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2017

SAHAR JAMSHIDIAN

IMPACTS OF COLOR DESIGN ON IMPROVING HUMAN PERFORMANCE IN SPACE

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Projeto apresentado ao IADE – Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Design de Produção realizada sob a orientação científica do Doutor António José de Macedo Coutinho da Cruz Rodrigues, Professor Auxiliar do IADE - Universidade Europeia, e do Mestre João Manuel Carneiro Antunes Rodrigues da Cunha, Assistente do IADE – Universidade Europeia

To my dearest one, Hamidreza, who has always been beside me



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acknowledgments

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keywords

Color, Stimulating, Calming, Optimal Performance, Optimal arousal level

abstract

Color is one of the inseparable elements of space design, which affects on human bodies and emotions. It enhances welfare, quality of life and comfort of individuals. Colors have stimulating and calming effects that can help improve efficiency of performances in space. However, frequently we observe places wherein users become under - or overstimulated due to exposing to strong and constant area of a color for a period of time, that in both cases result in impaired functions. According to the studies which have been done, *"Inverted-U"* hypothesis demonstrate that, in order to do any task optimally, our body requires to reach at a certain optimum arousal level.

This project pretends to introduce a new approach to color design in the project of spaces, creating modifications to the architectural plans. The proposed theory consists in the application of stimulating or calming colors in a phase before the phase in which a certain action is expected to occur. This helps the user to reach the optimal arousal level, which brings optimal performances. Consequently, balance is set in the environment.

palavras-chave

Cor, Estimulante, Calmante, Óptimo Desempenho, Nível de excitação ideal

resumo

A cor é um dos elementos inseparáveis do design do espaço, afetando o ser humano e as suas emoções, e permitindo melhorar o bem-estar, a qualidade de vida e conforto dos indivíduos. As cores têm efeitos estimulantes e calmantes que podem igualmente ajudar a melhorar a eficiência do desempenho no espaço. No entanto é frequente observar locais onde os utilizadores são sob ou sobre estimulados perante a exposição a uma determinada cor, por um determinado período de tempo, resultando na redução do desempenho. De acordo com a "Teoria do U invertido", é possível demonstrar que, de forma a desempenhar qualquer atividade de forma otimizada, o nosso corpo necessita de alcançar um determinado nível ideal de excitação.

Este projeto pretende apresentar uma nova perspetiva à seleção de cores no design de ambientes, criando modificações nos planos arquitetónicos. O conceito proposto consiste na aplicação de cores estimulantes ou calmantes numa fase anterior à fase em que se espera que uma determinada ação ocorra, com o objetivo de auxiliar o utilizador a atingir o nível ótimo de excitação ótimo, melhorando e otimizando o desempenho. Consequentemente, o equilíbrio com o ambiente é estabelecido.

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INTRODUCTION

INTRODUCTION

The presented research project will be elaborated as a final work of the Master course in Production and Space Design, to obtain the master's degree.

Colors play a vital role in our lives. They are fundamental elements of our visual perception and environmental experiences. We are surrounded by color whenever we open our eyes. We see it in different objects and our daily activities and responses are effected by it. Color influences us and our emotional world, even when we do not consciously perceive it. It is a significant element in every realm of life, fulfills many different functions and can change the way objects look, perceived and interpreted. Studies demonstrate that, color is more than just a visual stimulation and besides other external factors which impact on our moods and emotions, it directly influences our well-being, perceptions, feelings and our bodies. It can give a deep meaning to our life’s rhythm, and wide varied colors diversify each moment of our life. Physiological and psychological impacts of color on humans’ bodies and emotions, and the interaction between them, are essential indicators in understanding color impact to human. We perceive colors as a characteristic of objects that surround us. In addition to form, surface quality, smell, and taste, color is one of the characteristics that enable us to evaluate an object. People looking at a color already have some experiences and preconceptions in their memory, which influence their color perception. Color perception is linked to many factors, such as: associations and symbols, previous experiences, memory, cultural, and social factors. Hence, color is necessary to be considered and studied carefully in the beginning process of every aspect in Design, Industry, Architecture and so on. Choosing and considering color in design as an objective decision is as important as form and function.

The theme of this thesis which is being presented is "Color and Space". The reason of choosing this theme is the relationship between color and function of space and product. Color has a significant impact on human experience of space, and the interplay of colors and space, is extremely important. It is considered as an inseparable member of designing a space, and is as great as form. Color design

requires a professional and qualified analysis of the effects of colors in a spatial context, taking into account physiological, ergonomic, psychological, functional, and aesthetic demands. As a result, the spatial environment needs to be systematically analyzed and planned. Architectural spaces, perceived and experienced, have to meet the requirements of color design. This is the only way to achieve a design that is tailored to people's needs. An environment that conveys information about spatial function, provides space for individuals, and contributes to the quality of life, enhances our well-being, behavior, and actions besides improving the efficiency of the space. Studies indicate that color plays a crucial role in emotion, productivity, communication and learning inherently. So that, we can change the world around us tremendously by changing colors and applying the proper one in the right place and situation. When dealing with colors in any environment, we are always creating an atmosphere wherein through psychological and physiological effects of color, we are able to create wonderful and meaningful spaces. The challenge of developing a unique and functional palette for a space or a product is a magnificent opportunity to develop the world more efficiently.

Choosing and considering color in design as an objective decision can be meaningful, purposeful and functional. It is proved that color is an inseparable part of our daily life, and the features of color and its impacts on the human body and mind are studied and experimented. However, we rarely observe spaces designed by considering the whole features of color. Typically, designers tend to choose a color for a space regardless of considering physiological and psychological impacts of colors on the human body and emotion over time. Consequently, results in creating environments which are either under-stimulating or over-stimulating which both cause failing in establishing efficient performance in places. For example: we observe many spaces wherein, by applying some colors, people get anxious after staying there for a length of time or conversely, make a dull and passive atmosphere that both cases bring about impaired functions. Therefore, further studies prior to design a space is required; advanced researches on the impacts of color on humans over time in all aspects. Consequently, we will be able to improve the function and the efficiency of the space.

METHODOLOGY

To achieve the objectives defined above, a research methodology was chosen based on three essential phases:

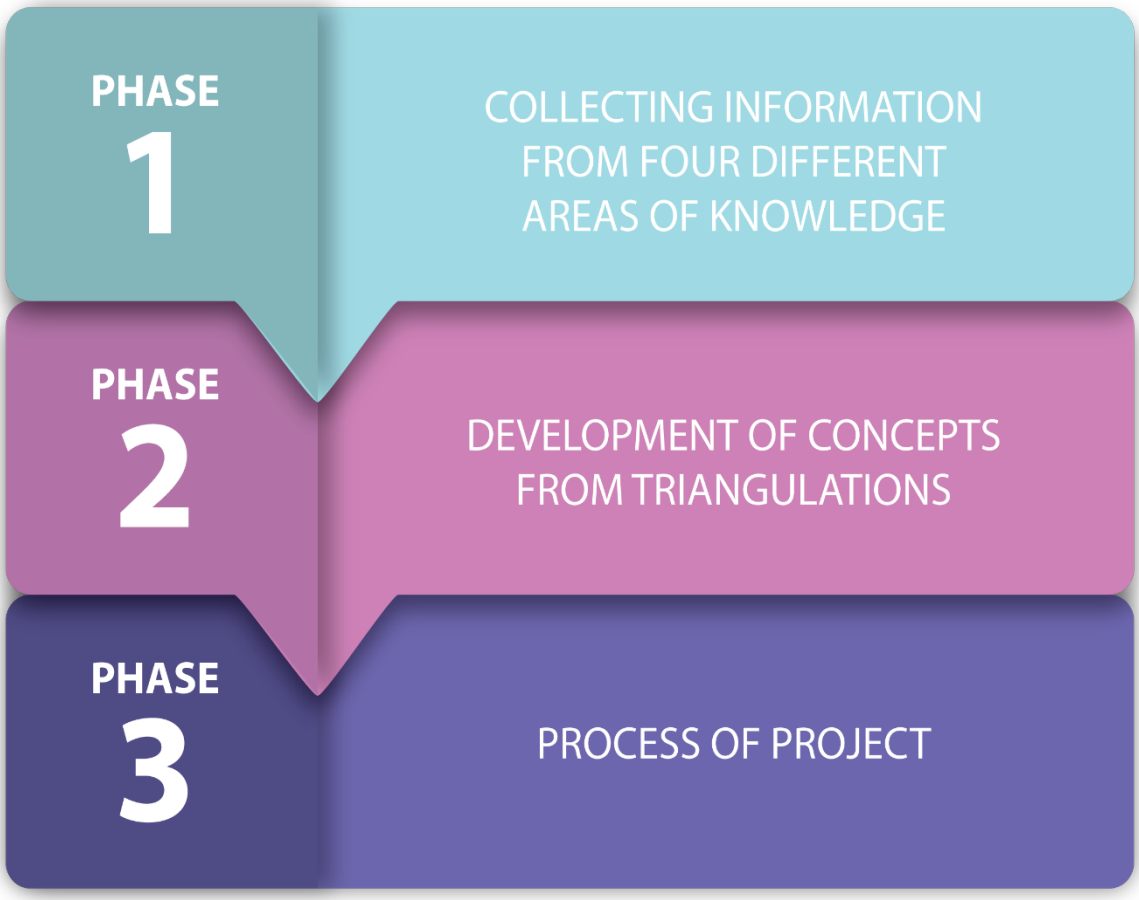

Fig. 1 – Thesis Methodology

Phase 1- Bibliographical Revision

The first phase of this thesis makes the review of the pertinent information available. The main objective is to amplify the knowledge, seeking a broader view of society that allows a free reflection of the current constraints.

To initiate in the first phase, different books, articles, and resources on the Internet have been selected and studied. If some of those books and articles are about color and its features in different aspects (pigments and dyes, color in space, the impacts of color on human, experiments done on effects of color on humans, the importance of color in products, logos, brands, and so on), other books were chosen from different areas (societies and different cultures, human evolution through history, memory and associations, habits, the ways guide us to be creative, and so on).

All the information is categorized in four different areas of Knowledge: Cultural, Scientific, Experimental, and Logistic.

1. **Cultural** - it is understood as the knowledge that brings us back to common sense. It portrays beliefs, speaks to us about art, morals, laws and customs, and exposes aptitudes, behaviors, and habits. In addition, this knowledge is acquired by man, as a social agent.
2. **Scientific** - it exposes factual matters; which analysis does not depend only on the observer's interpretation. It presents facts and data in a systematic and verifiable manner, using processes of observation, research, experimentation and validation.
3. **Experimental** - refers to the knowledge acquired through processes of observation, analysis and experimentation having as object of interest the nature, societies and man.
4. **Logistic** - it presents guiding contents for the execution of tasks, practices of procedures and analysis of activities. It is understood as logistic knowledge the creation and development of production methods, ideas, or behaviors.

The reason of selecting books from various areas of knowledge, is to obtain more information from different scopes which helps you to extend the perspective of mind. So that, you will find interesting connections between the main topic and others from different realms of study that had never thought of. Color is not only related to Art and Design, but also there is a strong tie between color association and cultures, beliefs, our physiology, and psychology.

At the end of each knowledge, a resume of the main ideas collected in the bibliography is presented, synthesizing information.

Phase 2- Triangulations

In the second phase, there will be project concepts, through the triangulation of ideas previously selected on the resume of each knowledge area. In order to allow the richness of contents in the origin of these concepts, it is suggested, from the methodological point of view, that the connections are originated in ideas from different areas of knowledge.

Thus, each triangulation consists in the selection of three citations, creating a project concept, expressed in one preposition. In this work, 3 triangulations are going to be developed.

Phase 3- Project

In the third phase, a triangulation among the three is chosen in order to be developed and worked on as a project. This project, more than a “product”, can be seen as a model that allows people to understand the importance of color in space, and the way it can be used to improve the performance of the user, in a specific space, for a specific activity. This project will be developed and presented through schemes, and three-dimensional visualizations (renders).

PHASE 1

This phase makes the review of pertinent information available, with the objective of amplify the knowledge, seeking for a broader view of society. All the information is categorized in four different areas of knowledge: Cultural, Scientific, Experimental, and Logistic. Although some materials and resources could be considered in more than one area of knowledge, we have categorized them based on the dominant content.

INTRODUCTION TO THE PHASE 1

The bibliographic review presented in this section, divided in different areas of knowledge, were accessed in book, articles and internet resources.

The information presented in books are summarized according the following structure:

Introduction: a short description of the content of the book.

Resume of the chapters: a brief description of a selection of the main ideas of each chapter.

Development: from the previous chapters, the ones regard as the most important for the research are developed

Reflections: selections of the main points of the developed chapter(s)

The information presented in articles and internet recourses are presented in a different way: they are sorted by their mutual area of knowledge, so that all the articles and online resources belong to a specific area are presented together. For these resources, the contents are organized according the following structure:

Articles and Websites: in this part main ideas of each article and webpage are mentioned.

Reflection: the overall main points of articles and websites are presented.

In the end of each area of knowledge, it is presented a resume of the main ideas retrieved from the reflections of all the bibliographic fonts selected for this chapter.

1 CULTURAL KNOWLEDGE

This chapter refers to the area of cultural knowledge, which relates to man's own empirical experience, including knowledge about beliefs, arts, morals, law and customs. In other words, aptitudes and habits that are acquired by a member of the society are considered. For instance; a book selected for this area of knowledge mostly cover the interaction between individuals in different societies. Also, it compares similarities and differences between small-scale societies and modern state societies.

1.1.- THE WORLD UNTIL YESTERDAY, What Can We Learn From Traditional Societies?

- Jared Diamond

This book argues anthropologists' studies in terms of mainly several aspects of social life in traditional small-scale societies and modern state societies. By reading this book, you can obtain many useful information about non-state societies lives, especially hunter-gatherer bands, such as the way they socialize, trade, war, educate and bring up their children and so on. In addition, the differences they have with state societies are significant and interesting to consider. Comparing similarities and differences between these two kinds of civilizations convince us that not only every feature of traditional societies is not destructive, but also some of them could be inspiring in our modern civilization in order to achieve better world.

1.1.1.- FRIENDS, ENEMIES, STRANGERS - Chapter one

In this chapter the author divides people of small-scale societies into three categories: friends, enemies, and strangers. "Friends" are considered as members of either your own village or neighboring bands and villages, that you are in peaceful terms at the moment. "Enemies" are members of neighboring bands and villages that your members are on hostile terms at the moment. And finally, "Strangers" who are considered as unknown individuals belonging to distant bands that your band has little or no contact with them. (Diamond, 2012, p. 98)

Trading is considered in two different kinds of traditional small-scale societies and modern societies and their features are explained. In addition, their differences and the similarity are compared. The author defines "trade" in small-scale societies: "A remaining relationship between neighboring societies, besides defending boundaries and sharing resources and making war, is trade." (Diamond, 2012, p. 114)

It is mentioned that, only a few modern traditional societies have been reported self-sufficient and carrying out little or no trade, however, most traditional societies like all developed societies did import some goods. So that, even if they are self-sufficient they preferred to achieve some goods by trading. Furthermore, the author (Diamond, 2012) mentions some differences between traditional small-scale societies trading and modern trading in this part:

- In modern trading, acquiring an item is not by barter, but by paying for it with money.
- The process of buying something is as an exchange, in which the buyer's handing-over of something else (usually money) is considered a payment, not a reciprocal gift.
- Almost most of our market transactions happen between the buyer and a specialist "salesman", in a specialist professional facility "store", instead of between the buyer and the supplier near the house of either one.
- Most professional markets operate either constantly or else regularly and often.

Diamond (2012) explains that, in traditional small-scale societies, like modern consumers and suppliers, often do trade objects to which one party has access and the other doesn't, and they trade objects that one party knows how to make but the other doesn't. However, they also do much trading of objects equally available to either party, and they do that trading to maintain relationships for political and social reasons.

In addition, a similarity in both kinds of trading is discussed which in both cases the objects traded cover a spectrum from materially essential "necessities" to materially useless "luxuries". (Diamond, 2012, p. 121)

1.1.2.- A SHORT CHAPTER, ABOUT A TINY WAR - Chapter three

This short chapter introduces traditional warfare by recounting a rather ordinary series of battles and raids among New Guinea's Dani people, through

observing and filming by anthropologists. Additionally, in the end of the chapter the author defines some features of these kind of wars and compares its death toll to wars among nations such as World War II. Diamond (2012) discusses features of New Guinea's Dani warfare that turn out to be shared with wars in many other traditional societies, such as:

- Usually tribal warfare is intra-tribal and occurs between groups speaking the same language and sharing the same culture, rather than inter-tribal.
- Typically, boys are trained in childhood how to fight in order to know how to attack. Also, revenge plays a dominant role as a motive for cycles of violence.
- Warfare involves the whole population instead of just a small professional army of adult men, so that there is intentional killing of civilian women and children as well as of male soldiers.
- Absolute death tolls are low from the small size of the populations involved compared to the populations of almost all modern nations, but relative death tolls as a proportion of the population involved are high.
- The feature that totally surprises us is appointments for battles. This means that, the battle takes place at an appointed place on an appointed day. Also, the other side is free to accept or ignore the challenge. (Diamond, 2012, p. 226)

1.1.3.- BRINGING UP CHILDREN - Chapter five

In this chapter of the book, the author compares child-rearing practices between small-scale societies - specially hunter-gatherer societies - and modern state societies. Also, he discusses their different features of each group. A small part is dedicated to "Infant-adult contact". This issue within modern industrial societies and traditional societies is compared. In this part differences in terms of a transporting device are mentioned:

> "One of the commonest Western devices for transporting a child is the stroller, which provides no physical contact between the baby and the care-giver. In many strollers, the infant is nearly horizontal, and sometimes facing backwards. Hence the infant does not see the world

> as its care-giver sees the world. In recent decades in the United States, devices for transporting children in a vertical (upright) position have been more common, such as baby carriers, backpacks, and chest pouches, but many of those devices have the child facing backwards." (…)
>
> "In contrast, traditional carrying devices, such as slings or holding a child on one's shoulders, usually place the child vertically upright, facing forwards, and seeing the same world that the care-giver sees. The constant contact even when the caretaker is walking, the constant sharing of the care-giver's field of view, and transport in the vertical position may contribute to! Kung infants being advanced (compared to American infants) in some aspects of their neuromotor development." (Diamond, 2012, p. 319)

In addition, bringing up children in these two different societies is compared. According to studies, Western children sleeping in separate rooms, transported in baby carriages, and left in cribs during the day which is considered sometimes more socially isolated compare to cradle-boarded Navajo children. (Diamond, 2012, p. 321)

Moreover, "Multi-age playgroups" is considered as a feature of small-scale societies. So that, in small-scale societies like in a typical hunter-gatherer society, there is one-room schoolhouses and it is impossible to assemble separate age-cohort playgroups, each with many children, as is characteristic of large societies. In a small-scale society, all children in the band form a single multi-age playgroup of both sexes. (Diamond, 2012, p. 345) Some advantages in multi-age playgroups are considered which are mentioned below:

> "In such multi-age playgroups, both the older and the younger children gain from being together. The young children gain from being socialized not only by adults by also by older children, while the older children acquire experience in caring for younger children." (Diamond, 2012, p. 346)

Diamond (2012) claims that premarital sex is another subject which is affected by multi-age playgroups in small hunter-gatherer societies. Children in playgroups imitate the different adult activities and they have sex games, and simulating intercourse.

1.1.4.- LIONS AND OTHER DANGERS - Chapter eight

This section of the chapter discusses the reason that people in small-scale societies aggregate and disperse. “When food resources are few and concentrated in a few areas, people gather to live at those areas. At favorable times of year when resources are widely and uniformly distributed, people spread out over the landscape.” (Diamond, 2012, p. 533) So that, groups spend the winter in a camp with a source of water and in the warm season the camp break up into nuclear families and spread out over the landscape.

Diamond (2012) claimed that how much we worry about dangers, and how extensively we defend ourselves against them depends on some factors which are mentioned below:

- The annual number of people killed or injured by a certain type of danger are low, because we are so aware of it and we are trying minimize our risk.
- Some dangers have potential benefits, so that we take a risk and expose ourselves to the danger.
- There are some dangers that we misestimate or underestimate, and this could sometimes cost our lives. Typically, the main reason is that people choose to do things that feel they can control them. Therefore, they know that those things won’t kill them and they consider themselves careful and strong enough to cope with. However, they are threatening and kill individuals.
- There are people who accept, or even sometimes seek and enjoy danger more than do other individuals such as; recreational skydivers, bungee-jumpers, and race-drivers.
- In some societies you will find more adventurous and tolerant of accepting risks compare to other conservative societies.

1.1.5.- DEVELOPMENT OF "BRINGING UP CHILDREN"

This chapter of the book discusses studies which are based on the comparisons between modern and small-scale societies. Modern societies which are given are cross-cultural, such as; German, American, Japanese, and Chinese children. They are sampling societies all drawn from the same narrow slice of human cultural diversity.

> "As a result, those and other state-level modern societies have converged on a small range of child-rearing practices that by historical standards are unusual. Those practices include systems of school education administered by a state (as opposed to learning as part of everyday life and play), protection of children by police and not just by parents, same-age playgroups (as opposed to children of all ages routinely playing together), children and parents sleeping in separate bedrooms (as opposed to sleeping together in the same bed), and mothers nursing infants (if the infants are nursed at all) on a schedule often set by the mother rather than by the infant." (Diamond, 2012, p. 302)

Moreover, the author explains the differences mentioned above in more detailed description. To start, he indicates circumstances of childbirth which is different even among the traditional societies. He adds that, a cultural ideal is for the mother to give birth alone and unassisted. (Diamond, 2012, p. 305)

Next subject is "Infanticide" which refers to the intentional acknowledged killing of an infant. Although, it is illegal in most of the modern societies, it is acceptable in many traditional societies under the specific conditions. For example, it is possible to commit infanticide when the infant is born deformed or weak or when there is a short birth interval between children. Another situation is when a hunter-gatherer women give birth to twins and result in the killing or neglect of at least one of the twins. One more situation in which infanticide is allowed is when the father is absent or dead and the mother is unable to protect and feed the child. Also, in some traditional societies the ratio of boys to girls increases from birth to adolescence, which is the result of dying female infants through being killed by strangling, exposure, or burying alive intentionally or by neglect due to the reason that value of boys are over girls in some societies. (Diamond, 2012, pp. 307-308)

In this part Diamond (2012) discusses the subject “Weaning and birth interval”. He claims that the proportion of infants who were nursed at all by their mothers, and the age at which those nursed infants were weaned decreased in the U.S. in the 20th century. However, traditional societies do wean at a later age than do modern Americans and weaning is often initiated by the child rather than by the mother. Furthermore, he mentions the two main reasons for the long birth intervals of nomadic hunter-gatherers which have been the subject of much discussion:

• First reason is:

“(…) a mother without access to cow’s milk or cereal gruel, and hence likely to nurse a child until the age of three or more years, cannot produce enough milk to nurse both a newborn and a not-yet-weaned older child.” (Diamond, 2012, p. 311)

• Next:

“(…) only when a child is around four years old or more does it become capable of walking fast enough to keep up with its parents when they are shifting camp. Younger children have to be carried then.” (Diamond, 2012, pp. 311-312)

According to studies, in hunter-gatherer groups nursing is often on demand. Whereas, many mothers in modern societies schedule nursing at times when the mother’s activities permit it.

Here Diamond (2012) compares the way infant-adult contact in both societies:

> “In modern industrial societies today, we follow the rabbit-antelope pattern: the mother or someone else occasionally picks up and holds the infant in order to feed it or play with it, but does not carry the infant constantly; the infant spends much or most of the time during the day in a crib or playpen; and at night the infant sleeps by itself, usually in a separate room from the parents.” (…) “Studies of modern hunter-gatherers show that an infant is held almost constantly throughout the day, either by the mother or by someone else.” (Diamond, 2012, p. 317)

In addition, the stroller is considered as on of the commonest Western devices for transporting child which provides no physical contact between the baby and the care-giver:

> "In many strollers, the infant is nearly horizontal, and sometimes facing backwards. Hence the infant does not see the world as its care-giver sees the world. In recent decades in the United States, devices for transporting children in a vertical (upright) position have been more common, such as baby carriers, backpacks, and chest pouches, but many of those devices have the child facing backwards." (Diamond, 2012, p. 319)

Whereas, in traditional societies, carrying devices are different from the transportation devices in modern societies:

> "In contrast, traditional carrying devices, such as slings or holding a child on one's shoulders, usually place the child vertically upright, facing forwards, and seeing the same world that the care-giver sees. The constant contact even when the caretaker is walking, the constant sharing of the care-giver's field of view, and transport in the vertical position may contribute to !Kung infants being advanced (compared to American infants) in some aspects of their neuromotor development." (Diamond, 2012, p. 319)

This part argues the important role of allo-parenting in improving the social skills of the children. Allo-parents means individuals who are not the biological parents but who do some care-giving. According to the studies, in traditional societies allo-parenting is much more important, and parents play a less dominant role in contrast with modern Western society in which a child's parents are typically by far its dominant care-givers. So that, Hunter-gatherer mothers share care of infants with fathers and allo-parents, including grandparents, aunts, great-aunts, other adults, and older siblings. (Diamond, 2012, p. 324). Moreover, anthropologists believe that, allo-parental relationships in small-scale societies provides development of social skills among children in those societies.

Diamond (2012) considers a difference in responses to crying infants among these two societies. So that, he claims that, in contrast with Western modern societies, if an infant begins crying, the parents' practice is to respond immediately.

Studies according the physical punishment indicates that, there is a great variation among human societies in their attitudes towards punishing children. There is a variation within a given society from generation to generation, and a variation between similar neighboring societies within the same generation. So that, most hunter-gathers do minimal physical punishment of young children and many farming

societies do some punishment, and herders are especially likely to punish. (Diamond, 2012, p. 324) There is a common explanation for this attitude, which is mentioned in the paragraph below:

> "One contributing explanation is that misbehavior by a hunter-gatherer child will probably hurt only the child and not anyone or anything else, because hunter-gatherers tend to have few valuable physical possessions. But many farmers, and especially herders, do have valuable material things, especially valuable livestock, so herders punish children to prevent serious consequences to the whole family (…)." (Diamond, 2012, pp. 334-335)

Child autonomy is another subject that Diamond (2012) compares in this chapter. Hunter-gatherers do not tell anyone, not even a child, to do anything, they believe in egalitarian. So that, small-scale societies appear to be not almost as convinced as are we WEIRD moderns of the idea that parents are responsible for a child's development, and they can influence how a child turns out. Some hunter-gatherer and small-scale farming societies don't intervene when children or even infants are doing dangerous things that might be dangerous and harmful for them. While, that could expose a Western parent to criminal prosecution. In some environments where are relatively safe for children, children enjoy more and are more independent compared to dangerous places:

> "(…) how much freedom children enjoy seems to depend partly on how dangerous the environment is, or is perceived to be. Some environments are relatively safe for children, but others are dangerous because of either environmental hazards or else dangers from people." (Diamond, 2012, p. 341)

"Multi-age playgroups" is considered as a feature of small-scale societies. The author discusses that, in small-scale societies like in a typical hunter-gatherer society, there is one-room schoolhouses and it is impossible to assemble separate age-cohort playgroups, each with many children, as is characteristic of large societies. In a small-scale society, all children in the band form a single multi-age playgroup of both sexes. Based on the studies some advantages in multi-age playgroups are considered:

> "In such multi-age playgroups, both the older and the younger children gain from being together. The young children gain from being socialized not only by adults by also by older children, while the older children acquire experience in caring for younger children." (Diamond, 2012, p. 346)

Additionally, premarital sex is considered as another subject which is affected by multi-age playgroups in small hunter-gatherer societies. Children in playgroups imitate the different adult activities and they have sex games, and simulating intercourse. (Diamond, 2012, p. 347)

Researchers on "Child play and education" demonstrates that educational play of children among small-scale societies is imitation of what adults do around them. They see the adults or hear stories told by adults. Although kids play for fun, their play serves the function of letting them practise things that they will later have to do as adults. However, in contrast to all those "educational games" that imitate adult activities and prepare children for them, there are some non-educational games considered as "child culture", so that, children learning to get along with other children, and playing games that have nothing to do with becoming an adult. (Diamond, 2012, pp. 348-349)

Furthermore, it is mentioned that, there is a regular feature in the games of hunter-gatherer societies and the smallest farming societies, which is the lack of competition or contests:

> "A regular feature of the games of hunter-gatherer societies and the smallest farming societies is their lack of competition or contests. Whereas many American games involve keeping score and are about winning and losing, it is rare for hunter-gatherer games to keep score or identify a winner. Instead, games of small-scale societies often involve sharing, to prepare children for adult life that emphasizes sharing and discourages contests." (Diamond, 2012, p. 351)

In addition, there are some differences between toys that children of traditional societies and Modern societies play with:

> "American toy manufacturers heavily promote so-called educational toys to foster so-called creative play. American parents are taught to believe that manufactured store-bought toys are important to the development of their children. In contrast, traditional societies have few or no toys, and any toys that do exist are made either by the child itself or by the child's parents." (Diamond, 2012, p. 351)

The author claims that, in small-scale societies in contrast to modern societies, knowledge is inseparable from social life which is caused by the different rules of training and education:

> "In modern state societies, there is formal education: schools and after-hour classes, in which specially trained instructors teach children material set by school boards, as an activity separate from play. But education in small-scale societies is not a separate activity. Instead, children learn in the course of accompanying their parents and other adults, and of hearing stories told by adults and older children around the campfire." (Diamond, 2012, p. 352)

Diamond (2012) claims that, there are some differences in child-rearing practices between small-scale societies and state societies. Even within some state societies, there are differences between farmers, urban poor people, and the urban middle class. Moreover, there are differences from generation to generation within state societies. In this part, the author names some societies, such as; the U.S., Germany, Sweden, Japan, and an Israeli kibbutz as state societies.

Although states have military and technological advantages which make them more powerful than hunter-gatherers bands, that doesn't necessarily imply that states have better ways of raising their children. Instead, some other hunter-gatherer child-rearing practices may fit readily into modern state societies:

> "It's perfectly feasible for us to transport our infants vertically upright and facing forward, rather than horizontally in a pram or vertically upright but facing backwards in a pack. We could respond quickly and consistently to an infant's crying, practise much more extensive allo-parenting, and have far more physical contact between infants and care-givers. We could encourage self-invented play of children, rather than discourage it by constantly providing complicated so-called educational toys. We could arrange for multi-age child playgroups, rather than playgroups consisting of a uniform age cohort. We could maximize a child's freedom to explore, insofar as it is safe to do so." (Diamond, 2012, pp. 356-357)

Hunter-gatherer rearing practices produce individuals capable of coping with big challenges and dangers while still enjoying their lives.

