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ATLAS OF COLORS

Colors for better therapeutic environments

Master's Thesis Spring 2023

Chalmers University of Technology
Department of Architecture and Civil Engineering
Architecture and Urban Design

Examiner: Cristiana Caira
Supervisor: Marie Larsson

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by Emma LAW-BO-KANG
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CHALMERS
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ABSTRACT

Perception may be defined as the process by which individuals receive, recognize, organize and interpret sensory information in order to give meaning to their environment. In the psychiatric field, it turns out several mental illnesses alter the senses of perception for patients. Architecture plays a critical role in psychiatric care, as the physical environment can have a significant impact on the emotional and psychological well-being of individuals receiving treatment.

The ability of color to impact human emotions, behavior, and well-being is significant and makes it a powerful tool that can be used to achieve desired outcomes. This color impact on human well-being is particularly important in healthcare settings, where it has been shown to influence people's mood, perception of pain, and recovery time. Therefore, it is important for architects to consider the impact of color in their designs and to use color in a thoughtful and intentional way to enhance patients' well-being and recovery.

The thesis rests on the analysis of the use of color in space and its effect on people diagnosed with Post-Traumatic Stress Disorder (PTSD), in the context of built environments. It then delves into different ways in which color can be used to support trauma recovery and promote feelings of safety and comfort. This includes an examination of color psychology, color symbolism, and the ways in which different hues and other color characteristics can impact emotional states.

The identification of stress-suitable colors led to the elaboration of a color palette. By suggesting this tool, the thesis aims to provide practical guidance and inspiration to architects for designing more supportive and healing environments in the psychiatric field. This thesis aims to bridge the gap between the psychiatric and architectural fields, shedding light on the importance of designing for individuals with disorders. It offers a valuable resource for professionals dedicated to creating environments that promote healing and well-being for those who have experienced trauma. More, it approaches a field with a lack of research and sets an explorative base for further research on the topic.

Keywords: color perception, mental health, therapeutic environment, psychiatric architecture, trauma-informed design

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00. |
Walden 7, Ricardo Bofill

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PREFACE

INTRODUCTION TO THE SUBJECT

BACKGROUND

Throughout history, healthcare dealing with mental illnesses has been changing and in the same way influencing society's eye, treatments and its architecture. New discoveries brought about new approaches and concepts for mental illnesses. By the middle of the 20th century, mental health facilities changed with the advent of new drugs and led to the phenomenon of deinstitutionalization¹ (Le Bonhomme & Le Bras, 2020). Psychiatric asylums with inhuman and barbaric conditions are over and new infrastructures for the mental health care are established. Today, healthcare centers represent a wide variety of specific facilities such as day hospitals, night hospitals, rehabilitations centers, community mental health centers, crisis centers... to only name a few. But this variety which proves a great advance in term of care remedies, also generates complexity when it comes to the design of these therapeutic environments.

In the last decades, research has proved the beneficial effect of therapeutic architecture in the recovery process of patients through the process of evidence-based design². Many books, articles and theories have been released about the subject (e.g., *Happy by Design* by Ben Channon). In parallel, researchers have been writing about color for even longer, such as the painter Josef Albers in his book *Interaction of color* (1963) or the psychologist Carlton Wagner with *Color response report* (1988). Several studies have proven that the effect of colors and our associations to it had an impact in our lives; in the way that we interpret information or in the way we feel. Although color represents an important part of the architecture, I found it quite difficult to reach theories and explanations based on studies about the use of color as a therapeutic element in hospital care. It turns out that this field is still quite little known.

According to the architect and researcher Evangelia Chrysikou, when the demands were about designing for mental health, architects found themselves disoriented until very recently (Chrysikou, 2014). It was due to the fact that they could not refer to evidence-based guidelines on which they could have based their design solutions on. The resources for the design work were quite poor and were more based on anecdotal evidence and "personal references". More, the care providers also had difficulties to brief architects on the needs of such a facility. The main reason was "the lack of understanding about how to translate the concept of community care

into a fully functioning building" (Chrysikou, 2014, p.4). Nowadays, while seeing the recent delivered psychiatric projects, we can see that this field has grown up and more, concepts and theories are stronger and based on recent research especially with evidence-based design. But even with these advances, when it comes to color in psychiatry, this branch still remains little studied and then quite poor in research.

RELEVANCE

Although research has been conducted on the significant effect of colors in our lives and that evidence-based design proved the importance of good therapeutic environments for better recovery, very little research and theories has been devised on the use of colors as a key element in psychiatric architecture to improve the quality of therapeutic spaces.

PURPOSE

The master's thesis seeks to emphasize the value of conscientiously using color as a prime element in psychiatric architecture to reduce stressors and enhance well-being in built environment. The objective is to analyse the effect of colors on the human being with a specific attention to its impact on stress – especially within the framework of the Post-Traumatic Stress Disorder (PTSD) – in order to develop a suitable and appropriate color palette. It aspires to give a new angle of perspective when it comes to design for psychiatric architecture by making color a main element to ease stress for efficient therapeutic design. The aim of this thesis is to combine the fields of architecture, color and psychiatry to be able understand if color in built environment can have a significant impact in well-being and then propose a draft of hypothetical solutions. This work has an explorative and challenging approach by suggesting potential more appropriate colors in stress reduction in the form of a color palette. Lastly, this thesis is a further way of questioning our role as architects in therapeutic design and more, raising questions and limits in this field by following this axis of research.

RESEARCH QUESTION

How could architects support a better design of psychiatric spaces regarding stress issues by being aware of stress conditions and working with suitable a color palette?

This question covers many other interrogations within the fields of architecture and psychology: such as: How important is color in architecture? How color can affect architectural design? In which way it influences the human being? Can it make a difference with regard to stress issues and then well-being? How much importance should we give to the use of color in design as architects?

¹ Deinstitutionalization: "movement that advocates the transfer of mentally disabled people from public or private institutions, such as psychiatric hospitals, back to their families or into community-based homes" (Stiker, 2013)

² Evidence-based Design : "the process of basing decisions about the built environment on credible research to achieve the best possible outcomes" (Apuccinelli, 2011)

THEORY

The book *Architecture for psychiatric environments and therapeutic spaces* by the architect and researcher Evangelia Chrysikou gives a general overview of the psychiatric architecture field. The pamphlet *Architectural Principles in the Service of Trauma-Informed Design* by Sam Grabowska et al. was a useful resource to understand the link between space and stress, as well as the other documents from Shopworks Architecture, Group 14 Engineering and the University of Denver. It helped me to elaborate on the color palette by comprehending the architectural needs of people reacting intensely to environmental stressors. In addition, the study *Effects of color on emotion: Evidence from self-report ratings and physiological measures* by Daniel Oberfeld and Lisa Wilms brought a more scientific approach to the analysis of color effects. Regarding the target group which is patients suffering from the Post-Traumatic Stress Disorder (PTSD), the book *Complex PTSD: From Surviving to thriving* by Pete Walker provides a complete vision of the disorder and the four types of stress responses it arises. Finally, among many articles and papers about color, the significant work from Gerhard Meerwein and Bettina Rodeck *Color – Communication Architectural Space* was a very complete, effective and helpful resource about color in general and its use in the built environment. The long journey of finding tangible information and valid sources shaped the work as it is now and had a strong influence on the framework process.

METHOD

The master's thesis follows a theoretical, explorative and practical approach in three chapters. Two additional parts come to frame the main work: a contextual introduction and a reflective conclusion. The theoretical part is the first point of entry to the subject, yet it continued to be supplemented and adapted as the work progressed.

About the research, literature studies are conducted around three crossed research axes which are Color, Space and Stress. These notions cover different disciplines from psychology and psychiatry to architecture. A short context and background history of psychiatry and psychiatric architecture set the base to apprehend this complex and delicate topic. Then, the main research part represents the starting point of the reflection and development of the color suggestions.

The exploration proceeds along an *Evidence-Based Design* approach by justifying each decision relying on available data studied during the work process. Thus, the elaboration of the color palette rests upon *Design by Research*.

The explorative part gathers the process of elaborating a color palette by connecting the three main notions. It explores the symbolism and complexity of color on its own. More, a deep analysis of color studies sets the base for the genesis of the color palette. Then, a link between the notion of Trauma-Informed Design, PTSD needs and the use of color is made following the research with the aim to refine the suggested colors. This part is a suggestive and personal interpretation resulting

from the whole work process. More, an interview and personal communication with professionals in the fields of architecture and psychiatry add other kinds of inputs to pursue the analysis.

The final product of the color palette is applied to existing rooms to show potential ways of using colors in the psychiatric built environment. Two psychiatric spaces are selected according to their importance in terms of visits and are analysed and explained. Then, color applications are based on pictures from the Psychiatric Clinic of Södra Älvsborg Hospital (SÄS) in Borås, Sweden designed by White Arkitekter and delivered in 2021. The application shows my own approach to the use of these colors in order to limit stress factors and improve well-being in architectural spaces for people suffering from mental disorders.

DELIMITATION

Initially, the idea around this thesis was to study, analyse and define different elements related to perception that could have a remarkable impact to reduce stressful environments. I pictured materiality, colors, the scale of the space, sound, light... to only name a few. However, the vastness and complexity of the subject combined to the duration allocated to the master's thesis did not allow me to treat all of these potential aspects. For improving the design of psychiatric spaces. Due to the interesting aspect of color effect on people, its predominance in architecture and the lacking research on it, I agreed to dive into this direction.

More, psychiatric architecture is a complex and wide field. As an application to my research, I established to work with two specific rooms which seem to me the most visited by the patients. The pictures used as a base are from the Psychiatric Clinic of Södra Älvsborg Hospital (SÄS) in Borås, Sweden. Finally, psychiatry and mental health themselves being an even broader subject and in addition, my limited legitimacy to talk about these subjects, result in the fact that the thesis work only approaches the notion of stress through the lens of the Post-Traumatic Stress Disorder (PTSD). Which means that many other aspects of stress and mental illnesses might be lacking from this academic research.

Like so, this paper only focuses on the use of colors in specific psychiatric spaces and how architects can work with it to fit the patients' needs and reduce spatial stressors related to stress in the context of PTSD.

Finally, the content of this thesis is subject to my subjective understanding of the topic. The chosen strategy and exploration are a personal and unique approach to the field which was also strongly influenced by the different resources I have worked with. Thus, it should not be read as an explicit and intangible result but rather as a suggestive method and hypothetical approach.

PERSONAL MOTIVATION

Before moving on to the main work of this thesis, recognizing and sharing my own sensitivity and implicit bias to the topic matter in the result and reading of this booklet. Although scientific papers and other articles does count way more in the legitimacy of this work, I still think that my own experience and vulnerability to the subject has its importance to grasp my approach to the work. However, this is only an additional and personal outlook regarding my sensibility to the topic and it does not involve any objective elements.

My personal interests led me to develop my work in relation to mental health, sensory perception, the human and body in space. During my bachelor, I have already worked on a similar topic with the following research question: “In which ways psychiatric architecture has influence over patients’ space? *Body’s place and influence on the recovery process*”. More, here is an intimate part about my background that I decided to share with you to better sense my approach.

As a former dancer, I have always paid a lot of attention to the space around me. I could say that I am very sensitive to spaces and their features. My own sensitivity to space made me realized how much the design of a room influenced my well-being and comfort. What makes me feel more at ease in this room rather than another one? My odd ways of appropriating and using space made me wonder about the architectural aspects that made me so comfortable, and also why other places could make me feel insecure. The scale of the space, its materiality, colors, lightness, can shape our bodies, our movements and the way we use a room.

As a personal experience and pleasant memory, one meeting room in the Convent of La Tourette designed by Le Corbusier located near Lyon, France still reminds me of this so singular relationship to space. The layout of the room has made it my safe place, my experimentation space, the origin of improvised choreographies within the spacious and intimidating concrete building. The pillars framing the room, beige carpet on the floor, the large colored windows punctuated by the mullions representing a score and the very unique and peculiar light coming in the room by the sunset time remains one the most remarkable experience that I have from a space.

Dancing has instilled in me a strong relationship to the awareness of my own body and can then better apprehend the surrounding space. More, thanks to architecture, I have a finer and more discerning critical look on the built environment. Still today, these two aspects tend to give me the irrepressible desire to experience and sense each space through these filters and definitely hold sway on my perception and experience of space.

*Free translation from French. Oiginal title:
ARCHITECTURE ET PSYCHIATRIE : Par quels moyens l'architecture psychiatrique régit-elle les espaces destinés aux patients ? Place du corps et influence sur le processus de guérison.*

READING INSTRUCTIONS

The *Preface* portrays the context and purpose of the master’s thesis, providing the theoretical background of the work.

The *Introduction* is a brief overview outlining the historical context of psychiatry and psychiatric architecture.

The *First Chapter* contains the main research with principal notions and theories regarding Color, Stress and Space.

The *Second Chapter* focuses on an analysis of color associations and effects with the aim to select stress-suitable colors. It results in the elaboration of a color palette.

The *Third Chapter* consists of the definition of two specific psychiatric spaces. These two types of rooms serve as a support for an application with a suggestion of the use of colors in space.

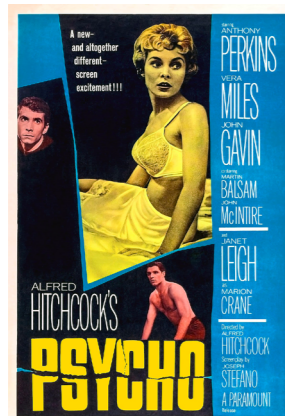
The *Conclusion* stands as a critical reflection on the work, with a conclusion and an opening discussion on the topic.



00_0.
Convent of La Tourette, Le Corbusier

00/ INTRODUCTION

00/ INTRODUCTION



Psycho by Alfred Hitchcock
(1960)



Shutter Island by Martin Scorsese
(2010)



Split by M. Night Shyamalan
(2016)

CONTEXT & SHORT HISTORY

Throughout history, society's vision of psychiatry has significantly changed and therefore, architecture for healthcare has changed over time following this progress. From deplorable conditions in infrastructures more similar to prisons than healing places, psychiatric healthcare evolved towards more humane and respectful approaches to the patients suffering from mental diseases.

MADNESS AND THE BUILT ENVIRONMENT

History of psychiatry is punctuated with revolutionary progresses regarding the medical approach and it was impacted by several changes in the nomenclature of the terms in the field. Nowadays, from what I've seen in medias, movies, interviews, the vision of our societies on the psychiatric field is still quite distorted compared to its reality. For instance, the movie *Split* by M. Night Shyamalan released in 2016 questioned on the Dissociative Identity Disorder (DID). The film has been the subject of much controversy, accused of conveying a false and wrong image of the disease. More, movies such as *Psycho*, *Black Swan*, *Shutter Island* also deal with mental diseases such as schizophrenia, which often contributes to unfavorable clichés about this diagnosis.

Lunacy asylums, imprisonment, violent insanity are the first images we could picture about the topic. Lunatics were excluded from the society and spent their lives in carceral institutions. But this imagery can't be blamed since this is indeed the place that psychiatry held in previous centuries. This vision has been conveyed for a long time in the media, films, documentaries, writings... Before the revision of people with mental illnesses' rights, patients were often placed in an asylum against their will, excluded from society and limited in their own rights. One of the most striking pictures of insanity is probably the patient chained to the bed, restricted to the maximum in their movements: a hindrance to their freedom. This restriction in space was sometimes one of the aggravating factors of the diseases. After reconsideration of treatments in psychiatry, many efforts have been made in the last decades to widen and democratize the perception of psychiatry.

In the start of the 19th century, psychiatry was in the turn to become a science and a medical discipline. In France, the doctor Philippe Pinel,

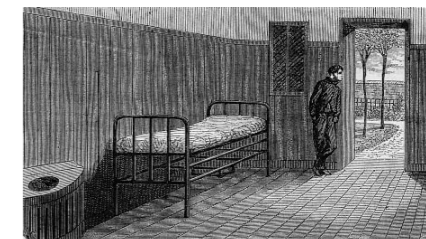
father of the French psychiatry who was specialized in the treatment of people with mental illnesses, works towards humanisation of these treatments (Caire, 2014). He affirms that lunatics can be cured. At this time, psychiatry questions and becomes a large field of research. In Sweden, Bror Gadelius which is one of the most influential Swedish psychiatrists of the 20th century maintains that modern psychiatry can treat patients and has nothing similar to the previous asylums that were considered as prisons. His role is to democratize psychiatry treatments and introduce the new approaches in the country. The turn of psychiatry becoming a science helped to change the looks on it. Instead of this dark past with asylums being prisons of torture, the new era proves that psychiatry is now a science and hospitals are built with humane and altruistic values. At that point, depicting the dreadful history of psychiatry as demonstrated by the painting of Emil Kraepelin³, was a way to reinforce the process of establishing psychiatry as a science and an attempt to change attitudes towards the mental asylums (Qvarsell, 1991).

