture with green spaces, the color of the plants, and the aesthetics of the ensemble with environmental concerns. This aspect is essential for encouraging an integrated architecture-nature relationship, maintaining principles of geometric rationality, and controlling color in the qualities of the whole. In economic terms, the number of plants has been reduced, and it was possible to combine geometry with the poetics of Zen gardens made with stones. Color is in nature. We have to choose the nature of the color.

4. CONCLUSIONS

The principles set out were accomplished, as they were part of a controlled project in ideation, detailing, execution, and monitoring. The underlying poetics enhanced the qualitative component of the intervention, where color combines with materiality and light to create psychological environments that encourage work. This type of qualitative functionality is crucial to humanizing the space. Three stages of artistic intervention use color: through the drawings inscribed on the stone support, in the vibration of the colored surface covered by the tiles, and in the dematerialization of the glass façades that virtually enlarge the image of the green roofs to artistic, psychological, environmental and ecological purposes.

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ColorApp: Technology to Educate, Inspire and Help Women Make the Best Color Choices for their Personal Image

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ABSTRACT

Brazil is a country that pulses with colors, enhanced by the tropical sun throughout the year, allowing us to perceive a multitude of shades manifested both in its exuberant nature and in large traditional urban events like Carnival. Color plays a significant role in cultural expression and identity formation, being widely used in fashion to enhance personal image. This phenomenon is driven by the national industry, which offers a wide range of colorful clothing options throughout the year. The female audience, in particular, is the largest consumer of chromatic variations in clothing, accessories, makeup, and hair dye. However, the vast array of available colors and the desire to use them to express one's best self often lead to doubts about how to combine colors harmoniously and practically in daily life. To meet this need, ColorApp was created – a tool designed to facilitate the choice of colors in clothing, offering greater confidence in creating looks with the best possible harmony, all in a straightforward manner via a mobile device.

1. INTRODUCTION

Interest in colors for personal image use has grown in Brazil over the past 5 years, particularly among women, as evidenced by the increasing demand for image consulting services, a topic frequently covered in journalistic outlets. Given that Brazil is the fourth-largest country globally in terms of digital presence, with 133 million active accounts, and the second-largest in social media usage, (Comscore 2023) the product format was designed with a focus on the digital realm.

The app was created for iOS and Android systems, initially to serve users who had undergone the image consulting technique known as the "12 Seasons Color Theory". This American-origin technique aims to suggest tones that best match skin, hair, and eye colors, using palettes that replicate shades found in nature. (Spillane 1995)

To attract this audience who had already undergone personal color analysis, the app was launched with these 12 palettes available for free consultation. These palettes include tones grouped by dimensions such as similarity, value, chroma, and temperature (which the technique classifies by noting the yellowish balance for warm tones and bluish for cool tones). ColorApp was already becoming a guiding tool for women.

By closely observing the work of consultants with their clients, we realized that the traditional color wheel was beginning to be limited for daily use in fashion, creating gaps and raising questions, such as which exact shades of blue and green would be the best analogs.

2. TECHNOLOGY TO MATCH

Our development process involved creating a digital intelligence capable of performing traditional color wheel combinations, with a special focus on how the tones from the ColorApp palettes could harmonize in the best possible way. Based on Munsell's principles, which propose harmonies that aim for a more visually pleasing perception through the grouping of colors with shared characteristics, we developed an algorithm that analyzes the dimensions of a selected color and suggests combination schemes with tones that have similar dimensions, using a database of 1,200 tones registered in the system.

2.1 Chromatic usability

From a simple photograph of the clothing, the app displays in a hierarchical order the palettes that contain tones most closely matching the value, chroma, and temperature characteristics of the average color captured. (Figure 1).

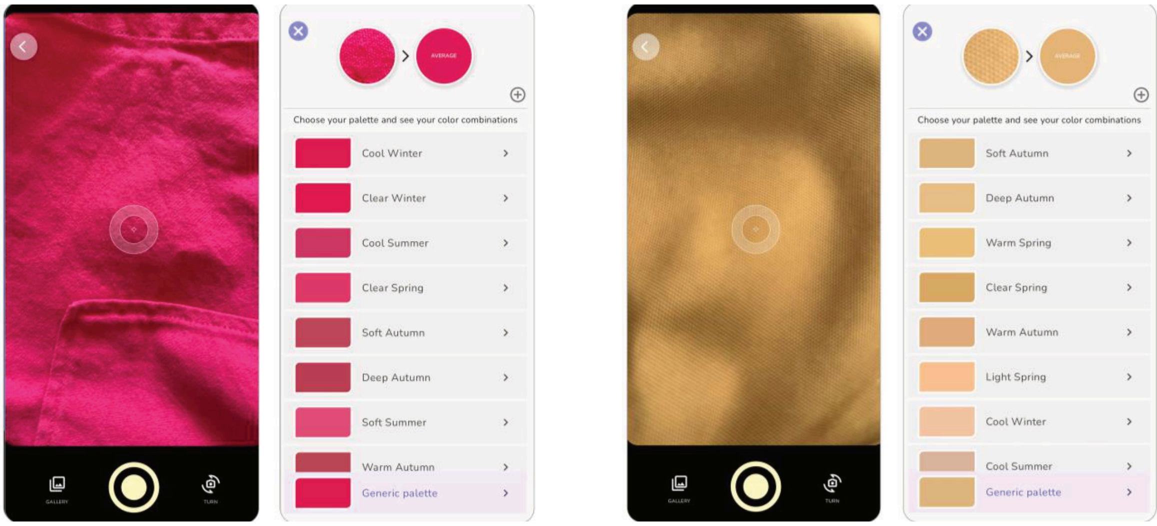

Figure 1: The app photographs the color and then suggests similar results to the average tone captured by the camera within palettes.

By selecting the palette that most closely matches the color, the app then generates more precise diagrams for monochromatic, analogous, and complementary formulas, composed of tones with similar dimensions. This intelligence aligns with the desires of our users, who, after discovering the palette of colors that enhance their beauty, prefer to build their wardrobe using tones from the same palette (Figure 2).

Understanding the preferences and tastes of Brazilian women, we decided not to present the classic super-colorful combinations from the color wheel, such as the triadic and square schemes. Instead, we added diagrams for combinations with achromatic tones (black, white, and gray) as well as browns and beiges, with appropriate adjustments to match the dimensions of the color being combined. These tones are widely popular and easily found in Brazilian stores. This section was named “Chic Style,” reflecting the common Brazilian perception of neutral tones as the most elegant colors.

As for the diagrams featuring six pairs of analogous combinations, we set aside two pairs to suggest more freeform combinations that encourage user creativity and do not necessarily follow any specific pattern from the color wheel (such as combining lilac with turquoise). Therefore, the section previously called “Analogous” was renamed “Rock with Colors,” a name chosen to be stimulating and fun (Figure 3).

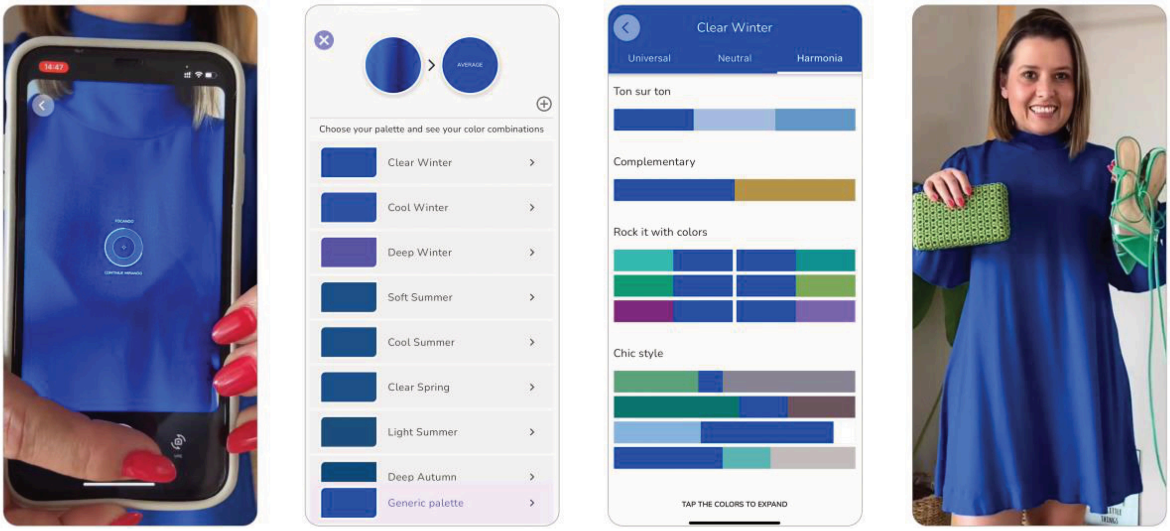

Figure 2: The user's choice of bag and shoes is guided by green tones suggested by the app, intended to complement the Klein blue dress.

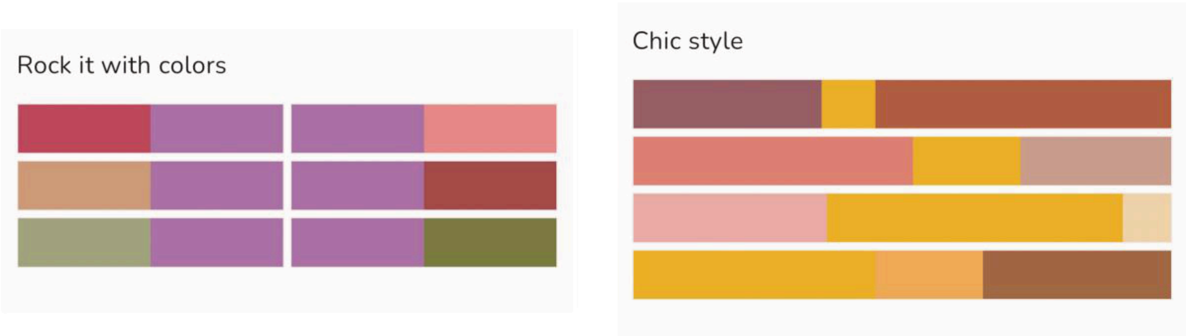

Figure 3: Inclusion of freer combinations in the third row of analogous colors and combinations with more neutral tones.

3. TESTS AND ADJUSTMENTS

We confirmed the applicability of the combinations generated by the app through hundreds of photos of real people, street style, and fashion shows, as well as color compositions observed in women's clothing across various retail stores in Brazil.

It was necessary to implement a tolerance margin in the algorithm for the similarities between the dimensions of the suggested tones. For example, if the color captured by the user contains 70% black, some of the shades in the diagram may vary by up to 15%, either lighter or darker in terms of value, as long as the temperature and chroma remain consistent. This adaptation was crucial to provide greater versatility in the results, allowing for compositions with more contrast and variety for the users.

4. CONCLUSIONS

The "Harmonia" tool, launched in October 2021, quickly gained popularity in the image consulting market, standing out for its efficiency in color combinations in fashion. This initial acceptance expanded into other sectors, such as architecture and design, establishing Harmonia as a reference for creative professionals. As a result, ColorApp, developed from this tool, became one of the leading fashion apps in Brazil, surpassing 2 million downloads.

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The app is valued for its practicality, allowing users to explore and apply color combinations in an intuitive and personalized way, in tune with the growing demand for authenticity and freedom in contemporary fashion. In a world where visual diversity is increasingly celebrated, ColorApp stands out by transforming the digital experience into tangible achievements, offering an accessible and powerful platform for those who want to experiment and express themselves through colors.

ACKNOWLEDGEMENTS

Adriano Dias, co-founder of ColorApp and responsible for programing all app code.

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Beyond Awareness: Stimulating Pro-Environmental Actions through Colour-Driven Web Interfaces

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ABSTRACT

The ongoing global environmental crisis highlights a significant gap between the recognition of the necessity for pro-environmental behaviours and their practical implementation. This research investigates the diverse motivations behind pro-environmental behaviours, from altruistic environmental concern to more self-oriented drives such as material gain or social comparison. The central hypothesis of this study is whether these motivations can be effectively channelled and influenced through the application of principles derived from colour psychology within web interfaces, thereby fostering a deeper emotional connection and promoting active engagement in environmental conservation efforts.

To test this hypothesis, an experimental web application was meticulously designed, incorporating carefully selected colour schemes aimed at eliciting emotional responses conducive to pro-environmental behaviours. This application, intended for seamless integration into public platforms like university websites, serves as a controlled environment to explore the intricate interplay between colour-induced emotional states and levels of engagement in environmental activism. To quantitatively assess the impact of individual behaviours, scores for perceived difficulty and frequency of execution were directly summed.

The anticipated outcomes of this research suggest that strategic manipulation of colour schemes within web environments can significantly enhance users' emotional engagement and cognitive focus, thereby deepening their understanding and commitment to environmental issues. By identifying effective colour schemes, this study aims to advance the understanding of pro-environmental awareness and activism, offering novel insights into ways to inspire and mobilise societal action for environmental preservation. Through this exploration of colour psychology within web design, the research not only illuminates the latent potential of this approach but also underscores the necessity of bridging the gap between environmental awareness and proactive engagement. Ultimately, it presents a compelling case for the integration of technological innovation and psychological insights to advance environmental activism, paving the way for a more sustainable future.

Keywords: colour design, environmental awareness, web communication, emotional engagement, pro-environmental behaviour

1. INTRODUCTION

The worsening environmental crisis demands immediate action to promote sustainable lifestyles and pro-environmental behaviours. As challenges such as water pollution, biodiversity loss, and climate change intensify, it is essential to address these issues directly and cultivate an eco-conscious mindset that mitigates harmful behaviours at their source. Designers play a crucial role in this process by creating digital platforms that encourage sustainable actions and foster environmental awareness (Chen, Yu, Westland and Cheung 2021).

This study explores two key areas: identifying everyday activities that contribute to environmental sustainability, such as product leasing and used recycling, and examining how the strategic use of colour in web interface design can enhance environmental awareness and motivate pro-environmental behaviours. By understanding the psychological drivers behind these behaviours, the research aims to provide insights into designing digital environments that effectively promote sustainable practices (De Groot and Steg 2008). Colour, as a powerful conduit of visual and psychological perception, significantly influences emotions and behaviours (Ou, Luo, Woodcock, and Wright 2004). Therefore, this study suggests that application interfaces can be designed to evoke emotional responses that strengthen users' connection to environmental conservation, thereby encouraging meaningful and sustained pro-environmental behaviours (Steg, Van den Berg and De Groot 2012).

2. METHOD

To test these hypotheses, three research activities were conducted, as outlined in Figure 1. The first activity was an online questionnaire (https://www.wjx.cn/vm/PpXsGFa.aspx#), which collected data on participants' attitudes and motivations concerning pro-environmental behaviours.

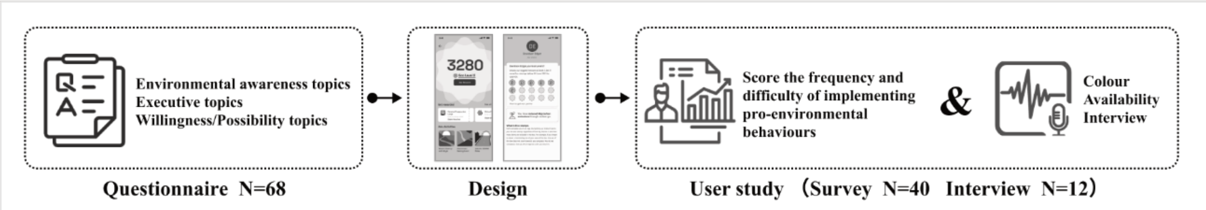

Figure 1. The research approach design.

The second involved the design of an interface featuring four different colour schemes, all applied to the same interface layout (see Table 1 for colour details and Figure 2 for the design output). These colour schemes were selected based on their psychological impact, with the intention of eliciting emotional responses that align with pro-environmental motivations, such as ease of action and habitual engagement.

Table 1. The characteristics of the UI colour.