1.1.6.- REFLECTIONS

Here are the main points of chapter five:

Anthropologists believe that, allo-parental relationships in small-scale societies provides development of social skills among children in those societies. (Diamond, 2012, p. 327)

In some environments where are relatively safe for children, children enjoy more and are more independent compared to dangerous places:

> "(…) how much freedom children enjoy seems to depend partly on how dangerous the environment is, or is perceived to be. Some environments are relatively safe for children, but others are dangerous because of either environmental hazards or else dangers from people." (Diamond, 2012, p. 341)

> "In such multi-age playgroups, both the older and the younger children gain from being together. The young children gain from being socialized not only by adults by also by older children, while the older children acquire experience in caring for younger children." (Diamond, 2012, p. 346)

> "American toy manufacturers heavily promote so-called educational toys to foster so-called creative play. American parents are taught to believe that manufactured store-bought toys are important to the development of their children. In contrast, traditional societies have few or no toys, and any toys that do exist are made either by the child itself or by the child's parents." (Diamond, 2012, p. 351)

> "In modern state societies, there is formal education: schools and after-hour classes, in which specially trained instructors teach children material set by school boards, as an activity separate from play. But education in small-scale societies is not a separate activity. Instead,

children learn in the course of accompanying their parents and other adults, and of hearing stories told by adults and older children around the campfire." (Diamond, 2012, p. 352)

"It's perfectly feasible for us to transport our infants vertically upright and facing forward, rather than horizontally in a pram or vertically upright but facing backwards in a pack. We could respond quickly and consistently to an infant's crying, practise much more extensive allo-parenting, and have far more physical contact between infants and care-givers. We could encourage self-invented play of children, rather than discourage it by constantly providing complicated so-called educational toys. We could arrange for multi-age child playgroups, rather than playgroups consisting of a uniform age cohort. We could maximize a child's freedom to explore, insofar as it is safe to do so." (Diamond, 2012, pp. 356-357)

1.2.- THE LONG SUMMER, How Climate Changed Civilization

- Brian Fagan

This book describes the first detailed record of climate change from 15,000 years of warming. Also it shows how climate changes gave rise to civilization. It indicates that, the key to survival had always been human flexibility, mobility, adaptation, technology and making adjustments in their diet.

After the Ice Age in which glaciers covered most of the world, temperature began to rise. The warm temperature started from 15,000 years ago, civilization and all recorded history occurred in this warm period. This era is known as the Holocene, which is the long summer of the human species.

1.2.1.- PUMPS AND CONVEYOR BELTS, THE LATE ICE AGE ORCHESTRA 18,000 TO 13,500 B.C. - Part one

This chapter discuses a period which is late Ice Age in Europe. In this period of time Europe was surrounded by rubble-strewn desert, and encircled by steppe/tundra further to the south. In this period, Europe was a breathing continent that drawing animals and people into itself during warmer times, then expelling them in colder ones. So that, the steppe/tundra acted like a pump, sucking in reindeer and their predators in spring and push them out in the fall.

> “Fall came early 18,000 years ago, a brief period in September when daytime temperatures were still warm but nighttime frosts kills the lush grass and winds drove the leaves from the few deciduous trees. Now the bands went their separate ways, living as extended families in large rock shelters, with tattered hide curtains over their openings to retain the warmth from the large hearths within. Soon temperatures plummeted and the snow came. For months, each band lived in virtual isolation, aware of others nearby, but with only sporadic contact between them.” (Fagan, 2005, p. 17)

> “The late Ice Age is so remote from us that scientists still have only a general impression of its climatic variations. We tend to think of Europe 30,000 to 15,000 years ago as a refrigerated world that endured unchanged for many millennia. But then as now, the climate

varied from year to year, from century to century, in an endless succession of colder and warmer cycles. Animal populations fluctuated with the climate, increasing in warmer millennia and declining in colder ones." (Fagan, 2005, p. 21)

As it is mentioned before, Europe acted as a breathing continent, in which Cro-Magnons got in and out by changing climate:

"We can again envisage late Ice Age Europe as a breathing continent, drawing people and animals into itself during warmer times, then expelling them in colder ones, only to suck them in again thousands of years later. Humans never left the continent entirely, but their population, like those of the animals they depended on, ebbed and flowed." (Fagan, 2005, p. 23)

Studies show that, where Neanderthals rarely ventured to face due to the extreme climate, Homo sapiens with great ingenuity accepted the challenge:

"This inhospitable environment challenged human ingenuity to the limit, so much so that Neanderthal bands of 50,000 years ago rarely ventured onto the plains. They lacked the clothing and technology to survive in such savage terrain, except at the height of summer. Even then, only a handful of bands hunted there for a few short weeks before retreating southward. But where the Neanderthals rarely ventured, Homo sapiens sapiens thrived. The newcomers faced their environmental challenges with great ingenuity." (Fagan, 2005, pp. 26-27)

It is demonstrated that, the key to survival of people in extreme climate, had always been technology, mobility and flexibility, so the obvious strategy was to move southward, into more sheltered terrain. (Fagan, 2005, p. 28)

1.2.2.- PUMPS AND CONVEYOR BELTS. THE VIRGIN CONTINENT, 15,000 TO 11,000 B.C. - Part one

100,000 years ago, as the sea level fell by 90 meters, a land bridge – Central Beringia – had formed between Asia and America. Genetic and linguistic researches reveal that the first Americans came from northeast Asia around 13,500 BC,

following a warming phase that had begun 1,500 years earlier. So that, the northeast Siberians moved eastward to Alaska. (Fagan, 2005, p. 37) An ice-free corridor developed in what is now Canada east of the Rockies. The key factors of survival of people in this period is indicated in the following paragraph:

> "In a world where hunting bands survived by virtue of their small size, flexible social organization, and ability to adapt to rapidly changing environment condition, the Americas could have been settled and abandoned-or seen settlements die out- dozens of times. The rapid and irregular warming of the late Ice Age would have drawn in and expelled people from the savage landscapes of northeastern Siberia like a fibrillating heart." (Fagan, 2005, p. 41)

> "The first settlement of the Americas followed the opening of a climatic window in northeastern Siberia around 13,500 B.C., when the great warming began. Within a generation or so, the dynamics of hunter-gatherer life must have seen some of the northeast Siberians moving eastward into Alaska." (Fagan, 2005, p. 43)

It is demonstrated that, people in that period, by following the ancient lifestyle, relied on mobility. Besides, social flexibility is a factor which helped them to survive. (Fagan, 2005, p. 45) Moreover, technology played a significant role to help people survive in extreme conditions, as well as diet adjustment:

> "In such biologically impoverished environments, plant foods would have been scarce outside the most sheltered locales. But the people who might have passed through this corridor were adapted to harsh extremes, with subfreezing temperatures and widely dispersed supplies. They had developed the technology and clothing to survive comfortably even under severest conditions." (Fagan, 2005, p. 49)

> "For thousands of years, the flexibility and small scale of hunter-gatherer life allowed people everywhere to adjust effortlessly to drought and flood, to warmer and colder temperatures, or to rising seas by simply moving or making adjustments in their diet." (Fagan, 2005, p. 57)

1.2.3.- THE CENTURIES OF SUMMER, THE CATACLYSM, 10,000 TO 4000 B.C.

- Part two

This period of time discusses an era which is end of the Younger Dryas with warmer temperature and increasing rainfall. In this period hunters and gatherers became farmers:

> "Over a large area, from the Jordan Valley in the south to southeastern Turkey in the north, and east in the Iranian highlands, numerous small communities now subsisted not on wild grasses and other plant foods, but on domesticated emmer, rye, and barley. Hunting and wild plants were still important, especially gazelle and deer, but humans were now food producers." (Fagan, 2005, p. 100)

Climate is known as a factor which led development of animal domestication which also expanded farming compared to the previous era:

> "Animals domestication developed simultaneously at several locations right around the time warming resumed, in about 9000 B.C., just as farming was taking hold over a far larger area than it had during the Younger Dryas. Agriculture and animal husbandry are not necessarily compatible activities, nor did cultivation lead to domestic animals. Herders, with their insatiable demands for grazing and water, are always on the move, while farmers stay close to their lands. Tension between nomads and settled villagers developed as soon as people domesticated animals, as droughts drove herders and their animals onto settled lands." (…)
>
> "Both plant cultivation and animal domestication resulted from the need to ensure reliable food supplies at a time of intense drought. And as village populations rose, the pressure on gazelle and other game increased, to the point that many communities acquired domesticated animals to ensure a dependable source of meat and other products." (Fagan, 2005, p. 102)

The author claims that, mobility is a virtue that made Cro-Magnons and their successors survive in climate shifts:

> "We have seen how the Cro-Magnons and their successors, and the hunter-gatherers of southwestern Asia, adapted effortlessly to major climatic shifts by virtue of their mobility and effortless opportunism. The vulnerability equation began to change when mobility gave way to

> sedentism in the oak and pistachio forests of the Levant; but even then, people adjusted to the severe droughts of the Younger Dryas by the simple expedient of deliberately cultivating wild cereals. Within a few generations, the foragers became farmers, anchored to their lands by high-yield cereals and then by their herds" (Fagan, 2005, p. 124)

Even during the flood, due to the flexibility of farmers, they had rapid movements, and leapfrogged on the shores of the new Black Sea or inland. So that, they reached forests and rivers in Europe.

1.2.4.- THE CENTURIES OF SUMMER, GIFTS OF THE DESERT, 6000 TO 3100 B.C. - Part two

By 5,000 BC the major climatic shifts were largely over, and the long summer had established itself. The period to the present was not a period of stability. So that, smaller climatic changes had tremendous impacts for settlements and civilizations. This chapter discusses a period of time, that the drying of the Sahara forced its inhabitants to live along the banks of the Nile which was a viable landscape for cattle herders. (Fagan, 2005, pp. 147-148)

Studies show that Badarian communities lived along the Nile, and their toolkits and vessels are found in the place they settled, Nile Valley:

> "During the early fifth millennium B.C., Badarian communities (named after a settlement near the village of el-Badari) flourished over a long stretch of the Nile between the modern cities of Cairo and Luxor. The Badarians lived a relatively easy life in the fertile Nile Valley. Their toolkits were light and portable, known to us from settlements and cemeteries near the river and from their highly polished, thin-walled clay vessels. Like many subsistence farmers, the Badarians placed a high premium on body decoration as a way of showing personal status and social affiliation. They ground their pigments on stone palettes, aircraft that remained a mark of Egyptian life for the next two thousand years. The siltstone for these palettes came from the Black mountains of the Wadi Hammamut in the Eastern Desert, a natural route to the Red Sea." (Fagan, 2005, p. 161)

1.2.5.- DEVELOPMENT OF "THE CENTURIES OF SUMMER, THE CATACLYSM, 10,000 TO 4000 B.C."

This period of time discusses an era which is end of the Younger Dryas with warmer temperature and increasing rainfall. In this period, hunters and gatherers became farmers and they had domesticated animals:

> "Over a large area, from the Jordan Valley in the south to southeastern Turkey in the north, and east in the Iranian highlands, numerous small communities now subsisted not on wild grasses and other plant foods, but on domesticated emmer, rye, and barley. Hunting and wild plants were still important, especially gazelle and deer, but humans were now food producers." (Fagan, 2005, p. 100)

In the following paragraph, the author explains how domestication took place:

> "The arid conditions between 11,000 and 9500 B.C. concentrated human settlement around permanent water sources such as lakes, perennial rivers, and springs. Here the most diverse wild plant foods are to be found. Here, too, game congregates, both for water and to gaze on the lusher vegetation. Inevitably, animals and humans were thrown together, so much so that the hunters would know individual herds intimately and could perhaps identify specific animals." (Fagan, 2005, p. 100)

Additionally, it is mentioned how domestic animals became a village staple. "When the hunters isolated wild herds from a larger gene pool for selective breeding under human care, they produced domestic goats that yielded regular milk supplies, which soon became a village staple, and sheep with woolly coats." (Fagan, 2005, pp. 101-102) Climate is indicated as a factor which led development of animal:

> "Animals domestication developed simultaneously at several locations right around the time warming resumed, in about 9000 B.C., just as farming was taking hold over a far larger area than it had during the Younger Dryas. Agriculture and animal husbandry are not necessarily compatible activities, nor did cultivation lead to domestic animals. Herders, with their insatiable demands for grazing and water, are always on the move, while farmers stay close to their lands. Tension between nomads and settled villagers developed as soon as

people domesticated animals, as droughts drove herders and their animals onto settled lands." (Fagan, 2005, p. 102)

People in this period, cultivate plants and domesticate animal in order to have enough supplies at the time of drought:

"Both plant cultivation and animal domestication resulted from the need to ensure reliable food supplies at a time of intense drought. And as village populations rose, the pressure on gazelle and other game increased, to the point that many communities acquired domesticated animals to ensure a dependable source of meat and other products." (Fagan, 2005, p. 102)

When people became farmer, they had to anchored to their land so that, village communities were made gradually and in a short time, some of these settlements achieved an impressive size. Also, soon a much larger farming community rose close to springs, a dense cluster of beehive-shaped houses separated by courtyards and narrow alleyways. By 8300 B.C., farming villages flourished on the Anatolian plateau in central Turkey and some of them were close to source of lustrous obsidian and it was the place for tool making and ornaments. So that, villages traded large quantities of obsidian to communities near and far. (Fagan, 2005, p. 104)

One of the oldest settlements which belongs to this era is Çatalhöyük which is located in Turkey that was not an ordinary settlement. The community was carefully planned and very compact. So that, all the houses had the same general floor plane. (Fagan, 2005, p. 104) Excavations at Çatalhöyük shows paintings belong to shrine. Geometric patterns, flowers, plants, symbols, goddesses, human figures were painted on the walls of the shrines. "Bull's heads and goddesses adorn Çatalhöyük's shrines, the former perhaps a male deity, the latter a fertility figure." (Fagan, 2005, p. 106)

It is explained how people in lakeside communities lived:

"They herded cattle, goats, and sheep; cultivated emmer, barley, and pluses; and lived in close-knit settlements of mud-brick houses linked by narrow alleyways, each with its own ovens, storage bins, and courtyards. None of them was self-sufficient. Every cluster of villages was linked to neighbors down the coast, up- or downriver, or on higher ground far from the

lake. They must have traded foodstuffs and volcanic rock for stone tools, sea shells, and other ornaments, perhaps jewelry, clay vessels, and baskets. Like their forebears in Asia, they must have had profound spiritual ties to the landscape that provided their crops, under the protection of revered ancestors, just as it had done since the beginnings of village life far to the south and east four thousand years before." (Fagan, 2005, p. 109)

It is believed that sedentary lifestyle made farmers to be more flexible. "Sedentary the farmers might be, but their simple agricultural economy and regular dependence on game and wild plant foods gave them a flexibility unheard of in later agricultural societies." (Fagan, 2005, p. 109)

In this period flooded. Flood made the life of farmers vey difficult in order to produce crops and food:

"We do not know what time of year the flood began, but the effects would have been devastating on people tied to their lands, who relied on stored food, hunting, and fishing to see them through the winter. Whether caught with growing crops in their gardens or, even worse, at harvest time, or with only stored food to hand, the farmers were left with only their herd animals and whatever they could take from the forest." (…)

"Perhaps even before 5600 B.C., some now-crowded communities leapfrogged from the plain into unexplored river valleys to the north and west. We can trace their movement across central and western Europe by tracking their highly distinctive clay vessels decorated with swirling impressions and incisions, and the foundations of the timber long-houses where they lived." (Fagan, 2005, pp. 114-115)

Agriculturalists settled the new lands as their ancestors did. So that, they carefully selecting cultivable soils and leapfrogging over neighboring village communities.

In that period, hunters and farmers trading by exchanging their productions over few years:

"After a time, the two groups meet again, the hunters bring honey and elk hides, which they lay on the ground outside the village; the farmers display emmer and seashells. These bartering transaction become routine in a few years. We can only speculate as to what happened over the generations. Some of the hunters must have been drawn ever closer into farming orbit." (Fagan, 2005, p. 116)

> "Until 4000 B.C., farmers occupied only a tiny part of the European continent. Newcomers in an ancient world of hunting and gathering, they shared much the same forms of simple agriculture over long distances. In many respects, they enjoyed the flexibilities of hunter-gather life, with the addition of cereal crops and domesticated animals. They lived in a far from crowded world, where initially at any rate, there was enough land to go round on the most fertile and easily turned arable soils. Life and its rituals still centered around the household." (Fagan, 2005, p. 121)

It is believed that, for thousands of years, most life and ritual had revolved over the link between living and dead. So that, rituals became public.

> "Especially in the west, emphasis shifted from the household and the village to burials as a symbol of community, defined not by individual interments with elaborate adornment but by communal graves. The new traditions came from a melding of ancient hunter-gatherer and farming beliefs, reflected in the buildings of timber or stone mortuary houses buried under earthen mounds. These tumuli were monuments to the ancestors, built in the midst of landscapes full of symbolic places and imbed with powerful supernatural meaning." (Fagan, 2005, p. 122)

The author claims that, mobility is a virtue that made Cro-Magnons and their successors survive in climate shifts:

> "We have seen how the Cro-Magnons and their successors, and the hunter-gatherers of southwestern Asia, adapted effortlessly to major climatic shifts by virtue of their mobility and effortless opportunism. The vulnerability equation began to change when mobility gave way to sedentism in the oak and pistachio forests of the Levant; but even then, people adjusted to the severe droughts of the Younger Dryas by the simple expedient of deliberately cultivating wild cereals. Within a few generations, the foragers became farmers, anchored to their lands by high-yield cereals and then by their herds" (Fagan, 2005, p. 124)

Even during the flood, due to the flexibility of farmers, they had rapid movements, and leapfrogged on the shores of the new Black Sea or inland:

> "When the Mediterranean Sea inundated the Euxine Lake, hundreds of sedentary farming communities along the lakeshore moved rapidly inland, up the Danube and other rivers, bringing with them their simple farming methods and cushioning the disaster by relying

heavily on the wild foods that were always there for the taking. They surely suffered hunger and death, but the sheer flexibility of the early farming adaptation permitted rapid movement, whether on the shores of the new Black Sea or inland. During the two millennia of warm climate that followed, their descendants leapfrogged north and west into the heart of temperate Europe with its dark forests and great rivers." (Fagan, 2005, p. 124)

"By 5000 B.C., the major climatic shifts that affected humanity were largely over. Sea levels had stabilized at near-modern levels, the great ice sheets were almost gone, and global vegetation was effectively that of today except when modified by human activities. The Holocene is the longest period of stable, warmer climate to have descended on earth since 15,000 years ago. But this does not necessarily mean that the climate was always benign, or that there was plenty of rain in every part of the world." (Fagan, 2005, p. 125)

1.2.6.- REFLECTIONS

Here are the main points of part two, Cataclysm:

"Both plant cultivation and animal domestication resulted from the need to ensure reliable food supplies at a time of intense drought. And as village populations rose, the pressure on gazelle and other game increased, to the point that many communities acquired domesticated animals to ensure a dependable source of meat and other products." (Fagan, 2005, p. 102)

"We have seen how the Cro-Magnons and their successors, and the hunter-gatherers of southwestern Asia, adapted effortlessly to major climatic shifts by virtue of their mobility and effortless opportunism. The vulnerability equation began to change when mobility gave way to sedentism in the oak and pistachio forests of the Levant; but even then, people adjusted to the severe droughts of the Younger Dryas by the simple expedient of deliberately cultivating wild cereals. Within a few generations, the foragers became farmers, anchored to their lands by high-yield cereals and then by their herds" (Fagan, 2005, p. 124)

"When the Mediterranean Sea inundated the Euxine Lake, hundreds of sedentary farming communities along the lakeshore moved rapidly inland, up the Danube and other rivers, bringing with them their simple farming methods and cushioning the disaster by relying heavily on the wild foods that were always there for the taking. They surely suffered hunger and death, but the sheer flexibility of the early farming adaptation permitted rapid movement, whether on the shores of the new Black Sea or inland. During the two millennia of warm climate

that followed, their descendants leapfrogged north and west into the heart of temperate Europe with its dark forests and great rivers.” (Fagan, 2005, p. 124)

1.3.- THE POWER OF HABIT - Why We Do What We Do in Life and Business

- Charles Duhigg

The first three chapters of this book discuss how habit shapes and explains three steps which lead to the creation of a habit loop. Furthermore, the importance of habit in our daily lives is argued. So that, by converting routines in habits the brain can concentrate on other tasks. Moreover, the author mentions “Craving” as a main factor in order to create new and permanent habits, which is a strong desire that drive the habit loop. Duhigg, by indicating successful companies and studies, claims that carving is a inseparable component of a habit loop in order to insert new habits in our daily lives. In addition, scientists believe that we can not discard a habit, instead, we can change it. A chapter of this book discusses the way habits can be changed and the factors influence them to stay for good. It is believed that, in order to change some habits belief is important.

1.3.1.- THE HABIT LOOP, HOW HABITS WORK - Part one, Section one

The first section of this part describes the process in which a habit is created. In addition, it explains how Basal ganglia as a part of the brain stores habits while the rest of the brain goes to sleep. The reason that a habit is created and how habits are vital for humans’ brain is mentioned below:

> “Habits, scientists say, emerge because the brain is constantly looking for ways to save effort. Left to its own devices, the brain will try to make almost any routine into a habit, because habits allow our minds to ramp down more often. This effort-saving instinct is a huge advantage.” (Duhigg, 2012, pp. 45-46)

According to the experiments, the process of habits in a brain is a three-step loop which is explained in the following paragraph:

> “First, there is a cue, a trigger that tells your brain to go into automatic mode and which habit to use. Then there is the routine, which can be physical or mental or emotional. Finally, there is a reward, which helps your brain figure out if this particular loop is worth remembering for the future (…).” (Duhigg, 2012, pp. 47-48)

the author (Duhigg, 2012) indicates that, habits are encoded into the structures of our brain and that is the reason why we do not forget how to drive after a vacation and by triggering the right cues and rewards our habits emerge again, no matter if it is a good habit or bad one. Although habits can emerge outside our consciousness, they can be deliberately designed and reshaped by changing their parts. Habits are so strong so that, they make our brains to cling to them at the exclusion of all else, including common sense. However we are blind to our abilities to control habits, we are able to learn how to observe the cues and reward so that we can change the routines subsequently.

1.3.2.- THE CRAVING BRAIN, HOW TO CREATE NEW HABIT - Part one, Section two

The second section of this part starts by exampling a prominent American executive named Claude C. Hopkins as a person who had a new business idea for selling a brand of a toothpaste called “Pepsodent”. Hopkins believed that a trigger is needed in order to justify the toothpaste’s daily use which was the secret to his success. He had found a certain kind of cue and reward that fueled a specific habit, so called “craving”. Hopkins believed that craving, is what makes cues and rewards work and powers the habit loop. (Duhigg, 2012, p. 70)

Besides, the author (Duhigg, 2012) names Schultz, as a professor of neuroscience at the University of Cambridge who was studying the brains of a monkey and he explains his study in order to convey the role of craving in a habit loop.

According to the experiments, habits create neurological cravings which is a strong desire to expect the reward. Often we are not aware of the existence and effects of them. But when we associate a cue with a specific reward, a subconscious craving emerges in our brains which starts the habit loop spinning. Consequently, craving is vital for a habit loop to drive and this is the reason we continue a habit in our daily life. Additionally, the author explains how we can create new habits easier by putting together a cue, a routine, and a reward and then sparking a craving. (Duhigg, 2012, pp. 93-95)

1.3.3.- THE GOLDEN RULE OF HABIT CHANGE - Part one, Section three

The third section of this part indicates that, by observing the investigations, there is a Golden Rule of of habit which states that we can never truly extinguish bad habit, instead, we can change it. Moreover, to change a habit, we must use the old cue, and provide the old reward, but shift the routine so that almost any habit can be transformed. (Duhigg, 2012, p. 118)

Furthermore, the author believes that sometimes for some habits to stay changed belief is essential. So that, people believe that change is possible. Additionally, often you need a group to help you believe the change, even if that group is only as large as two people. (Duhigg, 2012, p. 162) Hence, by knowing the habits' mechanisms, we are able to change our daily behaviors into new habits easily, but we can not eliminate them for good.

1.3.4.- DEVELOPMENT OF "THE HABIT LOOP, HOW HABITS WORK"

The author explains scientifically that, if you picture the human brain as an onion, it is possible to observe that it is composed of layer upon layer of cells, toward the center of the skull, which is like a golf ball – sized lump of tissue which is called basal ganglia. Moreover, he describes the process in which habit is created and how Basal ganglia as parts of the brain that store habits while the rest of the brain goes to sleep. Habits emerge because the brain needs to save effort and ramp down more often. Therefore, an efficient brain is looking for a way to convert any routine, such as walking and choosing what to eat, into a habit in order to stop thinking constantly about basic behaviors and save more energy and diverts focus to other tasks which is a huge advantage. (Duhigg, 2012, pp. 45-46)

According to the experiments, the process of a habit in the brain is a three-step loop which are explained in following:

> "First, there is a cue, a trigger that tells your brain to go into automatic mode and which habit to use. Then there is the routine, which can be physical or mental or emotional. Finally,

> there is a reward, which helps your brain figure out if this particular loop is worth remembering for the future (…).” (Duhigg, 2012, pp. 47-48)

Habits never really disappear, which is a precious advantage for us. For example; you do not need start learning driving over and over after any single vacation. Moreover, the pattern of a habit will unfold automatically unless you deliberately change it or replace it. No matter your habit is good or bad, your brain keeps it and by any right cues and rewards it starts to occur. (Duhigg, 2012, p. 49)

Following paragraph discusses the importance of habits and the role of them in our daily lives by indicating the situation for whom have their ganglia damaged:

> “Without habit loops, our brains would shut down, overwhelmed by the minutiae of daily life. People whose basal ganglia are damaged by injury or disease often become mentally paralyzed. They have trouble performing basic activities, such as opening a door or deciding what to eat. They lose the ability to ignore insignificant details—one study, for example, found that patients with basal ganglia injuries couldn’t recognize facial expressions, including fear and disgust, because they were perpetually uncertain about which part of the face to focus on. Without our basal ganglia, we lose access to the hundreds of habits we rely on every day.” (Duhigg, 2012, p. 50)

As long as our basal ganglia is intact and the cues remain constant, the behaviors will occur unthinkingly. Besides, habits can emerge without our permission outside our consciousness, or can be deliberately designed and be shaped by changing their parts. Hence, this is the reason for instance families usually intend to eat fast food on a regular basis, because it becomes a habit for kids to consume unhealthy food during a week. So that, gradually a series of cues and habits rewards forming that can make this habit loop. Although we are blind to our abilities to control habits, we are able to learn how to observe the cues and reward so that we can change the routines subsequently. (Duhigg, 2012, p. 60)

1.3.5.- DEVELOPMENT OF "THE CRAVING BRAIN, HOW TO CREATE NEW HABITS"

The author starts this chapter by exampling a prominent American executive named Claude C. Hopkins as a person who had a new business idea for selling a brand of a toothpaste called "Pepsodent". Hopkins believed that a trigger is needed in order to justify the toothpaste's daily use which was the secret to his success. He had found a certain kind of cue and reward that fueled a specific habit, so called "craving". Hopkins believed that craving, is what makes cues and rewards work and powers the habit loop. (Duhigg, 2012, p. 70)

Hopkins found a simple trigger to convince consumers to use his products every day. To do so, regarding the human psychology, he followed two basic rules: First, find a simple and obvious cue. Second, clearly define the rewards. He had identified a cue, tooth film, and a reward beautiful teeth, that had persuaded millions to start a daily use of the toothpaste.

Furthermore, the author mentions another study which was conducted by the Schultz, a professor of neuroscience at the University of Cambridge on the brain of a monkey called Julio. Julio's job was to touch a lever whenever colored shapes appeared on the screen. If Julio touched the lever when a shape appeared, a drop of blackberry juice would run down a tube hanging from the ceiling and onto the monkey's lips. As the monkey became more and more practiced at the behavior — as the habit became stronger and stronger — Julio's brain began anticipating the blackberry juice. Also, the shapes on the monitor become a cue not just for pulling a lever, but also for a pleasure response inside the monkey's brain. Julio started expecting his reward as soon as he saw the colored shapes on the screen. Schultz explains that in the monkey's brain a new pattern emerges which is called craving. So that, when Julio saw the cue, he started anticipating a juice-fueled joy. But if the juice didn't arrive, that joy became a craving that, if unsatisfied, makes Julio angry. (Duhigg, 2012, p. 92)

According to the experiments mentioned in this part, habits create neurological cravings which is a strong desire to expect the reward. Often we are not aware of the existence and effects of them. However, when we associate a cue with a specific

reward, a subconscious craving emerges in our brains which starts the habit loop spinning. (Duhigg, 2012, p. 93) This is how new habits are created; by putting together a cue, a routine, and a reward, and then cultivating a craving that drives the loop. Studies demonstrate that, to create a new habit a cue and a reward are not enough. Your brain needs to expect a reward which is craving. (Duhigg, 2012, p. 98)

Febreze is another successful product which is presented in this chapter. So that, by a little change the product got a regular part of consumers' lives. It became a daily habit for each housekeeper by creating a craving, which in this case is nice smell. Therefore, daily cue is cleaning a room, making a bed or vacuuming a rug. The reward is the nice smell that occurs at the end of a cleaning routine. Also, a craving that things will smell as nice as they look when the cleaning ritual is done. (Duhigg, 2012, p. 104)

Duhigg (2012) believes that, secret of each successful product is that the inventors considered the right clue, reward which result in triggering a craving, those specific products could be used as habits in daily lives. So that, cravings are what drive habits and figuring out how to spark a craving makes creating a new habit easier.

Consequently, the craving is considered as a vital component for a habit loop to drive, because this is the reason we continue a habit in our daily lives. Additionally, we can create new habits easier by putting together a cue, a routine, and a reward and then sparking a craving.

1.3.6.- REFLECTIONS

Here are the main points of part one, section one and two:

According to the experiments, the process of a habit in the brain is a three-step loop which are explained in following:

> "First, there is a cue, a trigger that tells your brain to go into automatic mode and which habit to use. Then there is the routine, which can be physical or mental or emotional. Finally,

there is a reward, which helps your brain figure out if this particular loop is worth remembering for the future (…).” (Duhigg, 2012, pp. 47-48)

Although we are blind to our abilities to control habits, we are able to learn how to observe the cues and reward so that we can change the routines subsequently. (Duhigg, 2012, p. 60)

According to the experiments, habits create neurological cravings which is a strong desire to expect the reward. Often we are not aware of the existence and effects of them. But when we associate a cue with a specific reward, a subconscious craving emerges in our brains which starts the habit loop spinning. (Duhigg, 2012, p. 93)

This is how new habits are created; by putting together a cue, a routine, and a reward, and then cultivating a craving that drives the loop. Studies demonstrate that, to create a new habit a cue and a reward are not enough. Your brain needs to expect a reward which is craving. (Duhigg, 2012, p. 98)

1.4.- DYES AND PIGMENTS

- Ahmet Gürses, Metin Açıkyıldız, Kübra Güneş, & M. Sadi Gürses

According to the three chapters of this book that have been studied, the authors (Gürses, Açıkyıldız, Güneş, & Gürses, 2016) reflect about the sources of different colorants and their story throughout history. Also, they explain what colorant means and define differences between dyes and pigments, their properties and applications. They show how dyes are predominately organic compounds that dissolve or react with substrates, whereas pigments are predominantly finely ground inorganic substances that are insoluble and therefore have a different mode of coloring. Moreover, a chapter of this book explores the environmental impact of dyes and their effect on our surroundings. Studies claim that environmental pollutants, caused by discharging the untreated wastewater, generated by synthesis and fiber dyeing are known as main hazards which threaten human health and all forms of life. Therefore, they emphasize to do an alternative treatment method in order to avoid health problems.

1.4.1.- HISTORICAL DEVELOPMENT OF COLORANTS - Chapter one

This chapter reviews the historical development of dyes and pigments also, explains the sources of colorants, which are being applying in dyeing since prehistoric periods.