On the other hand, the totalitarian side of psychiatry questions and leads to deinstitutionalisation⁴ going along with the policy of sectorisation from where the new psychiatric facilities originate from. This is how we're getting closer to a more humanizing architecture today: to make people forget the shameful infrastructures and methods in lunacy asylums which marked the past of psychiatry.

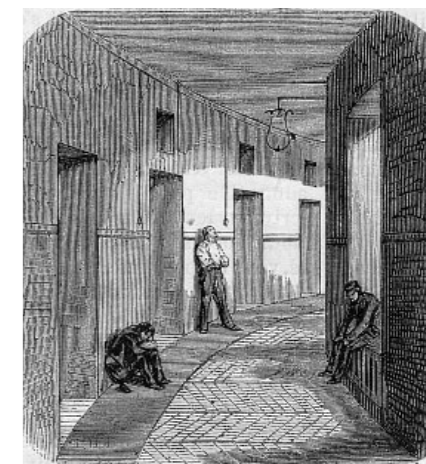
CURRENT INITIATIVES IN PSYCHIATRY

Henceforth, facilities for people with disorders are multiple following the sectorisation. Nevertheless, the most common institution when it comes to severe symptoms, the need of surveillance and treatment are the psychiatric wards. It consists of hospitals based on inpatient care, in other words long-stays for inpatients with disorders whose needs cannot be satisfyingly met in an outpatient facility. The aim of these centers is to provide intense care in high-secured units, to insure everyone against injuries or accidents, despite the violent behaviour some patients might have after being triggered.

On the other hand, outpatient facilities offer support to patients that are more stabilized or freshly new visitors who need to be seen by a doctor. They guarantee consistent meetings according to the needs but the patients do not live at the hospital. There still is possibility to be committed if the situation suggests it. Also, other types of facilities can just as much offer psychiatric care such as community mental health centers or private clinics.



00_1.
View of a cell in Saint-Anne Asylum, Paris (1960)



00_2.
View of a corridor in Saint-Anne Asylum, Paris (1960)



00_3.
Hydrotherapy practice: attendants wrap patients in wet sheets and wait for several hours. (~1900)



00_4.
"The Interior of Bedlam" by William Hogarth, 1763.

³ German psychiatrist founder of modern scientific psychiatry.

⁴ [Removing from the institution] Process of replacing long-stay in psychiatric hospitals for people diagnosed with a mental disorder by shorter stays in mental health centers that are less isolated, closer to the community.

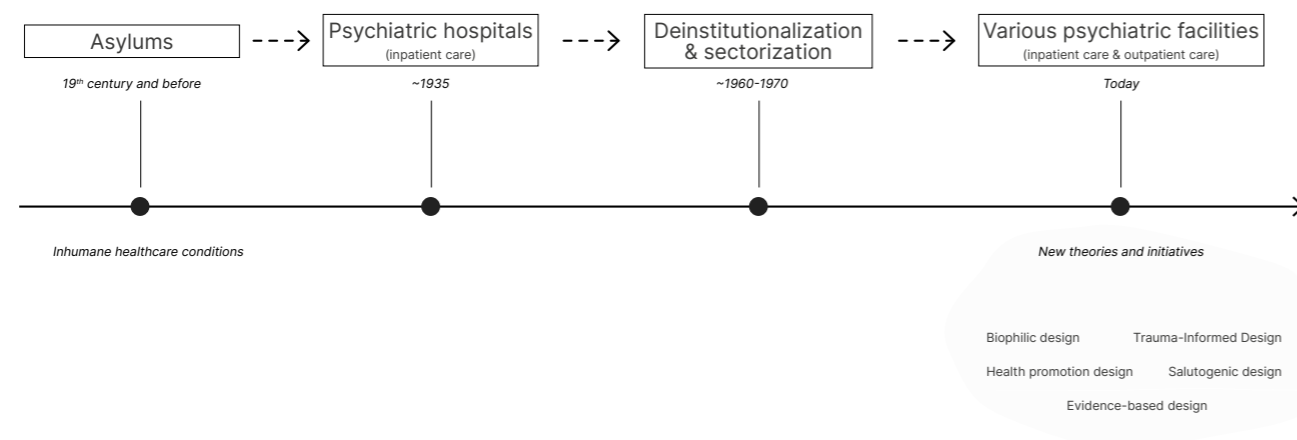
EVIDENCE-BASED DESIGN

For the last decades, psychiatric architecture leans towards a more humane and informed approach, especially with the notion of Evidence-Based Design (EBD). This method can be applied to many fields but is quite reputed in healthcare architecture. EBD consists of designing buildings and spaces following research and empirical evidence. It involves studies and scientific data which are gathered to identify efficient solutions of promoting health (Apuccinelli, 2011). The main goal is to enhance the physical and psychological well-being of the users in space (Alfonsi, 2014). For instance, with a good exposure to natural light and the presence of greenery. Then, it is not only about creating good-looking environments, but more importantly about promoting health, safety, and well-being for the patients.

The following chapter dives into the different notions and theories of the subject by collecting knowledge on the three major aspects of the thesis: Color, Space and Stress.

01/ COLOR, SPACE & STRESS

00_5. Simplified chronology of the psychiatric care and psychiatric architecture



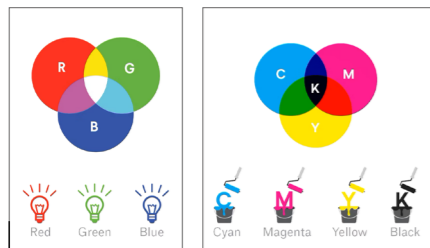
01/ COLOR, SPACE & STRESS

COLOR PERCEPTION

UNDERSTANDING COLOR



01_1. Visible light spectrum



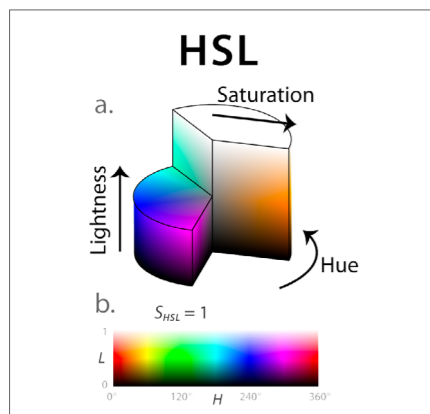
01_2. Additive synthesis of colors RGB (digital)

01_3. Subtractive synthesis of colors CMYK (printing)

Color represents the aspect of any object that may be described in terms of hue, saturation and lightness (Nassau, 2023). In physics, colors are defined through wavelengths, and each color corresponds to a specific wavelength. These wavelengths of colors are distributed on the Visible Light Spectrum (fig.1) which corresponds to the different frequencies that the human eye is able to sense. Our vision of color is dependent on the three following suppositions: that there is light, that the person's eye has the ability to see color, and that the person's brain can process the color stimulus from the eye. It is indeed thanks to these stages that we can perceive color.

Superpositions of wavelengths enables to create new colors. However, color can be processed in two different ways: with the additive synthesis. The additive color model (RGB, fig.2) uses light to display color by adding red, green and blue is more appropriate for digital content. The superposition of all the wavelengths results in giving white light. Whereas the subtractive color model (CMYK, fig.3) which uses ink to display color by mixing cyan, magenta, yellow and black is better for printed work. The mixing of colors results in giving black paint or ink.

However, there is one color system which aligns more closely with the way human vision perceives color-making attributes: the HSL color system with Hue – Saturation – Lightness (fig.4). The HSL representation is similar to what mixing paints would look like in the physical world. The hue represents how much cyan, magenta and yellow can be found in the chosen color. The saturation corresponds to the amount of white paint and the lightness represents the varying amounts of black paint in the chosen tint. To be brief, these three notions define colors that we are able to experience in space: the hue simply gives the rough color (red, blue, green...), which can be more or less saturated (intensity of the hue – vivid or not) and affected by lightness (more or less light in the hue).



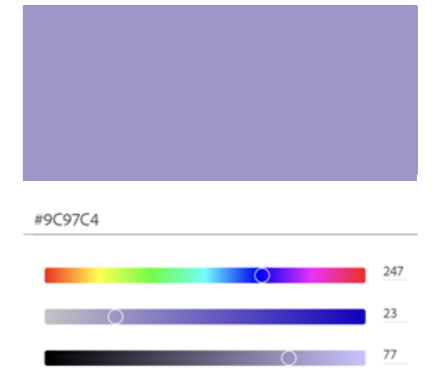
01_4. Hue - Saturation - Lightness color system

EXAMPLE OF LAVENDER COLOR

Hue: 247° >> On the color wheel (upper row), the hue stands in a tint between violet and blue.

Saturation: 23% >> On the middle row, saturation can be read from left to right, left being the less saturated. The tint of the lavender color is not very vivid and we notice that the saturation is quite low.

Lightness: 77% >> The lavender tint appears quite bright, it means that the lightness level is rather high as we can see on the last row.



In 1666, the first color wheel was invented by Isaac Newton and it allowed later to come up with other color theories such as the trichromatic color theory (the fact that wavelengths of red, blue and green can be combined to create every color on the visible light spectrum) that was explained earlier the additive synthesis of color. But the most important concept that emerged from this color wheel is actually The Color Theory that will be explained later on.

There is one last important aspect before moving on: the use of black and white. In physics, black, white and gray are not considered as colors since they don't have a specific wavelength. They can be defined as achromatic (literally "without color"). However, later in the work, we will still qualify them as "colors" in the sense of flat tints or color paints that we're able to cover surfaces with.

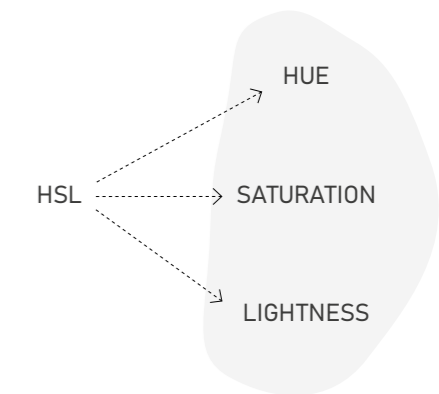
Apart from the scientific facet of the visible spectrum of colors, being able to see colors is not the main aspect of their ability. It is the way to interpret and react to them which is full of interesting aspects.

EXPERIENCING COLOR

More than only being a certain wavelength, color is also a sensory perception (Magagula, 2018). It finds its meaning in people's interpretation. But the fact that color is a sensory perception also means that its interpretation remains personal. Color has many effects on our environments and everyday lives and many factors can influence our perception of colors.

According to Meerwein and Rodeck in their book *Color - Communication in architectural space*, we sense and experience colors at different levels which can be represented in a scheme. Even though the complexity that influences our experience to color is difficult to summarize, they assume that six interdependent factors affect our color experience. These factors are illustrated on the following scheme (fig.6) where their interplay is described in a spatial model (Meerwein et al., 2007).

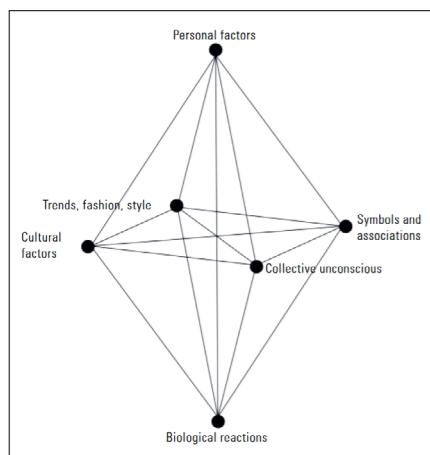
01_5. Lavender Color HSL characteristics



"All human perceptions lead to reactions."
- Meerwein et al., 2007, p.23

• Biological Reaction

Admittedly, the optical reaction to color is quite obvious: it signifies a reaction to the energy of the light waves. Yet, experimentations revealed that the pulse of a person will still react by increasing when exposed to the color red or decreasing while exposed to the color blue, even if the candidate is blindfolded.



01_6.
Spatial color scheme
(Meerwein et al., 2007, p.20)

The collaboration between light, eye, and brain serves more than just the purpose of “seeing”. Apart from the optical visual pathway, there is also an energetic pathway that carries light and color stimuli directly to the inter-brain, affecting metabolism and organ functions (Meerwein et al., 2007, p.20). As a result, several studies have proven the effect of colors on our body, including the study *The Influence of Color on Student Emotion, Heart Rate, and Performance in Learning Environments* from researchers in architecture, design and psychology. They proved that being exposed to red increased the heart rate whereas blue decreased the heart rate (AL-Ayash et al., 2016, p.203). These reactions are purely biological and occur regardless of how individuals think about or evaluate colors aesthetically.

In one of his conferences, the designer and writer Jean-Gabriel Causse explains more about this aspect of color effect reporting an interesting study which was conducted in England. Adults were asked to play with Lego. “Do something that’s never been done before” was the instruction. Some had these instructions in blue, the others in red. The people in the group which had the blue instructions used the right hemisphere of their brains and started making creative objects whereas the other people which had the instructions in red used their logical brain and made functional objects. By simply giving information written in one color influences the way we interpret it. Blue environments activate creativity, it gives us better, original and more ideas in general. On the other hand, if we want to stay focused, it is preferable to be in a warm color scheme. A room with red elements will give energy to stay focused longer (Causse, 2015).

• The Collective Unconscious

The collective unconscious is a part of our psyche that stores ancient patterns and impressions, separately from our personal experiences. It contains archetypes which are innate tendencies that shape our perceptions and reactions. These archetypes are deeply embedded in our genetic heritage and can be improved through learning. The archetypal relevance of color should be considered in relation to our response to it, based on our primal connection to nature. The “personal unconscious” could also be taken into account. This would mean that a personal experience can also influence our reaction to color. For instance, a person could be triggered by the color red, the color of blood, after having lived through a traumatic experience (Meerwein et al., 2007, p.20).

Color influence is strongly integrated in our subconscious. For instance, wearing red makes us feel stronger. It has been proven in sports, such as the case of football teams which dressed in red performed better. In Greco-Roman wrestling, since 1896 and the start of the modern Olympic games, 67% of the fights were won by wrestlers dressed in red. With red clothes, we are physically stronger and the opponent sees us stronger (Causse, 2015).

• Conscious Symbolism and Association

There are many examples of color impressions, symbols, and associations that most people will interpret in the same way. Since we are exposed every day to colors, we build connections in our heads with what we keep seeing. For instance, yellow is associated with the sun and light, red with blood and fire, green with nature. These fundamental associations stem from our experience of nature and have evolved over time. Despite differences in cultural heritage and education, research has shown that there are both collective and individual responses to color associations that are shared by a majority (Meerwein et al., 2007, p.21).

Marketing for example tends to use these associations of colors (fig.8) since color has a huge impact in communication. Indeed, it represents 80% of a brand-recognition (Causse, 2015). From all over the world, some associations remain universal, such as using blue to refer to the sea or the sky. More, cross-cultural studies have revealed surprising similarities in preferences, mood associations, and connotations related to color. Although cultures have their own color associations, the evidence suggests that there are universal responses to color (Meerwein et al., 2007, p.21).

• Cultural Influence

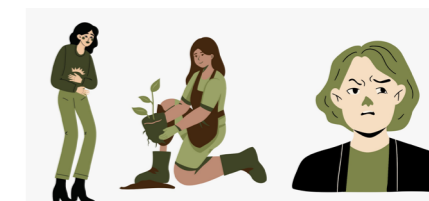
Even if there are universal reactions to colors, it doesn’t exclude the existence of cultural associations and meanings. We can notice for example, in the English language, if a person is said to be green, they feel sick; in German, on the other hand, if a person is said to be green, they are hopeful; and in French, they are envious (TMD STUDIO, 2020). As another example, red is associated with danger, passion, anger or blood in the French culture, especially related to the revolutions. But on the other hand, in China, red symbolizes luck, joy and happiness and represents celebration especially since it is believed to ward off evil and relates to the element of fire in a positive way.



01_7.
Greco Roman wrestling



01_8.
Color Emotion Guide



01_9.
English: feeling sick
German: feeling hopeful
French: feeling envious

- Trends, Fashion, Style

Moreover, colors are fashionable. Every year new color trends show up with fashion and dominate the market for some months. This overexposure to colors still influences our associations but these trends are short-lived and not reliable when it comes to architecture (Meerwein et al., 2007, p.21).

- Personal factors

Last but not least, personal factors have a dominant impact on our color perception. According to Meerwein and Rodeck (Meerwein et al., 2007, p.21), these include:

- Basic personal disposition
- Personality structure and temperament
- Physical and psychological constitution
- Age and gender
- Sensitivity to color

Unfortunately, the architect or designer cannot really have control over it. Some studies revealed that according to age, socioeconomics and character traits, some patterns in color preference have been shown. In general, “younger people tend to prefer more saturated and primary colors, where older people prefer less saturated and subdued colors” (TMD STUDIO, 2020).