Hue	Squares	*R*	*G*	*B*	*Hex*
Grey		56	56	56	#383838
Cyan		17	137	83	#006970
Blue		65	100	234	#4164ea
Green		0	105	112	#118953

Based on the results of the first step and the colours chosen in the second step, an online questionnaire, six daily low-carbon activities that contribute to environmental improvement were identified: Product Leasing, Used Recycling, Idle Trading, Online Enquiry, Electronic Payments, and Virtual Currency Usage. Consequently, three baseline application pages were designed, tailored to these specific use cases. These pages were then modified with different colour schemes, creating the experimental materials used in the subsequent user study (see Figure 2).

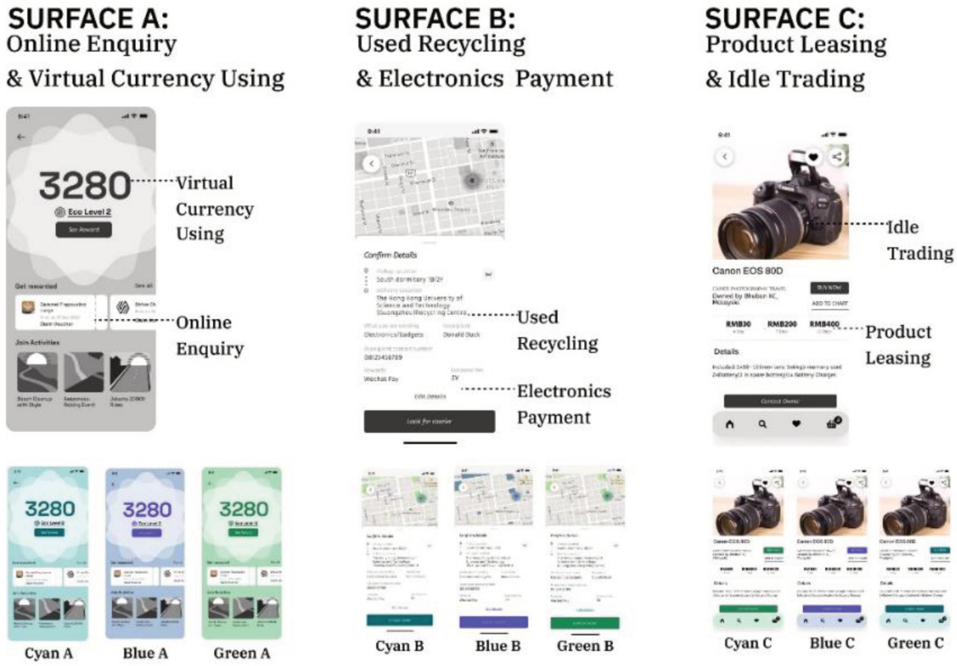

Figure 2: Four colours were used for the web pages to test the execution of six behaviors.

Finally, a user study was conducted, which included offline interviews and surveys with each participant to evaluate how variations in colour schemes within web interfaces influenced their perceptions and emotional responses. The perceived difficulty and frequency of execution of pro-environmental behaviours were then rated by participants, and the scores were summed to provide a total score for each behaviour. This scoring provided a direct measure of each behaviour's significance in the context of environmental sustainability.

3. RESULTS AND DISCUSSION

The experimental data reveal that colours commonly associated with environmental themes – such as Green, Cyan, and Blue – serve as more effective guide colours on web pages, significantly increasing the frequency of participants' engagement in pro-environmental behaviours compared to Grey. Additionally, these environmentally themed colours reduced the perceived difficulty of such behaviours. The extent of behavioural change was assessed by calculating the total scores of six primary low-carbon activities. As illustrated in Figure 3.1, among the activities studied, product leasing exhibited the most significant change in behaviour frequency, while online enquiry showed the least. Notably, web pages using Blue as the dominant guide colour recorded the highest frequency of pro-environmental behaviours, with a total score of 271, whereas pages with Grey as the guide colour had the lowest score of 234.

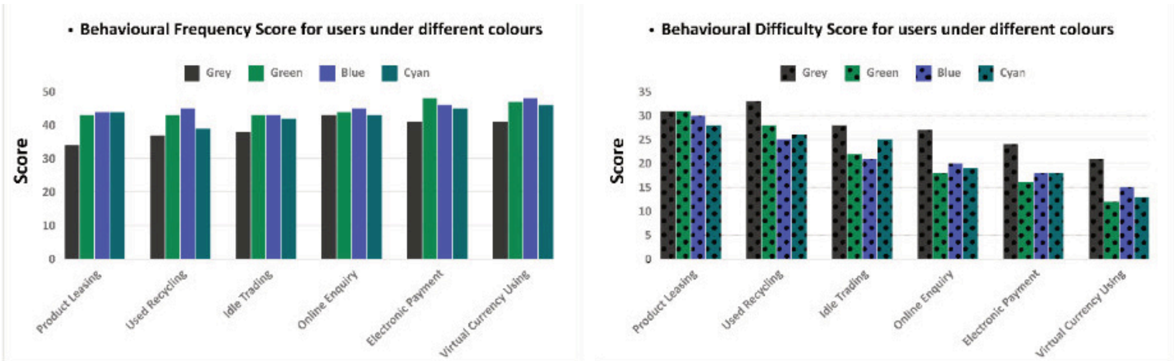

Figure 3.1 Behavioural Frequency Score for users under different colours *Figure 3.2 Behavioural Difficulty Score for users under different colours*

Figure 3 User study results.

As shown in Figure 3, when examining the perceived ease of adopting pro-environmental behaviours under different guide colours, activities related to electronic or online operations were consistently viewed as the easiest to perform. The Green guide colour was associated with the lowest perceived difficulty, scoring 127 points, while Grey was linked to the highest perceived difficulty, with a score of 164 points. These findings indicate that colours with environmental associations are more effective in lowering the perceived difficulty of engaging in pro-environmental behaviours.

4. CONCLUSIONS

The experimental results demonstrate that colours with environmental connotations, such as Green, Cyan, and Blue, not only significantly increase the frequency of pro-environmental behaviours but also reduce the perceived difficulty of adopting such behaviours. Specifically, these colours effectively encourage more frequent engagement in activities like product leasing and online operations, while also making these actions feel easier to undertake.

Colour plays a pivotal role in shaping user behaviour within digital interfaces, much like its influence in product marketing. This study demonstrates that strategically designed colour schemes can subtly yet significantly enhance pro-environmental behaviours. This study demonstrates that colours with environmental associations, such as Green, Cyan, and Blue, effectively increase pro-environmental behaviours and make these actions easier to undertake. This aligns with existing research, suggesting that these colours foster greater emotional engagement and make environmentally friendly actions feel more accessible. However, it is important to consider that, similar to product colour preferences, the impact of colour on environmental behaviours may vary based on demographic, cultural, and individual differences. While this study focused on a specific web interface designed to encourage sustainable actions, further research is necessary to explore whether these findings can be generalized to other digital platforms or environmental contexts. The insights gained underscore the critical role of integrating colour psychology into digital design strategies.

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Study of the Correlation among Mineral Contents, Instrumental and Censory Color of Brown Sugar

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ABSTRACT

Color is one of the main attributes that define the acceptance or rejection of a product, being mainly used as a parameter of evaluation. Nevertheless, the use of techniques that minimize the variations of a subjective visual evaluation are necessary. It is verified that color assessments by instrumental methods are useful when they present a good correlation with the sensory measurements. This study aimed to correlate the mineral composition of different brown sugars with the instrumental and sensory visual color analyses. Eight samples of brown sugar were evaluated and identified from A to H. The mineral composition concentration was measured using inductively coupled plasma-optical emission spectrometry. For the instrumental color analysis, samples were standardized regarding granulometry, and for the determinations, the colorimeter Minolta Chroma Meter was used. The sensory visual test adopted was the difference ranking test performed with 60 untrained evaluators. Data results were treated applying a multivariate statistics analysis ($p \leq 0.05$). Results on the concentration of minerals indicated that they are in accordance to the Brazilian Food Composition Table. The eight samples presented differences on the minerals Ca, Mg, P, K, S, Na, Fe, Mn, Zn and for Cu, sample F showed a prominent content of 5.65 mg/kg^{-1}, differently from the other samples which presented lower values. It was not possible to verify a correlation between the visual analysis of color and the mineral content. The results for L* varied from 57.00 for sample A (lighter) to 27.0 sample H (darker), with statistical difference between samples, except for samples B and C. There was a statistical difference among the samples for the parameters a*, b*, C* and hue. The correlations between minerals and instrumental measurements showed the highest values for L* with Mg (R-Sq = 41.2%) and parameter a* with Fe (R-Sq = 56.5%). Regarding the discrimination of the sensory color, samples B and C were similar for the evaluators. The matrix of correlation between sensory color and the variables of instrumental color indicated that there was a low correlation with a* (R-Sq = 28.6%); moderate with C* (R-Sq = 72.9%) and b* (R-Sq = 79.6%), and a strong correlation with the variables L* (R-Sq = 94.8%) and hue (R-Sq = 84.0%). In conclusion, despite of not being able to establish a correlation between color and mineral composition, a high correlation between instrumental color and sensory analysis was observed, therefore, variable L* and the sensory analysis of color were efficient parameters to differentiate the studied brown sugars.

1. INTRODUCTION

Color is one of the main attributes that defines the acceptance or rejection of a product, once is the first contact of the consumer with the product. Brown sugar presents a wide diversity in color (Durán-Rojas et al. 2012) which can interfere in the processed products appearance. Brown sugar's color is related to the sugar cane variety, syrup composition and variations in the processing steps (Generoso et al. 2009).

An accurate color analysis depends on the selection of techniques that minimize the variations of subjective visual evaluation. Color evaluations applying instrumental methods are useful when it presents good correlation with the sensory analysis. Therefore, this study aimed to correlate the mineral composition of different brown sugars with the instrumental and sensory visual color analyses.

2. METHOD

Eight samples of brown sugar were purchased from markets and selected visually by differences on color and identified with codes A to H. To determine minerals (calcium, magnesium, phosphorus, potassium, sulfur, sodium, iron, manganese, zinc and copper), the samples were digested in nitric-percloric acid. After digestion, the samples were swelled to 25 mL, with deionized water, and stored in plastic tubes at room temperature. The mineral composition was performed by inductively coupled plasma-optical emission spectrometry (ICP-AES), with a dichroic spectral combiner for simultaneous data collection in the radial and axial visualization mode (VistaRL CCD-Simultaneous ICP-AES, Varian).

For the instrumental and sensory color analyses, samples were standardized by granulometry and pour over a petri dish (60×15mm) and color measurements were performed in three different points of the dish using the Minolta Chroma Meter CM-25d model, CR10, to determine parameters from the CIELAB color space system, lightness (L*, 0 (black) to 100 (white)), a* (green to red) and b* (blue to yellow); saturation or color intensity (C*) and pure color (hue).

Sensory evaluation was carried out using ranking test (ISO 2006) by 60 assessors. They ranked the 8 brown sugar samples according to their color (from light to dark brown). Samples were presented simultaneously and were coded with three digits random numbers. This project was approved by the Ethics committee of the Federal University of São Carlos (number 75804723.7.3001.5504).

Results were analyzed applying a statistical multivariable technique ($p \leq 0{,}05$). Friedman Analysis of Variance (Christensen et al. 2006) was applied to the sensory data obtained in the ranking test, and significance of differences between samples, were determined by the Friedman test (a = 0.05).

3. RESULTS AND DISCUSSION

Mineral concentration results presented values in accordance to TBCA (2023). All eight samples presented statistical differences for the minerals Ca, Mg P, K, S, Na, Fe, Mn, Zn and for Cu, sample F showed a high content of 5,65 mg/kg^{-1}, different from other samples which showed lower values (Table 1). Results indicated no correlation between sensory color analysis and mineral concentration.

Table 1. Mineral concentration of the eight brown sugar samples.

	Ca	Mg	P	K	S	Na	Cu	Fe	Mn	Zn
					mg/kg					
A	1410b	750ef	701cd	5890b	0,30e	642b	1,38b	570,07a	8,84g	2,21f
B	1060c	690f	956a	4560de	0,43d	525c	1,45b	265,02c	38,42a	11,73a
C	1340b	1111ab	911a	1960f	0,99a	99g	2,31b	78,35f	20,29c	9,44b
D	1660a	860cd	761bc	4350e	0,446	339d	1,69b	304,43b	23,35b	6,67c
E	1160b	790de	751bc	5290c	0,65c	372d	1,51b	213,86d	23,02b	5,89cd
F	1640a	910c	811b	4920cd	0,71bc	963a	5,65a	73,07f	17,90d	6,83c
G	1590a	1040b	708cd	7893a	0,75b	244e	1,23b	178,04e	14,23e	3,91ef
H	1570a	1160a	675d	5360bc	0,51d	198f	1,08b	166,99e	10,57f	4,14cd
TBCA (2023)*	126	1,84	38,2	521	-	25,2	0,17	8,30	2,03	0,01

*mg/100g. Values within a column with different letter are significantly different ($p \leq 0{,}05$) by Tukey test.

L* of samples varied from 57,43 (lighter, sample A) to 27,20 (darker, sample H), which indicated a statistical difference among samples, with exception of samples B and C. Samples presented a statistical difference among themselves for the parameters a*, b*, C* and hue. Sample F presented the highest a* values (9,90) while sample A presented the lowest value for this parameter (5,90). For b*, results varied from 24,44 (sample B) to 10,93, of H sample. As for saturation C*, values indicated a variation of 25,65 (sample B) to13,44 (sample H) and for hue, sample A presented the highest value (75,30) whereas sample H, the lowest value (54,44) (Table 2).

***Table 2**. Results of instrumental color analysis (L, a*, b*, C* and hue)[1] and sum[2] from the ranking test of the eight brown sugar tests.*

Sample	L	a*	b*	C*	hue	Sum
A	57,43a	5,90e	22,49b	23,25b	75,30a	67a
B	52,19b	7,79c	24,44a	25,65a	72,32b	158,5b
C	50,92b	8,48b	20,37c	22,07bc	67,39d	151b
D	46,20c	8,52b	19,86cd	21,62bcd	66,76d	225,5c
E	41,36d	7,05d	18,44d	19,74de	69,05c	302d
F	39,07e	9,90a	18,14d	20,66cd	61,36e	356e
G	31,93f	9,83a	15,29e	18,18e	57,27f	420f
H	27,21g	7,82c	10,93f	13,44f	54,44g	480g

[1] Values within a column with different letters are significantly different ($p \leq 0,05$) by Tukey test.
[2] Values within a column with different letters are significantly different ($p \leq 0,05$) by Friedman test. Minimum difference among sum ≥53.

Correlations between mineral concentration and instrumental measurements were higher for L* with Mg (R-Sq = 41,2%) and a* with Fe (R-Sq = 56,5%), although are considered low correlations. In relation to the sensory color discrimination analysis, samples B and C (samples of light brownish color) were considered similar by assessors (Tabel 2). For the 60 assessors it was not possible to differentiate these samples visually.

The correlation matrix among sensory color determination with the instrumental color variables indicated a low correlation with a*(R-Sq = 28,6%), moderate with C* (R-Sq = 72,9%) and b* (R-Sq = 79,6%), and a high correlation with the variables L (R-Sq = 94,8%) and hue (84,0%) (Figure 1).