It is believed that plants, animals and minerals are primary sources of colorants such as berries, blossoms, barks, and roots. It is stated that, ruddy range colors such as; red, brown, and orange are the first colors in many of ancient textiles, across the Levant, Egypt, Mesopotamia and Europe. And the evidences of blue, yellow, and green colors have been achieved later. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 4)

Authors (Gürses, Açıkyıldız, Güneş, & Gürses, 2016) mention that, according to studies on archaeological sites, reds, blues, and yellows from plant sources were in common use in the late Bronze Age and Iron Age. Also, Alizarin red (AR) known

as Mordant Red was used as a prominent red dye throughout history. Additionally, natural pigments such as ochre's and iron oxides, hematite, manganese oxide, and charcoal have been used as colorants since prehistoric times, which can be seen in the cave paintings.

Moreover, it is believed that, Lapis lazuli as a blue color was used as semi-precious stone and decorative building stone in Egypt. Also, it was used to produce a pigment known as ultramarine. Furthermore, due to the high-cost of lapis lazuli, more cheap alternatives created such as; mineral azurite (Egyptian Blue), and biological (indigo) pigments. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 8)

1.4.2.- DYES AND PIGMENTS: THEIR STRUCTURE AND PROPERTIES

- Chapter two

In this chapter Technical explanations for "Dyes" and "Pigments" are discussed. They are known as the main colorants used to add a color or to change the color of something such as; textiles, pharmaceutical, food, cosmetics, plastics, paint, ink, photographic, and paper industries:

> "Dyes are colored substances which are soluble or go into solution during the application process and impart color by selective absorption of light. Pigments are colored, colorless, or fluorescent particulate organic or inorganic finely divided solids which are usually insoluble in, and essentially chemically unaffected by, the vehicle or medium in which they are incorporated." (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 13)

The authors explain differences between pigments and dyes:

> "Both pigments and dyes are used to provide color to all sorts of substances and have been important to humans since the dawn of history. The difference between the two is that dyes are soluble in the substrate and thus disperse at a molecular level, while pigments are insoluble and are dispersed as particles. Dyes provide brighter color than conventional pigments, but they are less light stable and less permanent." (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 14)

Totally, pigments are highly durable, heat stable, solvent resistant, lightfast, and migration fast. However, they tend to be hard to process and have poor color brilliance and strength. Moreover, more differences are indicated by authors between pigments and dyes which are mentioned in the following paragraph:

> "Pigment particles have to be attached to substrates by additional compounds, for example by a polymer in paint, in a plastic or in a melt. Dyes, on the other hand, are applied to various substrates (textile materials, leather, paper and hair) from a liquid in which they are completely, or at least partly, soluble." (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 16)

1.4.3.- COLORANTS IN HEALTH AND ENVIRONMENTAL ASPECTS - Chapter five

The authors in this chapter indicate common industrial environmental pollutants, caused by discharging the untreated wastewater, generated by synthesis and fiber dyeing as a main hazard which threaten human health and all forms of life. It is believed that some synthetic dyes cause skin irritation and contact dermatitis depending on the application area. Therefore, researches on alternative treatment method is conducted especially on the use of biological material. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 69)

Colorants are being used in textiles, paper, leather, plastic, lasers, ink-jet printers. Also, they have been used for applications such as food, drug, cosmetic and photochemical production. Dyestuffs that are used in textile industry give color to the water which leads to deteriorate the color of water. Thus, one method to decrease the problem related to treatment of textile is providing the fixation of dye with a higher efficiency onto the fiber which results in the use of less amount of dye in dyeing process. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 70)

The authors believe that the color of food or beverage is so effective on judging the flavor of them. Therefore, it is important to create a pleasant perception for people by observing the color of food or beverage before having them. Natural colorants are non-toxic and are healthier to be added in food and beverages. Although natural colorants are more beneficial for our health, they have some

disadvantages as well such as; the high price and low stability compared to synthetic ones. nevertheless, people still prefer natural colorants by reason of being nontoxic. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 71)

Some problems caused by textile dyes that people might encounter are mentioned in this chapter. Such as; contact dermatitis, respiratory diseases, allergic reaction in eyes, skin irritation. Therefore, it is believed that the pollution control and treatment is vital and undoubtedly is the key factor in terms of the future of humanity. Otherwise, discharging the wastewater into the local environment without any treatment will be one of the main hazards which threat humans' lives besides other creatures. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, pp. 78-79)

1.4.4.- DEVELOPMENT OF "HISTORICAL DEVELOPMENT OF COLORANTS"

The authors (Gürses, Açıkyıldız, Güneş, & Gürses, 2016) initiate the first chapter by indicating the sources of different colorants which are being applying in dyeing since prehistoric times, such as; scale insects to produce crimson-colored dyes, Madder which has been utilized since ancient times as a red vegetable dye for leather, wool, cotton and silk. In addition, indigo is a natural blue dye, and Tyrian purple, which has been extracted from shellfish of the Murex genus since ancient times on at least three Continents (Europe, Asia and the Americas).

Moreover, they affirm that plants, animals, and minerals are known as the primary sources for colorants, dyes or pigments from prehistoric era till the middle of the nineteenth century, such as; Many shades of red which was derived from a plant named Rubia tinctorum. It is indicated that the first known fiber dyes were from berries, blossoms, barks, and roots. Indigoid as a typical vat dye, might be the oldest natural dye used by man and is found in the plant Indigofera tinctoria and has been known in India for about 4000 years. Additionally, another source of blue colorants in Europe was Woad, Isatis tinctoria which used since Bronze Age. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, pp. 1-2)

It is significant to consider that, the preference toward a special dye and colorant was mostly dependent on the availability of the related plant sources, like;

roots, berries, bark, leaves, and wood or fungi and lichens. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 3)

The authors claim that ruddy range colors such as; red, brown, and orange are the first colors in many of ancient textiles, across the Levant, Egypt, Mesopotamia and Europe. Also, the earliest surviving evidence of textile dyeing was found in Çatalhöyük in Turkey at Neolithic settlement, where was found the traces of red dyes probably derived from ochre. Although, the evidences of blue, yellow, and green colors have been achieved later, studies on archaeological sites prove that reds, blues, and yellows from plant sources were in common use in the late Bronze Age and Iron Age. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 4) Furthermore, In medieval Europe, purple, violet, murrey and similar colors were produced by using woad or indigo and red dyes such as madder, or kermes and cochineal.

Studied demonstrates that, in the 1900s commercial dyeing with natural dyes was gradually disappeared due to the widely usage of new strong aniline dyes such as; reddish-purple, blue, violet, green, and red. Also, expensive natural dyestuffs began to be out of fashion, because the cost of these dyes has exceeded the costs of the wools and silks. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 8)

According to the studies, Mauveine, known as aniline dye purple or Perkin's mauve, is considered as the first synthetic organic dye, which was discovered in 1856. Also, it is considered as the pioneer of synthetic dyes and pigments as azo and diazo compounds which helped us to produce a wide variety of colors in dyeing industry. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 7) Moreover, the authors name Alizarin red (AR) known as Mordant Red, as a prominent red dye throughout history. In addition, they claim that, natural pigments such as ochre's and iron oxides, hematite, manganese oxide, and charcoal have been used as colorants since prehistoric times which can be seen in the cave paintings. And it is believed that The pigments and paint grinding equipment invention dated back to 350,000 to 400,000 years ago. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, pp. 8-9)

It is believed that, Lapis lazuli as a blue color was used as semi-precious stone and decorative building stone in Egypt. Also, it was used to produce a pigment known as ultramarine. However, due to the high-cost of lapis lazuli, more cheap alternatives created such as; mineral azurite (Egyptian Blue), and biological (indigo)

pigments. Moreover, authors name white lead and blue frit as the first two synthetic pigments that the latter is known as Egyptian Blue. Also, the six main colors used by Egyptians in ancient times were; white, black, blue, red, yellow, and green which were found in coloring walls in Dendera-Egypt. And to paint the walls either oil or water was used as a base (the diluting, solvent or vehicle for the pigment). (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, pp. 8-9)

1.4.5.- REFLECTIONS

Here are the main points of chapter one:

The authors claim that ruddy range colors such as; red, brown, and orange are the first colors in many of ancient textiles, across the Levant, Egypt, Mesopotamia and Europe. Also, the earliest surviving evidence of textile dyeing was found in Çatalhöyük in Turkey at Neolithic settlement, where was found the traces of red dyes probably derived from ochre. Although, the evidences of blue, yellow, and green colors have been achieved later, studies on archaeological sites prove that reds, blues, and yellows from plant sources were in common use in the late Bronze Age and Iron Age. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 4)

It is believed that, Lapis lazuli as a blue color was used as semi-precious stone and decorative building stone in Egypt. Also, it was used to produce a pigment known as ultramarine. However, due to the high-cost of lapis lazuli, more cheap alternatives created such as; mineral azurite (Egyptian Blue), and biological (indigo) pigments. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 8)

In addition, they claim that, natural pigments such as ochre's and iron oxides, hematite, manganese oxide, and charcoal have been used as colorants since prehistoric times, which can be seen in the cave paintings. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 9)

1.5.- WEBSITES

This subchapter is dedicated to a set of summaries related to pigments and the history of them. In the beginning, the methods of cavemen paintings are discussed briefly. All of the data retrieved from the Internet. In order to prepare a comprehensive resource of all major pigments, they are put together in a row without departing and mentioning the title of each webpage. So that, the citations are organized by the type of the pigments not webpages.

1.5.1- PIGMENTS

“Although many modern dyes are synthetic, our ancestors managed to obtain a wide spectrum of colors from mineral and animal sources long before chemical equivalents were manufactured. Those most rare and difficult to obtain became symbols of wealth and status.” (Douma, 2008)

> “Dyes and pigments are words we use loosely to describe colors in food, fabrics, paints, and other materials, but in reality their meanings are distinct. Dyes are colored substances that change the color of other materials permanently. They are soluble substances, though some become insoluble after they have been applied. They have a special affinity for the substrate they color. In contrast, pigments are insoluble color particles that require a binding agent to hold them onto the surface of the material being colored.” (Douma, 2008)

> “Primitive man used pigments from his natural environment in painting, thus the pigments found in different areas of the world tend to vary. It is thought that pigments were applied by two methods. The first was to mix pigment with animal fat and apply it as a paint with the fingers or a reed. The second method was to blow pigment powder onto the painting surface using a hollow tube.” (Johansson, 2004)

> “Carbon black was usually found in the form of soot obtained from charred bones or wood, or charcoal from the wood itself, which could be used for drawing. Yellow and red earths were iron oxides in various states of hydration. These substances occur naturally throughout the earth's crust, so were probably used by all primitive people, and synthetic forms of yellow and red ochre are still used today. Brown earth was a mixture of iron and manganese oxides,

again occurring in all parts of the earth. The shade of these brown earths could vary from red brown to almost purple, depending on the purity and exact oxide content. Green earth came primarily from two clay minerals, celadonite and glauconite. These have a complex silicate structure containing aluminum, iron, magnesium and potassium ions, which give a dull green colour. It was used less frequently than the other primitive pigments due to its relative scarcity. White pigments were obtained from chalk (calcium carbonate), and from crushing up animal bones (essentially calcium phosphate). The palette of the primitive artist was thus quite limited and contained only dull, earthy shades." (Johansson, 2004)

Clay earth pigments are naturally occurring minerals, principally iron oxides, that have been used since prehistoric times as pigments. The primary types are ochre, sienna, and umber. (Clay earth pigment, 2016)

Ochre:

"Ochre is a family of earth pigments, which includes yellow ochre, red ochre, purple ochre, sienna, and umber. Yellow and red ochre pigment was used in prehistoric and ancient times by many different civilizations on different continents." (Clay earth pigment, 2016)

Sienna:

"In its natural state, it is yellow-brown and is called raw sienna. When heated, it becomes a reddish brown and is called burnt sienna. (…)"

"Along with ochre and umber, it was one of the first pigments to be used by humans, and is found in many cave paintings. Since the Renaissance, it has been one of the brown pigments most widely used by artists." (Sienna, 2016)

Umber:

"Umber is a natural brown or reddish-brown earth pigment that contains, iron oxide and manganese oxide. It is darker than the other similar earth pigments, ochre and sienna." (Umber, 2016)

Egyptian Pigments:

"Natural pigments introduced by the Egyptians included malachite, azurite, cinnabar, orpiment and lapis lazuli. Malachite and azurite are deep green and blue minerals that occur in close proximity to each other." (Johansson, 2004)

Pigments of the Greeks:

"The Greeks inherited the painting palette from the Egyptians but soon started to create an entirely new group of pigments, inventing methods for making some of the natural pigments for themselves." (Johansson, 2004)

"To the existing natural pigments the Greeks may have made a number of additions of sepia, gold and chrysocolla. As with all natural pigments, it is difficult to pinpoint exactly when they began to be used, and indeed some or all of them may well have been used by the ancient Egyptians or even Babylonians." (Johansson, 2004)

"In addition to these new natural pigments, the Greeks introduced a group of new artificial pigments, some of which are still in use today, including white lead, red lead, yellow lead, verdigris and red vermilion." (Johansson, 2004)

Tyrian Purple:

"Tyrian purple, used by the Phoenicians in the 15th century BC, was produced from certain varieties of crushed sea snails." (Erik Wessen, 2008)

"Tyrian purple also known as Tyrian red, royal purple, imperial purple or imperial dye, is a bromine-containing reddish-purple natural dye." (Tyrian purple, 2016)

Egyptian Blue:

"One of the oldest synthetic pigments. It was used by Egyptians for thousands of years. It is considered to be the first synthetic pigment." (Douma, 2008)

Azurite:

"Occasional use began with Egyptians, but it was uncommon until the Middle Ages when the manufacture of the ancient synthetic pigment "Egyptian blue" was forgotten." (Douma, 2008)

"Blue was a latecomer among colours used in art and decoration, as well as language and literature. Reds, blacks, browns, and ochres are found in cave paintings from the Upper Paleolithic period, but not blue. Blue was also not used for dyeing fabric until long after red, ochre, pink and purple. This is probably due to the perennial difficulty of making good blue dyes and pigments. The earliest known blue dyes were made from plants – woad in Europe, indigo in Asia and Africa, while blue pigments were made from minerals, usually either lapis lazuli or azurite." (Blue, 2016)

Lapis Lazuli:

> "True lapis lazuli was chiefly supplied from Afghanistan during the Middle Ages while azurite was a common mineral in Europe at the time." (Azurite, 2016)

Lapis lazuli, a semi-precious stone, has been mined in Afghanistan for more than three thousand years, and was exported to all parts of the ancient world. In Iran and Mesopotamia, it was used to make jewelry and vessels. In Egypt, it was used for the eyebrows on the funeral mask of King Tutankhamun (1341–1323 BC). The cost of importing lapis lazuli by caravan across the desert from Afghanistan to Egypt was extremely high. Beginning in about 2500 BC, the ancient Egyptians began to produce their own blue pigment known as Egyptian blue, made by grinding silica, lime, copper, and alkali, and heating it to 800 or 900°C (1,470 or 1,650 °F). This is considered the first synthetic pigment. Egyptian blue was used to paint wood, papyrus and canvas, and was used to colour a glaze to make faience beads, inlays, and pots. It was particularly used in funeral statuary and figurines and in tomb paintings. Blue was considered a beneficial colour which would protect the dead against evil in the afterlife. Blue dye was also used to colour the cloth in which mummies were wrapped. (Lapis Lazuli, 2016)

Madder, Madder Lake:

> "Madder has been used since ancient times as a red vegetable dye for leather, wool, cotton and silk. It can yield pink, orange and purple shades as well as red. There is some evidence suggesting that it was used in Ancient Egypt. While brown and black pigments occur abundantly in nature, red was harder to reproduce and therefore rare and costly. For this reason, red fabric traditionally belonged to royalty." (Douma, 2008)

1.5.2.- REFLECTIONS

Here are the main points from summaries of websites:

> "Dyes and pigments are words we use loosely to describe colors in food, fabrics, paints, and other materials, but in reality their meanings are distinct. Dyes are colored substances that change the color of other materials permanently. They are soluble substances, though

some become insoluble after they have been applied. They have a special affinity for the substrate they color. In contrast, pigments are insoluble color particles that require a binding agent to hold them onto the surface of the material being colored." (Douma, 2008)

"Carbon black was usually found in the form of soot obtained from charred bones or wood, or charcoal from the wood itself, which could be used for drawing. Yellow and red earths were iron oxides in various states of hydration. These substances occur naturally throughout the earth's crust, so were probably used by all primitive people, and synthetic forms of yellow and red ochre are still used today. Brown earth was a mixture of iron and manganese oxides, again occurring in all parts of the earth. The shade of these brown earths could vary from red brown to almost purple, depending on the purity and exact oxide content. Green earth came primarily from two clay minerals, celadonite and glauconite. These have a complex silicate structure containing aluminum, iron, magnesium and potassium ions, which give a dull green colour. It was used less frequently than the other primitive pigments due to its relative scarcity. White pigments were obtained from chalk (calcium carbonate), and from crushing up animal bones (essentially calcium phosphate). The palette of the primitive artist was thus quite limited and contained only dull, earthy shades." (Johansson, 2004)

Clay earth pigments are naturally occurring minerals, principally iron oxides, that have been used since prehistoric times as pigments. The primary types are ochre, sienna, and umber. (Clay earth pigment, 2016)

Egyptian Blue:

"One of the oldest synthetic pigments. It was used by Egyptians for thousands of years. It is considered to be the first synthetic pigment." (Douma, 2008)

"Blue was a latecomer among colours used in art and decoration, as well as language and literature. Reds, blacks, browns, and ochres are found in cave paintings from the Upper Paleolithic period, but not blue. Blue was also not used for dyeing fabric until long after red, ochre, pink and purple. This is probably due to the perennial difficulty of making good blue dyes and pigments. The earliest known blue dyes were made from plants – woad in Europe, indigo in Asia and Africa, while blue pigments were made from minerals, usually either lapis lazuli or azurite." (Blue, 2016)

RESUMES OF CULTURAL KNOWLEDGE

In some environments where are relatively safe for children, children enjoy more and are more independent compared to dangerous places:

> "(…) how much freedom children enjoy seems to depend partly on how dangerous the environment is, or is perceived to be. Some environments are relatively safe for children, but others are dangerous because of either environmental hazards or else dangers from people." (Diamond, 2012, p. 341)

> "American toy manufacturers heavily promote so-called educational toys to foster so-called creative play. American parents are taught to believe that manufactured store-bought toys are important to the development of their children. In contrast, traditional societies have few or no toys, and any toys that do exist are made either by the child itself or by the child's parents." (Diamond, 2012, p. 351)

> "Both plant cultivation and animal domestication resulted from the need to ensure reliable food supplies at a time of intense drought. And as village populations rose, the pressure on gazelle and other game increased, to the point that many communities acquired domesticated animals to ensure a dependable source of meat and other products." (Fagan, 2005, p. 102)

> "When the Mediterranean Sea inundated the Euxine Lake, hundreds of sedentary farming communities along the lakeshore moved rapidly inland, up the Danube and other rivers, bringing with them their simple farming methods and cushioning the disaster by relying heavily on the wild foods that were always there for the taking. They surely suffered hunger and death, but the sheer flexibility of the early farming adaptation permitted rapid movement, whether on the shores of the new Black Sea or inland. During the two millennia of warm climate that followed, their descendants leapfrogged north and west into the heart of temperate Europe with its dark forests and great rivers." (Fagan, 2005, p. 124)

According to the experiments mentioned by Duhigg in this chapter, he proves that, habits create neurological cravings which is a strong desire to expect the reward. Often we are not aware of the existence and effects of them. But when we associate a cue with a specific reward, a subconscious craving emerges in our brains which starts the habit loop spinning. (Duhigg, 2012, p. 93)

This is how new habits are created; by putting together a cue, a routine, and a reward, and then cultivating a craving that drives the loop. Studies demonstrate that, to create a new habit a cue and a reward are not enough. Your brain needs to expect a reward which is craving. (Duhigg, 2012, p. 98)

The authors claim that ruddy range colors such as; red, brown, and orange are the first colors in many of ancient textiles, across the Levant, Egypt, Mesopotamia and Europe. Also, the earliest surviving evidence of textile dyeing was found in Çatalhöyük in Turkey at Neolithic settlement, where was found the traces of red dyes probably derived from ochre. Although, the evidences of blue, yellow, and green colors have been achieved later, studies on archaeological sites prove that reds, blues, and yellows from plant sources were in common use in the late Bronze Age and Iron Age. (Gürses, Açıkyıldız, Güneş, & Gürses, 2016, p. 4)

2 SCIENTIFIC KNOWLEDGE

The area of scientific knowledge presents topics and studies that are facts, certain knowledge and rational. They are obtained methodically, systematized and verifiable. Acquired through processes of observation, investigation, experimentation, validation and verification. The themes presented cover how feelings, reactions and emotions can be quantified. Mainly, analyzes how color impacts on humans' mind and body, and can change our moods and functions. Moreover, it discusses the important role of memory in our life as a tool that can be created and improved in order to perform tasks automatically.

2.1.- THE MEMORY ILLUSION; Remembering, Forgetting, and the Science of False Memory

- Dr. Julia Shaw

This book demonstrates the absolute centrality of memory to our existence, and helps us to discover ourselves by knowing how memory works. Dr. Shaw, discusses the process of shaping memory and explains different aspects of memory in terms of encoding, storage and retrieval. Also, she argues what false memory is, and the reason why we can not remember some memories in detail. In addition, different viewpoints are argued when it comes to memories of highly emotional events that result in flawed memory. Moreover, she considers how associations form in our brain and their role in remembering memories. Overall, it is a scientific book and it will be interesting for everyone who wants to investigate inside his brain and likes to know how memories are created and what the features related to them are.

2.1.1.- DIRTY MEMORIES - Chapter two

In this chapter the author claims that the way we perceive the world is arranged by a bottom-up processing. In other words, our representation of the world around us is almost through the information we collect from our primary senses, about our environment, and is minimally shaped by our expectations. This is the model that typically explains how our perception works, as most of our experiences must accurately reflect the world around us. Otherwise we would find it impossible to navigate in our environment.

Shaw mentions that our memories of previous experiences influence our understanding, not only of how we expect people to behave, but more generally, of how the world works such as: gravity, dimensions, possibilities. Additionally, in the same way that we can be fooled by first impressions of faces, we can be fooled by general perceptual illusions, like what magicians do. (Shaw, 2016, p. 39)

A part of this chapter is dedicated to arousal topic which emphasizes the role of arousal level in doing a task optimally:

> "(…) the theory suggests that performance on any task will improve as arousal increases up to a certain optimum point. However, beyond that point further arousal will actually worsen performance. The suggestion is that at the extremes, at no arousal or incredibly high arousal, a person cannot perform a given task at all." (Shaw, 2016, p. 41)

Scientifically, being aroused means: increasing the heart rate, sweating, pupil dilation or other physiological indicators relatively in our bodies. Also, it is experimented that our level of arousal plays an important role in our ability to encode, store and retrieve memories. So that, it turns out that an increase in arousal is associated with an increase in memory performance. Emotional arousal makes things that are perceptually important stand out even more and makes any high priority information even more memorable. Arousal reduces processing of low priority information. Moreover, it is considerable to mention that individual characteristics such as age, gender and personality may also play a role in how arousal affects memory. So that, one size does not fit all when we talk about exactly how memory and arousal are intertwined. (Shaw, 2016, p. 42)

Dr. Shaw discusses that "State-dependent" memory is a phenomenon which means, we generally remember things better if we are in the same state during the recall of a memory as during the encoding of it. Moreover, he argues another feature of our memory called "telescoping", which is referred to temporal placements. A census survey indicates that, we often remember things that happened more recently as having happened longer ago than they actually did (backward telescoping). Conversely, we often remember things from long ago as if it were yesterday (forward telescoping). This feature is called. (Shaw, 2016, p. 49)

2.1.2.- DANCING WITH BEES - Chapter three

This chapter of the book mainly discusses the way a memory is stamped in the brain and the organs which are necessary to create a long-term memory are

mentioned. The author states that the cells in our brain, called neurons which connect with one another to develop meaningful networks, and these networks change in accordance with new experiences. In addition, if we were unable to combine new information into our existing neural networks, we would not be able to change our thinking or behaviour, and we would be hard-pressed to deal with any alteration to our environment. (Shaw, 2016, p. 56)

Here Shaw explains what memory stamping is:

> "The process through which an experience is laid down as a physical memory representation in the brain is known as biological stamping. In order to stamp new experiences into long-term memory, a biochemical synthesis is required to make connections between the existing neurons in our brain." (Shaw, 2016, p. 57)

She adds that recording a memory is mainly an act of making and adjusting connections between existing brain cells, rather than making new ones. Since all parts of neuronal connections can be modified, most researchers argue that it is basically the synapses that are important for memory formation.

Another biochemical theory of memory is introduced which is called "retrieval-induces forgetting". Every time a memory is recalled, it is effectively retrieved, examined, and then recreated another time in order to be stored again. This process makes every memory physiologically vulnerable to distortion and forgetting whenever it is recalled. (Shaw, 2016, pp. 61-62)

Associations are considered as fundamental principle of memory, which should be precisely considered in order to get to know better what memory is. In fact, it is the association between the individual memory fragments in different parts of the brain, that makes what we think of as a whole memory. According to Aristotle, Dr. Shaw mentions four laws of association as Similarity, Contrast, Contiguity, and Frequency. Moreover, she describes what "Node" is: an individual concept or word in the brain that can be linked to one another to create complex ideas. So that, once we activate a node, the energy we send out to it can be conceptualized as radiating out from that original source and then activating other related nodes automatically. As an example; whenever you think about swimming, mostly you automatically

activate memories which are associated to water, pool, and bathing suit. In addition, it is believed that, when associations between some nodes are stronger, associated memories come more easily to us. (Shaw, 2016, p. 68)

Another theory which is discussed in this chapter is called “Fuzzy Trace”. It explains why we can develop inaccurate memories and a set of false memories. It hypothesizes that, remembering involves two things: gist and verbatim memory traces. A gist trace is a memory of the meaning of an experience, and a verbatim trace is a memory of specific details. Almost all memories have both gist and verbatim components. Fuzzy trace theory proposes that memory illusions are possible because each of our experiences is stored as multiple fragments, and these fragments can be recombined in ways that never actually happened. (Shaw, 2016, p. 71)

2.1.3.- WHERE WERE YOU WHEN 9/11 HAPPENED? - Chapter seven

This chapter of the book discusses the reasons why memory of emotional events is flawed. Shaw believes that there are a number of different viewpoints when it comes to memories of highly emotional events:

> “The first of these, they say, is the traumatic memory argument, which is the view that we remember traumatic events differently, and often worse, than other kinds of events. (…). This view assumes that our memories of traumatic events are thus stored as fragmented images, emotions and sensations without a coherent structure.” (Shaw, 2016, p. 131)

The medical argument of trauma encoding also suggests a diminished memory due to accidents or violent assaults that may cause physical trauma to the brain, which can result in amnesia. In other words, actually physically damaging parts of the brain can lead to memory loss.

According to another study conducted in 2007, the author mentions that traumatic events are consistent and vivid:

> "Porter and Peace found that the memories of the traumatic events were highly consistent over time, remaining virtually unchanged in almost all features. It also turned out that in comparison to the highly positive life experiences, the memories of negative experiences were significantly more stable over time. These findings suggest, as does Porter and Birt's research, that memories of trauma *are* special, just not special in the way that many people assume, indeed often being better than other kinds of memories." (Shaw, 2016, p. 134)

Additionally, another form of memory which is flashbulb is discussed below:

> "(…) we have the capacity for immediate powerful recollections of the circumstances we were in at particular significant moments. These are sometimes referred to as *flashbulb memories*. They are detailed and vivid, and typically involve recalling the situation in which a piece of historically important news was heard, along with a detailed recollection of the event itself." (Shaw, 2016, p. 135)

These kinds of events that make flashbulb memories have three main characteristics:

> "First, the event needed to generate a high level of surprise. It could not be a trivial or expected event. Second, the event needed to carry important consequences for the person or for people in general – referred to as having a high level of consequentiality." (…)
>
> "Finally, the event had to generate high levels of emotional arousal – the individual needed to experience fear, sadness, anger or some other strong emotion." (Shaw, 2016, p. 135)

"The researchers found that these memories often lacked consistency, the descriptions of them changing between the two memory interviews, despite confidence in the accuracy of the memory remaining very high." (Shaw, 2016, p. 136)

Dr. Shaw claims that by recalling and sharing our memories, we can create false memories, as if we think that event has occurred in reality. "It's not only outside sources that can dramatically alter our recollections of emotional events; we are also prone to distortion from internal influences. One way this can happen is through sharing our memories with others (…)" (Shaw, 2016, p. 142) So that, every time we

take images, sounds or smells and verbalize them we potentially alter or lose information, which sometimes lead making false memories.

2.1.4.- DEVELOPMENT OF "DIRTY MEMORIES"

This chapter discusses some of the ways in which perception and memory interact, and the possible flaws that can be built into a memory right from the moment of its creation.

To start Dr. Shaw gives an example of a magician and claims that, there was nothing magical about what he was doing, rather he was using science to fool our perceptual expectations. So that, the magician could make seemingly impossible possible. Even though we know that our perceptions influence our experience of reality, and our memories can be very flawed as a result, it usually still feels incredibly real.

As the next example, the author talks about a photo of a dress that some people saw it as blue with black lace while others saw it as being white with gold lace. Many experiment conducted in order to solve this question and know how most people interpret the color of the dress. They found that rather than having only two possible combinations, participants saw the images on more of a colour continuum, with some seeing the main combinations (black and blue / white and gold) as darker versions of those colours and others seeing more pastel shades. Experiments conducted a study to examine whether this phenomenon a the colour constancy. "Colour constancy refers to the way our vision compensates for differences in lighting to estimate what colour things really are." (Shaw, 2016, p. 35). This helps us to know the color of something which is outside exposed to bright sunlight or inside a dimly lit room, and we constantly interpret that colour as the same throughout the day, the light may change considerably though.