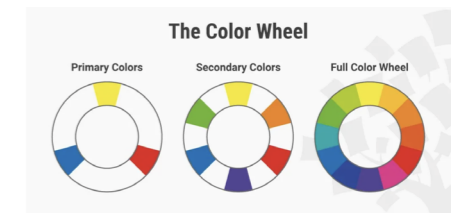
To put it in a nutshell, in front of colors, a person is both influenced by personal and universal aspects of this color in their environment. It should be noted that these different parameters of color experience must be considered more interactively instead of observed separately. Furthermore, all of these factors of interpretation also have an impact on our use of color as we have seen with marketing, and this aspect has particularly a role in the Color Theory.

USING COLOR

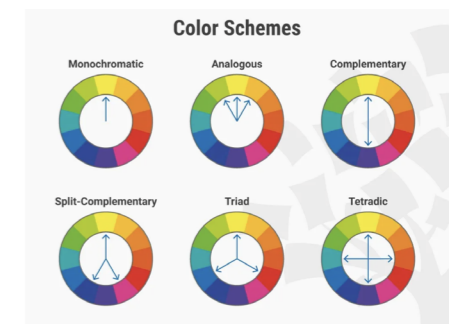
The Color Theory consists of both the science and art of using colors. According to the design writer Kris Decker, it can be defined as the way “how humans perceive color; and the visual effects of how colors mix, match or contrast with each other. Color theory also involves the messages colors communicate; and the methods used to replicate color” (Decker, 2022). In color theory, the color wheel helps to develop color harmonies mixing and palettes.

As Decker explains it, the color wheel consists of three primary colors: red, yellow, blue (fig.8); three secondary colors (results of the primary colors being mixed: green, orange, purple); and six tertiary colors (colors made from primary and secondary colors, such as blue-green). By splitting the color wheel in two, warm colors (reds, oranges, yellows; fig.10) are separated from cool colors (blues, greens, purples; fig.11). More, this color wheel shows different color schemes (fig.9). These schemes can help to develop harmonies for a design or marketing materials in order to get a message across or to draw attention. There are many ways to combine colors regarding the intended effect. Color theory is also defined by the Interaction Design Foundation as “a collection of rules and guidelines which designers use to communicate with users through appealing color schemes in visual interfaces” (IxDF, 2020). The effects and associations of specific colors will be developed later.

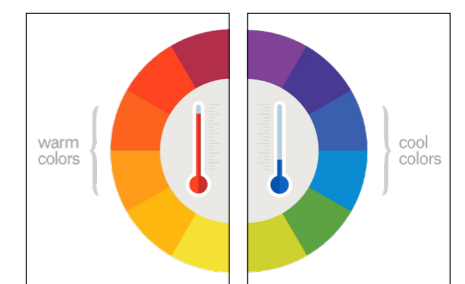
In architecture, color is used to delimitate spaces, to lead the visitor through a building, to draw someone’s attention to a specific feature... There are many possibilities in the use of color thanks to the several variants of hues, lightness and saturation. Moreover, architects portray color as a real powerful design tool in architecture.



01_10.
The Color Wheel

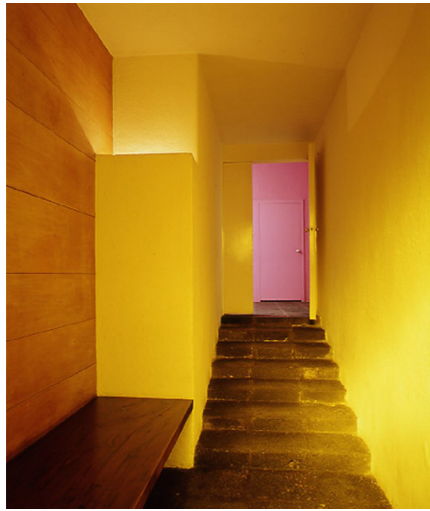


01_11.
Color Schemes

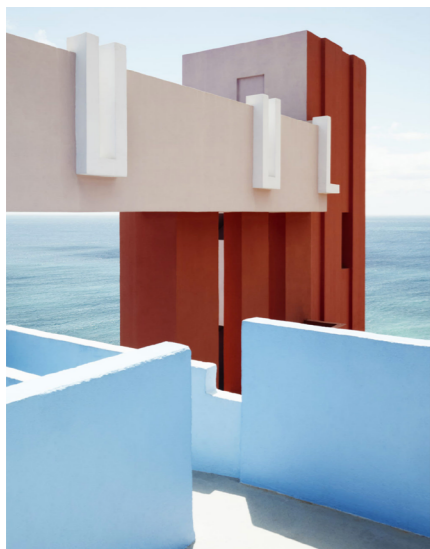


01_12.
Warm colors

01_13.
Cool colors



01_14.
Casa Barragán yellow entrance.



01_15. & 01_16.
La Muralla Roja, Ricardo Bofill

COLOR AS A DESIGN TOOL

Another huge influence of color in our daily life hides behind architecture. Even though, our world is less and less colored regarding the new designs as proven by the Science Museum Group⁵, some architects used and still use color as a powerful form of expression by being symbolic, emotive and associative. Le Corbusier once felt and described the color as “the daughter of light”. As we have seen before, color has this ambivalence to effect both individual and universal human response. Within architecture, it takes intimate symbolism and interpretation, with architects expressing their sensitivity and exploiting the ability to influence comfort and well-being in their designs.

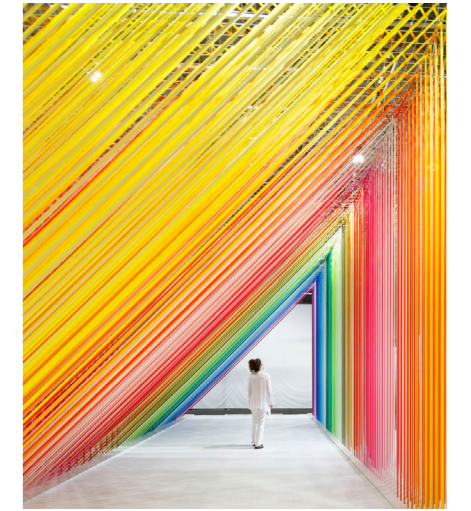
Although not everyone adheres to an assumed and original use of color, some architects stand out and make it their trademark. The Mexican architect Luis Barragán is one of those, with his love and use of bright and vivid colors in his projects. He liked playing with contrasts and raised a kind of architecture that “resonates on human scale” (Richardson, 2020). Starting from the 20s, the idea of “emotional architectural” made a turn in the modern movement. Barragán used color and light as a real material and also defined that the house was not “a machine for living in” but a safe and comfortable refuge. The work was done in a way that every space could chromatically complements another one and this also shows one of his wills: disrupting the codes. While Barragán described color as a way to express emotions, the Spanish architect Ricardo Bofill maintained functional purposes. For the latest, color was for contrasting and creating optic illusion in order to serve space. For example, in his famous project *La Muralla Roja*, red brings contrast to the landscape and the blue shades (blue, indigo and purple) tend to merge with the sky and the sea (fig.16). Thanks to the colors, the space makes the illusion of being wider than it is (Bonnet, 2019).

An interesting concept has been brought by the architect-artist Emmanuelle Moureaux: the concept of dividing and creating space through colors which she named “shikiri”. It is a made-up word in Japanese that literally means “to divide space using colors”. Through her art pieces, she uses colors as a tri-dimensional element, like layers, inspired by traditional Japanese spatial elements such as the sliding screens. But color remains a main tool of conception: it is not only a finishing touch applied on surfaces but a strong element to design with. In 2013, for the 10th anniversary of her studio in Tokyo, she unveiled her work *100 colors*, in between archi-

itecture and art piece with her aim being to give people the opportunity to experience colors in a unique way and feel color with their senses. “The overflowing effects of colors in space will show that colors can give more than a space, but a space with additional layers of human emotion” (Moureaux, n.d.).

Other designers and architects prefer to stay more discreet while using color. The interior stylist and color consultant Betsy Smith advocates minimalism in design and advises choosing neutral paint colors since according to her “minimal interiors are typically neutral and airy, creating a relaxing environment” (Lutyens, 2023). Even so, Smith adds that these neutral tones are quite hard to get right, it’s easier to work with more saturated colors because they are franker and clearer. Finding the right undertone becomes a real challenge since it impacts the room’s atmosphere. For instance, using neutrals with a red undertone in a light-deprived room can help warming up the atmosphere and accentuate the beauty of natural materials whereas sparkling whites with a blue tone look often cold and boring. More, adding details with accents of bright colors brings warmth in the space. Yet, these advices concern more an interior design approach with the art of furniture and decoration.

Nonetheless, the use of color in architecture is not something new. Even in the Antique Greece, temples were colored on the outside and inside, even if today these temples appear to us in a bright white. We could cite many other architects or movements for their work with color such as Le Corbusier or De Stijl with Van Doesburg. In architecture, color has a strong symbolic aspect. But all of these examples reveal that color in architecture has been used as a real tool, whether to decorate, to soothe, to alter space or as a way of expression. What is certain is that color was not left apart and since color can affect us psychologically and physiologically, it can considerably alter our experience of the space.



“I use colors as three-dimensional elements, like layers, in order to create spaces, not as a finishing touch applied to surfaces.”

- Emmanuelle Moureaux



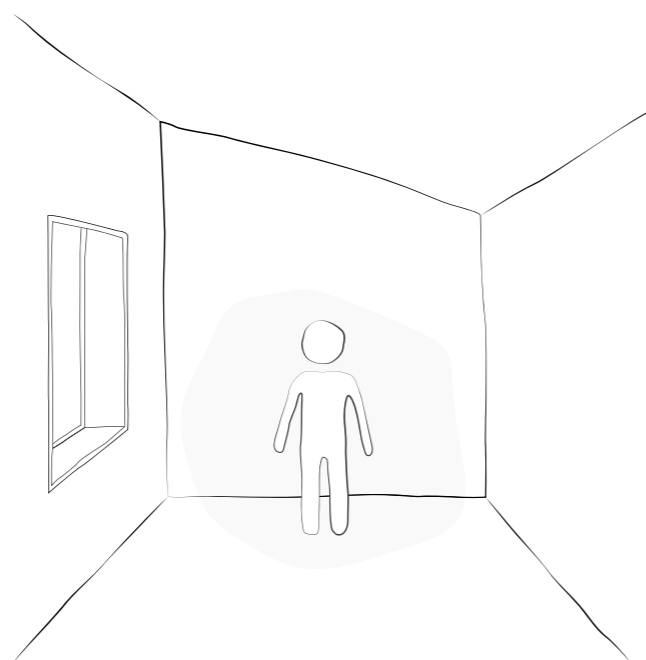
01_17., 01_18. & 01_19.
Work on colors

⁵The Science Museum Group consists of five British museums. The study was based on objects from different periods of UK history and it showed how colors has transformed over time, with vibrant tones fading and gradually becoming increasingly gray (Martino, 2023).

RELATION HUMAN / SPACE

As human beings, our experience of space is shaped by the environment through an ongoing interaction with our bodies. In healthcare, research in Evidence-Based Design (EBD) has proven that well-designed healing environments can make a difference to the patients' health conditions (Salonen et al., 2013, Huisman et al., 2012). The concept of Evidence-based design involves a scientific analysis methodology that uses data in order to improve the design process of hospitals. It focuses on measuring the physical and psychological impact of the built environment on its users.

The way we perceive space can directly influence our mental health. The research specialist Lindsay T. Graham⁵ once said "our homes can be incredibly important tools for shaping our daily experiences" (Segarra, 2021). This takes part of the field of environmental psychology which is a field of research that studies how the spaces we interact with affect our mental state. If we broaden it to space in general, every built environment we interact with can have an impact on us: places we live in, places we visit, places we work in... Thus, the designed spaces can have tremendous effects on emotional state, positive aspects, such as a welcoming and comforting ambiances, just as well as negative, such as stress or oppressive feelings.



⁵ Lindsay T. Graham is a research specialist at the Center for the Built Environment at the University of California at Berkeley, CA

STRESS

Indeed, stress is part of human feelings and it can be manifested in emotional or physical tension among other reactions (MedlinePlus, 2022). If color and architecture can affect emotions and well-being, it means that these factors can at the same time have an impact on stress.

Concisely, stress is a physiological, psychological and emotional response from the body. This response appears when an individual is facing a challenging or threatening situation and it can be characterized by physical, emotional and cognitive changes such as sweating, feeling overwhelmed or disorientation (Cleveland Clinic Editors, 2021). These threats or challenges can be external, such as work or school demands, financial problems, or relationship issues, or they can be internal, such as negative self-talk or past traumas. As described by the Cleveland Clinic, stress can be positive: keeping us alert, motivated and ready to avoid danger. But while some stress can be helpful in motivating us to take action, too much stress can lead to physical and psychological health problems. Stress can be a serious issue when stressors – what causes the state of stress – continue without relief. As a consequence, people suffering from high stress may experience bad health conditions such as anxiety, depression, sleep disorders, high blood pressure, and heart disease.

In response to stress, the nervous system responds by releasing a flood of hormones such as adrenaline and cortisol. The heart beats faster, muscle tense up, breath quickens, senses become sharper (Segal et al., 2023). These changes speed up the reaction time and lead to one of the common stress responses: Fight – Flight – Freeze – Fawn. Although stress is not considered as a mental disorder, it still represents a symptom that can be one of the cause or consequence of mental disorders (Mind Editors, 2022). So, as a target group for this work, the notion of stress will be analysed deeper through the lens of the Post-Traumatic Stress Disorder (PTSD).

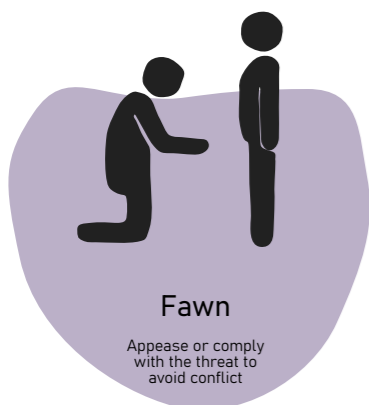
POST-TRAUMATIC STRESS DISORDER (PTSD)

Several people experience stress and/or anxiety at a different scale in their life. For some, it is a part of a disorder, which can have serious consequences on the daily life of the individual as it has been explained before.

The Post-Traumatic Stress Disorder (PTSD) is a mental illness that is closely related to stress – if not entirely related to. It is triggered by the onset of a trauma. Actually, anyone can undergo traumas throughout their lifetime: it can be a buried past childhood trauma, substantial trauma after an accident, or a death. Factors to trauma are multiple⁶ and everyone experiences trauma in their lives at one point or another. However, in general people



⁶ "The original crisis can be individual (like emotional abuse, a car crash, a natural disaster, or war) and can also be institutional and systemic (e.g. racism, sexism, homophobia, transphobia), chronic and enduring (e.g. homelessness), cultural and historical (e.g. colonization, genocide), and environmental (e.g. natural disasters, pollution)." (Grabowska et al., 2021).



quickly recover from these episodes. But for people with PTSD, the trauma embeds into their mind and their life. This kind of traumas can have life-long physical and mental health consequences. According to the doctor in psychology and psychotherapist Pedro Sanchau, it changes in some parts the way the brain functions and affects how one perceives and responds to the world around them (Sanchau, 2018). Given that data, our role as architects is not only to design healthcare spaces, but to design therapeutic spaces promoting healing and well-being.

4 F'S TRAUMA RESPONSES

As explained before, we, as human beings, have a strong relationship to the space that surrounds us, and from that, our bodies can interact with the environment we are in. For people with PTST, trauma is manifested with the body reacting before the mind has the time to think. They are in a state of permanent imminent danger and this causes fear, anger, sleeping disorders, irritability, concentration difficulties... Reacting to this danger represents an innate automatic response and this instinctive reaction is more accurately described as the 4 F's: fight, flight, freeze or fawn response (Walker, 2013, p.29). Facing stress, the body gets prepared to any menace and dispatches one of the stress responses:

- Fight: the person tackles the trigger and can act aggressively
- Flight: the person runs away from the danger
- Freeze: the person is paralysed and cannot act against the threat
- Fawn: the person turns into pleaser mode to avoid any conflict (Guy Evans, 2022)

When the body reacts to danger by provoking stress, the brain is more stimulated and the individual gets a higher sense of perception (Sanchau, 2018). From that response, we can understand how architecture has an important role to play in order to prevent stress episodes or ease patients who have been triggered. Environmental stimuli and atmospheres can be modulated to avoid stressors and then limit trauma's reactions.