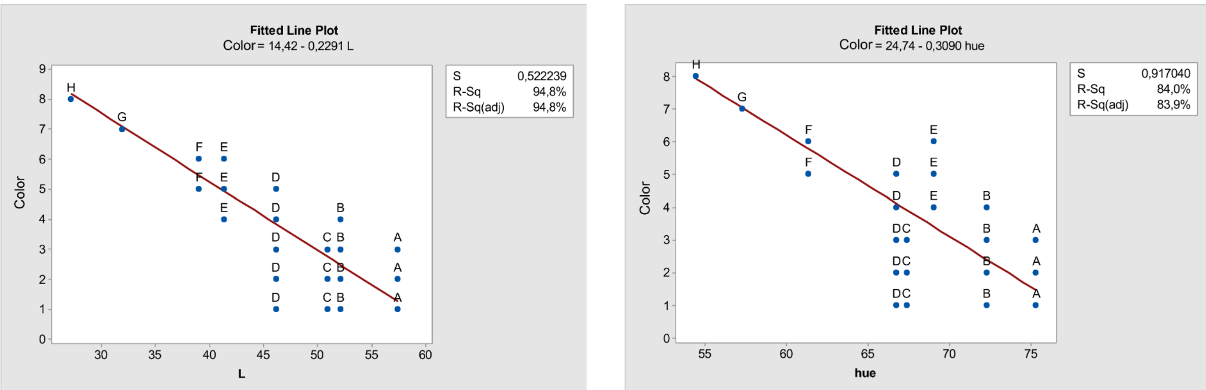

Figure 1: Correlation matrix for the Lightness and hue variables with sensory analysis.

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4. CONCLUSION

Despite of not being able to establish a correlation between color and mineral composition, a high correlation between instrumental color and sensory analysis was observed, therefore, variable L and the sensory analysis of color are efficient parameters to differentiate the studied brown sugars color.

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Understanding the Use of Colors and Characters in Snack Packaging Sold in Brazil

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ABSTRACT

This research aims to understand the use of colors and characters in snack packaging, identifying their characteristics and recurrences. This paper presents a comparative analysis between snacks with 'healthy' appeal and regular snacks sold in Brazil. An exploratory mixed-approach study was carried out in four stages: (1) literature review, (2) selection of the *corpus* of analysis, (3) registration and cataloguing of packaging, (4) analysis and interpretation of data. The main panel of 140 snack packages (70 'healthy' and 70 common) were analyzed with the Image Color Summarizer (ICS) tool and identification and classification of the characters was carried out. The results show a predominance of chromatic colors and a higher average saturation value in common products than in products with 'healthy' appeal, which have an approximate distribution between achromatic and chromatic tones. Characters were observed in more than half of common snacks packages and in only a quarter of the healthy ones. Characters aimed specifically at children were less present on the packaging of 'healthy' snacks than on regular ones. It is concluded that the restricted use of characters and chromatic or intense colors indicates that most snack packages with healthy characteristics are not attractive to children.

1. INTRODUCTION

In food packaging, visual cues are used to draw attention and communicate about the products (Vermeir and Roose 2020); and consumers associate these packaging characteristics with the food, influencing their perception and preference (Chitturi, Londoño and Henriquez 2022). Studies show that visual appeals to children are more predominant in unhealthy products (Elliott and Truman 2020, Borges and Duran 2023); and suggest that healthier products presented in an attractive way for children could promote a more adequate diet in this audience (Pires and Agante 2011).

In Brazil, there has been an increase in the supply of snacks with characteristics considered healthier (e.g. less sodium or fat), but the visual cues used to attract children and to communicate the healthfulness of these foods on packaging are not fully known. In this context, considering the importance of colors and characters in the targeting of products to children (Ogle et al. 2017, Bezaz and Kacha 2021), this research aims to understand the use of these visual elements in snack packaging sold in Brazil, identifying their characteristics and recurrences. Initially, 70 packages of snacks with 'healthy' appeal were analysed (Pereira and Souza 2024). Then, 70 packages of common snacks were analyzed. This paper presents a comparative analysis of the two sets.

2. METHOD

An exploratory study with a mixed approach was carried out, in four main stages: (1) literature review, (2) selection of the *corpus* of analysis, (3) registration and cataloguing of packaging, (4) analysis and interpretation of data (Figure 1).

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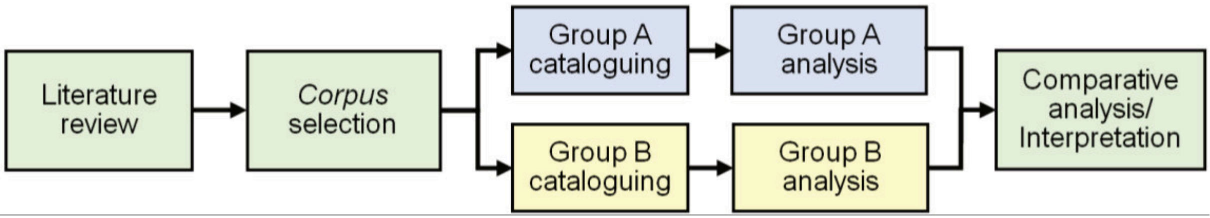

Figure 1: Flowchart of the research stages.

2.1 *Corpus* selection

The *corpus* of analysis was composed of 140 snack packages (70 with 'healthy' appeal and 70 common). Salty products sold in supermarkets such as chips and snacks were classified as common snacks (Group A, Figure 2). Crackers, peanuts and the like were not included in this research. Snacks with a 'healthy' appeal (Group B, Figure 2) were those displayed in supermarkets in the 'healthy' products sector, or available in specialized online stores. The 'healthy' claim includes nutrition claims stated on the main packaging panel and/or on manufacturers' websites, such as: 'whole food', fat and/or sodium reduction.

2.2 Analysis procedures

This study looked only at the main panel of the packages (front view). To identify the predominant chromatic characteristics in the two groups ('healthy' and common), the packages were grouped and analyzed with the Image Color Summarizer (ICS) tool (http://mkweb.bcgsc.ca/color-summarizer/), which provided descriptive color statistics and identified the most representative shades of each set, based on the following parameters: html, 10 color clusters, space and vhigh 200 px.

The background colors of each individual package were also identified through visual observation carried out by the researchers, accounting for recurrences. The packages were cataloged in previously prepared analysis sheets. The qualitative analysis considered the recurrences of hue, levels of lightness and chroma, and the meanings associated with these characteristics in the packaging (Pereira 2021).

A character design classification was carried out, considering the audiences to which they are addressed, as well as the typologies and styles of representation. The identification of the types of characters was based on the taxonomy proposed by Gomes (2018). The classification of the audiences and styles of representation was defined by the authors themselves, based on the visual language observation, the plastic characteristics of the drawings and the illustration techniques.

3. RESULTS AND DISCUSSION

A summary of the analysis carried out by the ICS is shown in Figure 2 and Table 1. HSV data show a considerably higher mean saturation value for the set of common products (S=61) than for products with 'healthy' appeal (S=29) (Table 1). In the set of common products, chromatic colors predominate (79.74%) with a lower incidence of achromatic tones (20.25%), while in products with 'healthy' appeal there is an approximate distribution between achromatic tones (53.23%) and chromatic colors (46.78%) (Figure 2).

Visual observation of each individual package shows that common snack packages mostly use chromatic colors (81.4%) and do not use white as the background of the main panel; while those of 'healthy' snacks use white or very light colors as dominant in almost half of the packages (44.3%), and use chromatic colors less frequently (21.4%). Black as a background color is more frequent in 'healthy' snacks (20%) than in common ones (4.3%).

Table 1. Summary of the color statistics (HSV) produced by ICS.

Categories	Group A (common snacks)				Group B (snacks with 'healthy' appeal)			
	avg	med	min	max	avg	med	min	max
H	371.00	55	0	360	341.00	60	0	360
S	56	61	0	100	34	29	0	100
V	73	77	0	100	70	75	2	100

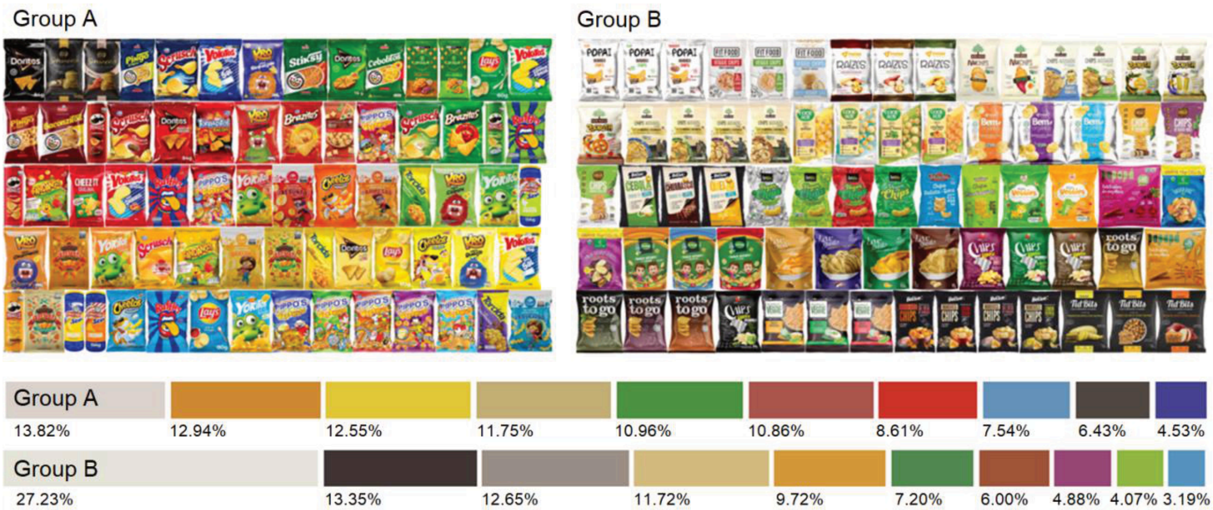

Figure 2: The two packaging groups and their predominant colors identified by ICS.

In Brazil, white and light colors have been associated with ‘healthy’ eating and nutrient reduction/restriction in other product categories, while the most frequent meaning of black is ‘superior quality’ but also signals nutrient reduction; saturated colors, on the other hand, are common in food packaging that is based on the idea of ‘fun’ (Pereira, 2021).

Characters were observed in more than half of the common snack packages (57.1%) and in only a quarter of the ‘healthy’ ones (25.7%). In both categories, the most frequent typology of characters was human (comic/caricatural), followed by anthropomorphic (animal). Characters aimed specifically at children were considerably less present in the ‘healthy’ snacks packaging (14.3%) than in the common ones (35.7%).

These findings are compatible with previous results indicating that the colors and other elements of the packaging differ between products positioned for ‘health’ and regular products, although these differences are not universal, and may vary between product categories and between countries (Festila and Chrysochou, 2018).

4. CONCLUSIONS

The results of this research show that the use of colors and characters in snack packaging sold in Brazil differs between products with ‘healthy’ appeal and ordinary products. This is a valid design strategy, as the colors and other packaging visual elements influence consumers' perception of the food healthfulness (see Steiner and Florack 2023).

However, the restricted use of chromatic colors and characters (associated with the idea of 'fun') indicates that most of the snack packages with healthy characteristics analyzed in this research are not attractive to children, since the colors attract the attention of children and the characters favor the choice of products by this audience, being more attractive to them than nutritional information (see Pires and Agante 2011, Ogle et al. 2017, Bezaz and Kacha 2021).

It is considered that the data obtained in this study contribute to support future projects and studies concerned with positively influencing the perception of healthier products by children.

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Chromatic, Ergonomic and Spatial Orientation Analysis of the Signage Project from the Regional Council of Medicine of the State of São Paulo: a Methodological Proposal

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ABSTRACT

This research presents an experimental analysis of the chromatic, ergonomic, psychological, and anthropological aspects of signage design at the Cremesp. The goal is to develop a new methodology to address identified gaps in spatial orientation and signage needs. Cremesp, a federal autarchy in São Paulo, Brazil, serves approximately 135,000 active physicians. The need for this study arose from observed difficulties in navigating the sections and wings of the facility due to insufficient visual information, leading to confusion among visitors and employees. The research aims to study the journeys of visiting physicians and Council employees, focussing on improving navigation and reducing confusion through enhanced signage solutions. These solutions include the application of recyclable adhesive PVC on existing surfaces and a digital navigation app, both designed to be cost-effective and sustainable. The research emphasises the role of colour and ergonomic lighting in influencing perception and behaviour, aiming to create a pleasant and intuitive navigation experience. Data collection methods include semi-structured interviews, material analysis, documentary analysis, and selection bias techniques. The study employs a developed project-based methodology with seven steps that demonstrates the potential for improving user navigation and can be tested by future researchers. The findings offer practical and sustainable solutions to signage design challenges, contributing to better spatial orientation within Cremesp.

1. INTRODUCTION

The relationship among design, space orientation, and human interaction forms a cornerstone of effective environmental planning and user experience. Spatial configurations, determined by design, directly affect human cognition and behaviour, influencing how individuals perceive and navigate spaces (Hillier, B., & Hanson, J., 1984). Moreover, human interaction serves as a critical feedback mechanism for design. Designing environments that support human activity and well-being requires a deep understanding of the relationship between environment and behaviour (Zeisel, J., 2006). This connection enables designers to create spaces that are not only functional but also enriching.

This study aims to conduct an analysis of these interconnected factors to support the proposed methodology. A key aspect is the examination of ergonomic factors, with a particular focus on colour. When well-designed, a colour system organises spaces and guides people through different sectors (Wheeler, A., 2008). Furthermore, inconsistent information and a lack of visual coherence in the environment are evident. Colours and typography are used in a haphazard, non-standardised manner, and makeshift signage, such as A4 paper instead of the appropriate material, compromises employees' effective navigation. As a result, this paper will provide a framework for designing effective environmental signage that enhances spatial orientation and supports human interaction within public spaces and workspaces.

2. METHOD

Data collection involved semi-structured interviews, material analysis, documentary analysis (written and photographic), and observations (structured, unstructured, and participant). The structured observation included distributing paper questionnaires to 40.54% of Cremesp employees, which facilitated direct interaction and insights into individual perspectives and challenges. Additionally, unstructured observations analysed customer behaviour in the service section, focussing on service times and user experience.

The study utilised Lynch's (2011/1960) concept of environmental legibility to assess the environment's characteristics, which were analysed through tools examining both individual and environmental factors. Surveys identified user behaviours and perspectives, creating personas for interaction patterns, while D'Agostini's (2017) anthropological context framework was applied to adapt information to users' communication styles. Data analysis employed ANOVA to compare colour recognition and comfort metrics between the initial and new signage designs.

The methodology proposal was based on project-based successful approaches from Wheeler (2008), D'Agostini (2017), and Scherer & Scherer (2015). The final methodology included seven steps (Figure 1), ensuring a comprehensive process for signage and wayfinding.

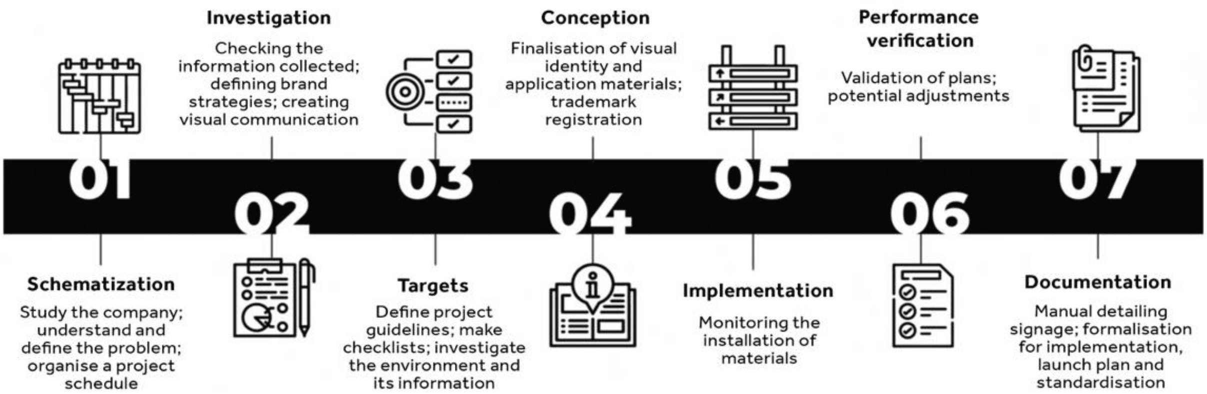

Figure 1: Project methodology with a focus on signalling and spatial orientation.