Moreover, the author states that, the reason we can have perceptual abilities such as colour constancy is not just because of our physiology, but because we have fundamental memories informing us about how the world works. Regarding to the dress mentioned above, it is indicated that:

> "This means that team #whiteandgold interpreted the dress as being dimly lit, meaning the blue tones were interpreted as shade, while team #blackandblue interpreted the dress as being better lit, correctly interpreting its colours as a result. Both teams were using a combination of ocular information and their internal memory-based models of the world." (Shaw, 2016, p. 36)

Besides, research supported the idea that the image is multistable, it can be perceived differently by the same person when viewed on separate occasions:

> "In addition to seeing, hearing, feeling, tasting and smelling, we are also constantly processing information about gravity, outside temperature, humidity, internal temperature, the location of our limbs in relation to the rest of us, tiredness, how our internal organs are doing, and muscle tension, to name but a few. And as with the other senses, if something is interpreted incorrectly during any of these many simultaneous processes – each of which is imperfect – it has the potential to introduce error into our memories at their inception." (Shaw, 2016, p. 36)

In addition, the author (Shaw, 2016) claims that the way we perceive the world is arranged by a bottom-up processing. In other words, our representation of the world around us is almost through the information we collect from our primary senses about our environment, and is minimally shaped by our expectations. This is the model that explains how our perception works typically, as most of our experiences must accurately reflect the world around us, otherwise we would find it impossible to navigate our environment. The definitions of "Stimulus input" and "percept" according to psychologists, James and Eleanor Gibson are mentioned:

> "The 'stimulus input' is the information going into our brains through our senses, and a 'percept' is simply a mental concept that is developed as a consequence of the process of perception. For example, if you are looking at a flower, memory into our interpretation of the world." (Shaw, 2016, p. 37)

We almost never just interpret an object in isolation, instead we bring memories into our interpretation of the world. This ability to interpret relatively basic information and make sense of it is surprisingly complex and memory-reliant. Our memories of previous experiences influence our understanding not only of how we

expect people to behave, but more generally of how the world works such as; gravity, dimensions, possibilities. Additionally, in the same way that we can be fooled by first impressions of faces, we can be fooled by general perceptual illusions, like what magicians do. (Shaw, 2016, p. 39)

A part of this chapter dedicated to arousal topic. According to the *"Inverted-U"* hypothesis, Shaw emphasizes the role of arousal level to do a task optimally:

> "(…) the theory suggests that performance on any task will improve as arousal increases up to a certain optimum point. However, beyond that point further arousal will actually worsen performance. The suggestion is that at the extremes, at no arousal or incredibly high arousal, a person cannot perform a given task at all." (Shaw, 2016, p. 41)

So that, at the extremes, at no arousal or incredibly high arousal, the performance is impaired due to the strong anxiety.

Moreover, scientifically being aroused means; increasing the heart rate, sweating, pupil dilation or other physiological indicators relatively in our bodies. "(…) it turns out that our level of arousal plays a major part in our ability to encode, store and retrieve memories." "(…) an increase in arousal is associated with an increase in memory performance." (Shaw, 2016, pp. 40-41)

> "They argue this because 'the findings we reviewed here indicate that emotional arousal makes things that are perceptually salient stand out even more and makes any high priority information even more memorable. At the same time, arousal reduces processing of low priority information. This increase in selectivity under arousal is likely to be adaptive in many situations, and can explain why sometimes arousing stimuli impair memory for nearby stimuli and sometimes they enhance it.'" (Shaw, 2016, p. 42)

"State-dependent" memory is a phenomenon which means; we generally remember things better if we are in the same state during the recall of a memory as during the encoding of it. "if we know we learned or experienced something during a particular type of arousal, by recreating that state we should be able to remember it better." (Shaw, 2016, p. 43) For example; if you always drink a cup of coffee right

before you study, your memory should be better if you drink a cup of coffee right before your exams.

Hence, all researches demonstrate that our stress and arousal levels matter for what we are able to store as memories, and how we are able to retrieve them later on. Therefore, our memories can be affected not only by uncontrollable parts of our external environment, but also by largely uncontrollable elements of our internal environment. (Shaw, 2016, p. 43)

There is a section in this book called “Time travelers”, which argues why the more aroused or excited we are the faster time seems to pass. Time is something that could be considered a primarily internal phenomenon and our subjective perception of time is called chronesthesia. Moreover, all of the scientific disciplines have demonstrated that, perhaps unsurprisingly, memory is necessary for our ability to perceive time. So that, we perceive the passage of time through sense of chronology. Accordingly, we remember the order of the events happened, that then allows us to infer when and for how long an event took place. Therefore, to percept the time, we need to remember what things happened, and in which order. (Shaw, 2016, p. 44)

The next topic that Dr. Shaw discusses is having an appreciation of time perception, which is necessary for understanding what is referred to retrospective timing. This has to do with our sense of the duration of events after we have experienced them: for example, estimating how long you were playing a video game.

The author (Shaw, 2016) states that, retrospective memory allows mental time travel, enabling us to take a look at our personal past. “Landmarks” is one type of cues that help us to date memories. Landmarks are important events either in our personal lives or it is a global subject. However, our estimation of landmark events is also fascinating, since we can make mistakes dating them as well.

Shaw discusses another feature of our memory: it is called “telescoping”, and refers to temporal placements. A census survey indicates that, we often remember things that happened more recently as having happened longer ago than they actually did (backward telescoping). Conversely, we often remember things from long ago as if it were yesterday. (Shaw, 2016, p. 49)

Here is the reason why telescoping happens:

> "one reason we might particularly think that things happened more recently than they actually did (forward telescoping) is because landmark memories are often very accessible. We can recall these important life events easily and with a lot of detail, just like memories of things that happened much more recently. We thus interpret this easy access and high vividness of the memory as indicating that it must have happened fairly recently." (Shaw, 2016, p. 49)

Dr. Shaw (2016) believes that we are poor at estimating how long things are going to take, and how long tasks took. Therefore, our recollections can play tricks on us that move even important events up and down along the timelines of our lives.

According to studies, the most vivid memories are the most important ones:

> "Time-travelling through our memories, we may find that some events stick out more than others. If we think about the characteristics that these memories have in common, we may notice that the most vivid are the most emotional, most important, most beautiful or most unexpected events of our lives. We may also notice that our memories cluster. And they often seem to cluster around particular periods in our lives." (Shaw, 2016, p. 50)

This is a phenomenon which is called the reminiscence bump, which explains "the good old days" and the "when I was your age" comments. The reminiscence bump means that we do not remember all ages in our life equally. (Shaw, 2016, p. 50)

Researches demonstrate that, we seem to retain the most memories of our teens and twenties. Although there might be some cultural differences in the nature of the memories, the density of memories we recall from this critical time might be the same for all of us. One of the explanations for the reminiscence bump is that, this is related to our emergence of a real sense of self, which seems to be a largely universal phenomenon. These are the memories that defined us and made us who we are. Also, they are the memories we seem to cherish and remember most vividly. (Shaw, 2016, p. 51)

Shaw (2016) concludes that, every single one of our perceptual abilities is imperfect. So that, our vision, our hearing, our taste, our sense of heat, our tactile

senses, our vestibular sense of balance, our proprioception of our body in space, every one of these can be fooled.

According to George Berkeley, “to be is to be perceived” means:

> “Only our perception of reality matters. It means that our misperceptions of reality can be placed into our memory systems to be later recalled in spite of never accurately representing more objective reality. While they may generally be close enough to be functionally useful, the truth is that probably every single one of our memories – even the clearest – contains perceptual flaws and inaccuracies, right from the outset.” (Shaw, 2016, pp. 51-52)

2.1.5.- DEVELOPMENT OF “DANCING WITH BEE”

Studies and experiments show that our brains are incredibly malleable and adaptive and they are prepared for quick decision-makings, which is known as a human feature has lead us to survive in harsh environments since our inception. This adaptive quality of our brain is called neuronal plasticity:

> “This adaptive quality of our brain is called neuronal plasticity, and it is only due to neuronal plasticity that we can have any memories at all. The cells in our brain, called neurons, connect with one another to develop meaningful networks, and these networks change in accordance with new experiences. If we were unable to incorporate new information into our existing neural networks, we would be unable to change our thinking or behaviour in light of new evidence, and we would be hard-pressed to deal with any alteration to our environment. It is also through this process that we are able to record and incorporate both the positive and negative experiences we have with others, and this can ultimately help us differentiate friend from foe.” (Shaw, 2016, p. 56)

To stick any experience in the form of memory, memory stamping is required:

> “The process through which an experience is laid down as a physical memory representation in the brain is known as biological stamping. In order to stamp new experiences into long-term memory, a biochemical synthesis is required to make connections between the existing neurons in our brain.” (Shaw, 2016, p. 57)

Neurons have thin arms called dendrites which let them physically stretch out to other cells; spines on them act as the communication centers between these arms. Messages move as electrical impulses within each neuron, but neurons mostly communicate with each other through chemicals passed via synapses. Synapses are gaps between two neurons which act as transmitters and receivers. So that, strong memories are the result of a continued easy flow of information from one neuron to the next. This communication happens through chemical messengers called neurotransmitters that tell neurons what to do, particularly whether they should become more or less active. Overall, recording a memory is mainly an act of making and adjusting connections between existing brain cells, rather than making new ones. Since all parts of neuronal connections can be modified, most researchers argue that it is basically the synapses that are important for memory formation. (Shaw, 2016, pp. 57-58)

“Long-term potentiation is the process through which connections between neurons are increased due to a strengthening of synapses. This strengthening happens because the neurons are strongly or repeatedly activated in relation to each other.” (Shaw, 2016, p. 58)

From a biochemical perspective, calcium is necessary to stimulate the proteins (calpains) in our brains in order to allow our synapses to undergo memory-related changes which can last. when a connection between neurons is repeatedly or strongly activated, calpains are activated at that exact location too. Therefore, the calpains then change the structure of our synapses, results in a stronger connection between the activated memory cells in the brain. In other words, whenever calpains come for a visit, the transformation from simple experience to lasting memory happens. (Shaw, 2016, p. 58)

Moreover, the author (Shaw, 2016) mentions some experiments on sea slugs, that introduce “Prion” as one of the proteins responsible for long-term memory, which is unlike most other kinds. Explains that, prions can change in shape, folding and reshaping in structurally distinct ways. Another of their remarkable properties is that they can exist on their own as well as they can form chains. Additionally, the main role of prions is mentioned in the following paragraph:

> "The primary role of prions in memory formation seems to be to stabilize the synapses that constitute long-term memories, thereby adding permanence to the physical changes that have already taken place due to long-term potentiation and the influx of calpains. Calpains are like the architects of the synapse, planning how communications should flow, while prions are the construction workers who make the changes more permanent." (Shaw, 2016, p. 59)

There is another biochemical theory of memory, which is called "retrieval-induces forgetting":

> "This theory states that whenever we remember we also forget. So, while it seems intuitively appealing that every time we recall a memory we consolidate it and form a stronger and more accurate memory, this is far from the truth. Instead, every time a memory is recalled it is effectively retrieved, examined, and then recreated from scratch to be stored again. It is the equivalent of keeping a file of index cards, pulling one out to read it, throwing it away, and then copying out a new version on a fresh card for filing once more. And this is thought to happen *every time* we recall *any* memory." (Shaw, 2016, p. 61)

So that, by recalling a long-term memory, the cycle of encoding and storage is repeated. This process makes every memory physiologically vulnerable to distortion and forgetting whenever it is recalled.

Dr. Shaw (2016) states that, it is clear that brain chemistry that is so essential to form memories can be manipulated by the consumption of certain kinds of drugs. However, memories are more than just biochemistry. Memories are networks.

In this part hippocampus is discusses as one of the important organs in the brain which plays a crucial role in forming long-term memories:

> "Information is channeled to the hippocampus, the brain region crucial for the formation of new memories and one of the only places in the brain where brand new neurons are regularly generated. The hippocampus links all of the relevant information together and encodes it into a new memory by forming new synapses. It's basically like someone knitting a terrifyingly complex tapestry in real time." (Shaw, 2016, p. 66)

Associations are the fundamental principle of memory which should be precisely considered in order to get to know better what memory is. In fact, it is the

association between the individual memory fragments in different parts of the brain that makes what we think of as a whole memory. (Shaw, 2016, p. 67)

According to Aristotle, four laws of association as Similarity, Contrast, Contiguity, and Frequency are explained below:

> "(…) similarity – the experience or recall of one object will elicit the recall of things similar to that object. Second is the law of contrast – the experience or recall of one object will elicit the recall of opposite things. Third, the law of contiguity – the experience or recall of one object will elicit the recall of things that were originally experienced along with that object. Fourth, the law of frequency – the more frequently two things are experienced together, the more likely it will be that the experience or recall of one will stimulate the recall of the other." (Shaw, 2016, p. 67)

Node is an individual concept or word in the brain that can be linked to one another to create complex ideas. So that, once we activate a node, the energy we send out to it can be conceptualized as radiating out from that original source and then activating other related nodes automatically. As an example; whenever you think about swimming, mostly you automatically activate memories which are associated to water, pool, and bathing suit. (Shaw, 2016, p. 68) Moreover, when associations between some nodes are stronger, associated memories come more easily to us.

> "Through our brains experimentally combining memories and ideas in novel ways, we get new associations – it is this that forms the foundations for our ability to be creative and artistic, to birth new ideas and solve complex problems. However, this same tendency can also lead to memory illusions when engrams become connected in ways that are inaccurate." (Shaw, 2016, p. 71)

There is a theory which is called "Fuzzy Trace" which explains why we can develop inaccurate memories:

> "It posits that remembering involves two things: gist and verbatim memory traces. Put simply, a gist trace is a memory of the meaning of an experience, and a verbatim trace is a memory of specific details. Most memories contain both gist and verbatim components." (Shaw, 2016, p. 71)

This theory summarizes the fundamental mechanisms which enable memory illusions in four principles. First principle is Parallel Processing and Storage. So that, individuals store ‘verbatim’ and ‘gist’ memory traces at the same time, and store them as independent pieces in the brain. Second principle is Separate Recall. One type of memory trace from an experience can be stronger than another. Then, the third principle is Error-proneness. The independent recall of the two types of memory traces opens individuals up to a host of potential memory errors. The last principle is Vividness. Both verbatim and gist processing cause vivid remembering. (Shaw, 2016, pp. 71-73)

The author (Shaw, 2016) claims that, fuzzy trace theory proposes that, memory illusions are possible because each of our experiences is stored as multiple fragments, and these fragments can be recombined in ways that never actually happened.

2.1.6.- REFLECTIONS

Here are the main points of chapter two and three:

We almost never just interpret an object in isolation, instead we bring memories into our interpretation of the world. This ability to interpret relatively basic information and make sense of it is surprisingly complex and memory-reliant. (Shaw, 2016, p. 39)

Our memories of previous experiences influence our understanding not only of how we expect people to behave, but more generally of how the world works such as; gravity, dimensions, possibilities. Additionally, in the same way that we can be fooled by first impressions of faces, we can be fooled by general perceptual illusions, like what magicians do. (Shaw, 2016, p. 39)

> “the theory suggests that performance on any task will improve as arousal increases up to a certain optimum point. However, beyond that point further arousal will actually worsen

performance. The suggestion is that at the extremes, at no arousal or incredibly high arousal, a person cannot perform a given task at all." (Shaw, 2016, p. 41)

So that, at the extremes, at no arousal or incredibly high arousal, the performance is impaired due to the strong anxiety.

"(…) emotional arousal makes things that are perceptually salient stand out even more and makes any high priority information even more memorable. At the same time, arousal reduces processing of low priority information. This increase in selectivity under arousal is likely to be adaptive in many situations, and can explain why sometimes arousing stimuli impair memory for nearby stimuli and sometimes they enhance it.'" (Shaw, 2016, p. 42)

"if we know we learned or experienced something during a particular type of arousal, by recreating that state we should be able to remember it better." (Shaw, 2016, p. 43)

"(…) The cells in our brain, called neurons, connect with one another to develop meaningful networks, and these networks change in accordance with new experiences. If we were unable to incorporate new information into our existing neural networks, we would be unable to change our thinking or behaviour in light of new evidence, and we would be hard-pressed to deal with any alteration to our environment. (…)" (Shaw, 2016, p. 56)

"The process through which an experience is laid down as a physical memory representation in the brain is known as biological stamping. In order to stamp new experiences into long-term memory, a biochemical synthesis is required to make connections between the existing neurons in our brain." (Shaw, 2016, p. 57)

Associations are the fundamental principle of memory which should be precisely considered in order to get to know better what memory is. In fact, it is the association between the individual memory fragments in different parts of the brain that makes what we think of as a whole memory. (Shaw, 2016, p. 67)

Node is an individual concept or word in the brain that can be linked to one another to create complex ideas. So that, once we activate a node, the energy we send out to it can be conceptualized as radiating out from that original source and

then activating other related nodes automatically. As an example; whenever you think about swimming, mostly you automatically activate memories which are associated to water, pool, and bathing suit. (Shaw, 2016, p. 68)

2.2.- WHAT MAKES US HUMAN?

- Charles Pasternak

Four chapters of this book have been studied. According to these chapters, the author proposes that despite of the similarities between human and other primates, some genetic differences distinguish Homo sapiens from other species, especially chimpanzees. And he discusses these great cognitive abilities and unique human characteristics that make us superior in many aspects. Furthermore, “language” is regarded as uniquely human feature which has played a vital role in human evolution. Also, this book argues the importance of the growing brain that led our ancestors survive in extreme weather. Furthermore, this book indicates causal belief as a necessary feature of humans in order to achieve technology which drives human evolution and development.

2.2.1.- MEMORY, TIME AND LANGUAGE - Chapter two, Michael Corballis & Thomas Suddendorf

In this chapter, Corballis and Suddendorf (2007) start proposing a hierarchy of behavioural adaptations, culminating in an adaptation that may help explain behavioural characteristics unique to human species. This adaptation is mental time travel, which is based on the recording of specific events in the past, and the imagining of specific events in the future.

It is mentioned that, at the most fundamental level, behaviour is dependent on bodily characteristics. As examples; bodies built for strength or speed have better chance to survive. Next, size is another bodily characteristic which is important. Also, specific adaptations, like wings for flying or fins for swimming.

The authors (Corballis, Suddendorf, 2007) claim that memory systems may permit still more flexible adaptation. So that, modern theories of memory recognize different levels of memory that themselves vary in flexibility. There are two kinds of memory; declarative and nondeclarative memory (sometimes known as implicit and explicit memory, respectively). Declarative memory are memories that can be

declared and it is conscious, and corresponds to what we normally think of as “memory”. (Pasternak, 2007, p. 19) Declarative memory provides the basis for language. Tulving drew the distinction within declarative memory between semantic memory, which is memory for facts, and episodic memory, which is memory for events. Also, the distinction between semantic and episodic memory has also been characterized as that between knowing and remembering, respectively. (Pasternak, 2007, p. 20)

The author mentions that our episodic memories provide our mental lives with the time dimension and they can be regarded as part of a more general capacity for mental time travel. Which allow us not only to mentally relive events in the past, but also to imagine the future in episodic detail. (Pasternak, 2007, p. 21) Researches claim that, episodic memory and more generally mental time travel, are uniquely human. Also, tool manufacture is sometimes considered as evidence for a sense of the future. It is a feature most attributed to humans, because there is little evidence that nonhuman primates make tools with any sense of future planning. The manufacture of tools by is designed for future use, and there is a temporal separation between manufacture and use. Additionally, language is considered as uniquely human capacity. Also, it is believed that our memories are accessible only through language. (Pasternak, 2007, p. 26)

2.2.2.- WHAT MAKES US HUMAN? - OUR ANCESTORS AND THE WEATHER

- Chapter seven, & Stephen Oppenheimer

This chapter discusses some factors that made humans in the past survive in the extreme climate-dry, cold or hot weather. “The needs of our increasingly exploratory and adaptive behaviour have fed back into the size of the organ responsible for that behaviour, our brain, and its virtual client our complex language ability.” (Pasternak, 2007, p. 94) It is believed that the need of big brains during the ice ages made us behavioural adaptations which is precede the physical adaptations that ended up new human species with progressively larger brains. Also, larger brains in an increasingly dry environment could help our ancestors to

find food which results in being survived. “Over the period from 2.5 to 1.5 million years ago, the average hominid brain size more than doubled, from 400 cm3 to 900 cm3.” (Pasternak, 2007, pp. 99-100)

However, surprisingly, there has been an overall decline in brain volume in modern humans over the past 150,000 years. Rapidly increasing brain size was considered as a key feature that set humans apart from the walking apes that lived before 2.5 million years ago. Since then our brains have trebled in volume. Hence, with the knowledge that just a few genetic alterations caused a huge growth of functional potential in the human brain, “language” drove that rapid growth 2.5 million years ago. “For the past 2 million years humans have been improving on the walking-ape model by using their brains, but they may have been aided in this by speech-driven coevolution in brain size.” (Pasternak, 2007, p. 111)

2.2.3.- CURIOSITY AND QUEST - Chapter eight, Charles Pasternak

In this chapter the author argues the reasons that no animal has come close to humans in so far as gratification of innate curiosity is concerned is the lack of four attributes that humans have achieved over the past four million years or so. The first is the upright gait. Second, freeing the hands has an equally important consequence: The flexible thumb, leading to an agile hand, then, is the second human attribute that is key to human quest. The third attribute is the human voice box (or larynx) which is speech. And the fourth attribute that allows us to exercise our superior quality of quest is, of course, the brain. (Pasternak, 2007, pp. 118-119) Furthermore, it is the combination of all three – hand, speech and brain – that allows humans to search more avidly than other creatures. As mentioned earlier, the human brain has increased some three-fold over the last 2 million years. However, the size of the chimpanzee brain has remained pretty constant for 6 million years.

Pasternak (2007) believes that, what makes us human is our innate curiosity and our never-ceasing quest. According to the researches, thousands years ago people searched, on average, as avidly as they do today. However, cultural, non-genetic, changes also affect our way of life.

2.2.4.- CAUSAL BELIEF MAKES US HUMAN - Chapter eleven, & Lewis Wolpert

The author (Wolpert, 2007) in this chapter discusses one of the main features that is uniquely attributed to humans, not even including non-human primates which is called causal belief. Moreover, it is claimed that, the evolution of causal belief opened up a new set of movements that were the basis of technology and understanding the environment. Therefore, technology which is a fundamental characteristic of humans, could improve chances of survival by manipulating the environment. Also, to reach technology a belief in cause and effect is necessary.

According to the experiments, lack of causal belief leads chimpanzees not to modify stone tools in order to make improvement it the function of the tools in a way that, to refine and combine objects to make better tools. A distinguishing feature of hominid tool use, compared to apes, is the use of secondary tools. Like tools that were made by the use of another tool. Such as; stone hammers, like those used by chimpanzees to break hard-shelled fruits or nuts, were then used to shape rocks for cutting tools. Furthermore, there is cooperation between causal beliefs, tool use and language which are possibly linked by the development of tool use. (Pasternak, 2007, p. 171)

It is claimed that, language in addition to causal beliefs, marks humans off from other species and its role in human evolution and there is a relationship in evolution between tool using, causal thinking and language which is interesting and one might have served to haul along the others. And this relationship was the origin of technology. (Pasternak, 2007, p. 178)

2.2.5.- DEVELOPMENT OF “CAUSAL BELIEF MAKES US HUMAN”

This chapter discusses one of the main features that is uniquely attributed to humans, not even including non-human primates which is called causal belief. The author explains more in the following:

> "The primary function of the brain is to control movement and interaction with the environment. Humans, unlike other primates, have a belief in physical cause and effect which enables the acquisition of new interactions, and led to technology. Human children have causal beliefs as a developmental primitive, and these can be demonstrated even in infants. By contrast, behavioural studies requiring simple manipulations of the environment show that chimpanzees do not have such concepts. It is proposed that the evolution of causal thinking was essential for the development of tool use as it is not possible to make a complex tool without understanding cause and effect. The evolution of language may have been linked to the same process. It has been technology that resulted from causal beliefs that has made us human, not social interaction." (Pasternak, 2007, p. 164)

It is believed that, humans have tendency to explore how physical world works and it makes them discover causes of important events like death, illness, and climate change. So, belief is considered as a property of the brain to control movements, so this must be at the core of any attempt to understand the origins of causal belief.

Humans movement is mentioned as one of the advantages that probably help our ancestors' dispersal and access to new habitats. And consequently opened up other advantages such as; finding food and avoiding danger. Moreover, evolution of the brain that gave us belief, expanded circuits that controlled movement in our ancient animal ancestors. Brain development took on other functions which were like hormonal release and temperature regulation. Studies claim that, the evolution of causal belief opened up a new set of movements that were the basis of technology and understanding the environment. Technology which is a fundamental characteristic of humans, could improve chances of survival by manipulating the environment. Also, to reach technology a belief in cause and effect is necessary. (Pasternak, 2007, p. 166)

We, as humans have had the causal belief since we were born, as they try to understand what is happening in the world around them. So that, it is a fundamental feature of children's development and behaviour. Also, explanatory is a main drive which is at the core of a child's development that leads drives for food and sex. (Pasternak, 2007, p. 166)

This section discusses some cognitive similarities and differences between human and primates in the following paragraph:

> "There are of course cognitive similarities between human and mammalian and especially primate cognition: primates remember their local environment, take novel detours, follow object movement, recognise similarities and have some insight into problem solving. They also recognise individuals, predict their behaviour, and form alliances. However, they have little understanding of the causal relationships between inanimate objects. They do not view the world in terms of underlying 'forces' that are fundamental to human thinking. They do not understand the world in intentional or causal terms." (Pasternak, 2007, p. 168)

Additionally, the author mentions an experiment conducted on chimpanzees regarding their cognition about the world around them, which is cited below:

> "(…) primates like chimpanzees do not have concepts of variable causes to explain interaction between objects. One might have thought that Wolfgang Kohler's experiments with chimpanzees showed just the opposite. His chimpanzees, some eighty years ago, could sometimes, perhaps with some training, stack boxes on top of each other to get a banana nailed to the ceiling. But Kohler himself acknowledged that the chimpanzees had no knowledge of the forces involved. For example, they would try to place one box on another along its diagonal edge; and if stones were placed on the ground so that the box toppled over, they never removed the stones. " (Pasternak, 2007, pp. 168-169)

Moreover, another experiment is indicated which has done on Kanzi, a kind of chimpanzee:

> "However the chimpanzee Kanzi, a bonobo ape, showed remarkable skills. It learned to create and use stone tools to gain access to food to cut a rope and it could make stone flakes and evaluate them after observing a human striking two rocks together." (Pasternak, 2007, p. 169)

Hence, experiments demonstrate that, chimpanzees do not reason about things and they have no concept of causality. They do appreciate that contact is necessary in using a tool to get food, but will focus only on the contact and not the force it generates on the target object. One example of a physical causal

understanding among chimpanzees is nut cracking technique of the Tai chimpanzee which requires about ten years of practice to master in the wild. According to the experiments, Pasternak claims that, lack of causal belief leads chimpanzees not to modify stone tools:

> "Chimpanzees and apes are thus at the edge of causal understanding as shown by their use of simple tools, such as trimming a grass reed to get out ants. But in no case of stone tool use is there evidence of modifying the structure of the stone to improve its function. All the above evidence makes clear that while primates and some birds use simple tools there is an almost total absence of causal beliefs in animals other than humans. In no case of stone tool use is there evidence that individual animals modified the structure of the stone in order to improve the tool's function, though a few cases of anvil stabilisation have in fact been observed." (Pasternak, 2007, pp. 170-171)

A distinguishing feature of hominid tool use, compared to apes, is the use of secondary tools. Like tools that were made by the use of another tool. Such as; stone hammers, like those used by chimpanzees to break hard-shelled fruits or nuts, were then used to shape rocks for cutting tools. Also, there is cooperation between causal beliefs, tool use and language which are possibly linked by the development of tool use. It is claimed that, causal belief made technology to be possible and made lifer easier. Moreover, the technological path took our primate ancestry completely different from other primate relatives. So that, our technological adaptation has formed our evolutionary dramatically. Also, tool use was probably the most important adaptation in human evolution. According to Julian Huxley, specific regions of the human brain are associated with tool use. (Pasternak, 2007, pp. 171-172)

Tomasello believes that, biological evolution which is genetic variation and natural selection could have created cognitive skills necessary for complex tool use such as language and complex social organization. However, Robin Dunbar claims that, primate brain evolution has been driven principally by the demands of the social world, interactions with the environment and particularly with other members of the group rather than by the demands of interacting with the physical environment. (Pasternak, 2007, p. 172)

Studies demonstrate that, brains of modern humans are three times larger than other primates, and 75 percent of the growth happens after birth, while it is 40 percent in chimpanzees which this increase in human brain size could require new and improved technology to acquire food. (Pasternak, 2007, p. 173)

There are some features attributed to human that led them to transcend in evolution compared to other primates. One of them is the humans' hands which are differ from apes, so that they have longer thumbs and less curved finger bones which make humans capable of both a power grip and a precision one. Also, freeing the hands from walking with the evolution of bipedalism was a crucial step. Human manipulative skills are intrinsic property of the brain and are genetically determined. Although the shape of human hand and bipedalism had profound effect on human evolution, we should not ignore the ability of the brain to control their complex movements. As it is mentioned before, specific regions of humans' brains are associated with tool use. Chimpanzees do have basic motor skills and can be taught to trace complex patterns, though. (Pasternak, 2007, p. 174)

Studies show that, progress in tool making was very slow, and may have required further evolution of the brain to give improved causal understanding. However, evolution from the stone axes to more complex tools took at least a million years, by 300,000 years ago, tool making skills had accelerated and hafted tools, which are composites that is composites, with the components joined together, had been created. The technology of making hafted tools is not achieved by chance for sure and unlike making the simpler stone tools, is non-repetitive and require fine hand motor control to fit the components together. (Pasternak, 2007, p. 175)

Furthermore, it is claimed that, there is a relationship in evolution between tool using, causal thinking and language which is interesting and one might have served to haul along the others. Additionally, this relationship was the origin of technology. People use language, not just to signal emotional states or territorial claims, but to shape each other's minds. Gestures may have been involved in the origin of language but on their own they are not a language. It is considered that tools and language share some critical features. So that, both tool use and speech are sequential. In a way that, speech and composite tool manufacture involve

sequences of non-repetitive fine motor control and making a composite tool like making almost a short story. (Pasternak, 2007, p. 178)

It is believed that, causal thinking preceded language and was an essential prerequisite for language development. Also, language would help effectively with the construction and use of new tools, both in terms of cooperation and imaginative thinking. Although some experiments demonstrate that the ability to make complex tools does not require language, it would have been difficult for early humans to acquire new beliefs from others without language. (Pasternak, 2007, pp. 179-180)

At the end of this chapter, to conclude, the author emphasizes the need of causal belief in human evolution:

> "A strong case can be made that a key step in human evolution that made *Homo sapiens* different from other primates was the acquisition of causal beliefs. Without such beliefs it would not have been possible for technology, which is the main driver of human evolution, to develop. Causal beliefs are essential for making complex tools and planning ahead, and all other mammals, including non-human primates, lack these abilities." (Pasternak, 2007, p. 180)

2.2.6.- REFLECTIONS

Here are the main points of chapter eleven:

> "The primary function of the brain is to control movement and interaction with the environment. Humans, unlike other primates, have a belief in physical cause and effect which enables the acquisition of new interactions, and led to technology. Human children have causal beliefs as a developmental primitive, and these can be demonstrated even in infants. By contrast, behavioural studies requiring simple manipulations of the environment show that chimpanzees do not have such concepts. It is proposed that the evolution of causal thinking was essential for the development of tool use as it is not possible to make a complex tool without understanding cause and effect. The evolution of language may have been linked to the same process. It has been technology that resulted from causal beliefs that has made us human, not social interaction." (Pasternak, 2007, p. 164)

A distinguishing feature of hominid tool use, compared to apes, is the use of secondary tools. Like tools that were made by the use of another tool. (Pasternak, 2007, p. 171)

There are some features attributed to human that led them to transcend in evolution compared to other primates. One of them is the humans' hands which are differ from apes, so that they have longer thumbs and less curved finger bones which make humans capable of both a power grip and a precision one. Also, freeing the hands from walking with the evolution of bipedalism was a crucial step. Human manipulative skills are intrinsic property of the brain and are genetically determined. Although the shape of human hand and bipedalism had profound effect on human evolution, we should not ignore the ability of the brain to control their complex movements. (Pasternak, 2007, p. 174)

(…) language in addition to causal beliefs, marks humans off from other species and its role in human evolution and there is a relationship in evolution between tool using, causal thinking and language which is interesting and one might have served to haul along the others. And this relationship was the origin of technology. (Pasternak, 2007, p. 178)

> "A strong case can be made that a key step in human evolution that made *Homo sapiens* different from other primates was the acquisition of causal beliefs. Without such beliefs it would not have been possible for technology, which is the main driver of human evolution, to develop. Causal beliefs are essential for making complex tools and planning ahead, and all other mammals, including non-human primates, lack these abilities." (Pasternak, 2007, p. 180)

2.3.- COLOR; COMMUNICATION IN ARCHITECTURAL SPACE

- Meerwein, Rodeck, & Mahnke

In this book, the authors claim that, since the impact of color is interplay of physiological and psychological events, it is necessary to consider precisely all the aspects of color. It is demonstrated that, various colors can effect on our psyches and bodies differently due to the physiological and psychological aspects, personal factors, symbolism, and so on. In addition, relationship between material and color is argued and authors believe that materials and colors are the key visual parameters for perceiving and experiencing space. Color accompany with material can lead various perceptions, such as; enhancing the synesthetic perception. Additionally, since people are directly and inseparably connected to the space surround them, the communication between people, color and space is necessary to be considered. It is believed that color accompany with design in an architectural space can affect on people's emotions, feelings, thoughts, and behaviours.