Actually, the emerging concept of Trauma-Informed Design approaches these different potential triggers in space for people who experience trauma. With the findings, architectural principles have been developed to support a more suitable design approach when it is dedicated to people with trauma.

TRAUMA-INFORMED DESIGN

Trauma is a widespread public health problem since anyone can experience trauma at any point of their life. As described by the Substance Abuse and Mental Health Services Administration (SAMHSA), "trauma has no boundaries in regard to age, gender, socioeconomic status, race, ethnicity, geography or sexual orientation. It is an almost universal experience of people with mental and substance use disorders." (SAMHSA et al., 2014). With the need to address trauma, a new field of research which takes into account the tough conditions of living with unresolved traumas has emerged: the Trauma-Informed Design.

These last decades, much progress has been done regarding the patient experience within healthcare. Especially, since the change of consideration of psychiatry. It has been more important to take into account the five senses during the design process in order to create a successful experience for the users (Stouhi, 2021). Senses call upon perception and as it has been mentioned before, all human perceptions lead to reactions. Thus, more work has been done to improve patients experience and therapeutic architecture (we can recall the Evidence-Based Design approach). Yet, this progress concerns more the physical healthcare than the psychiatric healthcare (Stouhi, 2021). Since the indoor is the main space for patients to recover when they are interned in a psychiatric centre, it seems natural to think that these spaces must contribute to the healing process. This is actually where the Trauma-Informed Design has its importance. This emerging concept have been growing in the field of design specifically for mental health with its approach to trauma.

Trauma-Informed Design (TID) is an emerging concept which is described as a design process. It is based on care principles which have been developed with a specific attention to trauma. These approaches are applied to the built environment in order to create physical spaces that promote safety, well-being and healing. As the trauma-informed designers Davis Harte and Janet Roche describe it on their website, this process takes into account environmental psychology, neuroscience, physiology and cultural factors with the goal to design unique spaces where the users can feel all of the TID notions. The point of using TID is also to build tailor-made environments for the users with the aim to meet their specific needs. Likewise, it signifies to understand that helpful and healing elements might look different from users to others.



01_20.
Trauma-Informed Design Framework
(Shopworks Architecture, 2020, p.28)

The six core values of the TID design process have been defined by Shopworks Architecture and consist of the following notions (Shopworks Architecture et al., 2020):

01_21. |
Core Values of TID Design Process
(Shopworks Architecture, 2021, p.7)

	<p>Hope, Dignity, and Self-Esteem We celebrate each individual's inherent worth, communicating positivity, emphasizing strengths, and maximizing potential.</p>
	<p>Connection and Community We create spaces that encourage camaraderie and collaboration—among residents as well as between residents and staff—and offer the opportunity to belong, helping residents to rebuild relationships built on trust.</p>
	<p>Joy, Beauty, and Meaning We honor culture and identity while creating spaces that spark and nurture imagination, hope, and aspiration.</p>
	<p>Peace of Mind We cultivate a comfortable, calm ambiance that supports relaxation, self-soothing, stress management, and coping through design details such as lighting, sound mitigation, natural elements, and access to nature.</p>
	<p>Empowerment and Personal Control We encourage individual agency, welcome self-expression, and offer choices for residents.</p>
	<p>Safety, Security, and Privacy We understand that residents' perceived safety is just as important as actual safety. We prioritize clear wayfinding, sight lines, and boundaries; minimize negative triggers; offer vantages of both prospect and refuge and paths of retreat; and recognize the role of program staff in creating a sense of safety and security.</p>

From these core values guiding the TID design process, three key concepts have emerged: the 3 C's which are the capacity of Choice, the sense of Community and the feeling of Comfort (Shopworks Architecture et al., 2020).

Using a TID approach could for instance be the possibility for inpatients to arrange their furniture the way they want. The stake of this process is to reflect each architectural and design element through the lens of trauma in order to approach to the closest to a suitable stress-relief environment for the patients. By considering a TID approach, it means that practisers are aware of the health situation of who they are designing for.

A program, organization, or system that is trauma-informed realizes the widespread impact of trauma and understands potential paths for recovery; recognizes the signs and symptoms of trauma in clients, families, staff, and others involved with the system; and responds by fully integrating knowledge about trauma into policies, procedures, and practices, and seeks to actively resist re-traumatization.

(SAMHSA et al., 2014, p.9).

Grabowska et al. emphasize the important of space in their pamphlet and they claim that space plays a crucial role in the service of TID. As humans, our close relationship with the physical environment makes it a major element in our well-being. Indeed, architecture can intensify or pacify the body's response to perceived stressors in the built environment. Adjusting stimuli and atmospheres can help reducing these stressors. Furthermore, maintaining an intimate and trusting relationship with a building can encourage a sense of safety and in this way, healing can take place (Grabowska et al., 2021, p.8).

Common triggers in built environments include disruptive sounds, unpleasant scents, lack of security for self and belongings, visual noise, uncomfortable sensations, institutional materials... (Grabowska et al., 2021, p.10). If we don't take the understanding of trauma into consideration, we might have a design approach that can perpetuate stressors presence in architecture. Then, special attention must be paid to the design of atmospheres to improve the healing conditions of patient. Architecture should serve as a medium for somatic and therapeutic processing.

Additionally, designing appropriate spaces taking stress factors into account can help PTSD people to feel more comfortable and supported. By understanding the impact of architectural space on people living with traumas, architects and designers can create environments that promote healing and well-being for this vulnerable population.

To summarize, the TID approach supports good therapeutic spaces in building environments which use TID principles and more generally taking into account all of the complexity of the users' needs with the aim to offer more suitable environments to enhance healing and living conditions.

In the previously cited papers, there is no scientific way to prove that color can directly impact all of these notions but researchers suggest the concept of "sensory boundaries" which consists of modulating stimuli and thinking the space through sensory information (Grabowska et al., 2021, p.16). Since color is itself subject to sensory perception, I assume that color can also be used in TID to design therapeutic spaces. But more, the strong effects of colors on the human-being justifies the importance of colors to be used as an architectural tool to reach the desired effects.

"Our first relationship is with our physical environment."

- Grabowska et al. (2021).

"We need to design not just in terms of program, section, and plan, but in terms of atmosphere, affect, and ambiance."

- Grabowska et al. (2021).

02/ EXPLORATION DEFINING COLORS

This chapter is about defining appropriate colors for spaces dedicated to people who experience trauma. Colors are selected according to the findings on colors and the needs of the four specific trauma responses (fight, flight, freeze, fawn) and are then compiled into a color palette.



SYMBOLISM OF COLOR







A symbol is a thing that stands for something else. It has a signification. More, it is a medium for conveying messages. Color symbolism has developed out of the original human color experience (Meerwein et al., 2007, p.25). The entire span of human experience should be considered in order to develop color symbolism basics. It is our “genetic memory” which remembers and contributes to our experience of color. As explained by Meerwein and Rodeck, color symbolism grew out of the generalization of color’s effects on the emotions, and the tradition of meanings associated with colors. However as soon as we change the color attributes, it also changes the way we associate this color.

“The symbolic meaning of a color, as well as its psychological effect, depends on the hue’s nuance.”
(Meerwein et al., 2007, p.25).

Indeed, variations in the nuance can considerably change the reading and effect of a color. For instance, a strong saturated blue may seem oppressive whereas a light pastel blue may seem light and calming.

The following table represents the findings on the impressions of colors based on my research from different articles, mainly on the book *Color - Communication in architectural space* (2007) by Gerhard Meerwein and Bettina Rodeck and the article *The Perception of Color in Architecture* (2017) by the TMD Studio, itself based on the book *The Wagner Color Response Report* (1988) by Carlton Wagner. The table represents how we associate colors, and the messages they communicate. However, it is not a dogmatic codification of the symbolic meaning of color, it still remains as a matter of perception and interpretation.

	ASSOCIATIONS	MESSAGES
	Stimulating, shining, revitalizing	Exaltedness, vitality, cheering
	Cheerful, radiant, exciting	Communication, activity
	Energetic, obstrusive, lively, loud	Restlessness, speed
	Passionate, fiery, provocative	Dynamics, stimulation, aggression
	Dominant, strong, active, warm	Grandeur, festiveness
	Dignified, sublime, pompous	Ritual, power, splendor
	Exclusive, solemn, deepening, spiritual	Mysticism, contemplation, extravagance
	Calm, concentrated, relaxing, deep,	Gathering, sumptuousness, calm
	Distant, cold, calming, reserved	Security, concentration, seriousness
	Refreshing, cool, hygienic, tranquil	Reservation, aloofness, cleanliness
	Relaxing, natural, balancing	Balance, simplicity, security, liveliness
	Conspicuous, unserious, superficial	Fast-moving, youth, joy of life

	ASSOCIATIONS	MESSAGES
	Lively, intimate	Delicate, feminine
	Dependable, conservative, calming	Wisdom, ethic, natural
	Subduing, warm, secure, stable	Comfortable, heavy, security, stability
	Open, vast, neutral, sterile, light	Purity, freedom, emptiness, indecisiveness
	Settled, fine, still, reserved	Unassertive, neutral, reserve, boring
	Heavy, dominating, ominous, hard	Immovability, distinction, steadfastness, burden

This table only focuses on the colors presented in the color wheel: yellow, orange, red, violet, blue and green (primary, secondary and tertiary colors). In addition, some other colors that we often experience are added (pink, beige, brown, white, gray, black). They are not part of the visible spectrum since they represent more complex color (more than one wavelength, mixing of different colors) but these colors are still considered as colors in the daily life.

Yet, the previous overview depicts common associations and effects conveyed by colors only according to a specific hue. However, hues cover a large number of nuances.

More specifically, the psychological effect of colors especially depends on the hue's nuance (Meerwein, 2007, p.28). Even though we can give general impressions associated to a "main color" - in other words *hue* -, we should be aware that even slight changes in the nuance can influence the symbolic behind it. For instance, blue is commonly linked to calming, but a light blue is often more associated with relaxing and airy, whereas a high saturated blue e.g. electric blue, gives an impression of stimulation and energy and a darker blue conveys depth and solemnity.

Then, to better understand the effect of saturation and lightness which create different nuances in the chromatic colors, I will analyse the color studies conducted by Oberfeld and Wilms (2015): *Effects of color on emotion: Evidence from self-report ratings and physiological measures*.

COLOR EFFECT ON EMOTION

As we have seen in the previous part, color can be defined according to three notions: hue, saturation and lightness. Older studies by psychologists revealed that, when focusing on the hue, long wavelengths (red) reported to cause higher arousal than short wavelengths (blue). More, other studies showed that saturation appears to have a stronger effect on the arousal than the hue. From these statements, the researchers in psychology Oberfeld and Wilms decided to conduct studies about the effect of colors on emotion, with independent variations of hue, lightness and saturation.

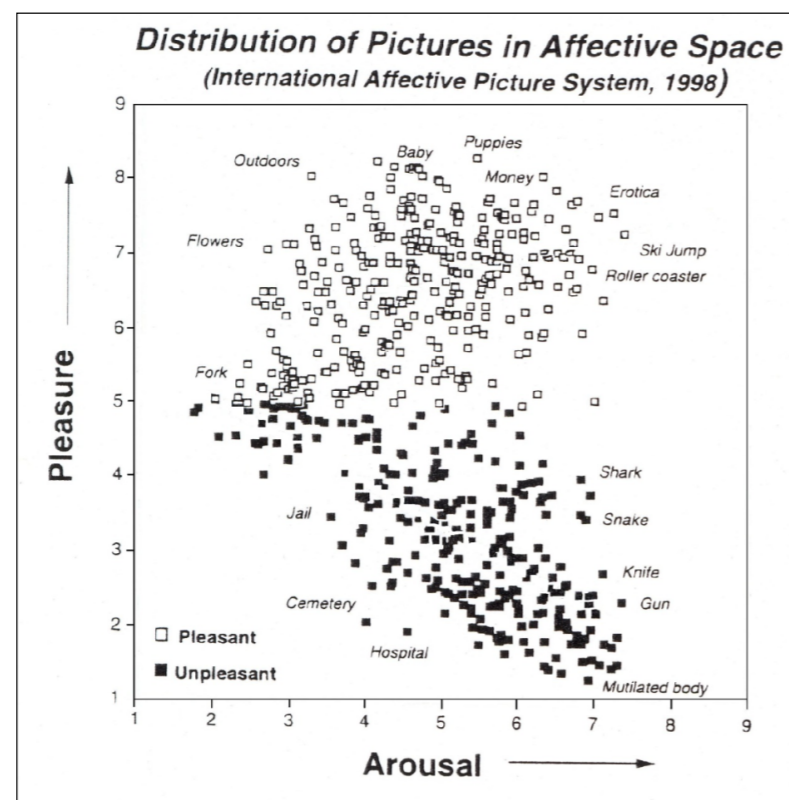
Moreover, we can highlight two ways of "reading colors" according to Whitfield & Wiltshire (1990):

- Color-induced emotion: "How do you feel while seeing this color?"
 - It makes use of the current feeling and analysis of the color in the current environment.
- Color-emotion associations: "Select a word to describe that color"
 - It reflects our preconceived notions of color as it has been studied in the previous part.

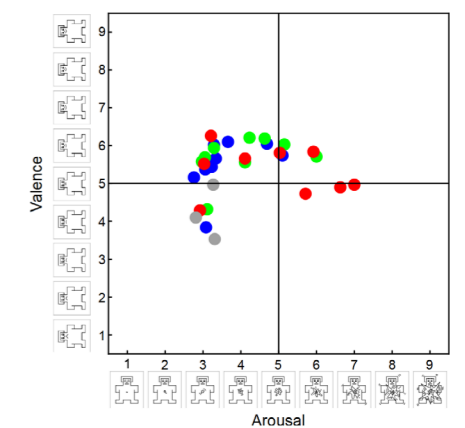
In the experiment of Oberfeld and Wilms (2015), about sixty participants were exposed to colors: four different hues (red, green, blue and gray) with various lightness and saturation. They were asked to rate their current emotional state while viewing a color and the data were collected by skin conductance response (SCR) and heart rate. Thus, these studies come under the emotional state provoked by color (color-induced emotion) and how bodies and minds react to it.

In the study, the notions of arousal and valence are used to analyze the effects of colors. In psychology, emotional valence describes the extent to which an emotion is positive or negative, whereas arousal refers to its intensity, in other words, the strength of the associated emotional state (Citron et al., 2014). For example, a "positive" valence would be joy. Anger refers to a "negative" valence. Here, the arousal would be the force with which it is perceived (fig.1).

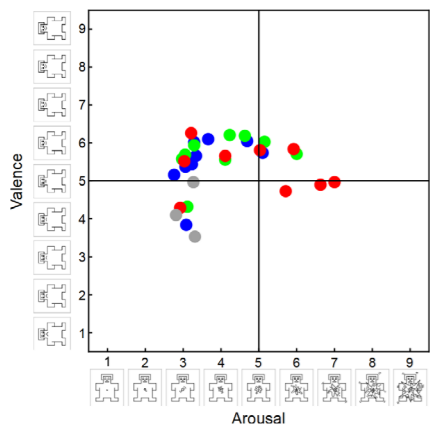
If we look at the results of experiment of Oberfeld & Wilms, we can observe a disparate sprawl of colors. First of all, no color reaches the extremes, they're all quite close the average of pleasure and arousal (fig.2).