The **Targets** phase distinguished itself by focussing on in-depth ergonomic and spatial analysis and integrating theoretical foundations to develop design guidelines that address user needs. The **Conception** process incorporated user feedback, as evidenced by the choice of layout inspired by a questionnaire analysis, which emphasised Gestalt principles to enhance visual clarity and user engagement. Although not fully applied due to bureaucratic issues involving permissions and in-depth documentation, the three last steps were not used.

3. RESULTS AND DISCUSSION

In the observational study, the findings indicate that employees initially struggled to navigate the council's premises but eventually adapted, memorising routes; most of them traverse at least ten sections weekly, underscoring the complexity of the environment. However, visitors consistently experienced difficulty on their first visit.

The ergonomic analysis, based on Itiro Iida's "Project and Production" and the NR17 standard, categorised employees into four types: direct service providers, outsourced staff, advisors, and delegates. Positive aspects included efficient digital booking services and reduced wait times. Participant observations categorised photos by geometric shapes, semiotics, and visual aspects such as space, form, time, dimension, light, and colour. The work environment includes accessible facilities and well-lit, though inconsistently toned, areas. Negative aspects included discomfort from air conditioning, sound from the street as a distraction, injury-causing signage, old computers and malfunctioning lifts. The lack of consistent design support hampers the Council's ability to present a coherent institutional image internally and externally.

3.1 Analysis 1: Initial Design with Random Colours

A survey was carried out with 40.54% of employees to assess their level of recognition of the colours in the signage and their comfort with the confusion caused by the incongruity of the colours in bright lighting. A Likert scale of 1 to 5 was used, where 1 represents 'very uncomfortable' and 5 represents 'very comfortable'. The results showed that the majority of employees had average colour recognition scores, with a tendency to recognise colours at moderate to high levels (scores of 3 to 5). The analysis of variance (ANOVA) carried out between colour recognition and comfort with colour incongruity revealed an F-statistic of 187.85 and a p-value of 1.73×10^{-33}. These results indicate a statistically significant difference between the two variables, suggesting that colour incongruity significantly impacts employee comfort (Figure 2).

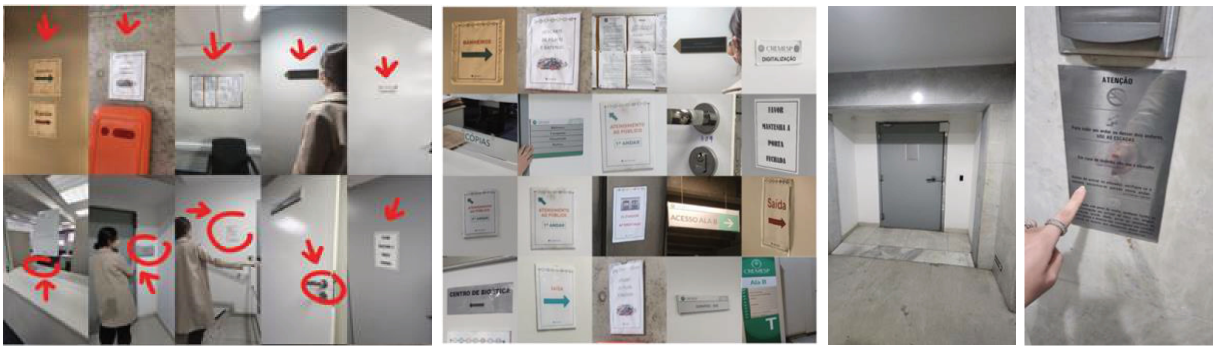

Figure 2: Examples of improvised signage elements outside the visual identity.

3.2 Analysis 2: New Signage Design with a Predominant Green Colour

In a second analysis, the level of recognition of the colours of the new signage project, which used the predominant green colour, and the employees' comfort with the clear and concise environment were assessed. The same Likert scale of 1 to 5 was used. The results indicated that the employees had high levels of colour recognition, with an average of 3.88, and high levels of comfort, with an average of 4.01. The scores were concentrated at the higher end of the scale (3 to 5), indicating that the new signage project was well received and provided a clearer and less confusing environment. The analysis of variance (ANOVA) between recognition of the new design's colours and comfort revealed an F-statistic of 1.79 and a p-value of 0.182. These results suggest that both colour recognition and comfort are aligned in the new signage design (Figure 3).

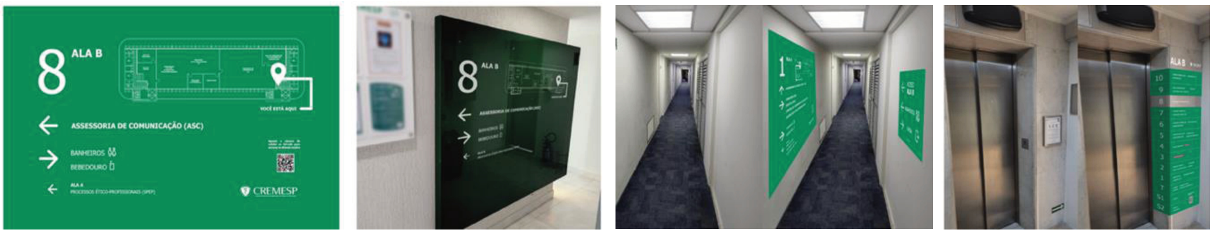

Figure 3: Application examples and comparison between current and new project.

The final deliverables, including the signage project and its application manual, were developed with a focus on low environmental impact and innovation, guided by the Life Cycle Design (LIDS) Wheel and utilising recyclable PVC. This approach not only conforms to the brand's visual identity but also enhances usability and sustainability. In addition, a targeting app was developed as a solution for users, with access via QR code on the premises.

4. CONCLUSIONS

The survey and analysis proved to be differential in understanding the studied environments. Although the analysis of variance (ANOVA) did not show a statistically significant difference between colour recognition and comfort, the high overall satisfaction and improvement in recognition and comfort metrics suggest that the new signage project achieved its objectives. While improvements can be made in the areas highlighted during the ergonomic analysis, it is evident that the company generally adheres to proper safety and ergonomic measures. Therefore, the implementation of the new signage project can be considered relevant. It will be interesting if the students, designers and architects can demonstrate how the project would be finalised with all its steps to achieve the full dimensioning of the conclusion of the methodology.

Regarding user behaviour in the environment, there is an aversion to searching for in-depth graphic information, a term suggested that can be explained by the observed characteristics of the user preferring to answer questions verbally rather than graphically, especially when there is no necessary and clear information visually in the environment or when there is too much of it. The applied methodology effectively organised the creative and design processes, demonstrating how well-designed signage can enhance and simplify the user experience.

ACKNOWLEDGEMENTS

The conception of this study was authorised by the president of Cremesp.

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Warm Color × Cold Color – Analysis of the Preferences of Teenagers in a Playful Business Game

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ABSTRACT

There are some basic rules to be considered concerning a Playful Business Game with teenagers. Some of them are being authentic and honest, creating a business environment that allows the production and sale of colorful items of their interest, keeping a simple message, making useful information available, interacting, asking questions and giving feedback.

In this article we present the analysis of the choice of colors of plastic pins used as raw material for making toys by high school students in a Playful Business Game. This Game has been applied since 1995 to more than 7000 participants, from the most varied age groups, level of training and type of activity in the labor market.

There is no unanimity regarding the choices of color made by children, teenagers or adults. This happens due to the fact that different cultural, social, economic and educational factors interfere in these choices. We present the result of these choices, classifying them into warm, cool and neutral colors. A total of 297 students from 12 classes of 5 private schools located in the city of Rio de Janeiro participated in the survey between 2019 and 2023. In the years 2020 and 2021, activities were interrupted due to the Covid pandemic. In total, 10941 pins were negotiated in the classes.

The Game is playful and uses plastic pins (Magic Pins) with 4 shapes (1 hole, 3 holes, 4 holes and half-wheel) and 5 colors (Blue, Green, Red, White, Yellow) as inputs for the manufacture of toys. Students act as Suppliers, Manufacturers and Retailers, following previously presented guidelines. There is always a rehearsal for them to understand the dynamics of the Game. In addition to working in the market, students evaluate the companies through previously defined questions, based on the Brazilian Business Excellence Model (MEG) of the National Quality Foundation (FNQ). The Game has 4 meetings with 2 hours each.

We emphasize that, historically, the participants of this Game have total freedom to act considering the negotiations of purchase-sale-production-evaluation and decide the shape and color of the pins they are going to work with. The best-rated company in the market wins the game. The market, formed by the students, is sovereign. There was never a case where the class disagreed with the final outcome of the Game.

1. INTRODUCTION

Concerning color preferences, some factors that affect individual differences have been analyzed, but are not yet fully understood (Cheng and Ou 2023). Colors are part of the day-to-day life of Brazilians and warm colors are more meaningful in a tropical country. Brazil is a country whose nature is multi-colorful, with forests, savannah, hinterland, an extensive and heated sea coast, as well as diverse and colorful species of birds, mammals, among others. It also has several colored popular festivals (Carnival and Saint John Party, to name just two). The 20 Brazilian Serie A football clubs, 19 feature White in their flag, 10 use Red, 9 use Black, 6 use Green, 5 use Blue and 3, Yellow. Although color preferences are not universal (Taylor, Clifford and Franklin 2013), both evolutionary considerations and recent research suggest that the color red serves as a signal indicating an object's importance (Kuhbandner, Spitzer, Lichtenfeld and Pekrun 2015).

Students participated in a meeting in two different rooms, one with a cold color, blue, and the other with a warm color, red. Students in the blue room did not express as much excitement as they did in the red room, possibly because cool colors are associated with calm and serenity while warm colors are associated with stress and excitement (Barbie West, Joshua Silberman 2020).

In a study using six colors (vivid red, vivid blue, vivid yellow, pale red, pale blue, and pale yellow), the results showed that in pale-colored conditions, participants rated the situation as relaxed, calm, and pleasant. However, scores were significantly higher in bright color conditions. Heart rates increased in both red and yellow conditions. (AL-Ayash, Kane, Smith, and Green-Armytage 2015).

2. METHOD

This Game is very dynamic. It can be more complex through additional rules or the creativity of participants, such as offering prizes for the first sale or using social media for marketing. The evaluation involves subjective criteria of the participants and quantitative measures of financial and physical results, based on the Brazilian Business Excellence Model. The Game, which uses Magic Pins (MP), plastic pins in 5 colors and 4 shapes (Figure 1), has been applied in various educational and corporate environments since 1996, involving thousands of participants. (Beltrão & Barçante 2015).

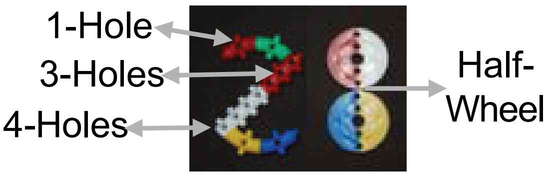

Figure 1: Magic Pins – Colors and shapes.

2.1 Sample Preparation

The Magic Pins are distributed to the Suppliers (SU) who sell to the Manufacturers (MA) who manufacture toys according to the demand of the Retailers (RE). The RE sells to the Exporter (EX), a function performed by the teacher[1].At the end of each Game, all products sold are disassembled and the pins separated by color and shape. Then they are counted by the teacher who writes down the values in a table.

2.2 Psychophysical Experiment

Figure 2 shows the Game Supply-Chain . The number of companies varies according to the number of students in each class. The SU ranges between 2 and 3, with 2 students each, the MA ranges between 2 and 4, each containing between 3 and 5 students and the RE ranges between 2 and 4 with 2 students in each. The teacher acts as the government and exporter.

[1] Prices are agreed between the parties.

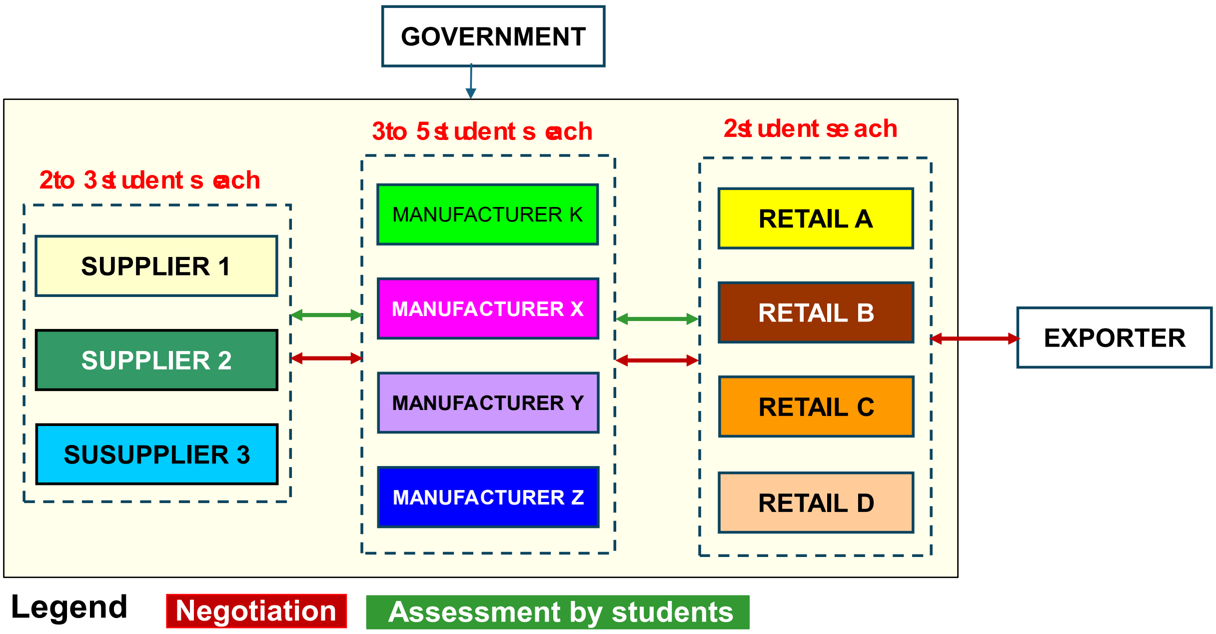

Figure 2: The Game Supply-Chain.

3. RESULTS AND DISCUSSION

In total, 10941 pins were negotiated in the classes (Table 1).

Table 1. Summary of number of colours and shapes used by students.

MAGIC PINS	COLORS					
SHAPES	WHITE	YELLOW	RED	GREEN	BLUE	TOTAL
1 HOLE	94	670	184	205	190	**1343**
3 HOLES	90	263	208	76	146	**783**
4 HOLES	1658	1666	1820	1780	746	**7670**
HALF-WHEEL	234	311	320	-	280	**1145**
TOTAL	2076	2910	2532	2061	1362	10941
	19,0%	**26,6%**	**23,1%**	**18,8%**	**12,4%**	100,0%
	NEUTRAL	WARM		COOL		

The total percentage of warm colors in the products that were purchased by Retailers was 49.7%, the neutral color was 19.0% and the cool color was 31.2%. The percentage of warm colors concerning pin shape is 63.6% for 1 hole, 60.2% for 3 holes, 45.4% for 4 holes and 55.1% for half wheel. Only the red 1-hole pin has a slightly lower percentage than the green and blue ones.

4. CONCLUSIONS

It is true that there is a preference to warm colors in the Game and there are some observable characteristics that may lead to this choice.

There are basic rules in the Game, but the market is sovereign to decide and act, which favors the dynamism of the Game. Students experience various roles, such as buying-selling-logistics-production-administration-evaluation, without playing a scripted role with pre-memorized texts, as in theater. They can form partnerships, import products like ropes and colored ribbons or consult the Internet. Their choices have significant impact on the business and the course of the Game. Their decisions can affect relationships, outcomes, and the Game environment. The tasks within each team (companies) are defined by the students themselves. Students are immersed in the experience and develop cognitive and soft skills.

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We believe that based on the nature of the Game, its environment and excitement involved the negotiations, it is possible to understand the students' preferences to warm colors in this Game.