2.3.1.- HUMANS AND COLOR - Chapter four

In this chapter perception and experiencing color, physiological, and psychological aspects of color are discussed. It is demonstrated that, the effect of color on people is interplay of physiological and psychological events, by the physical process of seeing color, and the data processing in our brain. People looking at a color already possess a certain amount of experience and preconceptions in their memory, which influence their color perception.

The authors (Meerwein, Rodeck, Mahnke, 2007) claim that, there are basically six interdependent factors that affect our color experience, which are; biological reactions to a color stimulus, the collective unconscious, conscious symbolism and association, cultural influence and mannerism, trends, fashion, style, and personal factors (Age and gender).

Scientists demonstrate that, the collective unconscious is a part of our psyche, which has nothing to do with the conscious reactions that we have collected through

personal experience in our lives. The collective unconscious reflects archetypes which are predispositions and latent images derived from period of times when people were directly connected to the nature. (Meerwein, Rodeck, & Mahnke, 2007, pp. 20-21)

Studies indicate that, each color whether red, green, yellow, or violet transmits specific physical waves that our eye records as a color stimulus. These stimuli go into the brain and direct pituitary gland, which regulates the body's hormones. One widely accepted scientific research demonstrates that, red is a stimulus that speeds up the heart and circulation, increases pulse and breathing rates, and raises blood pressure. Whereas, blue lowers blood pressure and calms the nerves. (Meerwein, Rodeck, & Mahnke, 2007, pp. 23-24)

According to experiments, the effects of color on the body are temporary and physical reactions do not remain constant. Hence, it can be assumed that relaxed, calm, or stimulating spatial environments can only be achieved in line with neuropsychological aspects, in other words, established applied color psychology. (Meerwein, Rodeck, & Mahnke, 2007, p. 24)

In addition to physiological effects of color, color stimuli impact on us psychologically as well. Different aspects of color psychology are mentioned in this chapter, such as: people's experience of color, the emotional effect of color, the synesthetic effect of color, and the symbolism of color and its associative effects. (Meerwein, Rodeck, & Mahnke, 2007, p. 25)

2.3.2.- MATERIAL AND COLOR - Chapter seven

This chapter considers colors and materials as two key visual parameters that we perceive and experience environments with. These two elements, materials and colors, serve a specific function. They have to fulfill the demands imposed by ergonomics, optics, aesthetics, and function. So that, they influence, enhance, or detract from each other and they are seen as a single entity. Therefore, a material and a color have to be placed together in order to create a specific effect. (Meerwein, Rodeck, & Mahnke, 2007, p. 50)

Materials can have a natural and characteristic color and texture, or they can be processed and fundamentally changed. Due to the individual character of each material accompany with its texture, each material represents a distinctive image and conveys a message. Since materials are more than shades of color, they can transmit different feelings and change the atmosphere through synesthetic perceptions. So that, they can make perceptions of warm or cold, pleasant, luxurious atmosphere. Furthermore, the senses of taste, smell, hearing, and touch all can be stimulated by material in order to create different perceptions. In addition, the image of materials complemented by colors, can create additional effects such as dominating, equal, subordinate, or accentuating elements. (Meerwein, Rodeck, & Mahnke, 2007, p. 55)

It is clamed that, surface structure (texture and processing method) has a great influence on how an object's color is perceived. Likewise materials, surface characteristics in combination with the color itself, and its position in the overall color scheme, work to create a value, an image impression. Since, nowadays the environmental awareness is growing, traditional materials and application techniques are making a comeback. So that, using natural pigments and binding agents, glazes are becoming very presentable. (Meerwein, Rodeck, & Mahnke, 2007, p. 55)

2.3.3.- COMMUNICATION: PEOPLE- COLOR- SPACE - Chapter nine

Designing atmosphere and the space that humans live in affects on them in psychological and physiological aspects. Therefore, it is necessary to design in a way that give them the sense of well being. One of the main factors which plays a vital role in design space is color. Color impacts people's feelings, desires, behavior and actions within a certain space. Hence, it is necessary to know how to make an appeling combination with color and space.

This chapter discusses space as an essential base for human existence. They are directly and inseparably connected to the space surrounds them. So that, symbolic effect, and impression made by an architectural space determine how

people feel within it, to what extent the space appeals to them, and how they identify with it. This chapter indicates the importance of design and its affects on transmitting different moods and emotions, in a way that designing a space can appear cheerful, cool or festive. And consequently influences on our emotions and moods and behaviour. (Meerwein, Rodeck, & Mahnke, 2007, p. 63)

Additionally, the authors claim that, atmospheres are closely linked to forms, materials, light, and colors. However, the possibility and intensity of the influence depend on people and their personal mood at the present time. In other words, people reactions toward a space is subjectively reaction, so that, the personal mood of individuals are important to be considered at the time they are located in a space. Hugo Kükelhaus studied the psychosomatic aspects of spatial experience. He claims that, people need spaces with different stimulations in order to avoid dysregulation which is triggered by under stimulation. So that, Restricted movement and monotone materials or colors can cause dysregulation. (Meerwein, Rodeck, & Mahnke, 2007, p. 63)

Moreover, studies demonstrate that, mind and body effect each other mutually. So that, a physical illness can be originated of psychological disease and vice versa. Furthermore, this chapter argues the components of color design as a key role in the relationship between people and architectural space which are important to consider them when developing color designs for architectural space. They are named as; Quality of impression, Invitational character, Conciseness, Appropriation. (Meerwein, Rodeck, & Mahnke, 2007, pp. 64-65)

There are some principles of color perception in architectural space that should be considered precisely while designing a space. For example; 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. Also, 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. In addition, colors can be used to influence the effect of room proportions, such as wide, narrow, high, low. Also, the synesthetic quality of experience (light or heavy in terms of weight) can be perceived by color design. So that, bright colors are perceived light in weight, and dark colors as heavy.

Additionally, Passive colors, like green and green-blue seem lighter in weight, and Active colors like red seem heavier. Also, brighter shades are perceived lighter than saturated ones. Hence, the effects of colors in architectural space, on the floor, wall, and ceiling, depend on the brightness and saturation of a color. (Meerwein, Rodeck, & Mahnke, 2007, p. 68)

2.3.4.- DEVELOPMENT OF "HUMANS AND COLOR"

This chapter of the book argues how we perceive and experience color and the factors which effect on our color perception and consequently experiencing color. It is claimed that, we perceive color mainly as a characteristic of the objects that influences on our perception of form, surface quality, smell, and taste. Also, it helps us to determine, judge, and evaluate an object. People looking at a color already have a certain amount of experience and preconceptions in their memory, which impact their color perception. Furthermore, color perception is even accompanied by cultural and social factors such as education and the environment (Meerwein, Rodeck, & Mahnke, 2007, p. 19)

It is important to mention that it is not possible to generalize color experience, color effect, or the human response to color because, human experience and response to color are as diverse as people themselves. It is demonstrated that, the effect of color on people is interplay of physiological and psychological events, by the physical process of seeing color, and the data processing in our brain. According to the experiments, color evokes certain emotional and aesthetic associations. So that, color influences physical procedures and affects our psyche, our feelings, thought processes, and emotions. (Meerwein, Rodeck, & Mahnke, 2007, pp. 19-20)

The authors (Meerwein, Rodeck, & Mahnke, 2007) discuss six interdependent factors that affect our color experience:

- Biological Reactions to a Color Stimulus
- The Collective Unconscious
- Conscious Symbolism and Association
- Cultural Influence and Mannerism

- Trends, Fashion, Style
- Personal Factors

The authors claim that, when we see something apart from the collaboration between light, eye, and brain, which is an optical visual pathway, there is also the energetic one, that directs incoming light and color stimuli directly to the interbrain, from where it affects the metabolism and organ functions. Therefore, this explains why the pulse increases with a red stimulus and decreases with a blue one. Biological reactions occur on purely physiological levels. (Meerwein, Rodeck, & Mahnke, 2007, p. 20)

Scientists believe the collective unconscious is a part of our psyche, which has nothing to do with the conscious reactions that we have collected through personal experience in our lives. The collective unconscious reflects archetypes which are predispositions and latent images derived from period of times when people were directly connected to the nature. This subject is explained more in the following paragraph:

> "(…) human beings have stored the knowledge of millions of years of evolution in the genetic map of their brain, and can improve this genetic map through the ability to learn. The archetypical, general primal relevance of color must therefore be considered in relation to our experience of and response to color. It originates from the time in our developmental history when people were still directly connected to the natural environment." (Meerwein, Rodeck, & Mahnke, 2007, pp. 20-21)

Besides, personal unconscious should be considered and be taken into the account collective unconscious. So that, personal unconscious associated with color can affect on our reaction to a specific color. For instance, after an accident a person may reject red, as it is the color of blood.

Associations are shaped by the human experience of nature, that have led to others over the course of evolution. So that, there are many examples of color impressions, symbols, and associations that most people interpret in the same way. For example, red stands for blood and fire, aggression, and also life and love. Although, some associations and symbols are varied by culture and there are

collective and individual responses to color associations, researches have shown astounding similarities concerning preferences, color-mood associations and connotations. (Meerwein, Rodeck, & Mahnke, 2007, p. 21)

Studies show that, culture, religion and tradition affect on the way people react towards color:

> "Even if there are universal reactions to colors, this does not preclude the existence of cultural and group-specific associations and symbols. These may be particular color statements of a cultural group or people regarding religion, philosophy, and tradition, and are especially significant only to them in this context. (Meerwein, Rodeck, & Mahnke, 2007, p. 21)

Studies reveal that trends and fashion are factors impacts on our color judgment and associations. The associations might be short-lived and temporary, though. Almost every year there are new trends in color throughout the world, specifically in fashion and consumer goods whereas, in architecture and interior design, color trends development is more slowly. (Meerwein, Rodeck, & Mahnke, 2007, p. 21)

The authors (Meerwein, Rodeck, & Mahnke, 2007) state that another factor which influence on our color experiences, are attributed to individuals which are known as dominated factors. Personal factors include:

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

Additionally, it is important to consider that how long a color stimulus affects on people and the design context in which colors exist and are perceived. Our experience of and response to color, and our color preferences are not the same and are varied. Also, our experience of and reaction to color are determined by the dynamics of our internal and external world. (Meerwein, Rodeck, & Mahnke, 2007, p. 21)

In this section of the chapter authors (Meerwein, Rodeck, & Mahnke, 2007) discuss physiological aspect of color. Studies show that, every impulse or stimulus that reaches the higher centers of the central nervous system of our brains, passes through the “formatio reticularis”, which is a control station for all incoming stimulation. So that, the formatio reticularis maintains a condition of normalcy in a state of stimulation.

> “Stress research has shown that states of sensory overstimulation or under stimulation can trigger dysfunctions in the organism. This is often disregarded by designers. It is thus important to adhere to one of the most important, fundamental rules of design that is, to integrate variation and stimulation into a visual order, and to create a balance between under- and overstimulation.” (Meerwein, Rodeck, & Mahnke, 2007, p. 22)

Designers must consider the subject of over- and under stimulation precisely, because overstimulation can trigger physical or psychological changes.

> “The amount of visual stimuli (colors, patterns, contrasts etc.), extreme monotony and sensory deficiency can lead to under stimulation, while an extreme surplus of stimuli can produce overstimulation. Overstimulation can trigger physical or psychological changes. On the physical level, breathing or pulse frequencies can be affected; blood pressure and muscle tension may increase. Studies have shown that people who suffer from under stimulation displayed signs of restlessness, irritability, difficulties in concentrating, and perception disorders.” (Meerwein, Rodeck, & Mahnke, 2007, pp. 22-23)

Studies indicate that, each color whether red, green, yellow, or violet transmits specific physical waves that our eye records as a color stimulus. These stimuli go into the brain and direct pituitary gland, which regulates the body’s hormones. One widely accepted scientific research demonstrates that, red is a stimulus that speeds up the heart and circulation, increases pulse and breathing rates, and raises blood pressure. Whereas, blue lowers blood pressure and calms the nerves. (Meerwein, Rodeck, & Mahnke, 2007, pp. 23-24)

Some significant factors are mentioned which impact on human reaction to color in space. They are; hue and nuance, amount and location of the color in space,

paint color and spatial function, and the effect of color over time in the space. Moreover, studies indicate that the effects of color on the body are temporary:

> "It is a mistake to assume that we could strategically place color in a space so as to achieve specific physiological effects, such as lowering blood pressure for hypertonic patients. These stimulus-reaction experiments are not sustainable. Research on physiological effects from color stimulus concludes that physical reactions do not remain constant. After an initial increase, for example via red light, blood pressure normalizes again or even shows a counter-reaction." (Meerwein, Rodeck, & Mahnke, 2007, p. 24)

Hence, it can be assumed that relaxed, calm, or stimulating spatial environments can only be achieved in line with neuropsychological aspects, in other words, established applied color psychology.

As it is mentioned before, beside physiological effects of color, color stimuli impact on us psychologically as well. Color effect is based on conscious and unconscious processes and is known as an experience that influences behavior. Here Meerwein, Rodeck, & Mahnke (2007) discuss different aspects of color psychology which should be considered precisely:

- People's experience of color
- The emotional effect of color
- The synesthetic effect of color
- The symbolism of color and its associative effects.

Scientists believe that we can experience a color by an external stimulus (seeing a color) as well as imagining a color (in our minds):

> "(…) color not only depends on a stimulus from the world outside, but also on the power of our own imagination. Color impressions recorded in the external world are sensory-spiritual experiences and sensations, which trigger the memory and recognition processes. A green color stimulus can trigger thoughts about nature, maybe about a walk in the green countryside or a particular experience. The thoughts continue working, and can lead to the areas of memory, which in the end no longer have anything to do with the triggering "green stimulus."" (Meerwein, Rodeck, & Mahnke, 2007, p. 25)

As we percept color we react toward it. This perception addresses the areas of emotions, thought, and will, and also triggers memory.

Synesthesia in a magnificent neurological phenomenon in which stimulation of one sensory leads to stimulating a second sensory automatically. So that, due to holistic associations and parallel sensations, color stimulates other senses such as touch, smell, taste, temperature, and hearing. This is why certain color nuances or color combinations are perceived as hard or soft, fresh or stale, sweet or sour, warm or cold. Therefore, by implementing color in spatial design, they can influence the perception of spatial dimensions. Since colors trigger very different sensations in touch, synesthetic links between color and surface sensation depend on the quality of hue and its nuance, as well as its shift in temperature sensation. Hence, it is important to mention that, the effect of a color always depend on its color tone, which involves saturation, intensity, and brightness, in other words, its hue and nuance. Furthermore, the impression of coolness and warmth depend on whether a surface is matt, muted, shiny, or polished and sensing weight is very dependent on the degree of saturation and brightness. Precisely. (Meerwein, Rodeck, & Mahnke, 2007, p. 26)

Symbolism of color is an interesting subject to be studied. Symbol is a picture that stands for something and is a medium for communicating messages. It is demonstrated that the symbolism of color has developed out of the original human color experience:

> "The human being's "primal experiences" of color in nature are stored as mutual, collective fundamental experiences, as primal images and archetypes, in our "genetic memory." They contribute to our personal experience of color. Color symbolism grew out of the generalization of color's effects on the emotions, and the tradition of meanings associated with color. Symbolic and psychological effects of color are thus closely linked." (Meerwein, Rodeck, & Mahnke, 2007, p. 28)

Additionally, it is admitted that experiencing colors and symbolic meaning of a particular color differ from a specific culture to another cultures:

> "Although certain generalizations do in fact merge, in line with an "objectification" of colors, and are then conveyed as symbolic messages, the individual, human color experience

still needs to be considered. Even if many connotations are identical, there are still cultural differences." (Meerwein, Rodeck, & Mahnke, 2007, p. 28)

The symbolic meaning of a color as well as its psychological effect, depends on the hue's nuance, context and color's material. Therefore, it would be false to assume that, for example, green is always calming. Because, the value and the saturation of green can trigger different emotion. How they are expressed, have to be considered as well. Hence, a saturated green may be stimulating, and a soft, pastel green, relaxing. (Meerwein, Rodeck, & Mahnke, 2007, pp. 28-29)

"The effect of colors always depends on their interaction with objects, and their different design characteristics: the same color, associated with different types of objects, can thus lead to completely different interpretations and opposite impressions and effects. Color effect is polyvalent." (Meerwein, Rodeck, & Mahnke, 2007, p. 29)

2.3.5.- REFLECTIONS

Here are the main points of chapter four:

(…) the effect of color on people is interplay of physiological and psychological events, by the physical process of seeing color, and the data processing in our brain. According to the experiments, color evokes certain emotional and aesthetic associations. So that, color influences physical procedures and affects our psyche, our feelings, thought processes, and emotions. (Meerwein, Rodeck, & Mahnke, 2007, pp. 19-20)

"(…) human beings have stored the knowledge of millions of years of evolution in the genetic map of their brain, and can improve this genetic map through the ability to learn. The archetypical, general primal relevance of color must therefore be considered in relation to our experience of and response to color. It originates from the time in our developmental history when people were still directly connected to the natural environment." (Meerwein, Rodeck, & Mahnke, 2007, pp. 20-21)

> "Stress research has shown that states of sensory overstimulation or understimulation can trigger dysfunctions in the organism. This is often disregarded by designers. It is thus important to adhere to one of the most important, fundamental rules of design that is, to integrate variation and stimulation into a visual order, and to create a balance between under- and overstimulation." (Meerwein, Rodeck, & Mahnke, 2007, p. 22)

Designers must consider the subject of over- and understimulation precisely, because overstimulation can trigger physical or psychological changes.

> "The amount of visual stimuli (colors, patterns, contrasts etc.), extreme monotony and sensory deficiency can lead to understimulation, while an extreme surplus of stimuli can produce overstimulation. Overstimulation can trigger physical or psychological changes. On the physical level, breathing or pulse frequencies can be affected; blood pressure and muscle tension may increase. Studies have shown that people who suffer from understimulation displayed signs of restlessness, irritability, difficulties in concentrating, and perception disorders." (Meerwein, Rodeck, & Mahnke, 2007, pp. 22-23)

(…) red is a stimulus that speeds up the heart and circulation, increases pulse and breathing rates, and raises blood pressure. Whereas, blue lowers blood pressure and calms the nerves. (Meerwein, Rodeck, & Mahnke, 2007, p. 24)

> "It is a mistake to assume that we could strategically place color in a space so as to achieve specific physiological effects, such as lowering blood pressure for hypertonic patients. These stimulus-reaction experiments are not sustainable. Research on physiological effects from color stimulus concludes that physical reactions do not remain constant. After an initial increase, for example via red light, blood pressure normalizes again or even shows a counter-reaction." (Meerwein, Rodeck, & Mahnke, 2007, p. 24)

Hence, it can be assumed that relaxed, calm, or stimulating spatial environments can only be achieved in line with neuropsychological aspects, in other words, established applied color psychology.

> "The human being's "primal experiences" of color in nature are stored as mutual, collective fundamental experiences, as primal images and archetypes, in our "genetic memory." They contribute to our personal experience of color. Color symbolism grew out of the generalization of color's effects on the emotions, and the tradition of meanings associated

with color. Symbolic and psychological effects of color are thus closely linked.” (Meerwein, Rodeck, & Mahnke, 2007, p. 28)

2.4.- WEBSITES

These two materials are retrieved from the Internet. They are put together because they can be placed in the same area of knowledge. One of them discusses the impacts of color on human's body and emotion physiologically and psychologically, respectively. The other one mentions the important role of arousal level in learning ability.

2.4.1.- EFFECT OF DIFFERENT COLORS ON HUMAN MIND AND BODY

- E. Staff

Every color has a unique effect on individuals and stimulates various responses. In this webpage, the author (Staff, 2013) mentions physiological and psychological aspects of each color, and their impacts on human's mind and body:

RED:

• Red is the most vibrant of all the colors.

• It stimulates the adrenal gland and the neurons.

• Too much exposure to the color red can cause stress; it may also cause frustration and provoke anger.

• It stimulates heartbeat and breathing.

YELLOW:

• Helps to release a chemical in the brain called Serotonin, essential for causing a happy mood.

• Enhances concentration and gives the brain and nervous system a "wake-up call".

• Too much of yellow color can cause fatigue.

• It is the most difficult color on the eye and people might lose temper more often in yellow rooms.

• It is also beneficial for speeding up metabolism.

BLUE:

• Blue has a soothing effect on human mind as it helps to produce some calming chemicals in the brain.

• Too much exposure to this color may cause depression.

• Blue is used a lot in cooperate sector as it denotes loyalty.

• It is also proved that materials in blue color appear to be light in weight.

• Blue is a non food color as it gives a toxic effect to edibles.

GREEN:

• Relaxes the body and alleviates stress.

• Improves vision. This could be the reason why classroom boards are in green color.

• Green has a healing and hygienic effect and for this reason it is used a lot in hospitals.

• People working in green offices have proven to be more satisfied with their jobs.

• Consumers spend more time shopping in shops painted green.

PINK:

• It is beneficial in reducing anger and anxiety. If a person tries to be angry or aggressive in the presence of pink, he can't. The heart muscles can't race fast enough.

• It is associated with femininity.

• It is the most tranquilizing color.

ORANGE:

• It stimulates mental abilities.

• It is useful for increasing appetite.

BLACK:

• Signifies power and authority

• Represents knowledge and intelligence.

• It is the most popular color in the fashion industry because of its association with style and it makes people wearing it look thin.
• A food product packed in black color may bring in more profits because it is perceived to be higher in quality.
• Black is the most aggressive color.

WHITE:
• The most neutral color.
• Baby products come usually in white to symbolize innocence and cleanliness.
• White is used by doctors and nurses to show sterility.
• In clothes, white is associated with sophistication.

PURPLE:
• Symbolizes royalty, luxury and sophistication.
• People wearing purple color are perceived to be wealthy.
• It develops spirituality and deep thoughts.
• It is helpful to intensify sexual activity.

2.4.2.- AROUSAL AND PERFORMANCE

- Donald Clark

According to researches, arousal is a main factor of the learning theory. So that, there is a correlation between arousal level and optimum performance:

> "Arousal is a major aspect of many learning theories and is closely related to other concepts such as anxiety, attention, agitation, stress, and motivation." (Clarck, 2004)

It is believed that a certain point of arousal is necessary to perform, change, and specifically learn optimally:

> "A certain amount of arousal can be a motivator towards change (with change in this discussion being learning). But too much or too little will work against the learner. You want

some mid-level point of arousal that provides the motivation to change (learn). Too little arousal has an inert affect on the learner, while too much has a hyper affect." (Clarck, 2004)

In addition, it has commonly been assumed that, there are two optimal level of arousal for learning two different tasks:

"There are optimal levels of arousal for each task to be learned:

- lower for more difficult or intellectually (cognitive) tasks
- higher for tasks requiring endurance and persistence

For example, the arousal level in a quality team training session must be quite high as it requires persistence and it is basically a low cognitive task. On the other side of the coin is an advanced algebra class. It is extremely high on the cognitive level, so arousal must be kept low as you need the learners' full attention on the subject matter - too much arousal and you overload them." (Clarck, 2004)

2.4.3.- REFLECTIONS

These are the main points of these two materials which have been studied:

RED:

• Too much exposure to the color red can cause stress; it may also cause frustration and provoke anger.

• It stimulates heartbeat and breathing. (Staff, 2013)

BLUE:

• Too much exposure to this color may cause depression.

• It is also proved that materials in blue color appear to be light in weight. (Staff, 2013)

"There are optimal levels of arousal for each task to be learned:

- lower for more difficult or intellectually (cognitive) tasks
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RESUMES OF SCIENTIFIC KNOWLEDGE

> "(…) the theory suggests that performance on any task will improve as arousal increases up to a certain optimum point. However, beyond that point further arousal will actually worsen performance. The suggestion is that at the extremes, at no arousal or incredibly high arousal, a person cannot perform a given task at all." (Shaw, 2016, p. 41)

So that, at the extremes, at no arousal or incredibly high arousal, the performance is impaired due to the strong anxiety.

Node is an individual concept or word in the brain that can be linked to one another to create complex ideas. So that, once we activate a node, the energy we send out to it can be conceptualized as radiating out from that original source and then activating other related nodes automatically. As an example; whenever you think about swimming, mostly you automatically activate memories which are associated to water, pool, and bathing suit. (Shaw, 2016, p. 68)

> "The primary function of the brain is to control movement and interaction with the environment. Humans, unlike other primates, have a belief in physical cause and effect which enables the acquisition of new interactions, and led to technology. Human children have causal beliefs as a developmental primitive, and these can be demonstrated even in infants. By contrast, behavioural studies requiring simple manipulations of the environment show that chimpanzees do not have such concepts. It is proposed that the evolution of causal thinking was essential for the development of tool use as it is not possible to make a complex tool without understanding cause and effect. The evolution of language may have been linked to the same process. It has been technology that resulted from causal beliefs that has made us human, not social interaction." (Pasternak, 2007, p. 164)

> "A strong case can be made that a key step in human evolution that made *Homo sapiens* different from other primates was the acquisition of causal beliefs. Without such beliefs it would not have been possible for technology, which is the main driver of human evolution, to develop. Causal beliefs are essential for making complex tools and planning ahead, and all other mammals, including non-human primates, lack these abilities." (Pasternak, 2007, p. 180)

> "Stress research has shown that states of sensory overstimulation or understimulation can trigger dysfunctions in the organism. This is often disregarded by designers. It is thus

important to adhere to one of the most important, fundamental rules of design that is, to integrate variation and stimulation into a visual order, and to create a balance between under- and overstimulation." (Meerwein, Rodeck, & Mahnke, 2007, p. 22)

Designers must consider the subject of over- and under stimulation precisely, because overstimulation can trigger physical or psychological changes.

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For example, the arousal level in a quality team training session must be quite high as it requires persistence and it is basically a low cognitive task. On the other side of the coin is an advanced algebra class. It is extremely high on the cognitive level, so arousal must be kept low as you need the learners' full attention on the subject matter - too much arousal and you overload them." (Clarck, 2004)

3 EXPERIMENTAL KNOWLEDGE

The experimental knowledge area does not present accurate and proven data. It merely demonstrates the process and the experiences that an individual has done. Then, presents his observations and analyzes or presents theories, essays, tests or studies that may results in something based on intuition. Chiefly, the themes presented in this part discusses the experiments and studies conducted to discover how color influences on our minds and bodies psychologically and physiologically, respectively.

3.1.- COLOR; THE SECRETE INFLUENCE

- Kenneth R. Fehrman, & Cherie Fehrman

Three chapters of this book have been studied. This book explores the vast and often hidden ways in which color affects our everyday lives. In this book, the influence of color in many aspects are discussed, such as; psychologically, physiologically culturally, and so on. Moreover, it emphasizes the importance of color controlling and its impacts on our emotions, color preferences, and perceptions. According to the experiments, by changing the saturation and value of the same color we will have different emotions and behaviours and even physiological changes toward that color. Furthermore, it argues color in textiles and apparel in order to understand the color in fashion better. The authors believe that to understand color in fashion we need to have at least a basic understanding of color's effect on the textile industry and dyeing process of textiles should be considered as well. Also, you will find a brief history of cosmetics. In addition, a chapter of the book discusses the symbolism and connotation of color in different cultures; ceremonies and religion, and so on. Also, a part of this chapter is allocated to the color vocabulary and talks about the researches have done to understand that which color terms precede another one in the history.

3.1.1.- COLOR AND PSYCHOLOGY - Chapter five

In this chapter, some experiments have been done regarding the relationship between color and psychology. According to many studies the authors (Fehrman & Fehrman, 2000) of this book have achieved some conclusions in every fields of color and psychology. This chapter discusses physiological aspect of color besides psychological aspects of it.

The authors mention studies that have been done by Humphrey on the reaction of humans toward colors:

> "(…) red is the most common color signal in nature, arising from the fact that red contrasts well with both green foliage and blue sky. Also, because it is the color of blood, it is

> easily accessible by animals for the purpose of changing their coloration. Problem arises from the ambiguity of its signal: It can signal either approach through sexual display or edible food, or it can signal avoidance through aggressive behavior or warning of a poisonous substance. According to Humphrey the response to red is a reflexive one, serving the purpose of preparing one to take some form of action that is defined by the context." (Fehrman & Fehrman, 2000, p. 101)

Most people believe that red is an exciting color while blue is calming. Regarding this assumption, some experiments have been done. "It was found that pigment colors of equal saturation and brightness resulted in comparable arousal and task performance scores; the result did not support the belief that red is more arousing than blue." (Fehrman & Fehrman, 2000, p. 102)

However, there may be a difference in the red and blue response, it is so important to consider the learned responses. So that, if we have learned to believe red is exciting, we will find it exciting. (Fehrman & Fehrman, 2000, p. 103)

Studies indicate that many factors influence color preference, such as; learned color bias, saturation or value of the color, interaction between light source, background color, contrast between colors in combination, size and placement of light sources, and cultural factors.

The authors (Fehrman & Fehrman, 2000) based on studies on color and emotion, discuss that colors have been stereotyped in terms of associations due to the learned behaviors. For example; most of the people equate red tones with excitement and activity while, blue tones with passivity and tranquility. Moreover, they believe that to understand colors we need to differentiate between the culturally learned color association and true biological responses, because they claim that colors themselves do not trigger emotions:

> "(…) colors do not contain any inherent emotional triggers. Rather, it is more likely that our changing moods and emotions caused by our own physiological and psychological makeup at the moment interact with color to create preferences and associations that we then link to the color-emotion response itself." (Fehrman & Fehrman, 2000, p. 108)

3.1.2.- COLOR IN FASHION AND TEXTILE DESIGN - Chapter nine

In this chapter discusses different subjects related to fashion, such as; Color Symbolism in Apparel, Color Trends in Fashion, Twentieth-Century Color in Apparel, Color in Cosmetics, and Color in Textiles. It is mentioned that, usually the textile manufactures make early important decisions to color, because the influential color apparel fashion field change faster than home furnishings, automotive, or kitchen appliance industries.