02_1.
Link Pleasure (valence) / Arousal
(Oberfeld & Wilms, 2015, p.6)



02_2.
Link valence / arousal of the studied colors
(Oberfeld & Wilms, 2015, p.6)

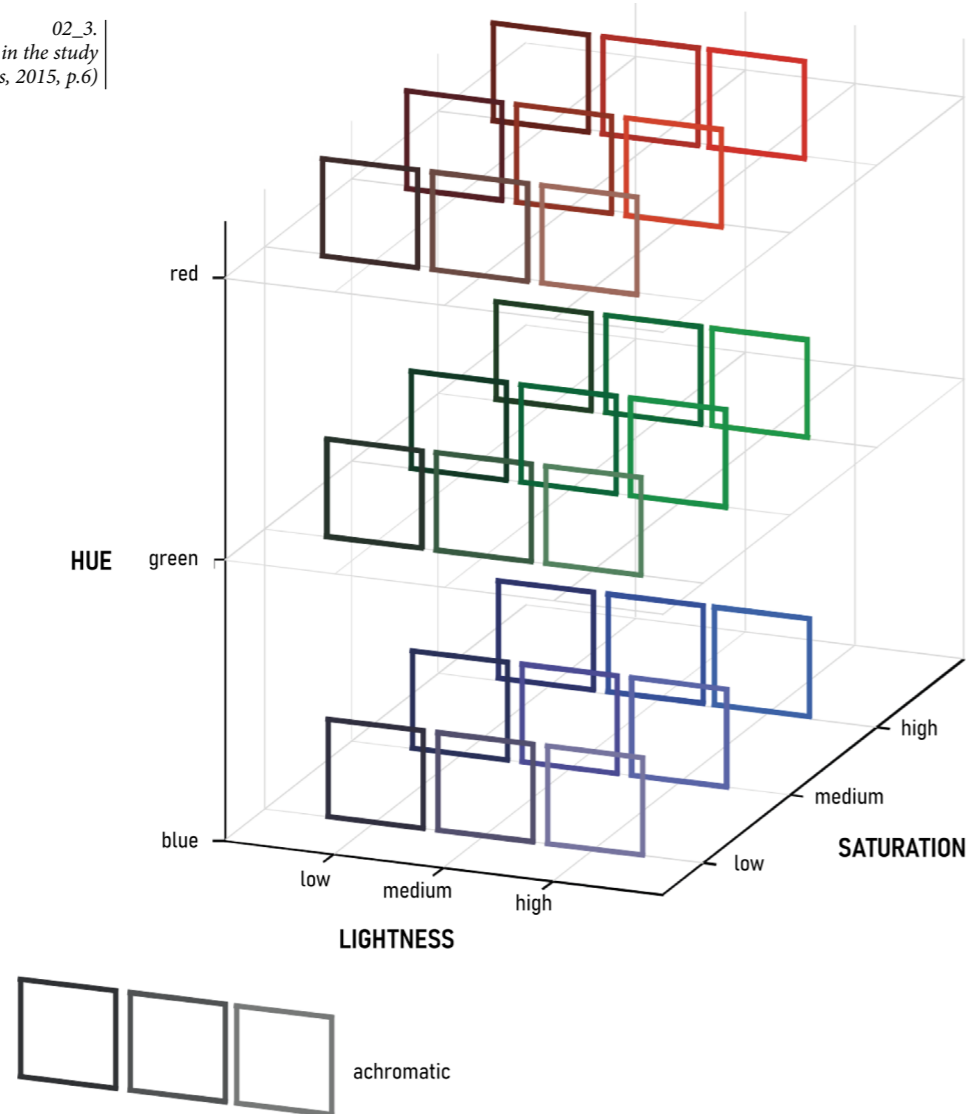


02_2. Link valence / arousal of the studied colors (Oberfeld & Wilms, 2015, p.6)

However, on the chart (fig.2), we can note that grey remains under the average of the scale of pleasure, interesting value since grey is often associated to sadness and depression. Blue spots are concentrated in the upper average of pleasure and lower part of arousal. It is in line with what we associate to blue: being a pleasant and calming color to look at. The green spots are quite similar to the blue ones but tend to go a little higher on the arousal scale. Unlike the red spots, they cover the largest part of the spectrum. Does it mean that this color is the most controversial in term of subconscious? Culturally, we give to red lots of meanings, such as danger, blood or passion. It could explain why some people don't like seeing these colors, while others might associate something more positive to it.

The studies explored reactions of the participants when they were exposed to the 30 colors (blue, green, red and gray with various saturation and lightness: fig.3). Following are the main conclusions that we can keep from this work.

02_3. 30 colors experimented in the study (Oberfeld & Wilms, 2015, p.6)



ANALYSING RESULTS

Arousal ratings - Hue and saturation

During the experiment, when analyzing the arousal rating according to the hue and the saturation, it has been proven that arousal increases with saturation and from blue to red. So, the most arousing color would be red with high saturation whereas blue with low saturation would be the less arousing color according to the results (fig.4 and fig.5).

Arousal ratings - Lightness

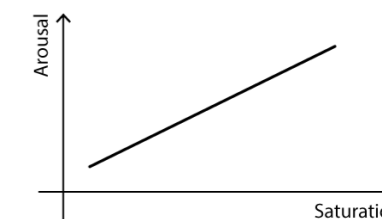
As a result, when it comes to lightness, the lighter the colors are, the most arousing the colors seem. But it only is the case if the colors are saturated. If they are not, the arousal stays quite low on the scale which means that pale colors (such as pastels) are calmer. And then, bright and bold colors are more arousing (fig.6).

Valence ratings - Hue and saturation

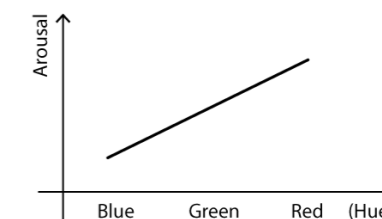
When studying the valence ratings according to hue and saturation, for colors with a high saturation, the color preference pattern was from blue being the most appreciated, then green, then red being the least appreciated. Yet, regarding gray levels, it has been rated as being less pleasant in general (fig.7 and fig.8).

Valence ratings - Lightness

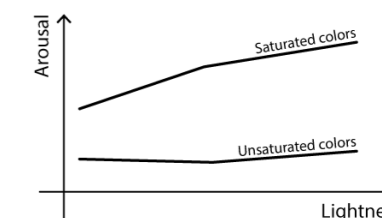
Lastly, there is the analysis of valence (the pleasantness of the perceived color) through the analysis of lightness. Valence increases with high lightness. However, it is not the case for saturated colors. More, regarding achromatic colors, they tend to appear more pleasant when the lightness is higher (fig.9).



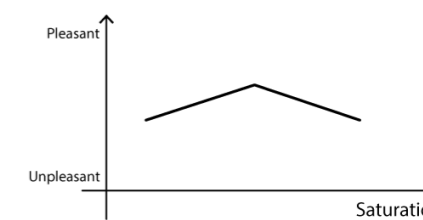
02_4. Saturation effect on arousal



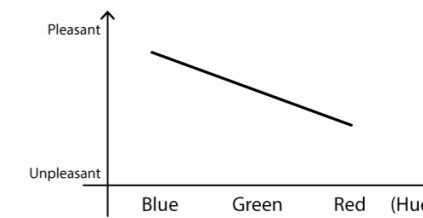
02_5. Hue influence on arousal



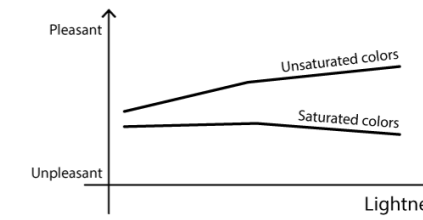
02_6. Lightness effect on arousal



02_7. Saturation effect on valence



02_8. Hue influence on valence

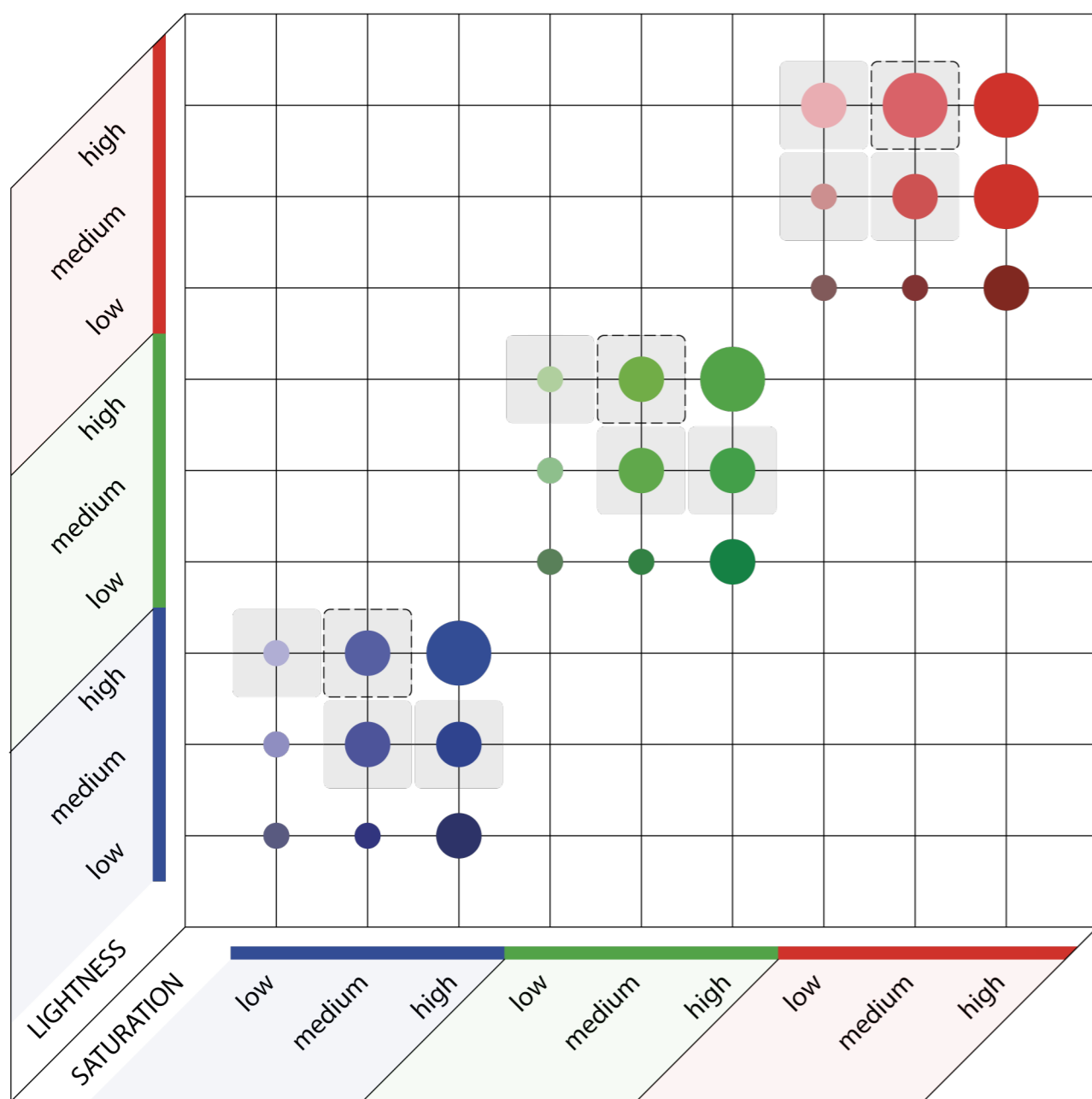


02_9. Lightness effect on valence

02_10. | Summazing diagram of correlation between hue, saturation, lightness & arousal and valence

- high arousal ●
- medium arousal ●
- low arousal ●
- more pleasant colors □
- most pleasant color □

To recap, the affective quality is higher for colors with low saturation when there are higher in lightness. For a medium and high saturation, it shows a higher rate of arousal. Below is a summary diagram (fig.10) of the tested colors and their influence on arousal. Even though this study has limits in term of the colors that have been studied – only blue, green and red, no yellow, pink or orange – it gives a general idea on the scientific side of perceiving colors with different characteristics.



DEFINING STRESS-SUITABLE COLORS

In order to define suitable colors for environments dedicated to PTSD patients, it is necessary to understand the different trauma reactions. Based on the research in the previous parts and on color studies, I will define suitable colors for each trauma response.

Indeed, a general color hue has specific associations but changing color parameters can influence the associated meaning to the color, as it has been previously showed. Thus, after choosing stress-suitable colors which are appropriate to each trauma reaction, these colors will constitute the color palette which will later serve for the application in space.

FIGHT RESPONSE

The fight response in PTSD is triggered when a “person suddenly responds aggressively to something threatening” (Walker, 2013, p.29). It appears with a very explosive and unpredictable temper, insults, yells, slammed doors, an aggressive behavior.

- Suitable color hues

Based on a TID approach, the fight mode needs a safe release option to soothe these violent reactions. For instance, the possibility of exercising and being in a calming environment in order to balance the extreme fight response (Grabowska et al., 2021, p.11).

So, when trying to fight the fight trauma response, it is important to choose colors that can promote a sense of calm and relaxation. As we have seen with the effects of colors; blue, green and purple tones can be helpful for this, as they are associated with relaxation, tranquillity and peace.

Blue, in particular is known for its calming and soothing effects. The previous assistant director of the Wagner Color Institute Eric Walker Johnson explained that it has been scientifically proven that the color blue causes the brain to secrete at least eleven tranquilizing hormones (Werne, 1989). Also, short wavelengths (blue) reported to cause lower arousal than high wavelengths (red) (Oberfeld & Wilms, 2015). In addition, a study conducted to determine the effect of colors on stress reduction showed that blue had strong effects in reducing stress (Lubos, 2012). Therefore, using blue seems like the best way to offer a calming environment.

Regarding the color green, it conveys a message of balance and harmony. Overwhelming feelings can be reduced and calmness can then increase. A study aimed to examine the influence of seeing green environment on psychophysiological parameters. This work revealed that “green might be processed as a calm, relaxing, and non-aversive (inoffensive) environment. Walking in a green environment induce a significant decrease in participants’ heart rate values (Briki & Majed, 2019, p.9).

Purple is often associated with relaxation and tranquillity. It also connects to spirituality, especially in religions (Williams, 2022). Purple symbolizes wisdom, compassion, spiritual growth, self-realization and it helps to promote a sense of inner peace. This color tends to encourage meditation and relaxation. Purple can bring a lot of introspection. Since purple wavelengths are the last visible before ultra-violet rays, purple also refers to time, space and cosmos (Schauss, 1979).

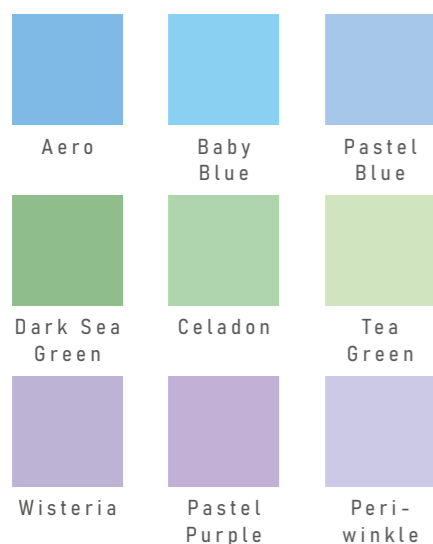
Blue, green and purple appears to be suitable colors for the fight response. However, they have many nuances with possible varying effects. So, to be more accurate, we can try to identify a range of colors that is the most suitable related to their saturation and lightness.

• Color nuances selection

According to the study of colors by Oberfeld & Wilms, if we focus of the blue color, the more saturated it is, the more arousing it is. Thus, a less saturated color would be preferable to obtain the calming effects of blue. On the other hand, the lightness doesn’t influence the arousal much but it does have an impact on the appreciation of the color. Indeed, lightest colors seem to be preferred compared to the darkest ones. With darkest tones, the color is also harder to identify and can quickly turn into grey shades (grey tones being generally the less appreciated). So, following the findings, the ideal range of blue color would be blues with high lightness and medium saturation to still get the facility of recognising and processing blue color.

For the green, the results from the color studies are quite similar to blue but with saturation having a slight bigger impact on the arousal. We could then choose to select a less saturated green, but still with quite high lightness.

Purple was not analysed in the color studies but as blue and green, purple is part of the cool colors. Its proximity to blue in terms of wavelength might imply that it is processed by human in a similar way. Thus, we could define purple tones that are light with reasonable saturation as calming color nuances.



Non exhaustive list of potential suitable colors

FLIGHT RESPONSE

The flight response is triggered when “ a person responds to a perceived threat by fleeing, or symbolically, by launching into hyperactivity” (Walker, 2013, p.29). As a result, the person might experience panic and can excessively turn to planning, rumination and perfectionism. The person will tend to escape into thought (obsession) and action (compulsion).

• Suitable color hues

According to Sam Grabowska et al. in their document about TID, people who go into flight mode need a safe place to hide in solitude and ease fear because every little stimulus can be overwhelming (Grabowska et al., 2021, p.11). Then, when trying to fight the flight trauma response, colors promoting calm, intimacy, safety and security seem like being the most important. As stated before for the fight response, blue and green are appropriate colors to soothe. Green being often associated to nature tends to bring openness and safety.

More, earthy tones like brown or beige can create a sense of safety and security with a more “down-to-earth” aspect. Beige is described as dependable, calm and comfortable due to its natural aspect, close to desert sands or even human’s skin (Xahra, 2021). Brown has a sense of seriousness and feels warm. It mostly refers as nature and earth and is associated to reliability and support (Schauss, 1979). Most of the time, brown reminds us wood. It makes it a solid and reliable color, appropriate to give a sense of security.

• Color nuances selection

Similar blue tones and green tones can work in the same way for the fight and flight responses in order to calm people.

Brown in painting, is a mix of the three primary colors: red, blue and yellow. Brown is defined as a dark color and it is its low lightness that creates this sense of comfort and stability. Brown can be described as a quite dark orange. However, such a gloomy color should be carefully used since it can darken a lot a room.