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Cultural Factors Impacting Car Color Choice: An Analysis in the Brazilian Market

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ABSTRACT

Color, although often considered secondary to other properties such as form and function, plays a crucial role in the perception and valuation of objects. Culturally, colors are linked to symbolic and emotional meanings, influencing choices in products and environments. Economically, color is fundamental in marketing and brand identity, with companies strategically using colors to attract consumers and convey messages.

In contemporary design, color is a powerful tool that can evoke emotions and influence behaviors. The choice of colors in products, furniture, and architectural spaces reflects cultural trends and sensitivities of the time. In Brazil, this research proposes an analysis of the evolution of color preferences in the automotive market, highlighting the transition from vibrant colors in the 1950s, 1960s, and 1970s to the current predominance of neutral tones such as gray, black, and white.

Economic factors, such as production costs and changes in purchasing profiles, are also evident. Historically, while the variety of colors increased, the prevalence of neutral tones intensified in recent decades. Color transcends aesthetics, impacting culture and consumer behavior. The choice of an automobile's color is not merely an aesthetic decision but also reflects brand values and personal identity.

1. INTRODUCTION

In contemporary society that produces and consumes a vast array of industrial products designed to facilitate various human activities, the automobile stands out. This prominence is attributed not only to the significant investment involved in acquiring such objects but also to their symbolic value. Few products garner as much interest and media coverage as automobiles, from the fascination surrounding new launches to discussions about traffic and accidents. Regularly, automotive shows and exhibitions present updates and innovations that captivate consumers eager for new acquisitions. As new models circulate on the streets, they are admired and desired like no other product. The perception of an object is a complex process influenced by various factors, including prior experiences, knowledge, and sensory systems that shape the interpretation of the environment and the object itself. If characteristics such as form, weight, and, particularly in this study, color, go unnoticed, it will affect the perception and valuation of the object. In assessing and attributing meaning to these characteristics, color occupies a unique position. Although often considered secondary to other properties like form and function, color profoundly impacts the perception and valuation of objects. These cultural associations influence color choices in products, packaging, and environments. Economically, color plays a crucial role in marketing and brand identity. Companies strategically select colors to attract consumers, create brand recognition, and convey specific messages. It can evoke emotions, establish atmospheres, and even influence user behavior. Thus, while color may be regarded as secondary to other characteristics, its presence and conscious use are essential for a comprehensive understanding of objects, products, and environments within the cultural, economic, and contemporary design context, particularly regarding automobiles. An initial observation indicates a loss of chromatic variability in automobiles, especially after the 1990s in Brazil, gradually leaving behind a period dominated by vibrant colors. Shades of yellow, green, red, and brown were common. First, many consumers demonstrate a preference for neutral colors such as white, black, gray, and silver, perceived as more elegant and easier to resell. The limitation in color variety also contributes to optimizing production and delivery, making manufacturing more efficient. Furthermore, vehicle rental companies, which represent a significant portion of automakers' clientele, tend to prefer neutral colors for easier rental and resale. Consequently, Brazil on wheels has become increasingly less colorful. Red remains an exception, while vibrant colors like blue, green, and yellow are now rare. In a global context of extensive production and consumption of industrial products, the automobile stands out significantly. This prominence is due to both the substantial financial investment involved and its symbolic and cultural value. Beyond its primary function as a means of transportation, the automobile represents status and personal expression. The choice of vehicle, encompassing aspects such as brand, model, and color, reflects individual preferences and cultural trends. This study analyzes how these factors influence the perception and valuation of automobiles in Brazil, emphasizing color as a design element that transcends aesthetics and impacts consumer culture and behavior.

2. HISTORY OF THE BRAZILIAN INDUSTRY

In the early decades of the 20th century, in 1908, *Grassi Carrocerias* was dedicated to manufacturing and maintaining vehicle bodies using imported mechanics. Ford became a pioneer by establishing operations in Brazil in 1919, beginning the assembly of the Model T, known as the Ford "*Bigode.*" In 1925, General Motors followed suit and between 1920 and 1939, the number of automobiles in São Paulo surged from 5,000 to 43,000 units. Until the mid-20th century, Brazil was limited to assembling vehicles without local production. While American cars dominated the streets previously, the 1950s saw an increase in European vehicles. The Brazilian automotive industry solidified in the 1950s with Juscelino Kubitschek's "*Plano de Metas*", which included the *GEIA* (Executive Group of the Automotive Industry) to promote national vehicle manufacturing. The first locally produced automobile, the Romi-Isetta, was launched in 1956, and *Vemag* company began producing models such as the *Belcar* and *Vemaguet*, along with the *Candango* jeep and the luxurious *Fissore*, based on licensed designs. Following the prohibition of complete car imports in 1953, Volkswagen began local production of the VW *Kombi* in 1957, followed by the Beetle, known as "*Fusca*." Mercedes-Benz started producing trucks, and Willys-Overland manufactured the iconic *Jeep*.

3. COLOR AND AUTOMOBILES

Since the arrival of the first automobile in 1891, a green Peugeot Type 3 imported by *Santos Dumont*, the variety of colors has been limited by the availability of paint. The Romi-Isetta was produced in a two-tone paint scheme, with combinations such as red and white, blue and white, and yellow and white. Shades of gray or black were not available. The same applied to the *Vemaguet*, which also featured a similar two-tone scheme. Later, vehicles from VW, Ford, and General Motors produced in Brazil expanded their color palettes during the 1960s and 1970s.

Figure 1: Colors of General Motors Brazil circa of 1975.

4. COLOR AND FORM

Understanding the impact of color on automobiles is essential. Internal spaces between components are covered with designed panels that express design concepts. These metallic panels are structured and colored to ensure harmony and attractiveness, making color coating an integral part of automotive design. The use of colors addresses the need for acceptance and reduces visual discomfort, as underlying components may not be easily understood. A coating layer helps prevent misinterpretations. The car's body protects occupants and provides visual appeal, aesthetic value, brand identity, and personalization options, significantly influencing resale value in Brazil. Properly utilizing these elements enhances aesthetics and functionality, while poor approaches can distort proportions and compromise visual harmony. Thus, manipulating light and surfaces must be carefully planned to convey the desired message and enhance the project, along with the right color palette. The decision to purchase a car starts with considerations of value, brand, and model, making color secondary. However, once the model and budget are defined, color becomes significant. Marketing strategies that utilize cultural elements influence consumer preferences, creating a connection between the product and the consumer, as exemplified by associative expressions such as "*a RED Ferrari*" or Brazilian cultural elements "a *YELLOW VW Brasília*" or "a *BLACK VW Beetle*" become expressions that immediately associate culture with the automobile and its color. The example of "*Harlequin*" automobiles, which originated from street culture, was embraced by the industry. In 1996, Volkswagen America launched the Golf Harlequin, a special edition of the vehicle in Tornado Red, Ginster Yellow, Pistachio Green, and Chagall Blue colors, to be used at brand events and attract attention with a colorful automobile. The Golf Harlequin gained widespread public acceptance, and due to numerous requests, Volkswagen decided to produce several units of this peculiar Golf version.

Figure 2: VW Golf Harlequin, 1996.

5. PURCHASE CHOICE AND RESALE

From a market and consumer perspective, the choice between a silver or blue car is largely inconsequential regarding maintenance. Research does not indicate a correlation between color and accident or theft rates, nor does it reveal significant differences in color preferences between genders. Preferences tend to be standardized, primarily influenced by superficial perceptions of comfort and aesthetics. Consequently, consumers often overlook factors like thermal comfort and visibility of risks, even if they may hesitate to choose striking colors at dealerships. In a scenario of free color choice, the variety of shades on the streets would remain limited, as marketing continues to shape preferences. Persuasion through increased exposure and "colors of the year" reinforces the notion that certain hues are more desirable, perpetuating the myth that popular colors are easier to sell. Fernando Purificação, project manager at Axalta, noted that the Brazilian market remains conservative, with approximately 82% of vehicles in neutral shades – white, black, silver, and gray; 8% in red and blue; and 1% to 2% in yellow and orange, with green and other colors making up the remaining 3% to 7%.

6. CONCLUSIONS

The analysis of the evolution of color in automobiles, in the Brazilian context, reveals a significant transformation in consumer preferences over the decades. Initially, the color of vehicles was a secondary issue, often relegated to protection and functionality. However, as the automotive industry developed, color began to play a crucial role in the perception and valuation of automobiles. In a second moment, in the 1950s and 1960s, reflecting the greater availability of paints and technology, automobiles were offered in vibrant colors such as yellow, green, and red, which reflected the culture and aspirations of the society of the time. This variety of colors not only met the desire for individuality of consumers but also became a symbol of status and personal expression. However, from the late 1990s onwards, a drastic change in color preferences was observed, with a growing predominance of neutral tones such as gray, black, and white. This transition can be attributed to various factors, including the rationalization of production costs and the change in the purchasing profile, where rental companies have become the predominant clients. The choice of more conservative colors reflects a market strategy that prioritizes resale and general acceptance, to the detriment of individual expression that communicates identity, status, and cultural preferences.

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The Subjective Use of Color: In Creative Practices with Alternative Materials

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ABSTRACT

The poster for the color congress proposes an exploration of the process of developing clothes from alternative materials, centered on the theme of the Clown. This theme was chosen to encourage students to access and express pure and naive aspects of their identities in the creation of their pieces.

The project challenged participants to engage in a deep process of self-knowledge, drawing inspiration from the expressive freedom and playfulness associated with the clown figure to infuse originality and meaning into their fashion creations.

The research particularly focuses on the subjective and expressive use of color in the students' creations, based on Johannes Itten's theories of color as an extension of the artist's individual and emotional expression. Itten articulates this deeply rooted connection between color and personal expression in the following quote: "Color is life, for a world without colors seems dead. Colors are primordial, identical to life, identical to nature." Johannes Itten.

This quote highlights the central idea that the choices and use of colors in students' fashion creations transcended aesthetic functionality, reflecting significant aspects of their experiences and personal identities.

In addition to investigating the creative process, this study also highlights the presentation of the clothes in a fashion show and the creation of a fashion editorial, which aim not only to show the final pieces, but also to communicate the essence of the students' creative journey. They demonstrate how colors were used not only as a design aspect, but as a vital means of storytelling and personal expression.

This poster, therefore, not only addresses the intersection between color theory and sustainable fashion, but also celebrates individual creative expression, encouraging a deeper reflection on the vital role of color in the expression of identity and fashion.

1. INTRODUCTION

This article aims to explore and analyze the use of colors in fashion shows that use alternative materials, focusing on a specific case developed at the University of Caxias do Sul (UCS). The fashion show in question, conceived by Professor Antônio Rabàdan, was organized in honor of the plastic artist Sérgio Lopes, creator of the discipline in which the project was carried out. The central theme of the show, "Clown", proposed that students revisit their inner child and express this rediscovery through the creation of clothes made with everyday materials, being essential that the creative identity of each student be immediately recognizable by the spectators.

A crucial aspect of this fashion show was the requirement that the clothes be designed to dress and undress, revealing a "second skin" worn underneath each outfit. This second skin symbolized the inner layers that make up the identity of individuals, in a direct parallel with the Clown theory, which explores the most intimate layers of the human being through the smallest mask in the theater. This approach not only highlighted the emotional and psychological depth of the costumes, but also emphasized the importance of color as an expressive and communicative tool.

To deepen the understanding of the role of color in this context, the study is articulated with the color theory developed by Josef Albers, in particular his explorations on color-matter and color-material. Albers, inspired by Seurat, dedicated himself to the study of the properties of light and palpable colors, considering the nuances between color as material and color as matter. In his didactics, especially since the Bauhaus period, Albers clearly distinguished these concepts, integrating them into his experimental exercises known as *Materialstudie* and *Materiestudie*.

In the context of the fashion show at UCS, the application of these theoretical distinctions allows for a deeper analysis of the students' creations, exploring how color was used not only as a decorative element, but as a structuring component that influenced the spatial and emotional perception of the clothes. Just as Albers demonstrated that color can function as a constructive material by defining planes and volumes in a three-dimensional space, this study investigates how academics applied these principles in the creation of costumes that not only reflected their internal identities, but also created a complete sensory experience for the viewer.

This article, therefore, seeks not only to document the students'creative process, but also to connect these practices with Albers' theories of color-matter and color-material, providing a broader and theoretical understanding of the implications of the use of color in performative and fashion contexts.

2. METHODOLOGY

The proposal is to explore and understand the use of colors by students in a fashion show with alternative materials, centered on the theme of "Clown". This fashion show was conceived and developed by Professor Antônio Rabàdan for the University of Caxias do Sul (UCS), within a discipline originally created by the plastic artist Sérgio Lopes. The theme "Clown" was chosen to encourage students to access and express pure and naive aspects of their identities, through the creation of clothes made with everyday materials. The proposal challenged participants to engage in a deep process of self-knowledge, where the expressive freedom and playfulness associated with the clown figure were used to infuse originality and meaning into fashion creations.

One of the fundamental aspects of this project was the requirement that the clothes be designed to dress and undress, revealing a "second skin" that the models wore underneath. This second skin symbolized the inner layers that make up people's identities, reflecting the Clown theory, which works with the most intimate layers of the human being, explored through the smallest mask in the theater.

The research particularly focuses on the subjective and expressive use of color in the students' creations, based on Josef Albers' theories of color as a tool for spatial construction and optical illusion. Albers, inspired by Seurat, dedicated himself to the study of the interaction between color, space and form, exploring how color can be used to create illusions of depth, movement and spatial hierarchy. In his classes, since the Bauhaus period, Albers distinguished between color as material and color as matter, integrating these distinctions into exercises that profoundly influenced his artistic and pedagogical approach.

In the context of the fashion show at UCS, this theoretical distinction allows for an in-depth analysis of the students' creations, examining how color was used not only as a decorative element, but as a structural component that shaped the spatial and emotional perception of the clothes. Just as Albers demonstrated that color can function as a constructive material by defining planes and volumes, this study investigates how students applied these principles in the creation of costumes that reflect their internal identities and create an immersive sensory experience for the viewer.

3. THEORETICAL CONTEXT

Alternative Materials in Fashion: Exploration and Creative Possibilities, refer to a wide range of resources that, traditionally, are not used in the manufacture of clothing, but which have significant potential to create pieces with a unique visual impact. These materials can include anything from textile waste, such as leftover fabrics, scraps and threads, to discarded everyday objects, such as medicine packaging, plastic bottles, cardboard, and other items that would be destined for the trash. The use of these materials in fashion represents not only an aesthetic innovation.

The visual impact of these materials on the catwalk is undeniable. The catwalk, being a space for spectacle, benefits from the aesthetic boldness that alternative materials bring. They allow the creation of sculptural forms, unusual textures and a color palette that ranges from natural tones to the most vibrant artificial colors. In addition, the use of unconventional materials challenges designers to rethink traditional manufacturing techniques, leading to innovation in the cut, sewing and modeling of the pieces. As a result, clothes created with alternative materials can stand out not only for their differentiated aesthetics, but also for their symbolic and social meaning.

Albers emphasized the importance of color as a constructive force within the work, not just an aesthetic element. He argued that "what matters is not what, but how," referring to the way colors interact to create meaning. This approach is particularly relevant in sustainable fashion, where alternative materials, such as textile waste or medicine packaging, are used to create clothes that not only clothe, but also communicate complex visual narratives.

The application of this theory in fashion, especially in projects like the Clown fashion show, connects with Albers' idea that color and form must be understood together, as expressions of a greater intention. In this case, the clothes are not just design products, but vehicles for the students' self-expression, reflecting their personal identities and their inner journeys. The choices of colors and materials are deliberately used to evoke emotional and visual associations, creating an additional layer of meaning that transcends mere functionality.