The authors indicate that the use of cosmetics is not something new. Body painting is found in many tribal communities. They have been using leaves, shells, feathers, tattoos, scars, and colored paint to change and enhance appearance. When ancient people began to use body paints for decorative purpose, they turn to cosmetics. (Fehrman & Fehrman, 2000, p. 224) Despite of a rebirth of natural cosmetics, nowadays, most cosmetics are made from synthetic pigments. According to this section of the book, in 1911 cosmetics gradually became socially acceptable for all woman:

> "Painted faces also arrived about this time. Suddenly, cosmetics were not just for ladies of the evening. With the introduction of rouge in 1911 "to protect a lady's skin against the coarsening effects of sun, wind and dust" from motoring, cosmetics gradually became socially acceptable for all woman. In 1912 Vogue magazine legitimized the use of cosmetics in its pages, and the first American lipstick in slide tubes appeared about 1915." (Fehrman & Fehrman, 2000, p. 208)

Furthermore, some guidelines mentioned to choose right tones of cosmetics according your complexion. So that, if you are blue-based, you will look best in cool colors. While, if you are yellow-based, warm colors suit you.

In the following part of this section the authors (Fehrman & Fehrman, 2000) consider colors effects in textile industry. The impact of textiles without pattern depends on two factors; color and texture. However light factor is so important whenever we are talking about texture. Because, light can affect how textured surfaces is presented. Furthermore, flicker is argued as annoying combination that happen when some colors pairs. Such as, red and green or cyan and orange flicker

when both colors have the same value and saturation. So that, they seem to flash when seen together. “Flicker is an attention-getting color device that is often used in advertising, packaging, or signage, but it is very irritating and unsuitable in textile, fashion, or interior design unless a particularly irritating effect is desired.” (Fehrman & Fehrman, 2000, p. 232)

In fashion and industry, color selection is determined by color consultants, who decide two or three years in advance on color palettes that are then adopted by industry. Since, clothing is dependent on textile industry, to understand color in fashion we need to have at least a basic understanding of color’s effect on the textile industry. Also, dyeing process should be considered in field of color in textiles. Initially, textiles were colored with pigments derived from natural sources. Whereas, In the late nineteenth century, dyes were synthesized, revolutionizing the textile and fashion industries. Color in fashion is always changing and fashions have a tendency to reappear every twenty to thirty years, when they may seem fresh again. Also, it is believed that, the colors of fashion show the sprite of their time and fashion reflects the changing influences at work on society. (Fehrman & Fehrman, 2000, p. 223)

3.1.3.- COLOR CULTURE AND SOCIETY - Chapter ten

This chapter discuses color connotation and symbolism in different cultures in various aspects such as; Ceremonies, Religion, Healing techniques, Amulets, Feng Shui, and Vocabulary**.**

Studies indicate that use of color in ancient and tribal civilizations arose not so much out of aesthetics but out of pigment availability, religion, and superstitions. Also, color use was functional and practical in that it was symbolic. The common cultural palette was simple: red, yellow, green, blue, purple (if available), and a range of neutral browns, white, and black. (Fehrman & Fehrman, 2000, p. 236) Weddings are ceremonies which are full of tradition and ancient color symbolism. Some tribes painted women’s faces red and white at marriage ceremonies and fertility rites to prevent the birth of monsters. Colors applied in some societies are different from other. For instance, red and yellow are the marriage hues of Egypt,

Asia, Russia, and the Balkans. Whereas, in Western countries white is most often used for bridal gowns. Moreover, black is the universal symbol of death among Western people with a few exceptions. (Fehrman & Fehrman, 2000, p. 240) Some primitive tribes even dyed their teeth black after the passing of a relative. Only in Egypt did black represent life, as a symbol of the fertile Nile mud. Colors associated with religion in many cultures are the spectral colors-red, yellow, orange, green, blue, and violet- seen in a rainbow which reminded people of God on earth. Also, purple was the most sacred color from early times, in part because it was so costly and difficult to obtain.

Colors in early cultures played a role of healing and the priests were also the healers. For example, in Tibetan medicine color plays an important role in healing. one ancient form of healing is reading the color of a person's aura and making necessary adjustments based on that. (Fehrman & Fehrman, 2000, p. 243) Many tribes have associations with talismans and amulets to protect them from evil or to make them stronger in battle. Talismans may include colored stones considered which is believed to have exceptional powers. Also, crystals and transparent golden amber represented the sun on the earth. (Fehrman & Fehrman, 2000, p. 245)

It is not known that how color terms develop exactly, but environment, culture, and economic growth undoubtedly play a large part. The basic color vocabulary of even the richest languages is fewer than a dozen words. Brent Berlin and Kay's as anthropologists studied on color terms in ninety-eight different languages and findings are revealed the following:

> "1. No language has only one color term; they all have at least two.
> 2. If there are three terms, the third is always red.
> 3. If there are four terms, green or yellow is added.
> 4. If there are five terms, green and yellow are added.
> 5. If there are six terms, blue is added.
> 6. If there are seven terms, brown is added
> 7. If there are eight or more terms, purple, pink, orange, and grey are always added, but they can occur in any order or combination." (Fehrman & Fehrman, 2000, p. 253)

Although, studies indicate that at the beginning of human communication, there were only two terms: black and white and gradually a name for red came into

use, still there are some confusion in color languages. So that, for instance; Melanesian, Welsh, Eskimo, and Tamil do not contain a word for brown at all, while Thais and Lapps call it black-red; neither ancient Greek nor modern Greek-Cypriot has any word for brown. In addition, in Japan the word for blue appears to be older than the word for green which is an exception to the usual evolutionary order. (Fehrman & Fehrman, 2000, pp. 253-254)

3.1.4.- DEVELOPMENT OF "COLOR AND PSYCHOLOGY"

Based on the studies Humphrey has done on the reaction of humans toward colors, response to red is reflexive:

> "(…) red is the most common color signal in nature, arising from the fact that red contrasts well with both green foliage and blue sky. Also, because it is the color of blood, it is easily accessible by animals for the purpose of changing their coloration. Problem arises from the ambiguity of its signal: It can signal either approach through sexual display or edible food, or it can signal avoidance through aggressive behavior or warning of a poisonous substance. According to Humphrey the response to red is a reflexive one, serving the purpose of preparing one to take some form of action that is defined by the context." (Fehrman & Fehrman, 2000, p. 101)

According a study that Gerad has done by using red and blue and white light in order to measure some physiological variables, indicates that statistical significant between the red and blue conditions for all physiological measures except heart rate. "Blood pressure was lower in the blue illumination than in the red and yielded a lower respiration rate and increased alpha wave frequency." (Fehrman & Fehrman, 2000, p. 101)

Gerad does caution the reader regarding the generalizability of his findings, because all the subjects conducted in this study are only men, which is not the population at large.

It is believed that, a better understanding of the impacts of color on humans can help us to improve the ability to perform tasks with greater accuracy and reduce stress an anxiety in environments and spaces. Therefore, many experiments have

been conducted to discover the colors effects and task performances. A study investigated the effect of interior pigment color (blue, red, or yellow) in task performance and arousal. In this study saturation and brightness of colors are precisely controlled. The result of this experiments is mentioned. “It was found that pigment colors of equal saturation and brightness resulted in comparable arousal and task performance scores; the result did not support the belief that red is more arousing than blue.” (Fehrman & Fehrman, 2000, p. 102)

However, there may be a difference in the red and blue response, it is so important to consider the learned responses. So that, if we have learned to believe red is exciting, we will find it exciting.

Studies indicate that many factors influence color preference, such as; learned color bias, saturation or value of the color, interaction between light source, background color, contrast between colors in combination, size and placement of light sources, and cultural factors.

In studies with adequate controls, it was found that the colors blue, green, and red were preferred in light tints over darker shades and that saturated colors were preferred over unsaturated colors. (Fehrman & Fehrman, 2000, p. 103) Additionally, background color is considered as the most important component of preference judgments due to contrast effect. So that, men were reported preferred blue, violet, and green while, women preferred colors in red, orange, and yellow range. Moreover, it was also found that value contrast was the most important factor for pleasant color harmony. So that, the greater the lightness contrast, the more the color combination was preferred. Also, the size and shape of light sources and their placement within a room have an affect on color preferences Furthermore, some believe that colors do not inherently contain exciting or calming effects. The arousal value of colors depends on the purity and intensity of the color, not the color itself. (Fehrman & Fehrman, 2000, p. 105)

The authors (Fehrman & Fehrman, 2000) based on studies on color and emotion, discuss that, colors have been stereotyped in terms of associations due to the learned behaviors. For example, most of the people equate red tones with excitement and activity while, blue tones with passivity and tranquility. Also, they believe that to understand colors we need to differentiate between the culturally

learned color association and true biological responses, because, they claim that colors themselves do not trigger emotions:

> "colors do not contain any inherent emotional triggers. Rather, it is more likely that our changing moods and emotions caused by our own physiological and psychological makeup at the moment interact with color to create preferences and associations that we then link to the color-emotion response itself." (Fehrman & Fehrman, 2000, p. 108)

Another area in which color plays an important role is effects of color on flavor. In which, color can outweigh the impression made by flavor. People mostly attribute sweetness and grater flavor to orange, red, white and pink foods and wines perceived sweetest when they are pink or white, whereas when they are yellow, brownish or purple perceived less sweet. Although, typically foods are rarely judged solely by colors, foods that are identified with a specific color are rejected if the color differs from what is expected. For example; foods in the blue-green range is rejected due to our inherent suspicion of molds. Since nature does not create blue food, expect blueberries, we do not have appetite toward blue-green foods. Also, blue, purple and black were the sign of poisonous fruits for our ancestors, which worked as warning signal for lethal food. (Fehrman & Fehrman, 2000, p. 109) Moreover, studies on orange color indicated that, people prefer orange juice color even oranger over natural orange juice. Also, red in known as a color which has a strong association with flavor. Besides, golden brown is associated with appetizing bakery products. Hence, this is the reason why almost bakery goods are packaged in some type of golden brown wrapping. White in foods is associated with refinement and delicacy and dark-colored foods are often preferred by men which is associated with strong flavor and spiciness. (Fehrman & Fehrman, 2000, p. 110) Overall, food color conditioning starts as we are born and it is not easy to break this habit. It only can be changed and altered by education and training.

Color and temperature perception is another feature of associations of color which is discussed in this chapter. A well-controlled study indicates that there is a strong relationship between colors and perceived temperature. So that, in the experiment subjects felt significantly warmer in the modified chamber during two-hour exposure periods. However, these responses were psychological and there

were no physiological changes on skin temperature. Therefore, it is possible to design a space by a specific color in order to have effects on thermal condition, but it is important to consider the fact that, the perception of temperature changes by colors are strictly a psychological phenomenon and it is not accompanied by physiological effects on our bodies temperature. (Fehrman & Fehrman, 2000, p. 112)

In addition, color in associated with weight as well. So that, researches demonstrate that, the brighter the color, the lighter in weight it was judged. Brightness and saturation of colors may be employed to communicate perceptual impression of weight. The important point to consider is that, control the variables or the lack of them in studies, can turn out different results. (Fehrman & Fehrman, 2000, p. 113)

Color in an interior environment plays a crucial role in order to change our perceived spaces. So that, by applying different colors we can alter people's perception in distance and spaciousness. For decades, design students have been taught that warm colors advance and cool colors recede, but a research conducted on this subject claims that, the operative factor in advancing and receding colors appears to be the contrast between colors and their backgrounds rather than the colors themselves. So that, objects showing high contrast with their background will be judged as standing out from the background and therefore nearer. (Fehrman & Fehrman, 2000, p. 114)

Studies demonstrate that, through the process of living we expect to see certain things with certain colors. Experiments claim that, our visual system is able to ignore changing conditions of light and to keep our learned expectations of color, even under adverse conditions. For instance, if a lemon is bathed in red light, it should appear much redder. however, we will continue to see the lemon yellow. The reason is that, part of our visual process is of learned responses. Therefore, we expect a lemon to be yellow, even if lighting condition change. (Fehrman & Fehrman, 2000, p. 119)

3.1.5.- REFLECTIONS

Here are the main points of chapter five:

> "(…) red is the most common color signal in nature, arising from the fact that red contrasts well with both green foliage and blue sky. Also, because it is the color of blood, it is easily accessible by animals for the purpose of changing their coloration. Problem arises from the ambiguity of its signal: It can signal either approach through sexual display or edible food, or it can signal avoidance through aggressive behavior or warning of a poisonous substance. According to Humphrey the response to red is a reflexive one, serving the purpose of preparing one to take some form of action that is defined by the context." (Fehrman & Fehrman, 2000, p. 101)

"It was found that pigment colors of equal saturation and brightness resulted in comparable arousal and task performance scores; the result did not support the belief that red is more arousing than blue." (Fehrman & Fehrman, 2000, p. 102)

However, there may be a difference in the red and blue response, it is so important to consider the learned responses. So that, if we have learned to believe red is exciting, we will find it exciting.

Some believe that colors do not inherently contain exciting or calming effects. The arousal value of colors depends on the purity and intensity of the color, not the color itself. (Fehrman & Fehrman, 2000, p. 105)

> "colors do not contain any inherent emotional triggers. Rather, it is more likely that our changing moods and emotions caused by our own physiological and psychological makeup at the moment interact with color to create preferences and associations that we then link to the color-emotion response itself." (Fehrman & Fehrman, 2000, p. 108)

People mostly attribute sweetness and grater flavor to orange, red, white and pink foods and wines perceived sweetest when they are pink or white, whereas when they are yellow, brownish or purple perceived less sweet. (Fehrman & Fehrman, 2000, p. 109)

It is possible to design a space by a specific color in order to have effects on thermal condition, but it is important to consider the fact that, the perception of temperature changes by colors are strictly a psychological phenomenon and it is not accompanied by physiological effects on our bodies temperature. (Fehrman & Fehrman, 2000, p. 112)

Color and temperature perception is another feature of associations of color which is discussed in this chapter. A well-controlled study indicates that there is a strong relationship between colors and perceived temperature. So that, in the experiment subjects felt significantly warmer in the modified chamber during two-hour exposure periods. However, these responses were psychological and there were no physiological changes on skin temperature. Therefore, it is possible to design a space by a specific color in order to have effects on thermal condition, but it is important to consider the fact that, the perception of temperature changes by colors are strictly a psychological phenomenon and it is not accompanied by physiological effects on our bodies temperature. (Fehrman & Fehrman, 2000, p. 112)

3.2.- ARTICLES AND WEBSITES

Some articles and websites which are summarized in this section present studies and experiments conducted on the impacts of color on human's body and emotion. Moreover, the factors which influence our reactions towards colors are discussed. Such as, color preferences, luminosity of the color, culture. Additionally, the factors which result in variation in color preferences are mentioned. Furthermore, some materials which have been selected to place in this set of summaries discuss the critical role of color in marketing and branding. Through experiments, it explains how the choice of color for a product is important. Besides, factors which influence on buying an article is argued. As an example; the impact of the background color of a product is examined, which results in interesting outcomes. Additionally, the role of applying various colors for logos and branding is presented.

3.2.1.- STUDY ON PHYSIOLOGICAL RESPONSES TO COLOR STIMULATION

- H.-R. Jin, M. Yu, D.-W. Kim, N.-G. Kim, & S.-W. Chung

This paper discusses an experiment to define physiological responses towards color stimulation. According to this article, color preferences affect on our physiology and psychology reaction toward a color stimulus:

> "Professional papers and previous works state that, universally, warm colors help to activate the sympathetic nerve system, while cold colors affect the parasympathetic nerve system. However, this experiment shows that by adjusting color luminosities to fit preferred levels of individual test subjects rather than using the typical color luminosities and stimulating with the adjusted colors, warm colors do positively affect the parasympathetic nerve system to calm the body and mind through the emotional adjective evaluation and the physiological signal measurement evaluation. This means that physiological and psychological reactions from colors can be assessed differently through the preferred color or luminosity of the user." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1969)
>
> "Color is a wavelength of light transmitted through our eyes. It affects secretions of hormones, reactions to stresses, the autonomic nervous system and the cerebral cortex where

emotions are located, ultimately affecting a large part of our life and the quality of our life. Lately, research has found that light received by the eyes could travel to the hypothalamus and hypophysis pineal body, and affects metabolism and genitals." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1971)

"Sight is information perceived through, color which makes up a significant part of the information received by the five senses, and transmitted to the brain. Also, skin sensation is said to receive color waves and possibly can distinguish between colors. Therefore, a person with a visual impairment, a cataract, or color blindness, can also receive energy from color in the same way that a non-impaired person does. The effect of colors on physiological functions has been effectively used as a color therapy for some time in various medical fields. By stimulating psychological emotion with color, medical circles are using color as an effective method of treatment." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

It is claimed that, there is a relationship between culture and physiological aspects of color, so that they enhance each other:

"The effects of color are generated by acculturation and physiological factors, and these two factors strengthen each other. Red, a color with the longest wavelengths, is a stimulating color that captivates eyes faster than any other colors. Colors with a short wavelength calm the mind. Actually, blue colors decrease blood pressure, pulse, and respiratory rate. The physiological characteristics of colors develop cultural associations that strengthen its effect even more." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

"(…) because humans react to colors psychologically, physiologically, physically, and sociologically, consumers' emotions and needs in terms of products and living environments must be scientifically and objectively analyzed when designing with color (…)." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

The research in this article argues that, red is appeared to have the most effect on emotional changes. So that, there are no significant changes with the other colors (orange, yellow, green, blue and purple). Therefore, red is the color that most stimulates human emotion.

3.2.2.- THE INFLUENCE OF COLOR ON PHYSIOLOGICAL RESPONSE

- S. Freiders, S. Lee, D. Statz, & T. Kim

Based on this article, by comparing neural activities and heart rate toward colored flowers and gray flowers the result shows no significant changes which is mentioned below:

> "We hypothesize that colors in nature that signal danger will increase the physiological variables like heart rate, brain activity, and retinal focus. Whereas the colors in nature that are non-threatening will decrease the heart rate, brain activity, and retinal focus or produce no changes. According to our analysis, the change in neural activity and heart rate between colored flowers and the grey-scaled flowers was insignificant." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

"It is evident that we associate colors with our emotions and this could be due to the fact that emotions and color vision are both processes of the right hemisphere." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

According to a hypothesis, there is a genetic preposition for color so that, based on this theory studies conducted to find out people's color preferences:

> "(…) there is another hypothesis that suggested color preferences are wired into our brains from selection. The hypothesis proposes that some colors send an "approach" signal while others send an "avoid" signal. These signals are "deeply ingrained natural color signals" that have improved survival of early humans." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

The authors of this article (Freiders, Lee, Statz., & Kim) explain why people prefer certain colors and lists the factors influence on color preferences:

- Different age
- Different cultures
- Life experience
- Genetic

> "Within different age groups, one study found that young children and adults have different attitudes about colors and the value of emotions. Seven year olds found yellow to be

appealing and green to be unappealing whereas adults found the reverse to be true." (Freiders, Lee, Statz, & Kim, n.d., p. 2)

According to an experiment, some participants from different countries were asked to associate emotions with colors. The result is shown in the following paragraph:

"(…) there is a greater cross cultural agreement with colors associated with fear and anger than colors associated with jealousy and envy. The researchers claim that these associations are based on cultural and life experiences along with the genetics of the participants, which is similar to the hypotheses above." (Freiders, S, D., & T., n.d., p. 2)

3.2.3.- RESPONDING TO COLOR

- Linda Adler

The way we perceive colors changes as we get older, so it is important to consider these changes while we are designing something:

"An increase in accuracy of color discrimination occurs between the ages of two and six. Generally, it is not until age fifteen that youth can discriminate colors as accurately as adults. Peak discrimination occurs between about ages 20 to 30 years and then may become less accurate and glare sensitivity may increase, especially around age 65." (Adler, 1999, p. 1)

Studies on color, vision and age claims that, there is a 70% decline in color matching by age 60 and additional 56% change by age 80:

"There is a decrease in the ability to distinguish different colors at the blue end of the spectrum where colors are closely related. This is thought to be due to the yellowing of the eye lens. Older persons tend to perceive bright, deep colors as lighter. They are able to see yellow, orange, and red more easily than darker colors at the blue end." (Adler, 1999, p. 1)

"Some evidence suggests that the light of different colors enters the eye and indirectly affects the hypothalamus, which in turn affects the pituitary gland. The

pituitary gland controls the hormone levels and perhaps thus our moods." (Adler, 1999, pp. 1-2)

"Some experiments have suggested that color may influence our emotions. One experiment showed that in a room colored in red light, time was overestimated while in green or blue light, time was underestimated." (Adler, 1999, p. 2)

In additions, it is mentioned that, some studies reveal the connection between color and physical reactions:

> "One explanation suggests that light may reach the hypothalamus that controls nerve centers and body functions such as heart action and respiration. The wave length and energy of each color varies with the intensity and this in turn affects us in different ways." (…)
>
> "Color may bring about a reflex action on the vascular system, but this may be brought about through feelings and emotions. Some studies indicate that red tends to increase perspiration, excite brain waves and raise the blood pressure, pulse rate, and respiration. Noticeable muscular reaction or tension and greater frequency of eye blinks result. Blue tends to have a reverse effect by lowering blood pressure and pulse rate. Brain waves tend to decline and skin response is less. Reactions to orange and yellow are similar to red, but less pronounced. Reactions to violet are similar to blue." (Adler, 1999, p. 2)

The length of time of exposure is also a factor which should be considered while choosing a color in a space:

> "However, the effects of color appear to be temporary. When exposed to strong areas of any color, there generally is an immediate reaction that can be measured with an instrument, but after a length of time, body response may fall to or below normal. So whether or not red is an "exciting" color may depend on the length of time a person is exposed to it." (Adler, 1999, p. 2)

"Some color authorities suggest that emotional excitements indicated through the physical changes in blood pressure, pulse frequency and rhythm are the result of association of colors with memories." (Adler, 1999, p. 2)

Adler (1999) indicates that color preferences differs in different ages:

- Children up to age three tend to prefer bright, primary colors over pastels, and favor bright luminous colors such as red, orange, pink and yellow.

• Early preschool years: Color is preferred over black and red is preferred.
• Interest in cooler colors increases as children grow older and preferences for high intensity decreases.
• Maturity: A greater liking for the colors in shorter wavelengths such as blue and green than for colors of longer wavelengths such as red, orange, and yellow.
• Adults: blue and less preference for yellow or yellow-red.
• Age 65-90: Prefer bright colors to pale pastels. This may relate to the physical changes in the eye.

Moreover, emotions are associated with various colors and they vary according to some factors, such as; individuals, cultures, learned responses, and amount of the value and intensity of a color. It is experimented that, due to the synesthetic aspect of color, perception of temperature and noise can be perceived differently by various colors.

> "In using color, extensive monotony can lead to under-stimulation and therefore anxiety, and extreme complexity to over-stimulation. A balanced approach and a variety of color is suggested. One color does not satisfy all the physical and emotional needs in our environment." (Adler, 1999, p. 4)

3.2.4.- IT'S A COLOR-CODED WORLD

- Jeri Smith

"Consumers have long been trained to associate certain colors with specific brands." (Smith, 2015, p. 18)

> "One of the biggest challenges for brand marketers is to generate instantaneous brand recognition whenever their target consumers encounter the brand, whether in advertising, in store or other via other touch points. Owning color can prompt brand identification, allowing consumers to know how to find the product and instantly recognize it." (Smith, 2015, p. 18)

The author introduces some ways in order to create linkage between your brand and color:

- "Choose a color that is unique within the category
  "once a brand "owns" a color, no one thinks about color psychology or color preferences."
- Use the color aggressively and consistently
  "Having a purple logo isn't enough—everything about the brand should reinforce purple: the packaging, the dominant color within its advertising materials, the color of the clothing worn by the actors in commercials, the trucks, the uniforms of company representatives. Everything."
- Take ownership of a color.
  (…) the more a brand invests initially, the faster it will build the link between the brand and the brand's color—and the faster the benefits will begin to accrue." (Smith, 2015, p. 18)

3.2.5.- BRANDING WITH COLOUR

- Sam Robertson

This article argues the importance of color in banding, which conveys the message of the brand:

> "All brands have a story to tell, and colour is the first sensory touch point that signals to the consumer what that story is all about. Colour is a visual shortcut for brands to communicate their values and their promise (…)." (Robertson, 2012, p. 78)

"All visual imagery can be made more meaningful and memorable through the use of colour. According to our research, effective use of colour increases brand recognition by 50 to 85 per cent. " (Robertson, 2012, p. 78)

"Colour ignites an instant and instinctive reaction, inducing moods and emotions, influencing behaviour and subtly communicating a variety of information (…)" (Robertson, 2012, p. 78)

The author of this article indicates that, the brand colors express the personality of the company:

> "The colour in a brand should create positive feelings. When I look at a brand or a website I want to feel happy. Colour brings out emotions and it's important that the brand colours express the personality of the company. Your brand colours should also appeal to your customer, it's important to always have them at the front of your mind when selecting your colour palette." (Robertson, 2012, p. 78)

It is believed that, a successful brand logo is a happy marriage of shapes, symbols and colours.

"Colour often becomes the brand identifier that reinforces the brand image in the marketplace. Many leading brands are so linked to specific hues that they are primarily recognized by their brand colour or colours (…)." (Robertson, 2012, p. 78)

One of the factors which cause to make a product successful is consistency of the color: "The Coca-Cola red has become so iconic because of the vast nature of Coca-Cola advertising and the consistent use of the colour over the years." (Robertson, 2012, p. 78)

"Colour acts as a strong identifier, an unusual or unexpected colour can give you character for how that brand wants to be perceived." (Robertson, 2012, p. 78)

The author believes that, all colors might be proper for everything, you just need to dare do it: "All colours can be appropriate for anything. When a certain colour is deemed inappropriate, and then someone deploys it anyway and success follows, all other brands start to wish they had been brave enough (…)." (Robertson, 2012, p. 80)

Moreover, it is important to consider the symbolism and connotations of color in culture and country you are working in, in order to choose the right color for your brand:

> "(…) most countries in the Western World associate white with innocence, purity and cleanliness. However, in East Asia, it is recognized as a symbol for death, and in the UK, it can also be recognized as being 'dull.' In the US, green has the negative connotation of envy, whereas in Japan, it is positively associated with love and happiness. Grey communicates inexpensive in China and Japan, while in the United States it is associated with expensive as well as high and dependable quality." (Robertson, 2012, p. 80)

"While colour psychology can certainly help when it comes to choosing colour, it's also important to look at a brand's position in the market, its competitor's use of colours and current colour trends (…)." (Robertson, 2012, p. 80)

"Colour is tricky to get right simply because it is such an emotional response. It helps to be clear about your goals for the brand and its use of colour." (Robertson, 2012, p. 80)

"We need to always have consistency of colour in a brand, and when using colour, we need to create a palette of colours for a brand not just one single colour." (Robertson, 2012, p. 80)

> "It is also important not to overuse colour as it becomes saturated and loses its more subtle associations, particularly if it's bright. "Using colour selectively can give it more impact. For example, the lively orange of Hermes is used only on certain aspects of the branding such as the packaging, ensuring the colour is not over exposed which gives more exclusivity and status."" (Robertson, 2012, p. 80)

3.2.6.- COLOR SELLS: HOW THE PSYCHOLOGY OF COLOR INFLUENCES CONSUMERS

- Sarah Tornetta, Tess Fox, & Jordan Blackbird

It is believed that, color plays a significant role in choosing a product. "Color sells products. It is a powerful marketing tool that significantly influences consumer purchases, so much so that it accounts for 85% of the reason why someone decides to purchase a product." (Tornetta, Fox, & Blackbird, 2013, p. 2)

"While no single set of rules governs color choices, research has established general guidelines based on the principle of associative learning, the relationship between color and emotion." (Tornetta, Fox, & Blackbird, 2013, p. 2)

"Hue is the wavelength of a color and determines its label, such as orange or green. Saturation is the intensity of a color, or, how pigmented a color is. Value is how bright a color is. Together, these three factors determine how people perceive color and thus the associations they form with it." (Tornetta, Fox, & Blackbird, 2013, p. 2)

“The study also reports that the brighter a hue, the more positively it is perceived. This research shows that some colors have stronger associations than others, which is important to keep in mind when designing the package for a product.” (Tornetta, Fox, & Blackbird, 2013, p. 3)

By implementing color associations in package designs we can increase products sales by conveying the message of the product to consumers, “Crest 3D Whitestrips, for example, consists primarily of blue. Blue is associated with cleanliness, emphasizing the product’s promise of clean, white teeth. White’s association with purity makes it the ideal accent color.” (Tornetta, Fox, & Blackbird, 2013, p. 3)

Authors discuss ways to establish brand recognition with color:

• “The key is consistency; the same colors must be present across all facets of a company. For example, a company’s website should be visually relatable to its store and consumer products.” (Tornetta, Fox, & Blackbird, 2013, p. 3)

• “Once a company succeeds at establishing brand recognition, it can temporarily manipulate trademark colors to add interest to a product.” (Tornetta, Fox, & Blackbird, 2013, p. 4)

Brand image with color show the personality of the brand and the company:

• “Color does more than establish brand recognition. It also conveys traits about a company and reflects a company’s personality, or, brand image.” (Tornetta, Fox, & Blackbird, 2013, p. 4)

• “Companies choose colors for their logos and store designs not just because they look good, but to communicate specific qualities about a service or product.” (Tornetta, Fox, & Blackbird, 2013, p. 4)

Colors can reflect the type of the consumer:

"While some color associations appear to be strongly rooted, a lot depends on the personality, age, gender, and cultural background of the consumer." (Tornetta, Fox, & Blackbird, 2013, p. 5)

> "Different shades of color appeal to specific personality types of shoppers. Fast food restaurants and clearance sales use stimulant colors like red, orange, and black to illicit a sense of urgency in impulse buyers. Retail clothing stores use lighter colors like pink and sky blue to evoke a calm, soothing experience for traditional shoppers who prefer to browse through items at a leisurely pace." (Tornetta, Fox, & Blackbird, 2013, p. 5)
>
> "Color preferences also vary depending on age and gender. Research findings reveal that 76% of women prefer cool colors compared to 56% of men. Men also prefer orange to yellow, while women prefer yellow to orange. Men's favorite colors include blue, black, brown, green, and red, while women like blue, orange, yellow, purple, green, and red the best. Color preferences and emotional connections to color also change with age. For example, 7-year olds prefer the color yellow much more so than adults." (Tornetta, Fox, & Blackbird, 2013, p. 5)
>
> "(…) it is important to recognize that color trends are not permanent, and can fluctuate over an extended period of time. Therefore, it is important to stay up to date with current marketing research on color in order to make the best decisions for a company." (Tornetta, Fox, & Blackbird, 2013, p. 6)

3.2.7.- THE EFFECT OF BACKGROUND AND AMBIENT COLOR ON PRODUCT ATTITUDES AND BELIEFS

- Susan E. Middlestandt

This study examines the effect of background color of products on customer's attitudes and beliefs. "Background color was used as the independent variable because, like music, it appears to be an aspect of the communication and exposure situation which carries little explicit information about the product." (Middlestandt, 1990, p. 244)

"In this study, respondents presented with a slide of a pen against a blue background exhibited a more positive attitude toward buying the product than those shown the same pen against a red background." (Middlestandt, 1990, p. 244)

“Gorn presented a product with liked or disliked music. He found that the product associated with the liked music showed a significantly higher preference in comparison to the product associated with the disliked music.” (Middlestandt, 1990, p. 244)

“like music, color would be expected to affect how people respond to products. And, like background music, background color does not convey explicit product information but seems to represent affectivity and emotion.” (Middlestandt, 1990, p. 245)

“In the present study, three products were presented against blue and red backgrounds. It was expected that a difference in attitude toward buying the product would be found between these two color conditions.” (Middlestandt, 1990, p. 245)

Three products presented against blue and red background were a pen, a mineral water bottle, and a perfume. The result is mentioned below:

> “There were no significant effects of the color manipulation on attitudes or beliefs with respect to two of the products, the perfume and the mineral water. Therefore, this report focuses on the effects of color on the respondents' ratings of the pen.” (Middlestandt, 1990, p. 246)
>
> “Thus, color had a significant effect on attitude toward buying the pen pictured in the slide. Compared to the red condition, those exposed to a pen against a blue background with blue ambient color held a more positive attitude toward buying the product.” (Middlestandt, 1990, p. 246)
>
> “The background and ambient color had the strongest effect on two beliefs, buying the pen means buying something which is elegant and which is unique. Compared to those in the red condition, those in the blue condition believed it more likely that the pen was elegant as well as unique.” (Middlestandt, 1990, pp. 247-248)
>
> “Although not statistically significant, it is interesting to note that the pen presented in the blue condition was perceived to be more likely to be expensive (overall, a slightly negative consequence) than the pen presented in the red condition. Thus, exposure to the pen in the blue condition did not invariably lead to more positive evaluative implications.” (Middlestandt, 1990, p. 248)
>
> “However, the data presented here do demonstrate that subtle differences in how a product is presented, differences which do not appear to involve product information, do produce differences in beliefs about the product. Thus, belief-based change remains a viable explanation for the observed changes in product attitude.” (Middlestandt, 1990, p. 248)

3.2.8.- EXCITING RED AND COMPETENT BLUE: THE IMPORTANCE OF COLOR IN MARKETING

- Lauren I. Labrecque & George R. Milne

This paper examines how color impacts consumer's perceptions based on a series of four studies.