Even though beige is not a color part of the color wheel, it still has its renown especially in interior design. It has different nuances and is variously described as “a pale sandy fawn color, a grayish tan, a light-grayish yellowish brown, or a pale to grayish yellow” (Xahra, 2021). It can be described as a light unsaturated yellow/orange. To obtain beige, it is a mix of white and yellow or yellow and brown. So beige, by definition, cannot be a saturated and dark color. Thus, it keeps the calming and soothing effects of unsaturated and light colors (as seen in the study of Oberfeld and Wilms). More, the touch of brown adds to the reliable aspect of the color.



Non exhaustive list of potential suitable colors

| FREEZE RESPONSE

The freeze response is triggered when “a person, realizing resistance is futile, give up, numbs out into dissociation and/or collapses as if accepting the inevitability of being hurt” (Walker, 2013, p.29). The person falls into avoiding human contact and is detached from the present moment.

• Suitable color hues

From a TID point of view, excitement and stimulation can help people in a freeze mode (Grabowska et al., 2021, p.11). Therefore, choosing colors that promote a sense of movement and action should be prioritized. Warm colors such as red, orange and yellow are a good choice since they are associated with energy and activity.

As colors communicating energy and stimulation, we could for instance choose yellow. Yellow is the brightest color in the spectrum and so the fastest color the eye process (“There’s Something About Yellow,” 2011). It is mainly associated to joy and happiness.

Green is another color that may be effective in combatting the freeze stress response. Its association to growth, renewal and vitality can help to promote a sense of balance and harmony. More, the relaxing effect of green can favor the reduction of overwhelming feelings that can be experienced in a freeze trauma response.

• Color nuances selection

According to Meerwein et al. in their book, a bright yellow appears more cheerful, shining and revitalizing compared to dark yellows which are closer to muddy, swampy colors (Meerwein et al., 2007, p.30-31). Unsaturated yellows convey a refreshing, sunny and embracing atmosphere and are also softer in term of stimulation compared to high saturated yellows. However, both kind of yellow can break monotony, but lighter yellows bring a gentler stimulation.

More, for big rooms and large spaces, softer yellows are adapted. However, for spaces where we spend a short amount of time or to accentuate one element in a room, bright yellows are better.

Deep greens are closer to the green color in forest (Meerwein et al., 2007, p.31). It radiates stability and security through its association to nature. Thus, tints like forest green and bottle green could be suitable colors to convey stability and security. Bright greens are synonym of growth and vitality, just as our plants when they are healthy. Then, dark green shades can add a sense of security while brighter and lighter green shades convey vitality and relaxation.



Non exhaustive list of potential suitable colors

| FAWN RESPONSE

The fawn response is triggered when “a person responds to threat by trying to be pleasing or helpful in order to appease and forestall an attacker” (Walker, 2013, p.29). The person becomes a people pleaser.

• Suitable color hues

According to Grabowska, people who fawn can be helped with setting clear physical boundaries and welcoming social interactions (Grabowska et al., 2021, p.11). Thus, colors with a sense of empowerment and confidence must have a positive effect. Bold, bright colors such as red, orange, yellow that are associated with strength, energy and power are the most appropriate.

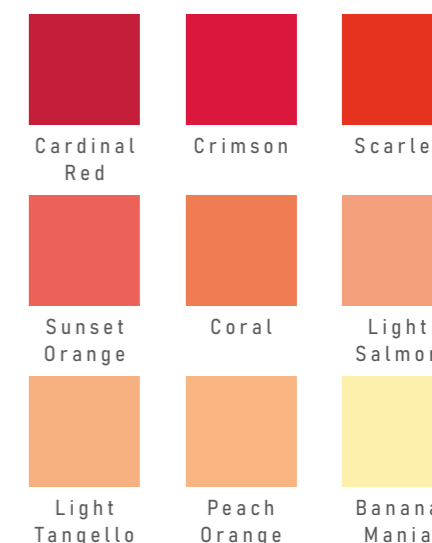
Red is the most powerful and stimulating of the warm colors usually evokes strong emotions and passion. It gives a dominant and strong impression (Meerwein et al., 2007). It is often used in sports and athletic branding to convey strength and energy, and it can help to promote a sense of confidence and assertiveness (Jean-Gabriel Causse, 2015).

Orange is associated with optimism and vivacity which can help to increase enthusiasm and energy levels. These associations create a sense of motivation and excitement, and it can help to promote a sense of empowerment and self-confidence. But too much use of orange may also bring feeling of superficiality, arrogance or pride (Cherry, 2023).

• Color nuances selection

According to the study of Oberfeld and Wilms, red with high saturation was the most arousing color of the study. So, to balance the high exciting aspect of red while keeping its dynamism, it might be a good choice to select reds with medium or low saturation. Also, a lightness between medium and high would be more appropriate regarding the appreciation of these nuances.

Emotions while being exposed to orange nuances was not a part of the color study of Oberfeld and Wilms. However, the color orange is another warm color, just as red. So, I could assume that our way to analyse it would be pretty similar. More, Meerwein and al. suggest that lighter orange still conveys a message of excitement and comfort. Then opting for orange nuances with medium to high lightness and low to medium saturation appears to be a good solution.



Non exhaustive list of potential suitable colors

NATURAL COLOR SYSTEM (NCS)

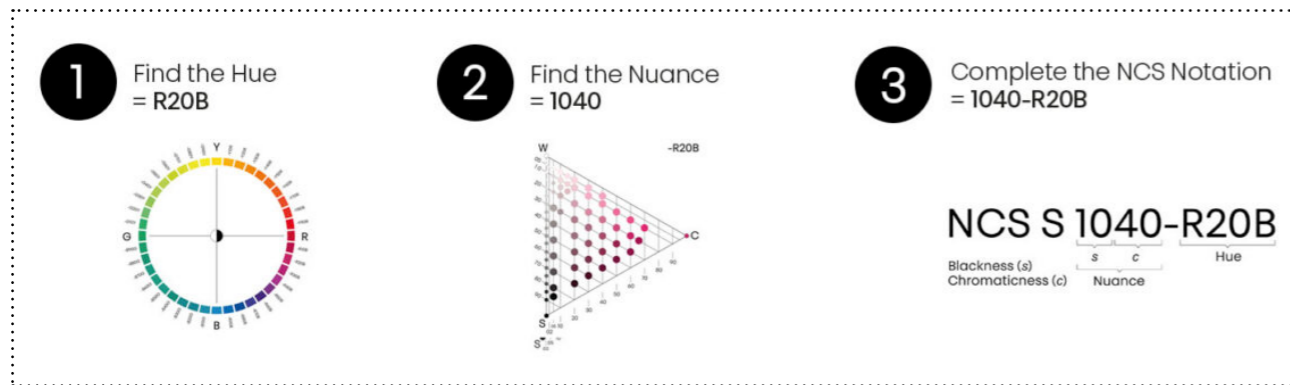
The HSL color system with the use of HEX color codes was helpful to choose and define what kind of colors were suitable for the color palette, however, in the architecture field in Sweden, it is the NCS system which is used to describe the different color nuances.

The Natural Color System (NCS) is a scientifically based system that allows accurate interdisciplinary color communication for professionals and customers. NCS is based on how we perceive color visually and is recognized as a global standard for color definition. This allows to describe colors on all imaginable surfaces and makes it as a quality assurance regarding color communication (NCS System, 2021).

The use of NCS system is more appropriate to describe precisely the nuance of a color. Thanks to the website NCS+, we can easily translate a HEX color code to a NCS color code. But colors on a screen and colors on a wall can drastically look different and our vision of it strongly depends on the light source. Thus, from the pre-selected colors, I picked the closest matches in NCS classification keeping in mind the final goal on these colors: being applied on walls. Then, I also realized that bright and saturated colors mainly used in web design and communication were not comparable to the colors applied to painting in interior design. The latter are indeed very hardly used in architecture. As stated by Meerwein in *Color Communication in Architectural Space*:

“The spatial effects of intense, saturated colors are only infrequently employed in interior design. In the reality of architecture and interior spaces, it is the more muted shades that are used (lightening and darkening).”
(Meerwein et al., 2007, p. 65).

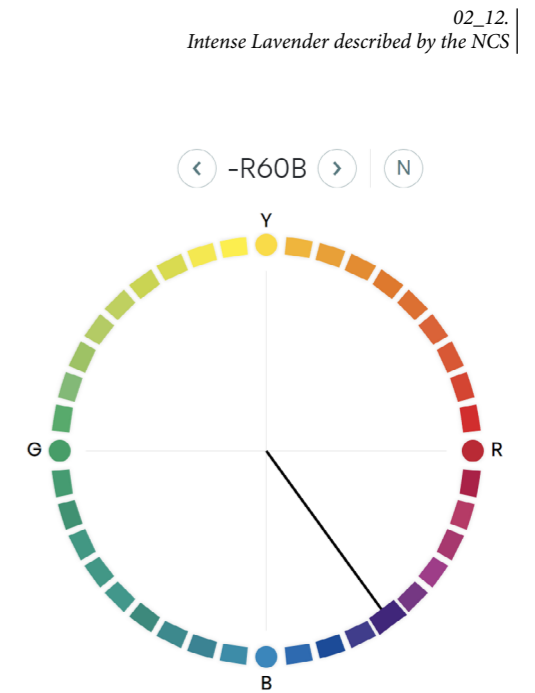
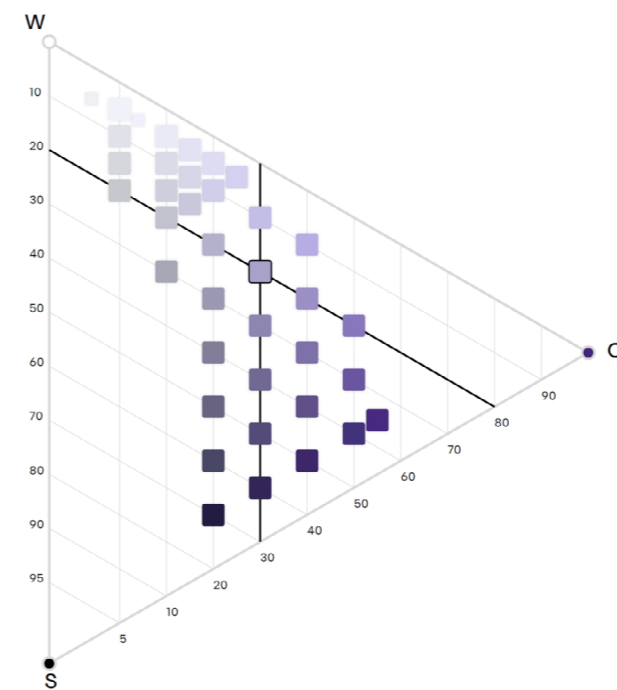
02_11. Natural Color System in three steps



NCS COLOR CODE CLASSIFICATION

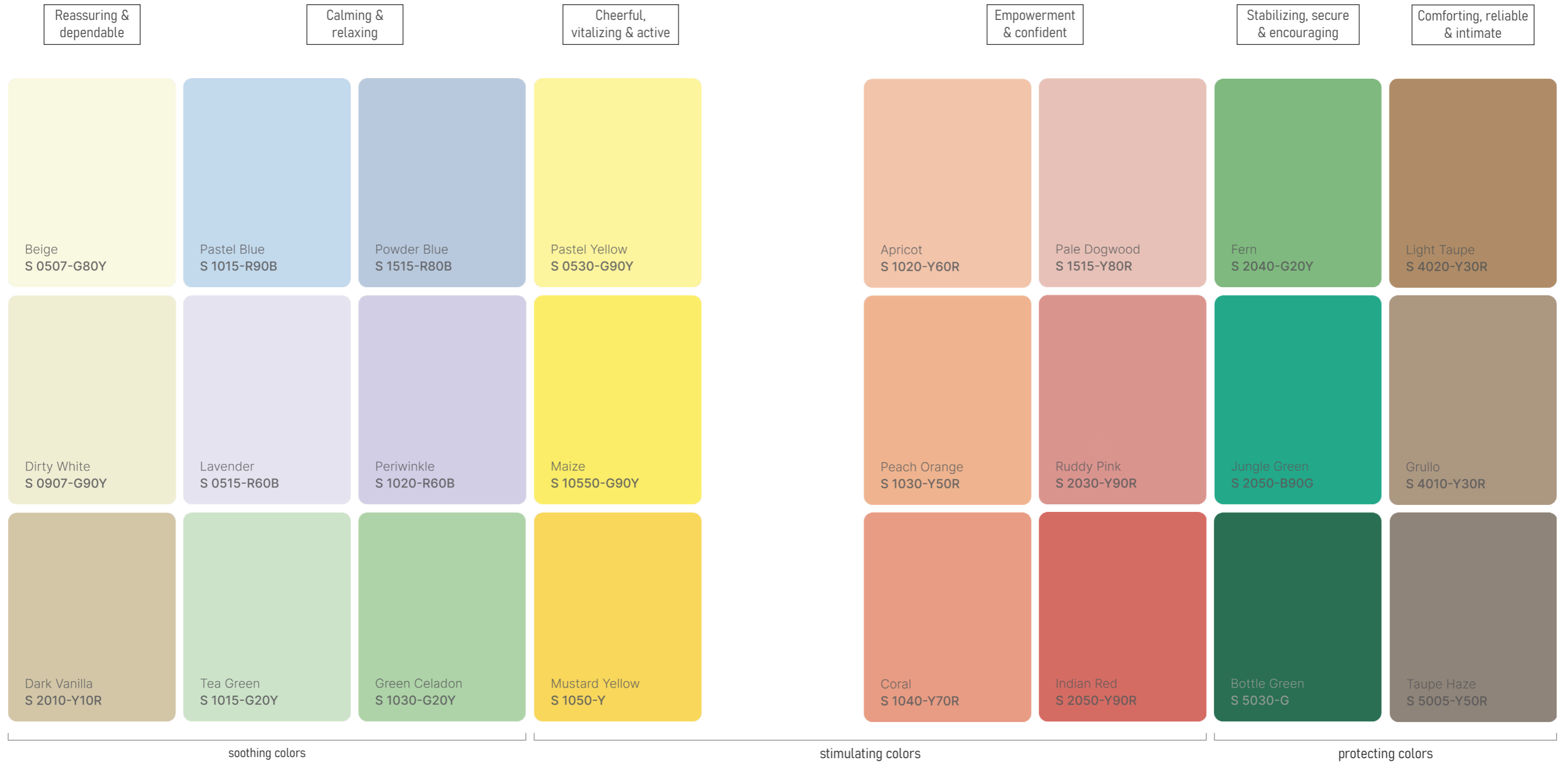
As described on the Figure 10, with the NCS the hue is found in relation to the four chromatic elementary colors (yellow, red, blue and green). The hue is read clock-wise. For instance, for the lavender color has a hue of R20B, which means a red with 20% blue in it. Then, the NCS shows the potential nuances of this specific hue. It describes the relation between white, black and the chromatic point of the selected hue. The intense lavender has 20% blackness and 30% chromaticness and 50% whiteness. These three values represent the nuance and always result in a value of 100% so the whiteness is not written in the color name and can be deduced. Then, the final name codification of this color results in S 2030-R60B.

Based on the NCS, I refined the choice of PTSD-related colors to select only 24 colors and gather them in a color palette. Following is a non-exhaustive selection of equivalent and redefined colors that I chose using the NCS classification.