Figure 1: Clown Fashion Show (designer's personal file)

4. CONCLUSION

The study of the use of alternative materials in fashion shows, such as the one presented at the Clown fashion show organized by Professor Antônio Rabàdan, offers a rich reflection on the impact of color and material on fashion design. The integration of Josef Albers' concepts on color theory with the creation of clothes from unconventional materials reveals an innovative way to explore aesthetics and personal expression in sustainable fashion. Albers contributes significantly to our understanding of how color can be used to create hierarchies and impactful visual effects. In his exercises with color bands, he demonstrates that the coordination and subordination of colors can lead to a more vibrant and dynamic palette, a concept that aligns with the practice of using alternative materials. In the context of the Clown fashion show, the application of these ideas allowed students to express their identity and creativity in a unique way, while addressing the issue of sustainability through the reuse of materials such as textile waste and packaging.

The contributions of this study to academia are substantial. First, it highlights the importance of incorporating Albers' color theory and the alternative materials approach into academic fashion design programs. The practical application of these theories in conceptual fashion shows offers students an opportunity to explore new forms of expression and innovation, preparing them to face contemporary challenges in the fashion industry.

To advance in this field, it is essential that future research focus on further exploring the intersection between color, materiality and sustainability. Further studies may investigate how different types of alternative materials influence color perception and visual impact in fashion shows. In addition, the integration of sustainable practices into the academic curriculum can prepare students to lead change in the fashion industry, promoting a more holistic and innovative approach.

The realization of continuous experiments and collaboration between academics, designers and materials specialists is encouraged to broaden the understanding and application of sustainable and creative techniques. In this way, fashion can evolve to incorporate practices that not only meet aesthetic and functional demands, but also respect and preserve the environment.

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Study on Reproduction of Spatial Brightness on a High-Luminance Large LED Display: Effects of image color and texture on subjective evaluation

poster

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ABSTRACT

Recently, simulation tools have become more familiar as the use of BIM has taken root in architectural design. Furthermore, as display performance improves, it is becoming possible to display luminance chromaticity equivalent to that of real space, as displays with high-resolution and wide-color range become more widely available. Visual experiences equivalent to real space utilizing displays are expected to reduce discrepancies before and after construction, leading to more efficient design. In this study, the spatial brightness evaluation in measured images (based on luminance chromaticity distribution by image photometry system)and simulated images (based on luminance-chromaticity distribution calculated by Radiance as a light environment simulation tool) was compared in order to verify the reproducibility of spatial brightness using a large display. Simulated images were created using three material setting methods used in general design practice: achromatic, coloured and textured. In all of these settings, the spatial brightness evaluation of the space in relation to the mean luminance on display matched the measured image. In light of previous research showing that spatial brightness equivalent to observing a real space can be obtained under luminance and chromaticity conditions that can be presented on a display, it is suggested that if luminance is reproduced by accurate illumination calculation, it is possible to obtain the spatial brightness perception from simulated images that is equivalent to that of real space.

1. INTRODUCTION

Recently, simulation tools have become more familiar as the use of BIM has taken root in architectural design. Furthermore, as display performance improves, it is becoming possible to display luminance chromaticity equivalent to that of real space, as displays with high-resolution and wide-color range become more widely available. Visual experiences equivalent to real space utilizing displays are expected to reduce discrepancies before and after construction, leading to more efficient design. The purpose of this study is to clarify the reproducibility of visual effects such as brightness for large displays. In this paper, we examine the effects of differences in image creation methods and reproducibility of color and reflectance characteristics on the spatial brightness evaluation for the large display when images of a interior room with a luminance-chromaticity distribution equivalent to that of real space is displayed on the display.

2. METHOD

In the experiment, measured images (based on luminance chromaticity distribution by image photometry system L-CEPT (Yamaguchi 2019)) and simulated images (based on luminance-chromaticity distribution calculated by Radiance as a light environment simulation tool) were displayed on the large display for different real spaces, and 18 participants evaluated the spatial brightness relative to the displayed images with different spatial styles and material characteristics. The large display used in the experiment was 4864 × 2736 mm in size, with a depth of 8 bits SDR (Standard Dynamic Range) and a maximum output luminance of 1200 cd/m^2 at the center of the display.

The three target spaces (space A - C) were spaces with distinctive textures, with wood, carpet and tiles used as interior materials. Figure 1 lists the characteristics of each space.

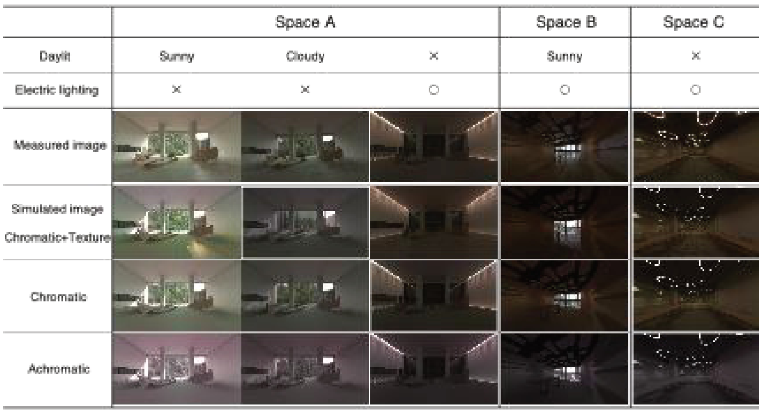

Figure 1: List of presented image.

The measured images were tone-mapped so that each pixel had luminance and chromaticity equivalent to the luminance-chromaticity distribution measured in the target space. Areas exceeding 1200 cd/m^2 in the actual space were set so that the measured image corresponding to that area was white (maximum tonal value).

Figure 2: Flowchart of convert image.

The simulated images were produced by Radiance, a light environment simulation tool. Electrical lighting was set using the “ies2rad” command to reflect the ies data of the actual installed luminaires. Daylighting was set to direct sunlight using the “gendaylit” command and skylight using the “gensky” command. The sky condition was set to the CIE Standard Overcast Sky (CIE 1996). The reflectance and chromaticity of materials such as walls and fixtures, etc. reflect actual measurements made with a spectrophotometer (KONICA MINOLTA CM-700d). In textured conditions, material images were mapped onto the materials. Finally, filtering and tone mapping were performed on the luminance chromaticity distributions obtained from the simulation, using the same procedure as for the measured images. For each of the simulated images in spaces A-C, three patterns were prepared: (1) chromatic rendering with gloss or texture applied, (2) chromatic rendering with diffuse reflection components, and (3) achromatic rendering with diffuse reflection components.

The measured image and simulated image were accurate to within 10% of the sum of squared difference for L*a*b* or L* for the luminance-chromaticity distribution of the displayed image and real space(Figure 3). White in the L*a*b* colour space is the maximum tonal value(x, y = 0.303, 0.311) of the screen.

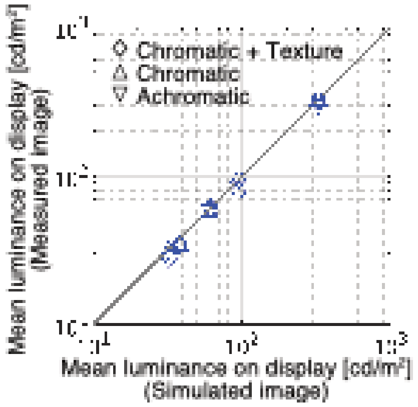

Figure 3: The error of mean luminance on display.

Participants were seated so that their viewpoint position was 1.2 m from the floor, offset by 1 m from the screen. After adapting to the experimental environment, they observed the image presented on the large display for 30 s and memorised the spatial brightness. Next, participants adjusted the luminance of the hemispheric space of uniform luminance so that it was perceived to be equivalent to the brightness when observing the display. The mean luminance in this hemispheric space is used as the brightness evaluation. The above procedure was repeated for various images presented in random order.

3. RESULTS AND DISCUSSION

The stratified analysis showed that the spatial luminance ratings were in statistical agreement with the measured images, even for achromatic images reproducing only the luminance distribution and for chromatic images reproducing the chromaticity as well (Figure 4). In a previous study, it was confirmed that the respective brightness ratings for measured images and real space were equivalent when luminance was lower than the maximum luminance (1200 cd/m^2) that could be displayed.

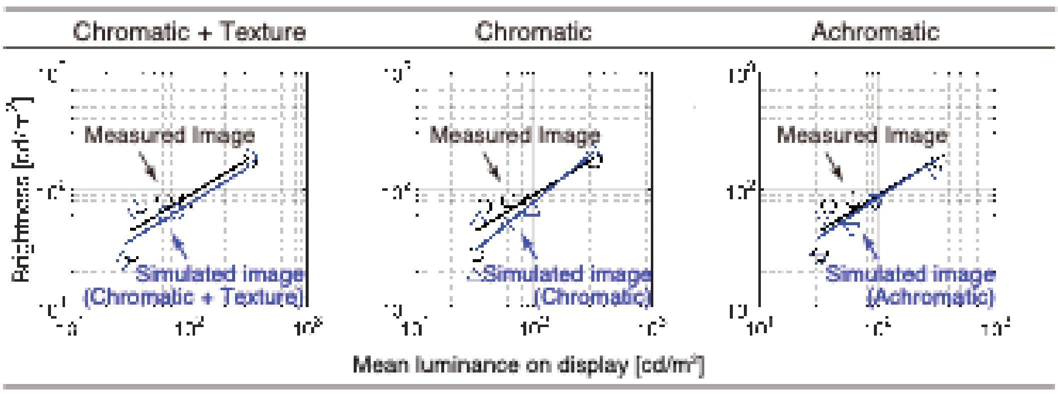

Figure 4: Relationship between mean display luminance and brightness.

4. CONCLUSIONS

In this study, the spatial brightness evaluation in measured and simulated images was compared in order to verify the reproducibility of spatial brightness using a large display. Simulated images were created using three material setting methods used in general design practice: achromatic, colored and textured. In all of these settings, the spatial brightness evaluation of the space in relation to the mean luminance on display matched the measured image. In addition, the results of the achromatic simulation images suggest that the perception of the space can be equivalent to that of a real space in the early stages of design, where no detailed representations such as coloring or textures have been made.

In light of previous research (Nomoto 2024) showing that spatial brightness equivalent to observing a real space can be obtained under luminance and chromaticity conditions that can be presented on a display, it is suggested that if luminance is reproduced by accurate illumination calculation, it is possible to obtain the spatial brightness perception from simulated images that is equivalent to that of real space.

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poster

Urban Polychromy: An Experimental Methodology Tested in Belo Horizonte, Minas Gerais, Brazil

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ABSTRACT

Urban polychromy is determined by geographic, cultural, historical, social, and economic factors. Cities have color schemes formed over time by different productive and historical developments. Unintentionally, in most Brazilian cities, this palette occurs without color planning mechanisms. The article introduces a scientific-artistic experimental methodology designed to identify the colors of some urban samples and analyze their relations with socioeconomic aspects in the city of Belo Horizonte, capital of Minas Gerais, Brazil, observed from links between the top view and compositional elements perceived at the scale of the pedestrian's gaze. Among the objectives, it aims to contribute to the dissemination of the academic field of urban chromatic analysis in Brazil and assist in the construction of other contemporary urban readings. As resources, satellite images were associated with urban parameters and demographic data such as income and race of the population by censustract. Eight samples were selected to support the production of predominance graphics, using the Natural Color System (NCS). Manual collages were also assembled to bring the human scale and urban dynamics not visible in satellite images alone. Belo Horizonte presented its own typical chromatic scheme and the results obtained in the graphics showed the predominance of blue, red, green, yellow, and gray hues, respectively, as well as the predominance of dark and low saturated colors. This polychromy reflects a combination of natural and geographic elements such as vegetation and land, and artificial elements like paving and roofing. The results were analyzed qualitatively and quantitatively and highlighted existing relations between the colors found in the urban environment and factors such as available materials, income and race of the population, urban environmental quality, and the presence of vegetation. Thus, it can be concluded that colors play indirect roles in other existing issues in Brazilian cities. However, it's important to note that the reliability of the results may be affected by the conditions under which the satellite images were extracted. Therefore, the findings were supplemented with visual investigation and collages. To improve precision, future research should establish the most standardized possible conditions for image extraction and color determination. It is also recommended to test the methodology in cities with differing characteristics to compare results and further validate the findings.

1. INTRODUCTION

This article is part of a research that addresses urban color analysis through the relationship between the colors found in the city's environment and the racial and socioeconomic profile of the population. To achieve this, a methodology was developed and tested – partially adapted from the one used by Cesar (2014), but for an urban chromatic analysis from the top view. It also relates to Lenclos' *Geography of Color* (2004) concept, which considers the importance of commonly used construction materials and natural elements (such as the color of the local earth) to form the urban polychromy. The article presents a case study of Belo Horizonte, the capital of Minas Gerais, Brazil.

Urban polychromy, in this research, is defined as the coexistence of all chromatic variations present in today's city, being composed of the union of natural elements – such as land, vegetation, and water, and artificial elements – such as street paving, roofs, facades, among others. Color, regarding the artificial elements that form the urban environment, is always related to the materials available in the consumer market.

2. METHOD

An example of the process carried out for each sample can be seen in Figure 1.

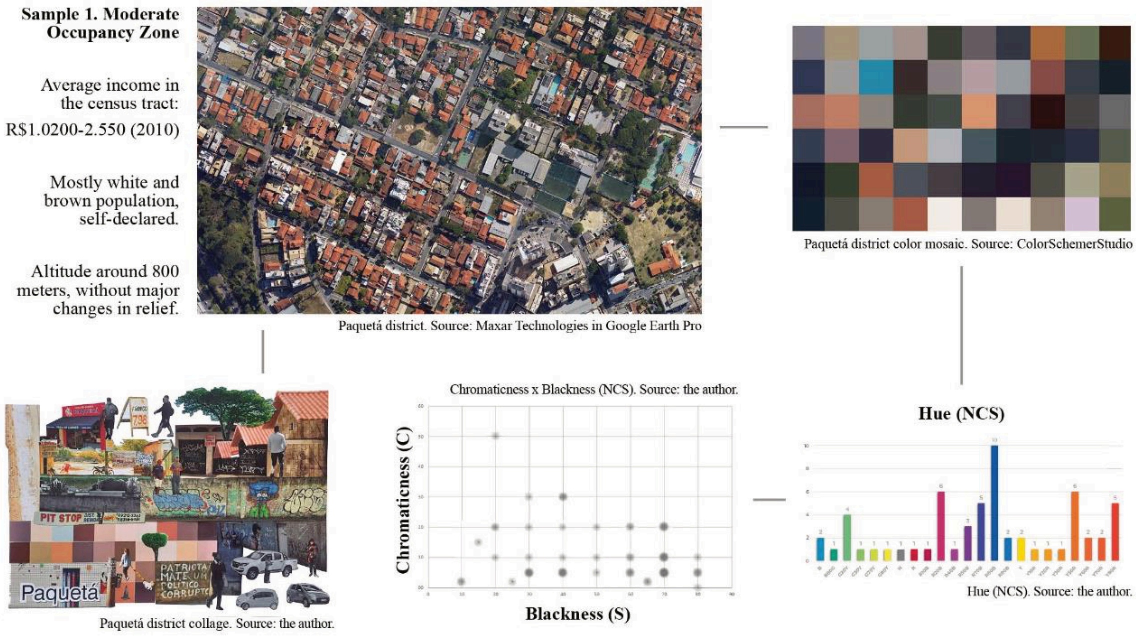

Figure 1: Flowchart illustrating the methodological process for each sample. Source: the author.

2.1 Sectorization of the city

Resources were sought that sectorize the city, to understand it based on its segmentation. The parameters defined were the *Zoning* from the Master Plan; *average income* in the census sectors and the *racial map* of the population, both using information from the Brazilian Institute of Geography and Statistics (IBGE). Furthermore, in a complementary way, the hypsometry and the *Urban Quality of Life Index* (IQVU) were analyzed.

2.2 Samples and color palettes

Eight samples were selected – one in each occupied zone from the Master Plan and with varying income ranges. The chosen images were inserted into ColorSchemer Studio software, which aggregated the chromatic information into a mosaic of predominant colors.

2.3 Chromatic notation and graphics

The colors present in the mosaics were transferred into chromatic notation spreadsheets to enable the production of chromatic attribute graphics. The results were processed using a qualitative-quantitative approach: the images and color palettes were analyzed based on their individual context and the graphics' results were considered quantitatively for comparative purposes.