"(…) color can shape consumer perceptions such as brand personality, familiarity, likability, and purchase intent." (Labrecque & Milne, 2012, p. 711)

> "Naturally, other non-color aesthetic stimuli, such as logo shape or sound, can activate other brand associations, which together with color inform consumers about the brand's personality.
>
> (…) if a consumer encounters a branding message (e.g., brand logo) for a known brand, these two cues (color and brand) become activated in memory and together influence brand perceptions.
>
> (…) if a consumer encounters a new brand logo, there are no relevant brand associations existing in memory, and the resulting personality perception is primarily based on activated associations triggered by the referential meaning of the color." (Labrecque & Milne, 2012, p. 713)

This paper mentions some hue hypotheses and individual characteristics of each color:

> "White, being the total reflection of all colors, can be linked to sincerity as it is associated with purity, cleanness, simplicity, hygiene, clarity, and peace and is also associated with happiness. Yellow taps the cheerful facet of sincerity as it generally elicits feelings of optimism, extraversion, and friendliness and happiness and cheerfulness. Pink can also be linked to the dimensions of sincerity as it is considered nurturing, warm, and soft." (Labrecque & Milne, 2012, p. 714)

> "The color red can be linked to excitement as it is considered an arousing, exciting, and stimulating color. It is generally associated with the characteristics of activity, strength, and stimulation and is considered up-to-date." (…)
>
> "Research has consistently shown that longer wavelength hues (e.g., red, orange, yellow) induce states of arousal and excitement." (…)

"Orange is arousing and exciting, although it is less so than red, and it is considered lively, energetic, extroverted, and sociable Having a medium-long wavelength, yellow also holds qualities of arousal and excitement, but less so than red." (…)

"Blue is linked to competence, as it is associated with intelligence, communication, trust, efficiency, duty, and logic. It is also seen as a secure color. Likewise, brown is a color that is related to seriousness, reliability, and support." (…)

"Black stands for sophistication and glamour. It is a very powerful color that signals power, stateliness and dignity. In the fashion world, black expresses status, elegance, richness, and dignity (e.g., black limousines, black tie events, little black dresses, tuxedos, suits)." (…)

"Likewise, purple is a color that also connotes luxury, authenticity, and quality. Purple is also seen as a dignified and stately color, which is likely due to its historical past as a color reserved for royalty and to connote social roles. Pink can also be linked to the sophistication dimension as it is considered soft and feminine, which are aspects of the charming facet. Like pink, purple is considered a feminine color." (…)

"Brown can be linked to ruggedness through associations of seriousness, nature, earthiness, reliability, support and protection. Green's primary association with nature creates feelings of security and a connection with the outdoors." (Labrecque & Milne, 2012, p. 714)

"Hue describes segments of wavelengths in the visible spectrum; red has the longest wavelength (700–630 nm) and violet the shortest (450–400 nm)." (Labrecque & Milne, 2012, p. 715)

The first study is to examine the relationship between hue, which refers to the wavelength of a color and brand personality in the context of logo design. The results of this study are indicated below:

"The perceived sincerity of a brand is positively affected by the presence of white, and yellow, and pink hues." (…)

"The perceived excitement of a brand is positively affected by the presence of red, orange, and yellow hues." (…)

"The perceived competence of a brand is positively affected by the presence of blue and brown hues." (…)

"The perceived sophistication of a brand is positively affected by the presence of black, purple, and pink hues." (…)

"The perceived ruggedness of a brand is positively affected by the presence of brown and green hues." (Labrecque & Milne, 2012, p. 714)

The results of the second study, which is the correlation between saturation and value, are mentioned following:

“These results illustrate that saturation and value influence brand personality and can be used in conjunction with hue to help determine appropriate brand personality decisions.” (Labrecque & Milne, 2012, p. 719)

The results follow these hypotheses:

Saturation and value influence brand personality perceptions.

> “High saturation increases arousal and excitement; high (versus low) levels of saturation exhibit a positive relationship with the excitement dimension of brand personality.” (…)
>
> “Saturation has a positive relationship with the ruggedness dimension of brand personality.”(…)
>
> “Value has a negative relationship with the ruggedness dimension of brand personality.” (Labrecque & Milne, 2012, p. 717)

The third study conducts on personality of a brand by changing the package color. The result of the study mentioned following:

“A product package with a low saturation, high value purple hue will be perceived as more sophisticated than an identical package with a high saturation, low value red hue.” (Labrecque & Milne, 2012, p. 720)

“A product package with a high saturation, low value red hue will be perceived as more rugged than an identical package with a low saturation, high value purple hue.” (Labrecque & Milne, 2012, p. 714)

“Consumer brand personality perceptions of product packages that match a preferred brand personality dimension will lead to higher purchase intentions.” (Labrecque & Milne, 2012, p. 714)

3.2.9.- COLOR RED INCREASES THE SPEED AND STRENGTH OF REACTIONS

- A. J. Elliot, & H. Aarts

This study indicates that when we see red our strength and the power become more and it enhances our physical reactions:

> "(…) when humans see red, their reactions become both faster and more forceful. And people are unaware of the color's intensifying effect." (…)
>
> "The findings may have applications for sporting and other activities in which a brief burst of strength and speed is needed, such as weightlifting. But the authors caution that the color energy boost is likely short-lived." (Elliot & Aarts, 2011)

An experiment has been conducted which shows that how red increases our power:

> "The study measured the reactions of students in two experiments. In the first, 30 fourth-through-10th graders pinched and held open a metal clasp. Right before doing so, they read aloud their participant number written in either red or gray crayon. In the second experiment, 46 undergraduates squeezed a handgrip with their dominant hand as hard as possible when they read the word "squeeze" on a computer monitor. The word appeared on a red, blue, or gray background.
>
> In both scenarios, red significantly increased the force exerted, with participants in the red condition squeezing with greater maximum force than those in the gray or blue conditions. In the handgrip experiment, not only the amount of force, but also the immediacy of the reaction increased when red was present." (Elliot & Aarts, 2011)

3.2.10.- THE PSYCHOLOGY OF COLOR IN MARKETING AND BRANDING

- Gregory Ciotti

"(…) it is important for new brands to specifically target logo colors that ensure differentiation from entrenched competitors (if the competition all uses blue, you'll stand out by using purple)" (Ciotti, 2016)

"When it comes to picking the "right" color, research has found that predicting consumer reaction to color appropriateness in relation to the product is far more important than the individual color itself." (Ciotti, 2016)

“There is a real connection between the use of colors and customers’ perceptions of a brand’s personality.” (Ciotti, 2016)

“(…) it’s far more important for your brand’s colors to support the personality you want to portray instead of trying to align with stereotypical color.” (Ciotti, 2016)

“It’s important to note that one’s environment—and especially cultural perceptions—plays a strong role in dictating color appropriateness for gender, which in turn can influence individual choices.” (Ciotti, 2016)

> “Additional research in studies on color perception and color preferences show that when it comes to shades, tints and hues men seem to prefer bold colors while women prefer softer colors. Also, men were more likely to select shades of colors as their favorites (colors with black added), whereas women were more receptive to tints of colors (colors with white added).” (Ciotti, 2016)

3.2.11.- COLOR & BRANDING, COLOR DESIGN AND PSYCHOLOGY FOR BRANDING

- Jill Morton

> “Marketing experts define "brand" as the "name, term, sign, symbol or design, or a combination of them intended to identify a company's products or services." In other words, a brand communicates the "idea" of company or product. This is what forms the connection with consumers.” (Morton, 2012)

“Brands and color are inextricably linked because color offers an instantaneous method for conveying meaning and message without words.” (Morton, 2012)

“Color is the visual component people remember most about a brand followed closely by shapes/symbols then numbers and finally words.” (Morton, 2012)

It is mentioned that there are two kinds of color symbolism for branding:

1. Natural and Universal Color Symbolism for Brands

2. Creative and Imaginative Color Symbolism, which are brands that break color traditions. Such as, T-Mobile's magenta that is an unexpected color in the crowded cellular communications marketplace. (Morton, 2012)

3.2.12.- THE MEANINGS OF BLUE

- Jill Morton

“Blue is the favorite color of all people. It’s nature’s color for water and sky, but is rarely found in fruits and vegetables.” (Morton, 2012)

“[Blue] is cold, wet, and slow as compared to red’s warmth, fire, and intensity. Blue has more complex and contradictory meanings than any other color.” (Morton, 2012)

The author mentions different associations with different shades of color:

“Dark blue: trust, dignity, intelligence, authority

Bright blue: cleanliness, strength, dependability, coolness (The origin of these meanings arise from the qualities of the ocean and inland waters, most of which are more tangible.)

Light (sky) blue: peace, serenity, ethereal, spiritual, infinity (The origin of these meanings is the intangible aspects of the sky.)” (Morton, 2012)

“Blue has very few connections to taste or smell. Therefore it may act as an appetite suppressant.” (Morton, 2012)

3.2.13.- REFLECTIONS

These are the main points of all the articles and websites which have been studied:

"(…) physiological and psychological reactions from colors can be assessed differently through the preferred color or luminosity of the user." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1969)

> "(…) skin sensation is said to receive color waves and possibly can distinguish between colors. Therefore, a person with a visual impairment, a cataract, or color blindness, can also receive energy from color in the same way that a non-impaired person does. The effect of colors on physiological functions has been effectively used as a color therapy for some time in various medical fields. By stimulating psychological emotion with color, medical circles are using color as an effective method of treatment." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

> "The effects of color are generated by acculturation and physiological factors, and these two factors strengthen each other. Red, a color with the longest wavelengths, is a stimulating color that captivates eyes faster than any other colors. Colors with a short wavelength calm the mind. Actually, blue colors decrease blood pressure, pulse, and respiratory rate. The physiological characteristics of colors develop cultural associations that strengthen its effect even more." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

> "(…) there is another hypothesis that suggested color preferences are wired into our brains from selection. The hypothesis proposes that some colors send an "approach" signal while others send an "avoid" signal. These signals are "deeply ingrained natural color signals" that have improved survival of early humans." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

> "Color may bring about a reflex action on the vascular system, but this may be brought about through feelings and emotions. Some studies indicate that red tends to increase perspiration, excite brain waves and raise the blood pressure, pulse rate, and respiration. Noticeable muscular reaction or tension and greater frequency of eye blinks result. Blue tends to have a reverse effect by lowering blood pressure and pulse rate. Brain waves tend to decline and skin response is less. Reactions to orange and yellow are similar to red, but less pronounced. Reactions to violet are similar to blue." (Adler, 1999, p. 2)

> "However, the effects of color appear to be temporary. When exposed to strong areas of any color, there generally is an immediate reaction that can be measured with an instrument, but after a length of time, body response may fall to or below normal. So whether or not red is an "exciting" color may depend on the length of time a person is exposed to it." (Adler, 1999, p. 2)
>
> "In using color, extensive monotony can lead to under-stimulation and therefore anxiety, and extreme complexity to over-stimulation. A balanced approach and a variety of color is suggested. One color does not satisfy all the physical and emotional needs in our environment." (Adler, 1999, p. 4)

"(…) when humans see red, their reactions become both faster and more forceful." (Elliot & Aarts, 2011)

"All visual imagery can be made more meaningful and memorable through the use of colour. According to our research, effective use of colour increases brand recognition by 50 to 85 per cent. " (Robertson, 2012, p. 78)

"Colour ignites an instant and instinctive reaction, inducing moods and emotions, influencing behaviour and subtly communicating a variety of information (…)." (Robertson, 2012, p. 78)

One of the factors which cause to make a product successful is consistency of the color:

"The Coca-Cola red has become so iconic because of the vast nature of Coca-Cola advertising and the consistent use of the colour over the years." (Robertson, 2012, p. 78)

"While colour psychology can certainly help when it comes to choosing colour, it's also important to look at a brand's position in the market, its competitor's use of colours and current colour trends (…)." (Robertson, 2012, p. 80)

"(…) the brighter a hue, the more positively it is perceived. This research shows that some colors have stronger associations than others, which is important to keep

in mind when designing the package for a product." (Tornetta, Fox, & Blackbird, 2013, p. 3)

> "Different shades of color appeal to specific personality types of shoppers. Fast food restaurants and clearance sales use stimulant colors like red, orange, and black to illicit a sense of urgency in impulse buyers. Retail clothing stores use lighter colors like pink and sky blue to evoke a calm, soothing experience for traditional shoppers who prefer to browse through items at a leisurely pace." (Tornetta, Fox, & Blackbird, 2013, p. 5)

"Background color was used as the independent variable because, like music, it appears to be an aspect of the communication and exposure situation which carries little explicit information about the product." (Middlestandt, 1990, p. 244)

"In this study, respondents presented with a slide of a pen against a blue background exhibited a more positive attitude toward buying the product than those shown the same pen against a red background." (Middlestandt, 1990, p. 244)

> "The background and ambient color had the strongest effect on two beliefs, buying the pen means buying something which is elegant and which is unique. Compared to those in the red condition, those in the blue condition believed it more likely that the pen was elegant as well as unique." (Middlestandt, 1990, pp. 247-248)

"Research has consistently shown that longer wavelength hues (e.g., red, orange, yellow) induce states of arousal and excitement." (Labrecque & Milne, 2012, p. 714)

"The perceived excitement of a brand is positively affected by the presence of red, orange, and yellow hues." (Labrecque & Milne, 2012, p. 714)

"The perceived sophistication of a brand is positively affected by the presence of black, purple, and pink hues." (Labrecque & Milne, 2012, p. 714)

“High saturation increases arousal and excitement; high (versus low) levels of saturation exhibit a positive relationship with the excitement dimension of brand personality.” (Labrecque & Milne, 2012, p. 717)

“Value has a negative relationship with the ruggedness dimension of brand personality.” (Labrecque & Milne, 2012, p. 717)

“When it comes to picking the “right” color, research has found that predicting consumer reaction to color appropriateness in relation to the product is far more important than the individual color itself.” (Ciotti, 2016)

> “Additional research in studies on color perception and color preferences show that when it comes to shades, tints and hues men seem to prefer bold colors while women prefer softer colors. Also, men were more likely to select shades of colors as their favorites (colors with black added), whereas women were more receptive to tints of colors (colors with white added).” (Ciotti, 2016)

RESUMES OF EXPERIMENTAL KNOWLEDGE

It is possible to design a space by a specific color in order to have effects on thermal condition, but it is important to consider the fact that, the perception of temperature changes by colors are strictly a psychological phenomenon and it is not accompanied by physiological effects on our bodies temperature. (Fehrman & Fehrman, 2000, p. 112)

> "(…) red is the most common color signal in nature, arising from the fact that red contrasts well with both green foliage and blue sky. Also, because it is the color of blood, it is easily accessible by animals for the purpose of changing their coloration. Problem arises from the ambiguity of its signal: It can signal either approach through sexual display or edible food, or it can signal avoidance through aggressive behavior or warning of a poisonous substance. According to Humphrey the response to red is a reflexive one, serving the purpose of preparing one to take some form of action that is defined by the context." (Fehrman & Fehrman, 2000, p. 101)

> "The effects of color are generated by acculturation and physiological factors, and these two factors strengthen each other. Red, a color with the longest wavelengths, is a stimulating color that captivates eyes faster than any other colors. Colors with a short wavelength calm the mind. Actually, blue colors decrease blood pressure, pulse, and respiratory rate. The physiological characteristics of colors develop cultural associations that strengthen its effect even more." (Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)

> "(…) there is another hypothesis that suggested color preferences are wired into our brains from selection. The hypothesis proposes that some colors send an "approach" signal while others send an "avoid" signal. These signals are "deeply ingrained natural color signals" that have improved survival of early humans." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

> "However, the effects of color appear to be temporary. When exposed to strong areas of any color, there generally is an immediate reaction that can be measured with an instrument, but after a length of time, body response may fall to or below normal. So whether or not red is an "exciting" color may depend on the length of time a person is exposed to it." (Adler, 1999, p. 2)

> “In using color, extensive monotony can lead to under-stimulation and therefore anxiety, and extreme complexity to over-stimulation. A balanced approach and a variety of color is suggested. One color does not satisfy all the physical and emotional needs in our environment.” (Adler, 1999, p. 4)

“Research has consistently shown that longer wavelength hues (e.g., red, orange, yellow) induce states of arousal and excitement.” (Labrecque & Milne, 2012, p. 714)

4 LOGISTIC KNOWLEDGE

The area of logistic knowledge refers to the knowledge, resources and equipment considered essential for the execution of a given activity. It is an exclusively technical knowledge related to constructive procedures, methods of production and materials. The materials presented in this chapter significantly cover the tips and ideas which guide us to understand how choosing the right color for branding and products affects on purchasing that product. Moreover, it discusses different color applications and their features that can be applied in industrial design and production. Additionally, a book considers the ways and environments which ushers to be more creative and productive.

4.1.- WHERE GOOD IDEAS COME FROM, The Natural History of Innovation

- Steven Johnson

This book shows the ways you can create new ideas, expand and develop them. It talks about the first notion (“Hunch”) in your mind and the ways make connections between the slow hunch and new hunches in order to unlock the door of the adjacent possible. Adjacent possible explains both the limits and the creative potential of change and innovation that by exploring the boundaries you can create new combinations. Also, it discusses how to discover more adjacent possible and environments that help you to reach new ideas. Furthermore, it discusses “Serendipity” which is an accidental connection which completes a hunch, or opens up a door in the adjacent possible that you had overlooked. Steven Johnson mentions the proper environments in which you can foster these serendipitous connections, on all the appropriate scales.

4.1.1.- THE ADJACENT POSSIBLE - Chapter one

In this chapter the author by indicating NeoNurture, which is assigned to an incubator made out of automobile spare parts claims that good ideas are like the NeoNurture device. They are created by parts and skills that surround them. So that, nature’s innovations rely on spare parts and evolution develops by implying available resources and connecting them together to create new uses. (Johnson, 2010, pp. 28-29)

A scientist, Stuart Kauffman suggests the name “adjacent possible” which is a kind of shadow future, suspended on the edges of the present state of things, a map of all the ways in which the present can reinvent itself. As you explore those boundaries the boundaries grow and each new combination guides new combinations into the adjacent possible. In a way that, if you want to think about the path of evolution, you need to explore the adjacent possible. (Johnson, 2010, p. 31)

Johnson claims that, the environments of big cities allow more commercial exploration of the adjacent possible than villages and small towns. So that, allow tradesmen and entrepreneurs to specialize in fields that would be unsustainable in smaller population centers. Furthermore, he believes that good ideas are made by existing ideas. “Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time.” (Johnson, 2010, p. 35)

The author indicates that, it is important to consider that a sudden acceleration is not possible to happen in adjacent possible. This progress must be from one door to another door:

> “(…) the truth is that technological (and scientific) advances rarely break out of the adjacent possible; the history of cultural progress is, almost without exception, a story of one door leading to another door, exploring the palace one room at a time. human minds are not bound by the finite laws of molecule formation, and so every now and then an idea does occur to someone that teleports us forward a few rooms, skipping some exploratory steps in the adjacent possible. But those ideas almost always end up being short-term failures, precisely because they have skipped ahead. We have a phrase for those ideas: we call them “ahead of their time.”” (Johnson, 2010, p. 36)

4.1.2.- SLOW HUNCH - Chapter three

In this chapter, Johnson discusses that, great ideas take shape in a partial and incomplete form. Although they seem like single, definable eureka-moments, in reality they tend to fade into view slowly. They are like gradually maturing slow hunches, which need time and cultivation to bloom and shape great ideas:

> “They have the seeds of something profound, but they lack a key element that can turn the hunch into something truly powerful. And more often than not, that missing element is somewhere else, living as another hunch in another person’s head. Liquid networks create an environment where those partial ideas can connect; they provide a kind of dating service for promising hunches. They make it easier to disseminate good ideas, of course, but they also do something more sublime: they help *complete* ideas.” (Johnson, 2010, p. 75)

Due to the fact that by making new connections hunches are converted to great ideas, if the connection does not occur, hunches remain hunches:

> "Most hunches that turn into important innovations unfold over much longer time frames. They start with a vague, hard-to-describe sense that there's an interesting solution to a problem that hasn't yet been proposed, and they linger in the shadows of the mind, sometimes for decades, assembling new connections and gaining strength. And then one day they are transformed into something more substantial: sometimes jolted out by some newly discovered trove of information, or by another hunch lingering in another mind, or by an internal association that finally completes the thought." (Johnson, 2010, p. 77)

Johnson indicates that, in order to keep slow hunches alive, we must write everything down to avoid hunches disappear:

> "Keeping a slow hunch alive poses challenges on multiple scales. For starters, you have to preserve the hunch in your own memory, in the dense network of your neurons. Most slow hunches never last long enough to turn into something useful, because they pass in and out of our memory too quickly, precisely because they possess a certain murkiness. You get a feeling that there's an interesting avenue to explore, a problem that might someday lead you to a solution, but then you get distracted by more pressing matters and the hunch disappears. So part of the secret of hunch cultivation is simple: write everything down." (Johnson, 2010, p. 83)

The author (Johnson, 2010) believes that, anyone with intellectual ambition in the seventeenth and eighteenth centuries was likely to keep a commonplace book which involved transcribing interesting or inspirational passages from one's reading.

4.1.3.- SERENDIPITY - Chapter four

As it is mentioned before, hunch is a network of cells firing inside your brain. However, for that hunch to blossom into something more substantial, it has to connect with other ideas. So that, the hunch needs an environment where new connections can be created. In this chapter the author (Johnson, 2010) introduces serendipity as an accidental connection that completes a hunch, or opens up a door

in the adjacent possible that you had overlooked. Sometimes dreams make connections link that has escaped waking consciousness and tries to find new truths by experimenting with novel combinations of neurons. “We conventionally associate dream inspiration with the creative arts, but the canon of scientific breakthroughs contains many revolutionary ideas that originated in dreams.” (Johnson, 2010, p. 101)

Hence, dreams explore the adjacent possible and they are the mind’s primordial soup. The medium that facilitates the serendipitous collisions of creative insight. Also, hunches seeking out new kinds of connections to help them make new chains of innovation. (Johnson, 2010, p. 102)

It is claimed that, serendipity needs unlikely collisions and discoveries, but it also needs something to anchor those discoveries. Moreover, he proposes an answer to the question; “how to create environments that foster these serendipitous connections?” which is written below:

> “The challenge, of course, is how to create environments that foster these serendipitous connections, on all the appropriate scales: in the private space of your own mind; within larger institutions; and across the information networks of society itself.” (Johnson, 2010, p. 109)

The author indicates that ideas rose in crowds in which new serendipitous combinations of existing ideas are produced in our heads. Also, technology, Web and brainstorming create more serendipitous encounters.

It is believed that, secrecy comes with great cost. So that, protecting ideas from copycats and competitors, protects them from other ideas that might improve them as well, which may convert them from hunches to true innovations. (Johnson, 2010, p. 124)

4.1.4.- DEVELOPMENT OF “THE ADJACENT POSSIBLE”

The author initiates this chapter by mentioning NeoNurture, which was an incubator made out of automobile parts instead of a modern incubator because the modern ones were complex and expensive. Moreover, the maintenance expenses

were high and needed technical expertise to fix. However, NeoNurture did not need trained medical technicians to fix it. As long as you could replace a broken headlight you could fix the incubator as well. The name of NeoNurture suggested by the Design that Matters team to call the prototype of the incubator. It is indicated that good ideas are like the NeoNurture device. They are bounded by the parts and skills that surround them. (Johnson, 2010, p. 28)

Johnson (2010) states that, nature's innovations rely on spare parts too. So that, evolution advances by taking available resources and connecting them together to create new uses.

A scientist, Stuart Kauffman suggests the name "adjacent possible" to explain both the limits and the creative potential of change and innovation. The adjacent possible is a kind of shadow future, suspended on the edges of the present state of things, a map of all the ways in which the present can reinvent itself. Johnson states that, "The adjacent possible is as much about limits as it is about openings. At every moment in the timeline of an expanding biosphere, there are doors that cannot be unlocked yet." (Johnson, 2010, p. 31) Also, he claims that, "The strange and beautiful truth about the adjacent possible is that its boundaries grow as you explore those boundaries. Each new combination ushers new combinations into the adjacent possible." (Johnson, 2010, p. 31) In a way that, if you want to think about the path of evolution, you need to explore the adjacent possible.

Johnson gives an example of adjacent possible that led to evolution and new ideas. "When our ancestors evolved opposable thumbs, they opened up a whole new cultural branch of the adjacent possible: the creation and use of finely crafted tools and weapons." (Johnson, 2010, p. 32)

The author indicates an inspiring part of Kauffman's notion of the adjacent possible, which is the continuum it suggests between natural and man-made systems:

> "Something has obviously happened in the past 4.8 billion years," he writes. "The biosphere has expanded, indeed, more or less persistently exploded, into the ever-expanding adjacent possible. . . . It is more than slightly interesting that this fact is clearly true, that it is rarely remarked upon, and that we have no particular theory for this expansion." (Johnson, 2010, pp. 32-33)

It is significant to mention that; each new innovation opens up new paths to explore. However, some systems are more adept than others at exploring those possible connections.

Johnson by comparing the ecosystem of a coral reef and waters of the ocean claims that; the environments of big cities allow more commercial exploration of the adjacent possible than villages and small towns. So that, allow tradesmen and entrepreneurs to specialize in fields that would be unsustainable in smaller population centers. Also, it is indicated that the Web has explored the adjacent possible of its medium far faster than any other communications technology. As an example of an adjacent possible is when a brilliant idea happens to an inventor somewhere in the world, and he goes public with his remarkable finding to explore that other minds had independently come up with the same idea in the past year. (Johnson, 2010, pp. 33-34)

It is believed that good ideas are made by existing ideas. “Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time.” (Johnson, 2010, p. 35) Moreover, the adjacent possible is about opening and limits both. So that, as there are some doors to be opened by connections and recombination, there are always doors that cannot be unlocked yet:

> “(…) the truth is that technological (and scientific) advances rarely break out of the adjacent possible; the history of cultural progress is, almost without exception, a story of one door leading to another door, exploring the palace one room at a time. human minds are not bound by the finite laws of molecule formation, and so every now and then an idea does occur to someone that teleports us forward a few rooms, skipping some exploratory steps in the adjacent possible. But those ideas almost always end up being short-term failures, precisely because they have skipped ahead. We have a phrase for those ideas: we call them “ahead of their time.”” (Johnson, 2010, p. 36)

The author mentions that all of us are living inside our own adjacent possible:

> “All of us live inside our own private versions of the adjacent possible. In our work lives, in our creative pursuits, in the organizations that employ us, in the communities we inhabit—in all these different environments, we are surrounded by potential new configurations, new

ways of breaking out of our standard routines. We are, each of us, surrounded by the conceptual equivalent of those Toyota spare parts, all waiting to be recombined into something magical, something new." (Johnson, 2010, p. 40)

To achieve scientific breakthrough and to reach new doors, we need to discover the edges of possibilities and change the environment:

"Unlocking a new door can lead to a world-changing scientific breakthrough, but it can also lead to a more effective strategy for teaching second-graders, or a novel marketing idea for the vacuum cleaner your company's about to release. The trick is to figure out ways to explore the edges of possibility that surround you. This can be as simple as changing the physical environment you work in, or cultivating a specific kind of social network, or maintaining certain habits in the way you seek out and store information." (Johnson, 2010, pp. 40-41)

Moreover, Johnson claims that, innovative environments help us to discover more adjacent possible than other environments:

"What kind of environment creates good ideas? The simplest way to answer it is this: innovative environments are better at helping their inhabitants explore the adjacent possible, because they expose a wide and diverse sample of spare parts—mechanical or conceptual—and they encourage novel ways of recombining those parts. Environments that block or limit those new combinations—by punishing experimentation, by obscuring certain branches of possibility, by making the current state so satisfying that no one bothers to explore the edges—will, on average, generate and circulate fewer innovations than environments that encourage exploration." (Johnson, 2010, p. 41)

Due to the fact that, adjacent possible is occurred by new combination of spare parts, it is important to make sure that we are innovating something and making new configurations, not repeating the old ideas:

"Part of coming up with a good idea is discovering what those spare parts are, and ensuring that you're not just recycling the same old ingredients. This, then, is where the next six patterns of innovation will take us, because they all involve, in one way or another, tactics for assembling a more eclectic collection of building block ideas, spare parts that can be reassembled into useful new configurations. The trick to having good ideas is not to sit around

in glorious isolation and try to think big thoughts. The trick is to get more parts on the table." (Johnson, 2010, p. 42)

4.1.5.- REFLECTIONS

Here are the main points of chapter one:

Johnson by comparing the ecosystem of a coral reef and waters of the ocean claims that; the environments of big cities allow more commercial exploration of the adjacent possible than villages and small towns. So that, allow tradesmen and entrepreneurs to specialize in fields that would be unsustainable in smaller population centers. Also, it is indicated that the Web has explored the adjacent possible of its medium far faster than any other communications technology. As an example of an adjacent possible is when a brilliant idea happens to an inventor somewhere in the world, and he goes public with his remarkable finding to explore that other minds had independently come up with the same idea in the past year. (Johnson, 2010, pp. 33-34)

"Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time." (Johnson, 2010, p. 35)

"(…) the truth is that technological (and scientific) advances rarely break out of the adjacent possible; the history of cultural progress is, almost without exception, a story of one door leading to another door, exploring the palace one room at a time. human minds are not bound by the finite laws of molecule formation, and so every now and then an idea does occur to someone that teleports us forward a few rooms, skipping some exploratory steps in the adjacent possible. But those ideas almost always end up being short-term failures, precisely because they have skipped ahead. We have a phrase for those ideas: we call them "ahead of their time."" (Johnson, 2010, p. 36)

"What kind of environment creates good ideas? The simplest way to answer it is this: innovative environments are better at helping their inhabitants explore the adjacent possible,

because they expose a wide and diverse sample of spare parts—mechanical or conceptual—and they encourage novel ways of recombining those parts. Environments that block or limit those new combinations—by punishing experimentation, by obscuring certain branches of possibility, by making the current state so satisfying that no one bothers to explore the edges—will, on average, generate and circulate fewer innovations than environments that encourage exploration." (Johnson, 2010, p. 41)

"Part of coming up with a good idea is discovering what those spare parts are, and ensuring that you're not just recycling the same old ingredients. This, then, is where the next six patterns of innovation will take us, because they all involve, in one way or another, tactics for assembling a more eclectic collection of building block ideas, spare parts that can be reassembled into useful new configurations. The trick to having good ideas is not to sit around in glorious isolation and try to think big thoughts. The trick is to get more parts on the table." (Johnson, 2010, p. 42)

4.2.- ARTICLES AND WEBSITES

This set of summaries consists of articles and material retrieved from the Internet. They are located at the same area of knowledge, which is Logistic Knowledge. Guides and tips to choose a proper color for brands and the role of applying various colors for logos are discussed. Besides, the impact of each color on branding is stated. In addition, various ways of using color application in industrial design are argued. For instance, using color to show the function, set a harmony, contrast, and so on. Moreover, it argues how color can change the way objects look and interpreted. Colors can deceive our eyes so that, they can emphasize the form of an object or conceal their features. In addition, it explains the importance of the color for a product which is considered as necessary and important as form.