02_12. Intense Lavender described by the NCS

COLOR PALETTE



COLOR PERCEPTION IN ARCHITECTURAL SPACE

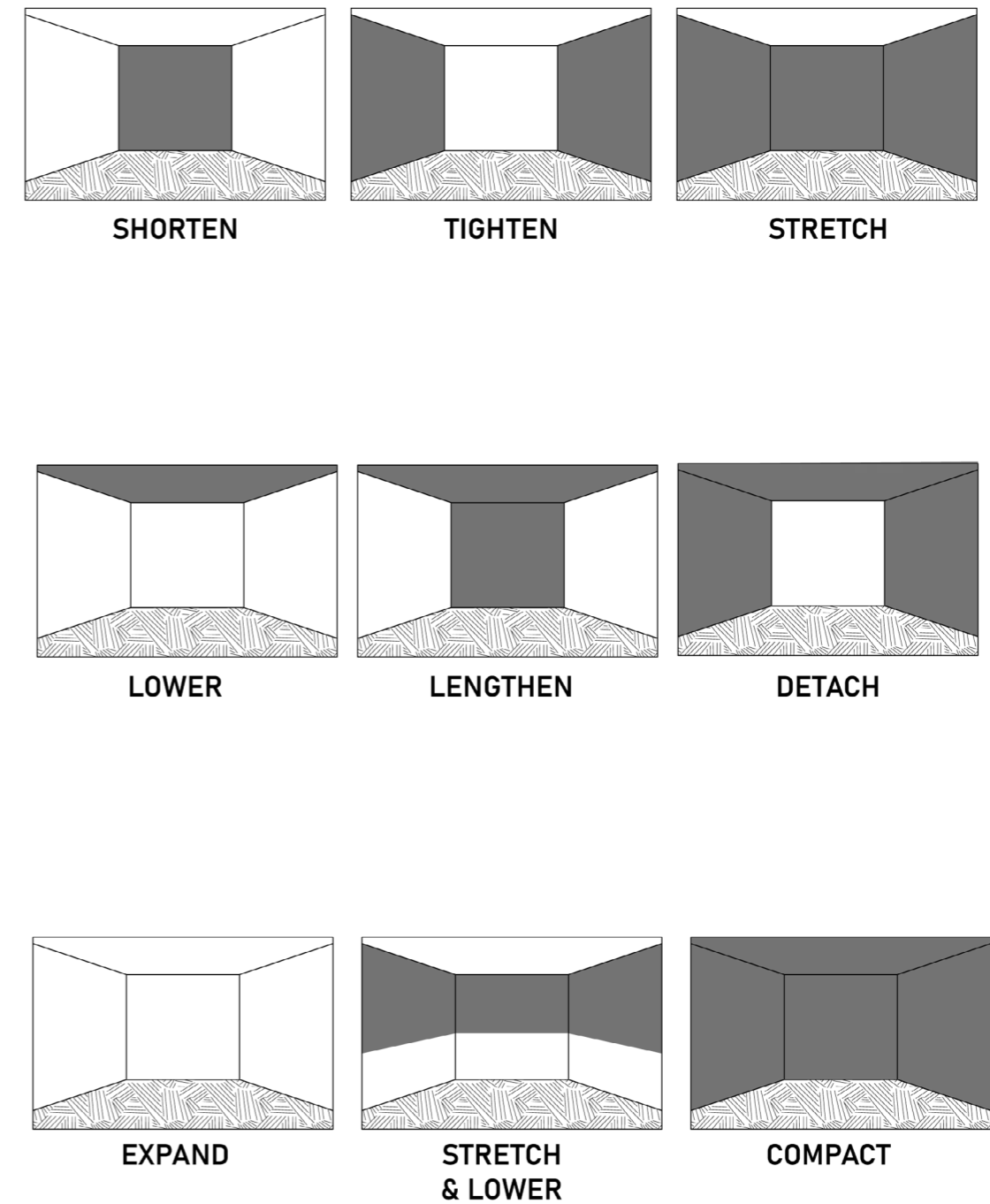
In accordance with what was studied before, colors can have various associations and effects on people. But it should not be forgotten that color remains a sensory perception which means that the surrounding environment can also strongly influence the perception of color. For instance, as explained in the first part, color is dependable on light but the materiality can also impact our perception of a color (Meerwein et al., 2007, p.50). More, the amount of one color in a room can also provoke different reactions.

The placement of color in a room can radically change our perspective and vision of the same space (Souza, 2023). Indeed, using color can be used to influence the effect of room proportions such as wide, narrow, high, low (Meerwein et al., 2007, p.68). The following figure shows the main principles of painting techniques to alter a room atmosphere and originate new ambiances.

More, color in space responds to physical-optical fundamentals ensuing from perspectival color perceptions in architectural space. As reported by Meerwein et al.:

- Warm, highly saturated, and bright colors (orange, ocher, sand yellow) advance to the foreground.
 - Colors that are neither clearly cold nor warm (green, violet, purple) are located in intermediate ground.
 - Cool and bright colors (light blue, lime green), as well as dark, warm and dark, cool colors (dark brown, dark blue) recede into the background.
 - Bright colors are experienced as being light in weight, and dark colors are experienced as heavy.
- Concerning hues of equal brightness:
- Passive colors (e.g. green, green-blue) seem lighter in weight,
 - Active colors (e.g. red) seem heavier.

(Meerwein et al. 2007, p.68).



Nonetheless, the vivid and intense colors are not the most commonly used in architecture and interior design to create spatial effect. In point of fact, the more subdued colors are used combined with lightening and darkening effects (Meerwein et al., 2007, p.68). Furthermore, color combinations and proportions additionally play a role in the experience of color in architecture.

Thus, importance should be attached to color proportions. For spaces where people spend long periods, balanced and low-key color schemes are recommended. The ideal would be to install a subtle atmosphere using light and low saturated colors without falling into boredom. However, bright warm and saturated colors which can attract attention, stimulate and highlight spatial elements should be sparingly and carefully used. They are great to reject monotony and boredom, but they can also and trigger reactions (positive or negative – including stress). So, it is important to use saturated color accents frugally and only in small proportions. More, highly saturated colors and intense contrasts are rather recommended for spaces where people spend shorts periods of time (Meerwein et al., 2007, p.72-73).

If we have a look at the color palette, some chosen colors might be too bright or too intense to be used as a main color on walls in a room. However, these color suggestions could be used in different ways and the way to use them should also be reflected (not always large painted surfaces). For instance, these colors could be used in smaller proportions if they are applied to pillars, doors, window frames or else furniture. These aspects could be a way to deepen the use of the stress-suitable colors in another context. However, in the following chapter, the use of these colors will be mainly explored through an application on walls of built environments for psychiatry. .

The next chapter depicts a practical approach by turning the acquired knowledge into an application in psychiatric spaces.

03/ APPLICATION COLORS IN SPACE

03/ APPLICATION

To experiment the acquired knowledge in space, I have to demonstrate the use of colors in specific psychiatric spaces. To do so, I chose to focus on main architectural spaces provided in psychiatric healthcare. In general, mental health facilities can be divided in two categories: outpatient care and inpatient care. To put it simply, infrastructures where patients either just come for an appointment or stay a longer period for hospitalization.

PSYCHIATRIC CARE FACILITIES

Outpatient care refers to healthcare services that do not require an overnight stay in a medical facility and it includes several medical services such as consultations, diagnostic tests, treatments. It is an essential component of mental health services, especially in the field of psychiatry. It provides psychiatric treatment for patients who do not require hospitalization or who have completed their inpatient treatment and are transitioning back to the community. In the field of psychiatry, outpatient care provides many services to patients, including psychiatric evaluations, individual or group therapy, medication management, crisis intervention, and other types of mental health treatment. The services of outpatient care can be provided in community mental health centers, private psychiatric clinics or in hospitals.

Inpatient care refers to the treatment of individuals with mental health disorders who require admission to a specialized facility for intensive care. It is reserved for individuals with severe and acute symptoms in mental health. Unlike inpatient care, outpatient care accompanies the patients with less restrictive conditions. It allows patients to receive ongoing support and treatment while living in the community. Whereas, inpatient care remains more excluded from the community due to the healthcare methods used, treatments provided and the increased surveillance, although it's getting better these last years.

In fact, mental health care has been for a long time excluded of the community, but recently, the psychiatric care is more and more integrated in the general healthcare scheme. These new approaches help repelling stigmatisation about mental health. Outpatient care plays an important role in supporting patients with disorders without marginalizing them from the society. By providing accessible and comprehensive care, psychiatric outpatient services can help patients to manage their symptoms, improve their quality of life, and achieve better mental health outcomes.

| HEALTHCARE SPACES FOR PATIENTS

Within the framework on this thesis, I decided to focus on the outpatient care services since this is the crossroads in between our societies and the inpatient care services. Then, many people may be more inclined to visit this type of facilities.

In PTSD treatment centers, we can find similar spaces to outpatient care in psychiatry, since these spaces are mainly the same for any disorders. More, some of these rooms are also similar to those we can find in inpatient care facilities. I decided to focus on two of them as supports to experiment with the colors. I selected the waiting room and the consultation room since they appear to me as being part of the most evident, frequent and main rooms that are visited by the patients.



03_1.
Waiting room



03_2.
Consultation room

The following applications are an experimental approach which offers a suggestion on how the color palette could be used and in which way the selected colors can add therapeutic qualities to the psychiatric spaces.

WAITING ROOM

Pale Dogwood
S 2010-Y80R

Powder Blue
S 2020-R80B

In outpatient areas, the reception area is the first point of contact for patients and visitors. It is closely connected to the waiting room where patients can await the health-care provider. The waiting room has as primary function people waiting in to be examined, receive medical treatment or consultations (Meerwein et al., 2007, p.123). But it appears to be more than this. People can also experience many feelings such as worry, stress, apprehension, hope while waiting. Sometimes it is even a gathering room, a meeting room or a playground for the youngest (Nurture, 2008, p.5).

The waiting room represents the very beginning of the healthcare experience and must be carefully thought through to meet comfort and privacy. Therefore, waiting rooms require a soothing environment with, in addition, soft visual stimuli in order to make the wait shorter and help directing attention toward the spatial environment for a better anchorage in the present (Meerwein et al., 2007, p.123). The following picture shows one existing waiting room in the Psychiatric Clinic of Södra Älvsborg Hospital (SÅS) in Borås, Sweden by White Arkitekter. I modified the color of the original furniture to only focus on walls for this application.

APPLICATION

As a suggestion with my own interpretation of the previous research findings, I would modify the waiting room with two goals in mind: a calming and comforting atmosphere combined to a possibility of gentle stimulation in order to get less bored while waiting.

To bring a soothing and calming atmosphere in the waiting room, blue is an ideal choice. Thus, patients who are stressed about their medical appointment have best chances to feel safe and relax before meeting their doctor. I chose the *Powder Blue* from the color palette which fits well with the layout of the room. Moreover, as discussed before, waiting can seem more or less long according to people's state of mind. Then, a small touch of a stimulating color could be used to offer a warmer and more distracting environment, for example the *Pale Dogwood* in red-pinkish tones. Since it's better for warm and bright colors to be used in small proportions, it could be applied on the left wall which is smaller. However, the position of the TV screen could be questioned since two sources of distraction are overlaid. The blue wall on the right is a great support for the art pieces and install a calmer atmosphere by standing as the main color in the room.



03_3.
Modified waiting room

NEUTRAL WAITING ROOM

Neutral walls in white tones giving a static and uniform ambiance.



SUGGESTION OF COLORS FOR THE WALLS

Left wall: smaller wall so more appropriate for a warm and brighter color which should be used in smaller proportions. Use of *Pale Dogwood* paint.

Right wall: bigger and main wall of the space, offering comfort and calmness. Use of *Powder Blue* paint.



NEW WAITING ROOM PROPOSITION

Colored walls adding movement, calming effect and soft stimulating distraction.

|CONSULTATION ROOM

Taupe Haze
S 5005-Y50R

The treatment room or consultation room is the space where the mental healthcare professional - psychiatrist, psychologist among others - meets the patient, discusses the healthcare issues and provides suitable personal treatment. The time of the consultation provides a safe way to talk with the doctor and the room dedicated to it must convey a sense of security (Meerwein et al. p.130). Treatment rooms may be used for a variety of therapeutic activities, such as individual or group therapy sessions, art or music therapy, cognitive-behavioral therapy, or other forms of psychotherapy. Furthermore, these rooms may be used for medication management but also for assessments and diagnostic procedures.

The purpose of a treatment room in a psychiatric center is to provide a safe and comfortable environment for patients to meet their doctor and receive treatment. More, the consultation room gains in effectiveness and efficiency if it is designed in a flexible way. Thus, its design allows to work on a precise sensory dimension according to the therapeutic strategy used (Karjania, 2023). It is essential for a treatment room to radiate safety and support in the environment which can then promote healing and recovery for patients with mental health disorders. The following picture shows an individual consultation space. I modified the original picture to have consistency in the neutral colors on the walls.

|APPLICATION

As a suggestion for the treatment room, I would change the consultation space by bringing an atmosphere of security and intimacy with the aim to make the patients feel safe and supported during the appointment.

To give a sense of safety and supportive environment, warm neutral colors could be used to add comfort to the room without triggering patients with too stimulating colors. The use of *Taupe Haze S 5005-Y50R* from the color palette, which is a deep brown with taupe nuance, helps to warm up the room and gives a feeling of comfort, reliability and security to the space. More, the walls are less reflective with a darker paint and make the room seem just like a cocoon, smaller and more intimate.



03_4.
Modified consultation room

NEUTRAL CONSULTATION ROOM

White walls reflecting light make the room seem highly luminous and quite neutral.



SUGGESTION OF COLOR FOR THE WALLS

Brownish color conveys a sense of security, reliability and comfort.
Use of Taupe Haze paint.



NEW WAITING ROOM PROPOSITION

Taupe color on the walls warms up the room and creates a cosy space with less reflection than on the previous white surfaces.

As a conclusion to the research, the following pages present a summarizing diagram of the entire research process, with the research axes, findings and outcomes.

The diagram follows the chronology of the booklet and acts as an overview of the master's thesis work.

The following and last chapter provides a more comprehensive conclusion of the work. In addition, a critical perspective and reflection on the topic are considered in a discussion part. To bring the work to a close, an opening and personal conclusion are provided.



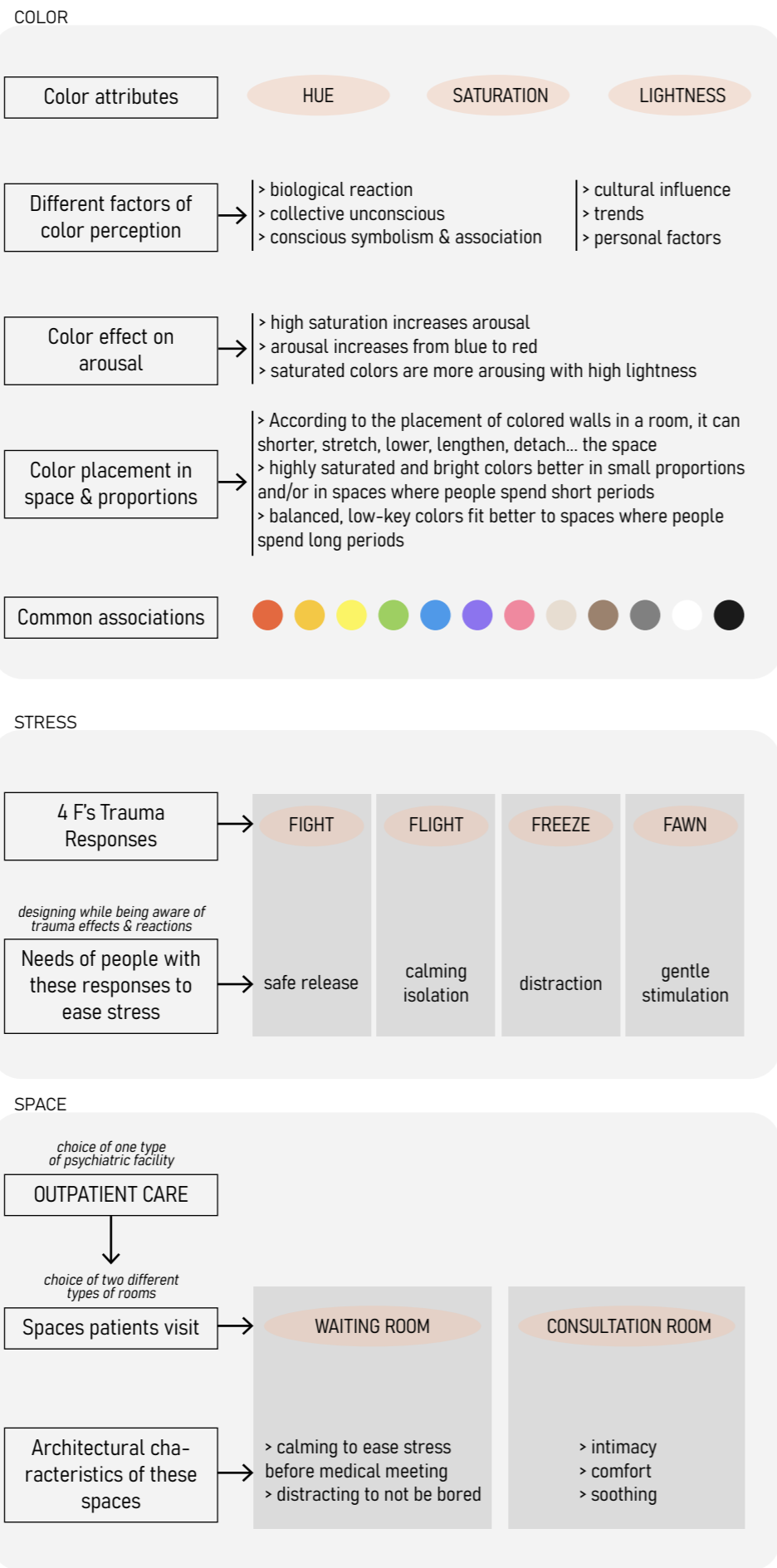
03_5.
100 colors no.35 - mt FACTORY TOUR
Emmanuelle Moureaux, Kurashiki (Japan)