2.4 Collages

An experimentation of a more free and artistic nature was then proposed to unite what was analyzed from the top view with elements on the human scale. The language of manual collages was chosen.

3. RESULTS AND DISCUSSION

The chromatic data from the eight samples were joined to generate the graphics for Belo Horizonte (Figure 2).

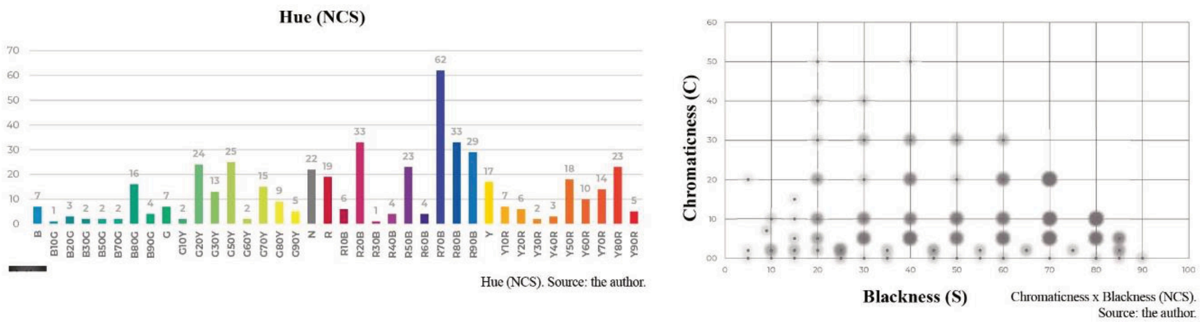

Figure 2. General graphics for Belo Horizonte. Source: the author.

Through the samples, it was observed that the chromatic scheme of Belo Horizonte is formed by blue, red, green, yellow, and gray hues, respectively. It was noticeable that the perception of neutrals (whites, grays, and blacks) is difficult, as they are mostly read as colored neutrals. This is due to several factors, such as reflections or specific conditions of the images and the real-digital conversion.

Disregarding the bluish whites and grays, the predominance of blue hues in the samples demonstrates the strong occupation and density in the city, since shadows are read as dark blues and appear more significantly where there are more dense built elements. The appearance of the red hue is due to the reddish ceramic tile roofs – an artificial element, and the color of the local earth – a natural element. The same is true for the yellow hue, although it can also originate from yellowish vegetation. Green hues appear in 3rd place as most prevalent in the samples, which represents the considerable existence of vegetation in the city. Furthermore, it was perceptible that the presence of vegetation interspersed with occupation and the urban environment influences the condition and quality of life of local inhabitants.

On the subject of luminosity, most samples show low rates, with a predominance of 70% blackness. In all samples are prevalent colors with low saturation, between 5 and 20% chromaticness, reaching a maximum of 50%.

Furthermore, when understanding urban polychromy in this research, it is impossible to dissociate it from socioeconomic reality: color is not just color. It shows how people live and occupy the city's territory. When analyzing the results taking into account the racial and socioeconomic profile of the population, it was discernible that the only occupied districts that had green between the two predominant colors, had the highest levels of urban quality of life and were occupied by a majority of white population with the highest average income brackets.

Urban color highlights social inequalities in the city, such as the choice of roofs. The ones with lower cost, durability, or thermal performance are present in places with lower incomes, with a majority of brown or black populations, and usually in the color gray. The highest value or quality coverings are found in areas with medium and high incomes and are red or yellow – colors that match the natural environment.

4. CONCLUSIONS

The chromatic variations found in a city reflect the choices made throughout its historical and productive processes, and are expressed as a result of the dynamic *human action* × *nature* × *materiality*. Associated with other layers of socioeconomic-spatial reading, this urban polychromy makes it possible to visualize the different levels of urbanity experienced in the city – i.e., color is one of the ways to carry out urban readings.

It is important to note that the quantitative data obtained from the images is not highly accurate. This is due to the unpredictability of the conditions under which the images were generated, that can alter the color perception. To improve accuracy, future research should establish the most standardized conditions possible for image extraction. It is also recommended to test the methodology in cities with different characteristics to compare results and validate the experimented methodology.

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A Study of Utilizing Mixed Reality (MR) to Establish Environmental Color Schemes

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ABSTRACT

The purpose of the study is to adopt mixed reality (MR) technology to enhance the color schemes of harbor buildings in mountainous regions, aiming to achieve color harmony and improve the overall aesthetics and visual quality of these port areas. The experimental process involves collecting image data of the harbor buildings and creating a comprehensive chromatogram database. Using digital imaging technology, various facade color schemes for the port buildings will be designed, taking into account the primary and secondary colors, architectural characteristics, surrounding environment, and regional culture to ensure a harmonious color effect. The proposed color schemes will be visually simulated to assess their impact on the appearance of the port buildings, facilitating comparison and evaluation. Participants will be invited to engage in a mixed reality experience, where they can observe and assess the visual impact and comfort of the different color schemes. Feedback will be collected to understand user preferences and suggestions, providing insights into the strengths and weaknesses of each color scheme. Based on the user feedback and evaluation results, the most effective color improvement scheme will be identified for potential application in actual environmental color planning. The ultimate goal of this research is to significantly enhance the environmental landscape quality and the overall beauty and appeal of the harbor area.

1. INTRODUCTION

The focus of environment color scheme, based on Jean-Philippe Lenclos' theory of color geography [7], is on the collection, induction and extraction of local chromatograms to represent the color composition of a region, to illustrate the architectural color and local natural geographical environment (such as local materials, and to construct the relationship between the environment conditions and the human geography (local cultural traditions, customs, etc.). In this study, an environmental color image analysis was through a systematic process to develop a color database from the Taiping Mountain District landscape [9]. The distributions of collected regional color samples was analyzed by NCS five color categories. Furthermore, an in-depth environmental color imagery survey conducted to provide a detailed environment image with comprehensive color information of region. The color imagery space of the regional environment and observer's cognitive semantics of local environmental color space will be used to develop color scheme.

2. METHOD

The environment color investigation is through a systematic process [11] using photography, color measurement, sampling, coding, and classification. The selected color images (see Fig.1) are analyzed, classified, and presented by means of chart chromatography. A subjective environmental color imagery survey is conducted in order to collect observer's cognitive semantics of local environmental color imagery space in help of developing color scheme for further color harmony test.

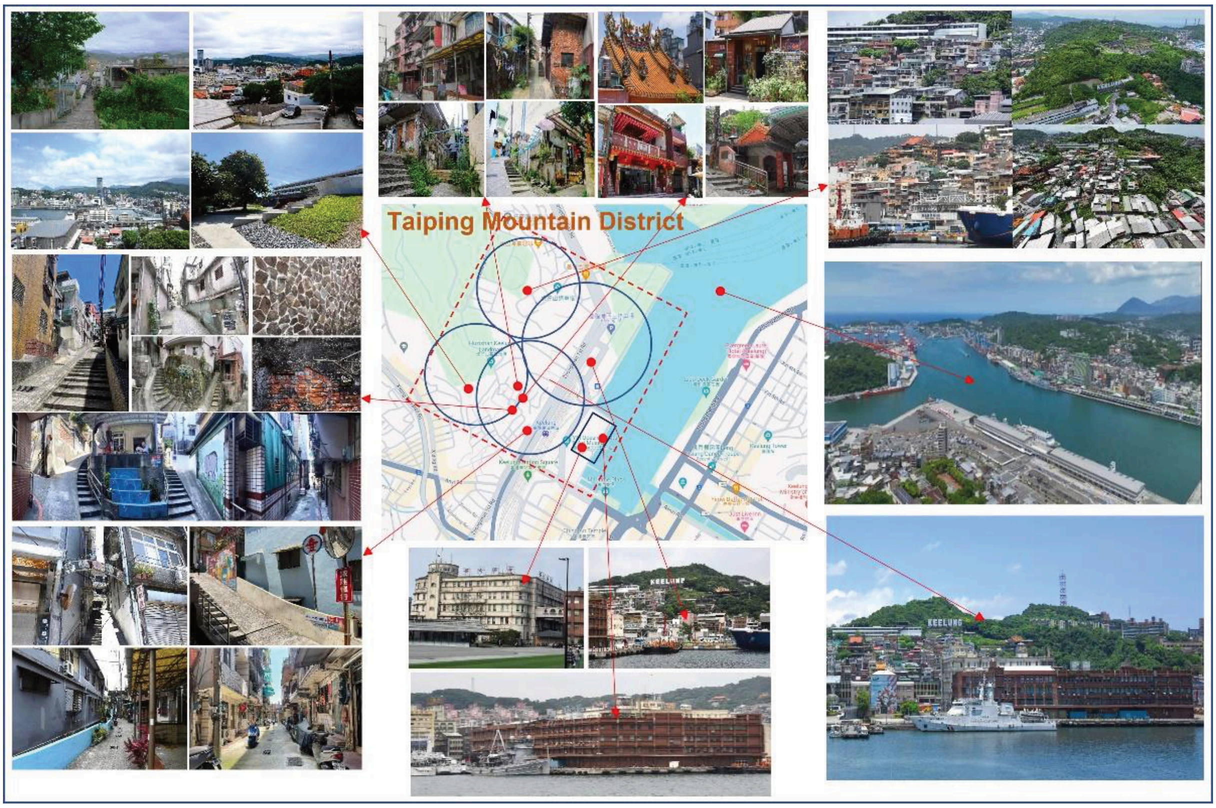

Figure 1. Selected images of Taiping Mountain District of Keelung City harbor region.

2.1 Environmental Color Imagery Survey and Tools

NCS color system [1, 2] was used for the survey. The use of NCS environmental color survey tools [12] included digital camera, NCS color ticket, NCS colorimeter, NCS color software and NCS Chromatography Set. NCS colorimeter and color ticket comparison used for the measurements of color sampling. (See Fig. 2.)

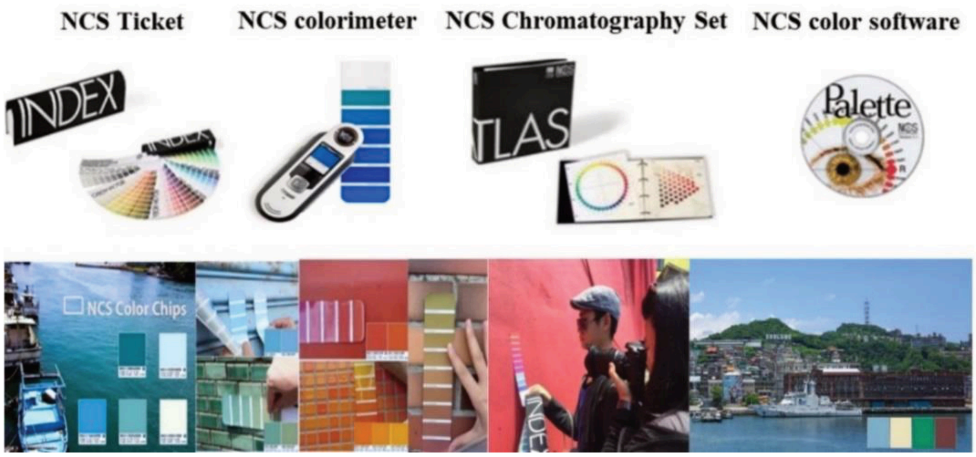

Figure 2. Tools used for the environmental color imagery survey

2.2 Environmental Color Chromatograms

Environment color collected from both the macro (sky, sea, mountain, harbor, urban landscape, etc.) and micro (architecture, street, façade, etc.) levels based on the characteristics of regional landscape colors including main color, auxiliary color and embellishment color are respectively marked on the local cultural color image space. Photoshop software is used for auxiliary analysis to establish the Taiping Mountain District environment color database (see Fig.3).

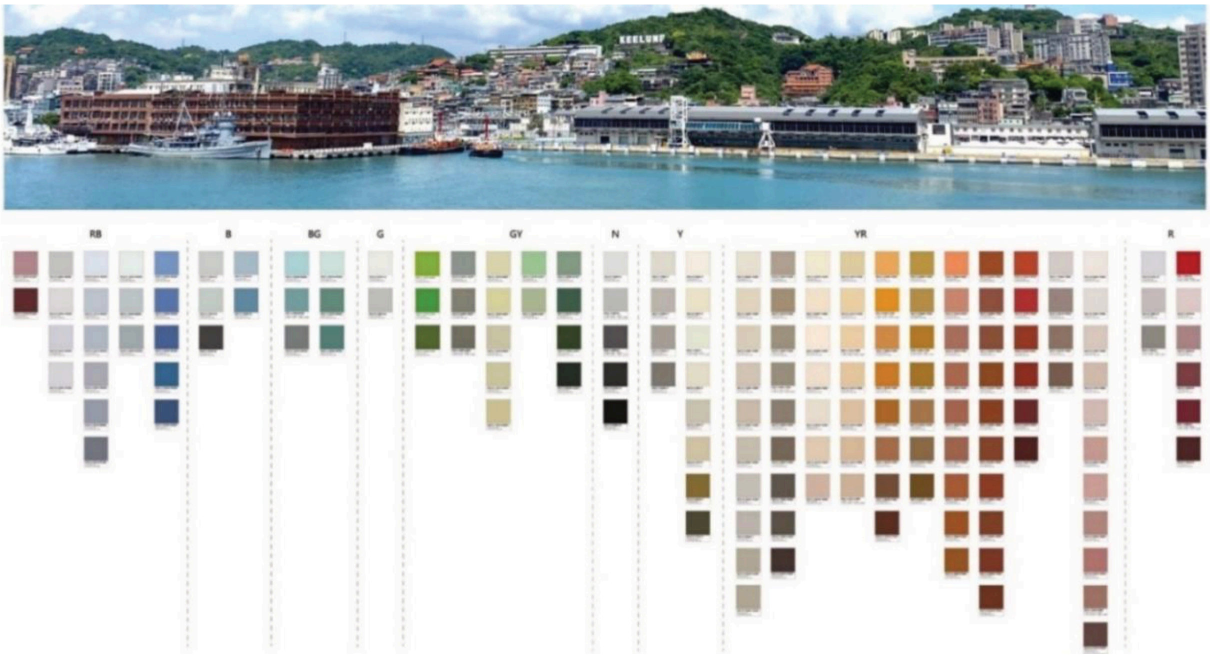

Figure 3. 164 chromatograms were categorized by NCS color system to represented the environment colors in this region.

2.3 Sample Preparation

This study focuses on developing a color scheme for a building near the harbor to achieve harmony between the building's color and the surrounding environment [6,9]. The color scheme is based on the selection of main colors of the background environment – red, yellow, green, and blue. These colors are combined with three levels of chromaticity (low, medium, high) and three levels of lightness (low, medium, high) to create variations in color matching [8]. (See Fig. 4) The color schemes are divided into two categories: single-color matching and three-color matching. The NCS color patches are used to represent the colors, with 23 colors available for single-color matching and 16 combinations for three-color matching, resulting in a total of 39 color schemes. Participants in the study evaluate the degree of coordination between the building's facade color and the background environment using a color harmony evaluation scale [10]. First, they assess whether the color scheme is harmonious or not. Then, they rate the strength of the harmony on a 5-point scale, where a smaller number indicates weaker harmony and a larger number indicates stronger harmony (see Fig. 5).