RESEARCH SUMMARIZING DIAGRAM

RESEARCH AXES

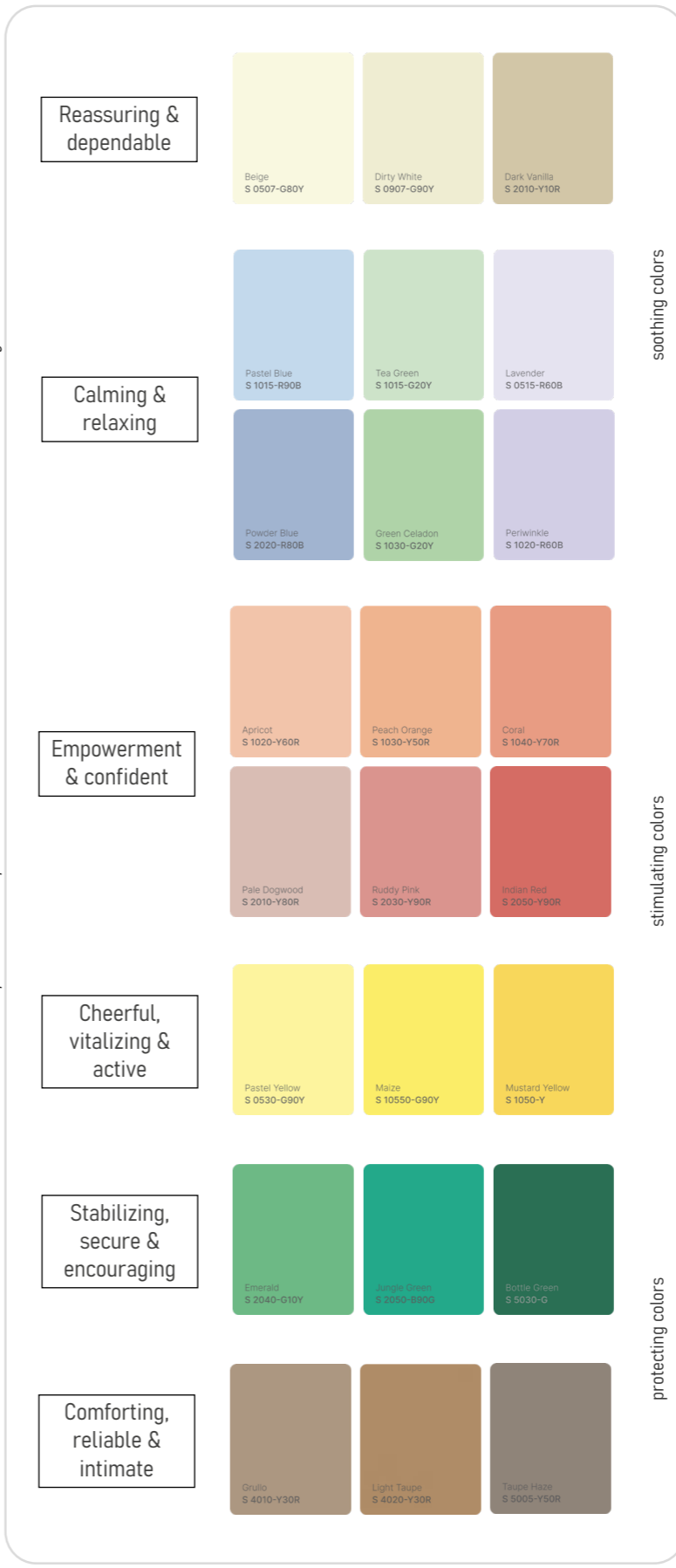
- Color (physics)
- Color theories (psychology)
- Color studies (from Oberfeld & Wilms)
- Color placement (from Meerwein & Rodeck.)
- Color symbolism (associations & effects)
- Stress & PTSD (Post-Traumatic Stress Disorder)
- Trauma-Informed Design (TID) (from Grabowska et al.)
- Current practice in psychiatric architecture
- Architectural aspects of space (from Meerwein & Rodeck)
- Interview architect + communication with psychiatrist

FINDINGS



COLOR PALETTE

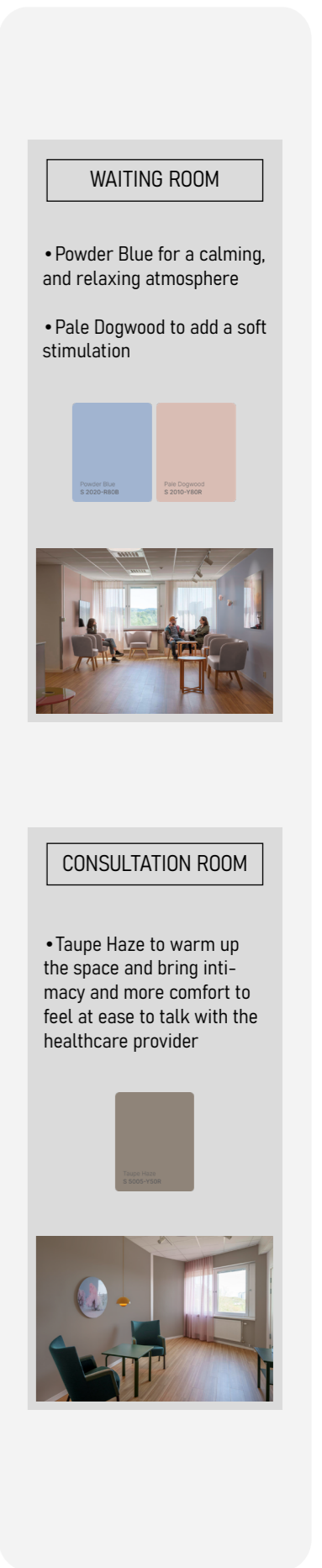
elaborated with the Natural Color System (NCS)



choosing the most suitable colors according to research

using the 4 trauma responses' needs to develop a suitable color palette

APPLICATION



04/ CONCLUSION CRITICAL REFLECTION

| CONCLUSION: THROWBACK TO THE RESEARCH

As a conclusion, a retrospective of the research's proceedings comes to frame the last chapter of this thesis. By looking back on the research question which led the work: *How could architects support a better design of psychiatric spaces regarding stress issues by being aware of stress conditions and working with suitable color palette?*, the work has approached, analysed and explored the topic in accordance with the following timeline.

As a first approach, a brief context and history of the psychiatric field and psychiatric architecture set the frame and the tone to grasp the importance and complexity of the topic in relation to its burdensome past. The awful healthcare conditions for mental health in the past led to stigmatization of the patients with mental disorders. With the progress done in the field, the care of psychiatric patients radically changed in the last decades. Thus, the important challenge to keep improving quality care and therapeutic spaces for patients has been recognized by the research. More, addressing psychiatric architecture is still an ongoing fight with the aim to prevent stigmatization and to reinforce inclusiveness.

In order to understand the different notions that are part of this thesis, the first chapter approached the main axes of research. First, by describing color and its characteristics. Realizing the predominance and importance of colors in our lives emphasizes the relevant dimension of lingering over the use of color in architecture to reach therapeutic efficiency. Color associations and effects on people take up a lot of space in the daily life and our perception of it can even influence our choices and actions. In addition, color in architecture has always been a meaningful aspect on its own. Architects chose color to express themselves and to communicate through their design. More than just being a paint applied to surfaces, color is an architectural element in its own right. Secondly, by bringing the notion of space and its link to people, we can better comprehend the scope of its potential to influence humans' state of mind. The concept of evidence-based design proved how much the built environment had the capacity to alter emotional and physical states of people, for the best or for the worst depending on its execution. Thirdly, by writing about stress, its origins and consequences, we can identify elements of the built environment as being potential stressors for people experiencing stress disorders. The focus on PTSD people allows a line of approach to stress with specific reactions: the 4 F's trauma responses. More, the concept of Trauma-Informed Design legitimates the attention paid to the understanding of trauma consequences. Being aware of the specific conditions of the patients is the most efficient way to target their needs in a realistic way. Beyond, these three cross-referenced notions of Color, Space and Stress put together, it clarifies their close connections which

intertwine. Thus, it explains the potential benefit and the necessity of an appropriate use of color in order to reduce stressors in space for stress-suffering patients.

As a logical continuation, the second part resulted as an analysis and understanding of color. Color associations and effects on arousal has been established according to the book *Color – Communication in Architectural Space* by Meerwein and Rodeck and the color study *Effects of color on emotion: Evidence from self-report ratings and physiological measures* of Oberfeld and Wilms. Then, general assumptions have been made on the interpretations and messages conveyed by the different colors. To be able to define colors and elaborate a suitable color palette answering the stress related needs, a deeper analysis of the four trauma responses has been conducted by mixing data about PTSD (*Complex PTSD: From Surviving to thriving* by Pete Walker) and TID (*Architectural Principles in the Service of Trauma-Informed Design* by Sam Grabowska et al.). From that, the different needs of the trauma responses set the basis for the selection of colors. Then, suggestions of appropriate colors has been made according to the previous acquired knowledge intertwined with my own choices. However, the colors previously chosen with color codes on a computer screen really differs from the kind of colors that are applied in built environments. Then, a more accurate selection of colors for psychiatric spaces has been done according to the NCS color system, which is the one used in the construction field in Sweden. As a last input and additional use of colors, the color placement in a room also proved to affect the space. The way the colors are applied in a room can alter its proportions and therefore, the sense of the space. More, different types of colors also have different ways to be cleverly used in architecture not to overwhelm the space. The second chapter results in the completion of the color palette.

As a final result of this research, the third chapter acts as a practical trial in space. Applications of colors in existing rooms have been done with pictures from the Psychiatric Clinic of Södra Älvsborg Hospital in Borås, Sweden. To narrow down the possibilities of psychiatric spaces, I selected to work with outpatient care services which represent a less stigmatized vision of the psychiatric field. After choosing and defining two types of rooms that are, according to me, the most visited by the patients in outpatient care, I proposed one makeover for each space with the use of colors from the pre-elaborated color palette. The last input of the chapter takes the form of a summarizing diagram as a recap of all the research work.

As a general conclusion, I could say that colors and architecture do have effect on the human being and it this effect is much more important when it comes to people with disorders since they might be more vulnerable and sensitive to sensory perception. Thus, the necessity to deepen this field of research seems to me promising and essential. Yet, I became aware that pursuing the aim to be able to design psychiatric spaces with therapeutic outcomes represents way more than only the use of colors, but the subtle art of combining many other impacting architectural elements to accompany people in their healing and life.

DISCUSSION: LIMITS, CRITICAL PERSPECTIVE & OPENING

During the process of the master's thesis, I had to face many questions and confront the limits imposed by the task. One semester is not enough to question a whole architectural dimension and above all, this thesis represents only a drop in the ocean of research, progress and innovation. Even by narrowing down the topic and focusing on specific notions within a certain framework, working on research always brings up more questions than answers.

From a critical point of view, the research work made me realize how tough the topic of color was. Its perceptual dimension beyond its scientific aspect makes it a complex field to approach. More, the various ways of representing, describing and communicating about colors does not make it easier. The multiplicity of colors – if not infinity – made me face many situations where I had to make decisions. And obviously, my choices, although motivated by research, also remain a result of my subjectivity. This is why my suggestions should not be seen as an ultimate truth. My own perception of colors is also subject to intrinsic bias due to my background and personal inclinations. However, beyond my own perception, everyone has its word to say on color in architecture. Although many studies managed to prove different effects according to the color used, it still remains a subject which is strongly dominated by subjective preferences. Furthermore, each individual perceives and interprets color in their own way with their personal sensibility. So, it might be difficult to predict all of the possible reactions, especially related to trauma. The wish I had to provide colors that are suitable for specific trauma responses made me realize at the same time that building architecture can sometimes not be so tailor-made. At some point, it has to suit the majority. Indeed, further investigation to know if the chosen palette could also work for other disorders could be a great input to have.

Furthermore, my work has been conducted with only one way of using colors: on the walls. Although, it might be the most common place to apply color paints, color could still be used in many other various ways; with patterns, to highlight architectural elements (pillars, window frames...), and even more in furniture.

Color may also have different associations depending on where they are placed – floor, walls, ceiling – (Meerwein et al., 2007) but my analysis only took color on walls into account. More, I particularly focused on colors but the placement of it in the room can truly change the dimension of a space, as studied by Desirée Grisoni and Silvia Meterc in their thesis work *The Mental Health Center in the psychiatric system – Experimenting with a multidisciplinary project*¹, they showed how different colors with different applications can greatly influence the perception of the individual in a room (Grisoni & Meterc, 2017, p.231).

¹ Own translation. Original title : *Il Centro di salute mentale nel sistema psichiatrico – Sperimentare un progetto multidisciplinare* by Desirée Grisoni and Silvia Meterc

In addition, color effect depends on color itself, but its perception depends even more on the surrounding environment. Light is an essential element to read color and small variations in light intensity can make a color look truly different. The whole surrounding environment with its own color complexity influences the perception of other colored surfaces. The same bright yellow spot will not look the same with a dark background or a light one (Albers, 1963). The materiality of the surface is also an important element that cannot be put apart. They directly “enhance synesthetic perceptions” (Meerwein et al., 2007, p.55). “We perceive materials holistically with all of our senses, just as we perceive space with all of our senses” once said the philosopher Hugo Kükelhaus. The five senses of taste, smell, hearing, touch and sight complement each other by creating perceptions while being stimulated. Each of these senses can be subject to stimuli and can then cause trauma reactions. As stated by Grabowska et al., disruptive sounds, unpleasant scents, visual noise, institutional materials represent common triggers in psychiatric architecture related to trauma (Meerwein et al., 2007, p.10). Thus, it must be considered to enhance the patients’ experience. For instance, the psychiatrist Dr. Karjania explains that light intensity should be adjusted carefully. Bright and intense white light from neon lights can remember traumatic events such as ambulance transportation. So, all of these other sources of stressors should also be taken into account while designing therapeutic spaces.

As another limit of the work, the application only covers two kinds of spaces. During the elaboration of the color palette, the trauma responses was the main support to select appropriate colors. However, I also realized that each individual might have different needs (regarding their trauma experience or personal background). But unfortunately, architecture finds its limits in the design. By wanting to adapt as much as possible a design to its user, it may not be suitable for others, only because at the end, we all are unique individuals. The challenge is then to be able to design and offer spaces that might suit to a majority.

More, the result of this work is itself directly influenced by the data I found and in which chronology. I had a hard time finding good and relatable scientific sources for this paper. The lack of scientific resources on the use of colors in psychiatric environment added a more complex dimension to the work, where I had to do a lot of assumptions and hypotheses. Sometimes, I has to trust some sources, even though they were not so recognized. Also, the order in which I found the resources had a big impact on my thesis plan. With time, the deeper I went, the more I could find relevant sources that were not accessible in the framework of my research at the beginning.

Finally, this paper encompasses all of these ordeals and processed limits to add a hindsight perspective and then open the discussion and possibilities to further research.

| FURTHER OUTLOOK: PERSONAL CONCLUSION

In the history of psychiatry, psychiatric architecture has shown its crucial role in the process of deinstitutionalization and development of new facilities, supporting the new healthcare approaches. Especially after the opening of psychiatry on the city, it gave a chance to people suffering from mental diseases to be more seen by the society. And just as a virtuous circle, improvement in the psychiatric field also brought about progress on the architecture side. A quote from the architect Akshat Bhatt really enlightened me on the subject: “Architecture forms the backdrop for human memories and contributes to society’s progress.” (Bhatt, 2022). Architecture represents a huge opportunity to remodel our society by making larger or smaller changes motivated by progress, inclusion and empathy.

Designing for a brighter future with better humane conditions is the direction that healthcare research has taken in recent decades. We can see that there is still a lot to discover and to research on in order to enhance the well-being of patients with an architecture which supports a better recovery process. I believe that pursuing research towards a more sensitive architecture can be the key to efficient pleasant and appropriate spaces, not only in healthcare facilities, but also in the design of housing buildings, offices... The architect’s expertise in ensuring a proper layout of a building, managing flows, security requirements, urban integration represents the scientific part of the construction field and ensures good quality in construction. But this is by implementing a social and sensitive approach that we can wish for a more sustainable architecture and wealthier people. Providing high quality buildings designed with an attention to its users is to me, the basis of good architecture. As once said the architect David Chipperfield: “There is a danger when every building has to look spectacular; to look like it is changing the world. I don’t care how a building looks if it means something, not to architects, but to the people who use it.” (Chipperfield, n.d.)

Finally, it appeared to me that, as architects, it is not enough to have the optimum knowledge on buildings and materials or to master the construction field. I stand by saying that our social and emotional intelligence and expertise carry weight in the execution of qualitative architecture. The will to seek and act for a better architecture will still remain the strongest driving force architects can have to pursue design progress and innovation.

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How could architects support a better design of psychiatric spaces regarding stress issues by being aware of stress conditions and working with suitable a color palette?