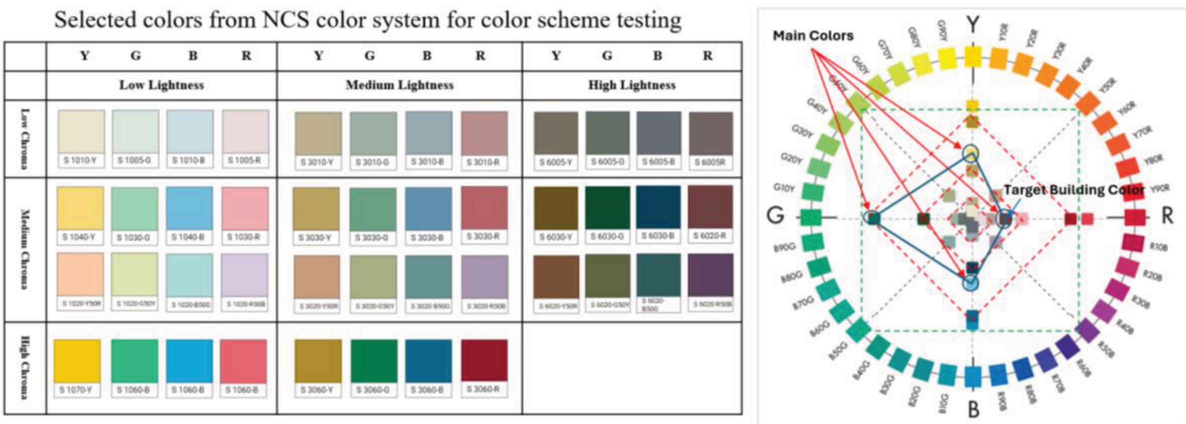

Figure 4. Selected colors from NCS color system for color scheme testing.

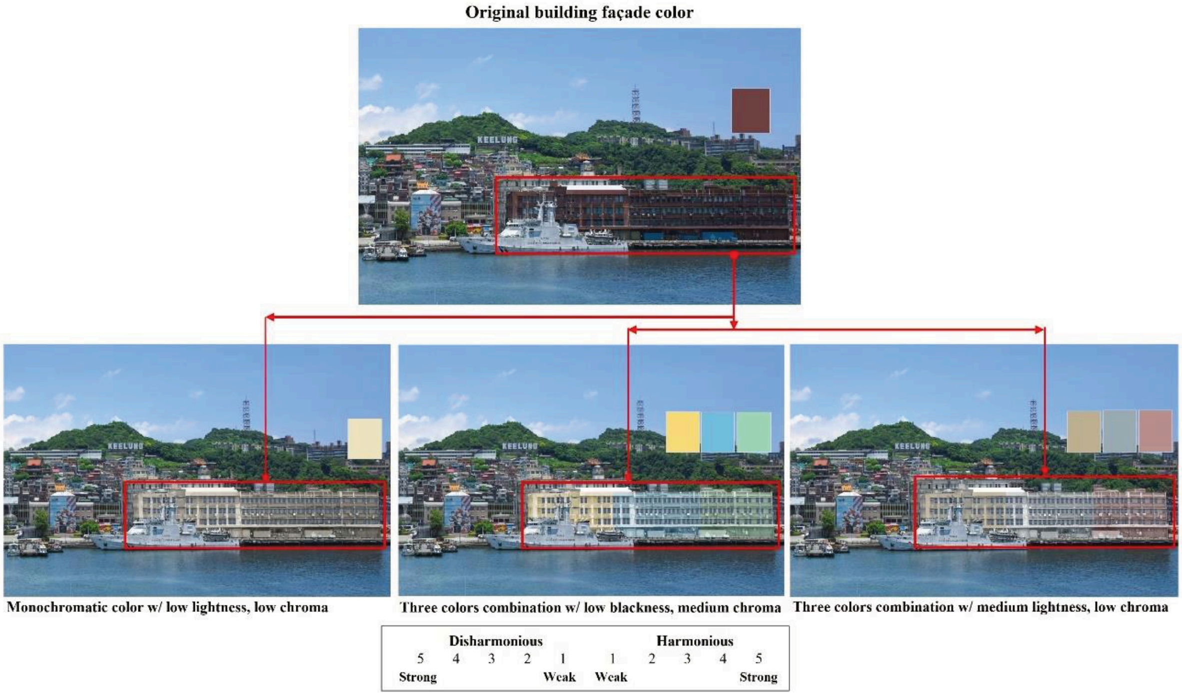

Figure 5. Harmony assessment among the environment color schemes w/ different hue, chroma, and lightness, above as the examples.

2.4 Psychophysical Experiment

A total of 21 voluntary observers were recruited from the general public to participate in this research. The experiment consists of two phases, with each observer participating in a single testing session. The entire experiment is designed to be completed within one hour.

2.4.1 Phase I: Environmental Color Imagery Survey

1. A Semantic Differential Scale (SDS) was developed based on the Kobayashi Color Image Scale [5] to assess the color image as perceived by the observers.
2. A video was produced to guide observers through the local environmental color imagery, helping them establish a comprehensive understanding of the region's color landscape.
3. The experiment utilized a color psychophysical approach to measure each observer's semantic perception of the environmental color imagery. The experiment, depicted in Figure 6, involved each participant completing one session, resulting in 21 trials of data for statistical analysis. The steps of the experiment were as follows:
   (1) Each participant first completed the Farnsworth Munsell 100 Hue Test to evaluate their color recognition ability.
   (2) Participants watched the guide video showcasing the local environmental color landscape.
   (3) After viewing the video, participants observed 2D reference images of the local environment on a computer screen. They were then asked to determine the semantic perception level of the environmental color image stored in their memory using the SDS. The scale value indicated the strength of their cognitive perception, with higher values reflecting a stronger impression. This process provided the psychophysical measurement of the environmental color image [3].

2.4.2 Phase II: Harmony Assessment of Environment Color Schemes

Following Phase I, the observer dons a Hololens 2 Mixed Reality (MR) headset to evaluate a series of color schemes for subjective color harmonization. The Color Harmony Assessment

Scale (CHAS) is employed to measure the observer's perception of color harmony [4]. Participants assess each color scheme based on the degree of cognitive strength, with higher scale values indicating a stronger sense of harmony.

Figure 6. The experiment is consisted of two phases: Phase I: Environmental Color Imagery Survey and Phase II: Harmony Assessment of Environment Color Schemes.

3. RESULTS AND DISCUSSION

3.1 Environmental Colors Imagery and Semantic Differential Analysis

After conducting statistical analysis, the spatial distribution of the local color image was plotted using the Kobayashi Color Image Scale coordinate plane are as follows:

1. The collected natural environment color image sample chromatograms were mapped to the Kobayashi color image coordinate plane. Semantic color image zones were created to present the natural environment landscape color imagery of Taiping Mountain District. Four zones were plotted as: 1. Clear-Natural-Cool Casual, 2. Natural-Casual-Domestic, 3. Casual-Dynamic, 4. Modern-Classic-Stylish-Wild (see Fig. 6).
2. The environmental landscape color image obtained through the SD evaluation experiment were mapped to the Kobayashi color image coordinate plane. Semantic color image zones were created to present the perceived landscape color image of Taiping Mountain District. Four zones were plotted as: 1. Pretty-Romantic-Casual, 2. Natural- Cool Casual-Elegant 3. Dynamic, 4. Classic-Stylish-Wild (see Fig. 7).

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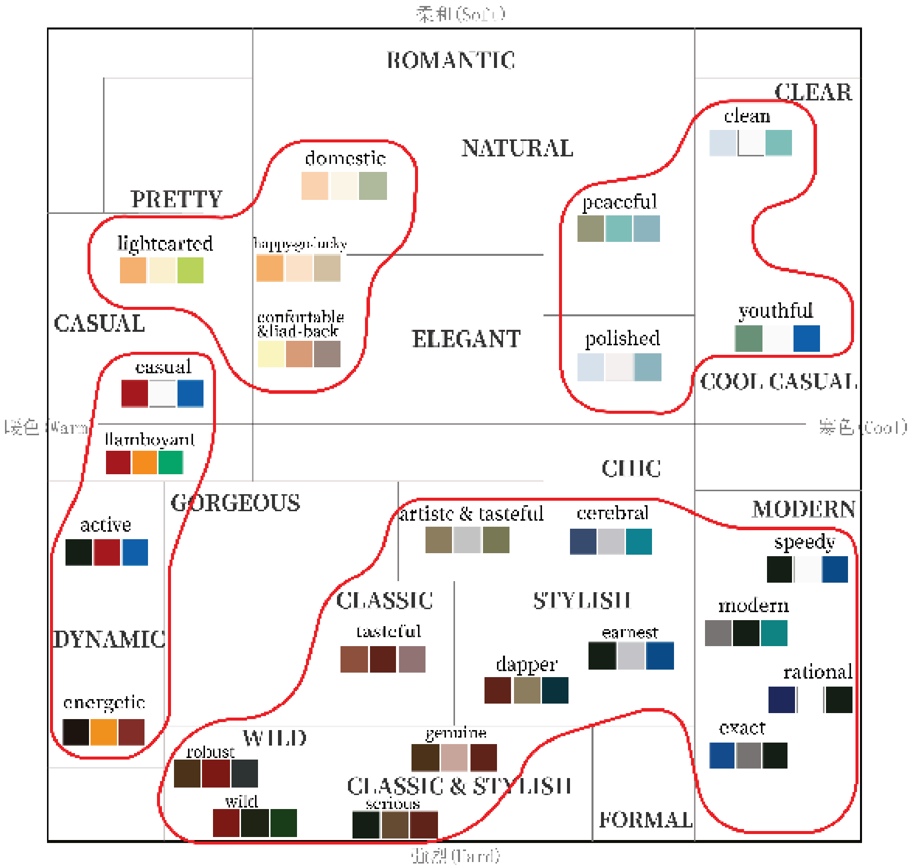

Figure 6. Natural environment color image zones plotted on Kobayashi color image scale coordinate plane.

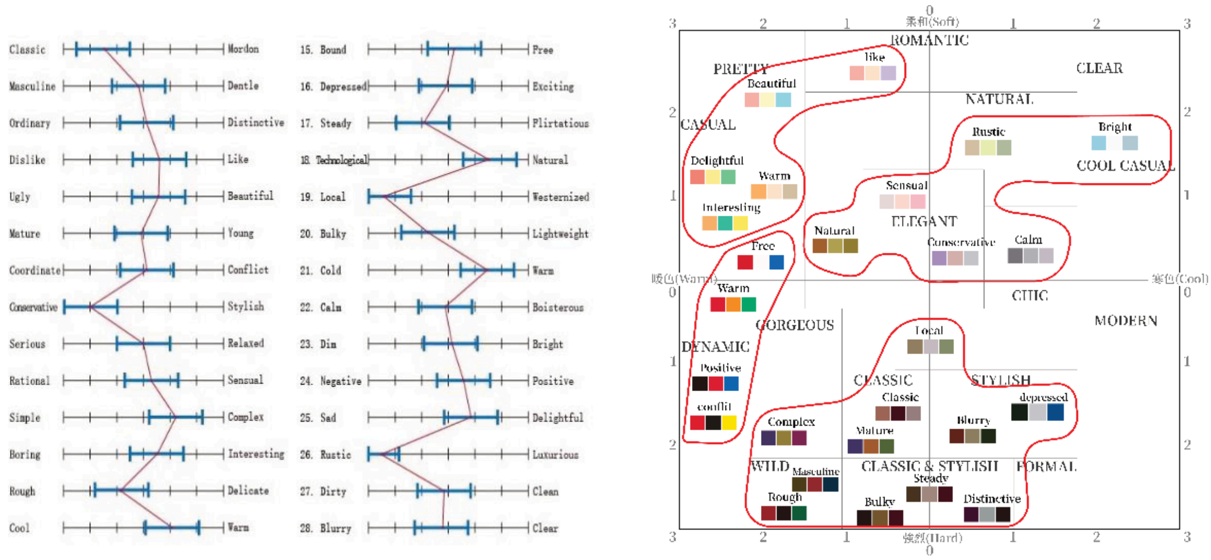

Figure 7. Color image SD evaluation results (left). Perceived semantic color image zones plotted on Kobayashi color image scale coordinate plane (right).

3.2 Analysis of Harmony Assessment of Environment Color Schemes

The value of indicators of harmonious or disharmonious shown on different colors or color combinations are as follows：(See Table 1, 2 & 3)

Table 1. Monochromatic color w/ different lightness

Y			R			B			G		
	S 3010-Y	S 1010-Y	S 6020-R	S 3030-R	S 1030-R	S 6030-B	S 3030-B	S 1040-B		S 3060-G	S 1060-B
	1.32	1.86	-0.82	1.50	0.68	-0.18	-0.59	0.36		-1.14	0.27
Y50R			R50B			B50G			G50Y		
S 6020-Y50R	S 3020-Y50R	S 1020-Y50R	S 6020-R50B	S 3020-R50B	S 1020-R50B	S 6020-B50G	S 3020-B50G	S 1020-B50G	S 6020-G50Y	S 3020-G50Y	S 1020-G50Y
1.50	1.14	1.36	-1.00	0.14	1.36	-0.18	0.55	1.27	-1.73	-1.05	0.82

Table 2. Y/B/G colors combinations w/ different chroma and lightness

	Y	B	G	Y	B	G	Y	B	G
	High Lightness			Medium Lightness			Low Lightness		
Low Chroma	S 1010-Y	S 1010-B	S 1005-G	S 3010-Y	S 3010-B	S 3010-G	S 6005-Y	S 6005-B	S 6005-G
	1.82			1.73			0.86		
Medium Chroma	S 1040-Y	S 1040-B	S 1030-G	S 3030-Y	S 3030-B	S 3030-G	S 6030-Y	S 6030-B	S 6030-G
	-0.23			-0.41			-1.18		
High Chroma	S 1070-Y	S 1060-B	S 1060-B	S 3060-Y	S 3060-B	S 3060-G			
	-0.32			-2.00					

Table 3. Y/B/R color combinations w/ different chroma and lightness

	Y	B	R	Y	B	R	Y	B	R
	High Lightness			Medium Lightness			Low Lightness		
Low Chroma	S 1010-Y	S 1010-B	S 1005-R	S 3010-Y	S 3010-B	S 3010-R	S 6005-Y	S 6005-B	S 6005R
	0.73			1.41			0.59		
Medium Chroma	S 1040-Y	S 1040-B	S 1030-R	S 3030-Y	S 3030-B	S 3030-R	S 6030-Y	S 6030-B	S 6020-R
	-0.77			0.45			0.18		
High Chroma	S 1070-Y	S 1060-B	S 1060-B	S 3060-Y	S 3060-B	S 3060-R			
	-1.64			-1.68					

3.3 Discussions

Regarding the issues of environmental color imagery analysis and the evaluation of the harmony of color schemes, the discussion is as follows:

1. The research findings revealed that there are significant differences between the color imagery of the natural environment when analyzed through scientific methods and the imagery as subjectively perceived by the observers. In particular, the perception of blue within this study was inconsistent with the salience predicted by the Kobayashi Color Image Scale coordinate plane. Furthermore, the statistical analysis of the observers' color semantic imagery did not show any cognitive association with "modernity." This suggests a divergence rooted in historical emotions and the environmental imagery specific to the region.
2. Statistical data analysis of the perceptual assessment of the harmoniousness of color schemes indicated that observers in this study showed a preference for colors with low chroma and medium to high lightness, regardless of whether the color scheme involved a single color or a combination of colors. On the other hand, it also shows that the perception of harmony between the environmental background color and the color scheme has a considerable degree of consistency.
3. Utilizing a scientific approach to environmental imagery surveys and systematic color schemes provides a dual benefit: it enhances the understanding of observers' environmental color imagery and provides objective feedback about their color preferences. This approach minimizes potential discrepancies in judgment that may arise from the subjective perceptions of color planners, ensuring more accurate and consistent application of color schemes in environmental design.

4. CONCLUSIONS

The research results indicate that color imagery encompasses a range of meanings connected to local cultural heritage and emotional experiences. The objective evaluation of color schemes further reveals that the public prefers to preserve the existing architectural and environmental color imagery in the Taiping Mountain district. Additionally, there is concern about areas in the mountainous region that have been adversely affected by man-made constructions or color projects, with the public offering suggestions for improvement. To achieve effective and universally accepted environmental color planning, it is essential to adopt a broader cross-cultural communication approach. This strategy will facilitate ongoing exploration and integration of research between color science and color psychology, ensuring that environmental color schemes are both scientifically sound and culturally resonant.

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