4.2.1.- THE PURPOSE AND POWER OF COLOR IN INDUSTRIAL DESIGN

- Jason A. Morris

This article discusses the importance of color of a product in order to make the product be chosen among other products. Also, it argues the ways that color can be used and applied in industrial design.

> “When the shopping customer glances at their choice of products and makes a quick decision on which to buy, they are determining the failure or the success of that product. If designers don’t consider and choose the colors of their products well those products are left on the shelf, unsold, unused, and eventually become garbage. This is a crime to the environment, the manufacturer, the retailer, and the general public.” (Morris, p. 10)
>
> “This paper discusses just a few ways to encourage industrial designers to make their choice and application of color more intentional, meaningful and well considered. Color serves numerous functions; it's not just decoration. Color has tremendous power that is usually underestimated and underutilized by design students. Because of the way the eye perceives and constructs the world, color is inextricably integrated with form, line, texture and shape. The visual process does not separate those factors, and neither should the visual designer.“ (Morris, p. 10)
>
> “In relation to industrial design, that critical decision is the purchasing decision. Within those first few seconds the majority of the information that is available is visual information

> and one of the most dominant aspects of that visual information is color. So, considering this, the application of color and finish in design becomes much more important than one first thought." (Morris, p. 1)

Color can dominate all other factors of a product designs success. A wrong choice of color and finish can make or break the success of a product. Colors chosen for a design can be meaningful, purposeful, and even functional.

"(…) choosing color in design is an objective decision and that this consideration is as important as the function and form." (Morris, p. 1)

It is necessary to indicate that, in this paper "color" refers to not just hue, but also value, Chroma (saturation), and finish.

It is claimed that, colors can be applied in order to evoke emotions and memories:

> "Color can have high emotional and symbolic associations. It can be applied in design to conjure up soothing emotions or vivid memories to the user. These associations vary by culture, geography, and generation. These emotions seem to come from general associations the mind makes with that color, through long-term memories. These memories were developed throughout our lifetime through repetition or specific indelible events." (Morris, pp. 1-2)

For instance, Apple iPod, looks clean. By considering the material, finish and colors, it might remind you of a bathroom.

Colors can also be meaningful by associated symbolism. such as; National flags.

Color can be used as user interface so that, it can be applied in order to help consumers to work with appliances. "Color can give cues as to how to operate a machine or an appliance. Even without understanding of the function of a form, a contrasting colored feature indicates how and what to do." (Morris, p.3) For example, a green button usually indicates "go" or "start" a red button may indicate, "stop" or on a trigger may mean, "fire". Our traffic lights use green, yellow and red to direct drivers with its color cues. Also, white stripes of a crosswalk and X-Box game controller are other examples.

The color in fashion get changed depending on the target market, the geographic region, the season of the year, the culture, the design.

The other way of applying color is to be used to identify the object with a person, a company, or a group. For examples, a sport team, the teal colored gift box with a white ribbon is synonymous with Tiffany's- Green and yellow on a tractor immediately identifies it with John Deere. (Morris, p. 5)

> "Colors used to identify are most successful when they are strong, saturated, and primary or secondary colors. This is to easily distinguish one from the other. Complex and subtle color distinctions may be confusing and harder to identify." (…) "Color can be used to emphasize the physical form, and to enhance the surface variation or three- dimensionality." (…) "Our eyes equate value variation with surface variation. When this variation is pronounced through color its three-dimensional form is enhanced." (Morris, p. 5)

"Metallic pigments can enhance this contrast by reflecting more light at its highlights and extending those highlights further." (Morris, p. 6)

"Vertical stripes may be used to emphasize height and can outline a form by creating contour lines. A form may be appearing larger if it is colored in light values and warm advancing hues." (Morris, p. 6)

"This application may be used in design to hide or conceal a feature of an object, or to de-emphasize a form." (Morris, p. 7) For instance, camouflage on a military vehicle, The F117A Nighthawk stealth fighter aircraft.

Another application of color is used as material emphasis:

> "Color may be used to celebrate a material's properties, rather than hide them. This is used when the material makes up is valuable or has exemplary properties to be emphasized. Jewelry designers do this naturally with precious metals and gemstones. The polishing of gold brings forth its luster and richness." (Morris, p. 7)

Color can be used as material deception. "The application of color can be used to deceive the viewer of its true material make up." (Morris, p. 8)

Color as harmony:

> "Color can be used to make a design visually compatible with its environment. A white kitchen appliance, for instance, is made to blend into and match the kitchen environment. This application of color can be used to achieve a quiet, neutral, harmonious environment and reduce visual chaos." (Morris, p. 8)

Color can be applied in contrast application: "In order to stand out and contrast with its environment, color can be critical. Whether it's an orange traffic cone or a yellow taxicab, color is a powerful differentiator. Distinction from environment can happen through contrasting hue, saturation, or value." (Morris, p. 8) Color contrast can be applied in safety concern:

> "This application is important when safety is a concern. On tools with cutting or rotating parts, a contrasting color can be used to focus the operator's attention where it needs to be directed. A garden tool may be colored a contrasting color to its predominately green environment in order to avoid being lost or stepped on." (Morris, p. 8)

4.2.2.- COLOR AND SHAPE APPLIED TO PRODUCT DESIGN

- Henriette Koblanck & Monika Moro

> "The aim of the research is to find a method to represent the complexity of the relationship between color and shape, in the specific context of the design of product or service, in order to make possible to communicate this parameter during discussions in a team of professionals or to the end user, further to be adoptable in design education." (Koblanck & Moro, 2012, p. 1)

The authors (Koblanck & Moro, 2012) believe that there is a relationship between color and market:

> "Generally, only large companies or refined niche brands, in addition to fashion, graphics and communication, devote a thorough attention to the selection and use of color. However, the rapidly changing global and cultural integration in recent years has apparently heightened the importance of color, a trend supported by evidence of sales reports that show the precise relationship between color and market." (Koblanck & Moro, 2012, p. 2)

"The color, when applied on a surface or a product, tends to have different behaviors as regards the impact with our perception." (Koblanck & Moro, 2012, p. 3)

According to the workshop study, which this paper presents, indicates the importance of applying cultural details to enrich a product:

> "A point of interest was the fact that a great part of the students had put in their products cultural details or concepts, some with intention other discovered how their own cultural background may influence them or better enhance their projects enriching them." (Koblanck & Moro, 2012, p. 3)

4.2.3.- A GUIDE TO CHOOSE COLORS FOR YOUR BRAND

- Dmitry Fadeyev

Here are some tips to consider while you are choosing the color of your brand:

"You should aim to pick a color that will represent your brand's personality best. One that will give your customers the right impression the first time they see it." (Fadeyev, 2008)

"You aren't limited to one color. Some brands like eBay choose to go with many colors to represent variety — but you can also choose a couple of colors that work well together." (Fadeyev, 2008)

> "Consider differences in cultural interpretations of your color. For example, in the Western world, white is considered the color of purity and peace, however, in some parts of Asia white is the color of death. Make sure the color you select will give the right impressions in the markets you're present in." (Fadeyev, 2008)
>
> "Pick a color opposite to that of your main competitor. If you're the first in a new industry or market segment, then you have first picks. Choose the color that represents your product and its personality. If you're second, then that first choice may already be taken." (Fadeyev, 2008)

4.2.4.- 21 OUTSTANDING USES OF COLOUR IN BRANDING

- Nick Carson

This webpage argues how different brands around the world have staked their respective claims to 10 colours:

Red:

“It's the colour of anger and danger, but also warmth and passion. And since it's also scientifically proven to increase your heart rate and raise your blood pressure, it's a bold choice to use it extensively.” (Carson, 2015)

Examples: Coca Cola, Target, Vodafone

Orange:

“Bright, fun and friendly, orange has a playful, childlike appeal (…)” (Carson, 2015)

Examples: Orange, Home Depot, easyGroup

Yellow:

“Positive, sunny and optimistic, yellow is energetic and eye-catching – and particularly effective for point-of-sale messaging, as it's proven to catch the eye quicker than any other colour.” (Carson, 2015)

Examples: Veuve Clicquot, Caterpillar, JCB

Green:

“Green is an emotionally positive colour, signifying growth and rebirth and, of course, nature. It represents stability and endurance, but it also prosperity and abundance, and taken to the extreme it can be a colour of wealth and luxury; a real mix of meanings.” (Carson, 2015)

Examples: John Deere, Harrods, Starbucks

Blue:

“Blue is a cool, clear colour which has a trustworthy, dependable feel, and is often the colour of choice for financial institutions as a result – notably Barclays.” (Carson, 2015)

Examples: NHS, Tiffany& co, Facebook

Purple:

“Pale lavender has a nostalgic, sentimental feel, whereas richer, darker purple has a sophisticated tone often linked with royalty.” (Carson, 2015)

Example: Cadbury's

Brown:

> “Earthy, simple and evocative of honesty and simplicity, brown (as well as green) is often used by organic companies to emphasize their links to the soil – although outside of this sector its largely avoided in a branding context due to potential negative connotations with 'dirt', although this of course depends on the shade chosen. The fact that brown hides dirt can be twisted to a company's advantage – one reason for Pullman railway coaches to have developed their distinctive shade.” (Carson, 2015)

Example: UPS

Pink:

“The level of intensity with which pink is used makes a big difference to its impact. Paler shades are often have 'girly' associations, while dusty pinks have a sentimental tone (…).” (Carson, 2015)

Example: T-Mobile

Black:

“(…) most brands use black in their branding some capacity – but used as the primary brand colour, it has a bold, powerful, classic effect that feels confident and sophisticated for more expensive products.” (Carson, 2015)

Example: Guinness

White:

“Simplicity and purity are the overwhelming associations with white in branding, and its brightness immediately catches the eye when used in signage. Baby and healthcare products regularly make use of it, and as a result, standout is tricky.” (Carson, 2015)

Example: Apple

4.2.5.- REFLECTIONS

These are the main points of these set of articles and material retrieved from the Internet:

> "Color can have high emotional and symbolic associations. It can be applied in design to conjure up soothing emotions or vivid memories to the user. These associations vary by culture, geography, and generation. These emotions seem to come from general associations the mind makes with that color, through long-term memories. These memories were developed throughout our lifetime through repetition or specific indelible events." (Morris, pp. 1-2)

"Color can give cues as to how to operate a machine or an appliance. Even without understanding of the function of a form, a contrasting colored feature indicates how and what to do." (Morris, p. 3)

Color contrast can be applied in safety concern:

"This application is important when safety is a concern. On tools with cutting or rotating parts, a contrasting color can be used to focus the operator's attention where it needs to be directed." (Morris, p. 8)

> "A point of interest was the fact that a great part of the students had put in their products cultural details or concepts, some with intention other discovered how their own cultural background may influence them or better enhance their projects enriching them. " (Koblanck & Moro, 2012, p. 3)

> "Consider differences in cultural interpretations of your color. For example, in the Western world, white is considered the color of purity and peace, however, in some parts of Asia white is the color of death. Make sure the color you select will give the right impressions in the markets you're present in." (Fadeyev, 2008)

“Pick a color opposite to that of your main competitor. If you’re the first in a new industry or market segment, then you have first picks. Choose the color that represents your product and its personality. If you’re second, then that first choice may already be taken.” (Fadeyev, 2008)

Red: “It's the colour of anger and danger, but also warmth and passion. And since it's also scientifically proven to increase your heart rate and raise your blood pressure, it's a bold choice to use it extensively.” (Carson, 2015)

RESUMES OF LOGISTIC KNOWLEDGE

"The strange and beautiful truth about the adjacent possible is that its boundaries grow as you explore those boundaries. Each new combination ushers new combinations into the adjacent possible." (Johnson, 2010, p. 31)

Johnson by comparing the ecosystem of a coral reef and waters of the ocean claims that; the environments of big cities allow more commercial exploration of the adjacent possible than villages and small towns. So that, allow tradesmen and entrepreneurs to specialize in fields that would be unsustainable in smaller population centers. Also, it is indicated that the Web has explored the adjacent possible of its medium far faster than any other communications technology. As an example of an adjacent possible is when a brilliant idea happens to an inventor somewhere in the world, and he goes public with his remarkable finding to explore that other minds had independently come up with the same idea in the past year. (Johnson, 2010, pp. 33-34)

"Good ideas are not conjured out of thin air; they are built out of a collection of existing parts, the composition of which expands (and, occasionally, contracts) over time." (Johnson, 2010, p. 35)

> "Consider differences in cultural interpretations of your color. For example, in the Western world, white is considered the color of purity and peace, however, in some parts of Asia white is the color of death. Make sure the color you select will give the right impressions in the markets you're present in." (Fadeyev, 2008)

> "Color can have high emotional and symbolic associations. It can be applied in design to evoke soothing emotions or vivid memories to the user. These associations vary by culture, geography, and generation. These emotions seem to come from general associations the mind makes with that color, through long-term memories. These memories were developed throughout our lifetime through repetition or specific indelible events." (Morris, pp. 1-2)

Color contrast can be applied in safety concern:

"This application is important when safety is a concern. On tools with cutting or rotating parts, a contrasting color can be used to focus the operator's attention where it needs to be directed. A garden tool may be colored a contrasting color to its predominately green environment in order to avoid being lost or stepped on." (Morris, p. 8)

PHASE 2

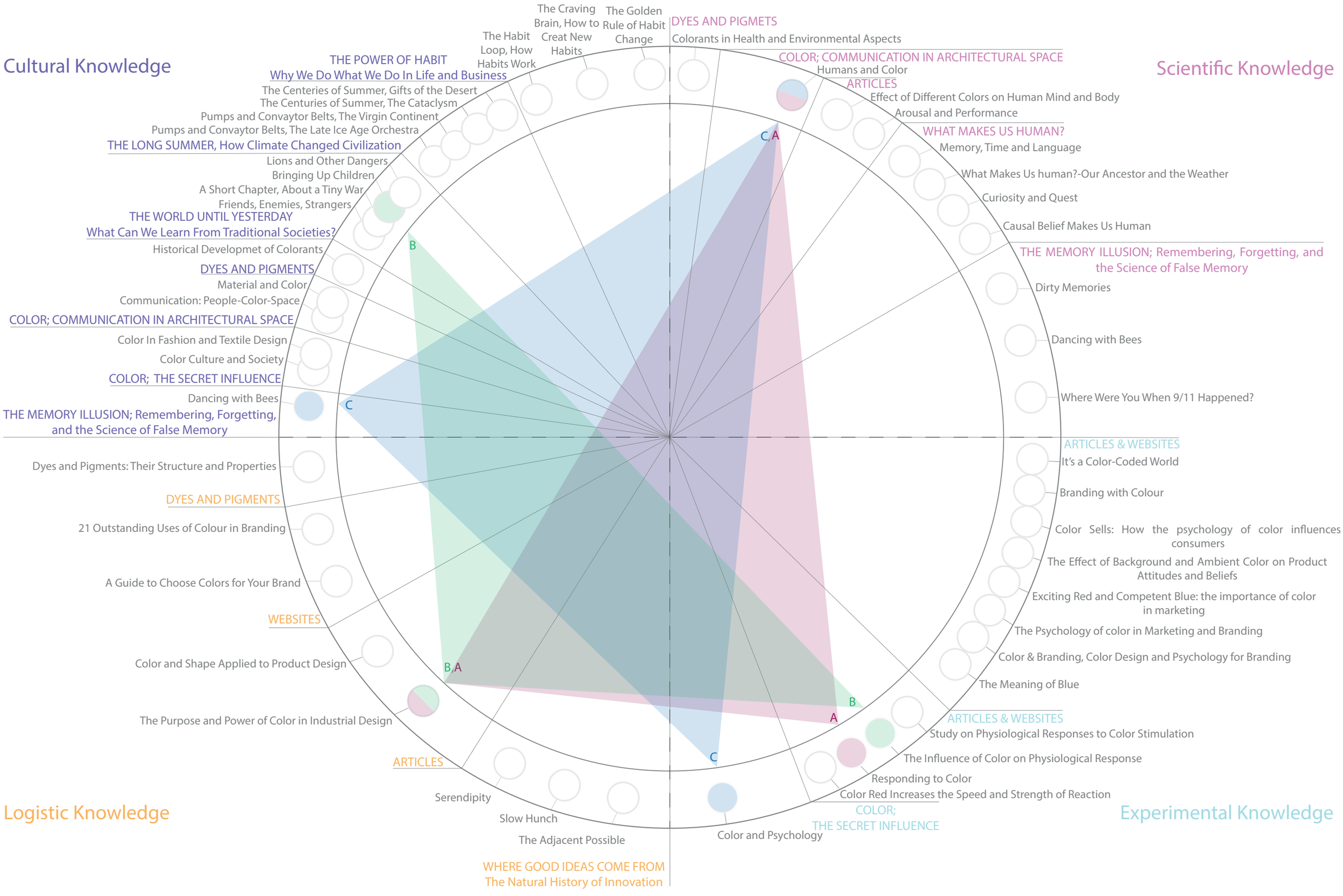
Second phase of design research corresponds to the definition of concepts and prepositions. The methodology used consists in the formulation of hypotheses in the form of triangulations. Starting from the theoretical study carried out in the previous phase, three citations from three different areas of knowledge are selected and combined, creating a triangulation of ideas that leads to a concept translated in a preposition. This process is repeated three times, which resulted in three distinct triangulations.

5 TRIANGULATIONS

This phase is dedicated to the creation of Concepts, which are generated through the triangulation of ideas, recollected in the research from the previous chapters. Each triangulation (based in at least three citations from different knowledge areas), allows the creation of a concept (materialized in a text that reflects it), and the respective preposition. By expanding this section, an idea or a theory is proposed.

Each concept is visualized through moodboards with abstract and real images, that validated it.

5.1.- Map of Triangulations



5.2.- Triangulation A

5.2.1.- Citations (A)

THE PURPOSE AND POWER OF COLOR IN INDUSTRIAL DESIGN, Article

"Color can have high emotional and symbolic associations. It can be applied in design to conjure up soothing emotions or vivid memories to the user. These associations vary by culture, geography, and generation. These emotions seem to come from general associations the mind makes with that color, through long-term memories. These memories were developed throughout our lifetime through repetition or specific indelible events." (Morris, pp. 1-2)

COLOR; COMMUNICATION IN ARCHITECTURAL SPACE, Book

HUMANS AND COLOR, Chapter four

"Stress research has shown that states of sensory overstimulation or under-stimulation can trigger dysfunctions in the organism. This is often disregarded by designers. It is thus important to adhere to one of the most important, fundamental rules of design that is, to integrate variation and stimulation into a visual order, and to create a balance between under- and overstimulation." (Meerwein, Rodeck, & Mahnke, 2007, p. 22)

Designers must consider the subject of over- and under-stimulation precisely, because overstimulation can trigger physical or psychological changes.

RESPONDING TO COLOR, Article

"However, the effects of color appear to be temporary. When exposed to strong areas of any color, there generally is an immediate reaction that can be measured with an instrument, but after a length of time, body response may fall to or below normal. So whether or not red is an "exciting" color may depend on the length of time a person is exposed to it." (Adler, 1999, p. 2)

5.2.2.- Concept (A)

Due to the symbolic associations of color, it can be used to design environments in order to evoke emotions and memories. However, it is important to set a balance between visual stimuli in any space. They can cause overstimulation and under-stimulation that both result in dysfunctions in the organism because of humans' physical and psychological reactions towards visual stimuli. Although, humans' bodies and emotions react towards colors psychologically and physiologically, body reactions towards a color do not remain constant and are temporary.

5.2.3.- Preposition (A)

In order to create an environment with determined function, the user's physiological and psychological reactions over time towards a color should be considered. It can be assumed that, to achieve the expected function in a space, color can be applied in a phase before an action expected to happen or in the same place where the action is required to occur due to the body and minds reactions towards a color.

5.2.4.- Abstract Images of Triangulation A



Fig. 2 - Abstract Images of Triangulation A

5.2.5.- Real Images of Triangulation A

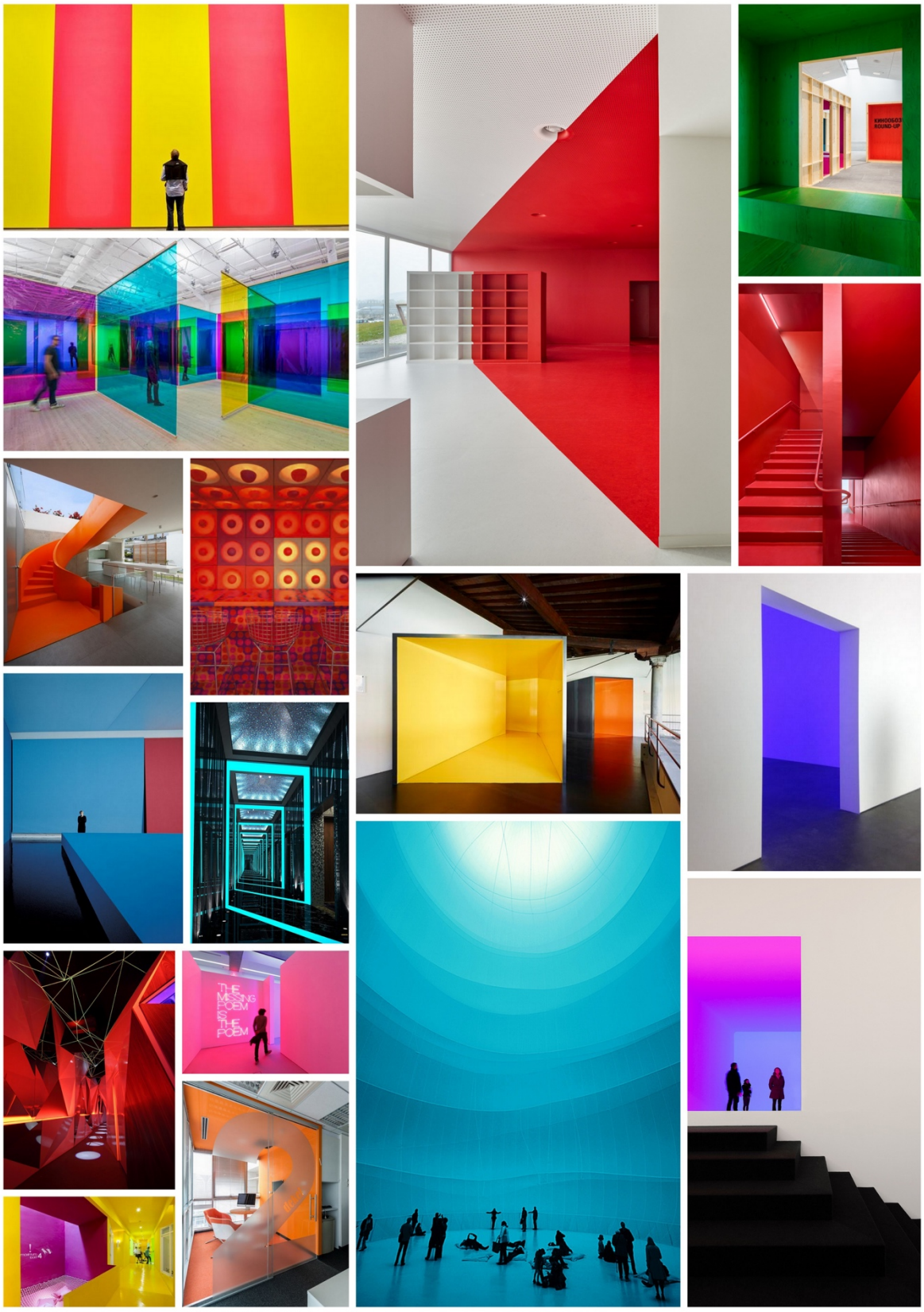


Fig. 3 - Real Images of Triangulation A

5.3.- Triangulation B

5.3.1.- Citations (B)

THE WORLD UNTIL YESTERDAY, Book
BRINGING UP CHILDREN, Chapter five

In some environments where are relatively safe for children, children enjoy more and are more independent compared to dangerous places:

> "(…) how much freedom children enjoy seems to depend partly on how dangerous the environment is, or is perceived to be. Some environments are relatively safe for children, but others are dangerous because of either environmental hazards or else dangers from people." (Jared, 2012, p. 341)

THE INFLUENCE OF COLOR ON PHYSIOLOGICAL RESPONSE, Article

> "(…) there is another hypothesis that suggested color preferences are wired into our brains from selection. The hypothesis proposes that some colors send an "approach" signal while others send an "avoid" signal. These signals are "deeply ingrained natural color signals" that have improved survival of early humans." (Freiders, Lee, Statz, & Kim, n.d., p. 1)

THE PURPOSE AND POWER OF COLOR IN INDUSTRIAL DESIGN, Article

Color contrast can be applied in safety concern:

> "This application is important when safety is a concern. On tools with cutting or rotating parts, a contrasting color can be used to focus the operator's attention where it needs to be directed. A garden tool may be colored a contrasting color to its predominately green environment in order to avoid being lost or stepped on." (Morris, p. 8)

5.3.2.- Concept (B)

It can be assumed that one of the factors which leads to raise independent and autonomous children is creating safe or less dangerous environment for them. In such spaces, they can play, study and learn with the least supervision by adults in. It is believed that, there are some colors which are sending “avoid” signal, while some are sending “approach” signal. These are derived from genetic maps formed in millions of years. These colors can be applied in order to create safe environments. In addition, using color contrast application in designing appliances and spaces can be applied due to the safety concern.

5.3.3.- Preposition (B)

Creating safe environment for children can be achieved by implementing special national color codes in defined contexts. These color codes can be generalized through teaching youngsters from early ages. Also, applying color contrast method in appliances and space around them can ward them off from danger. Additionally, this application can draw children attention and keep them in a safe place so that, distract them from a place where danger threatens them.

5.3.4.-Abstract Images of Triangulation B

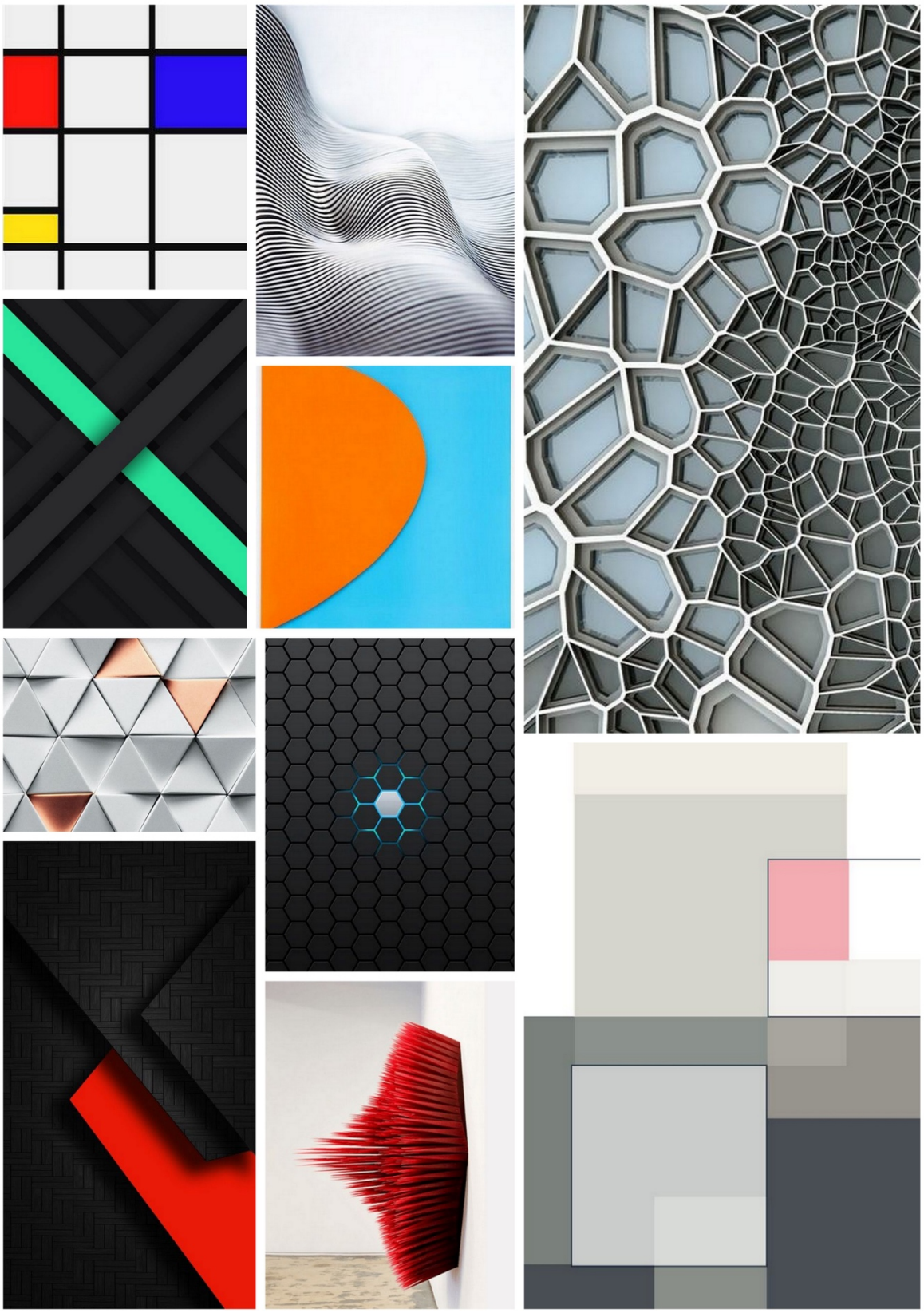


Fig. 4 - Abstract Images of Triangulation B

5.3.5.- Real Images of Triangulation B

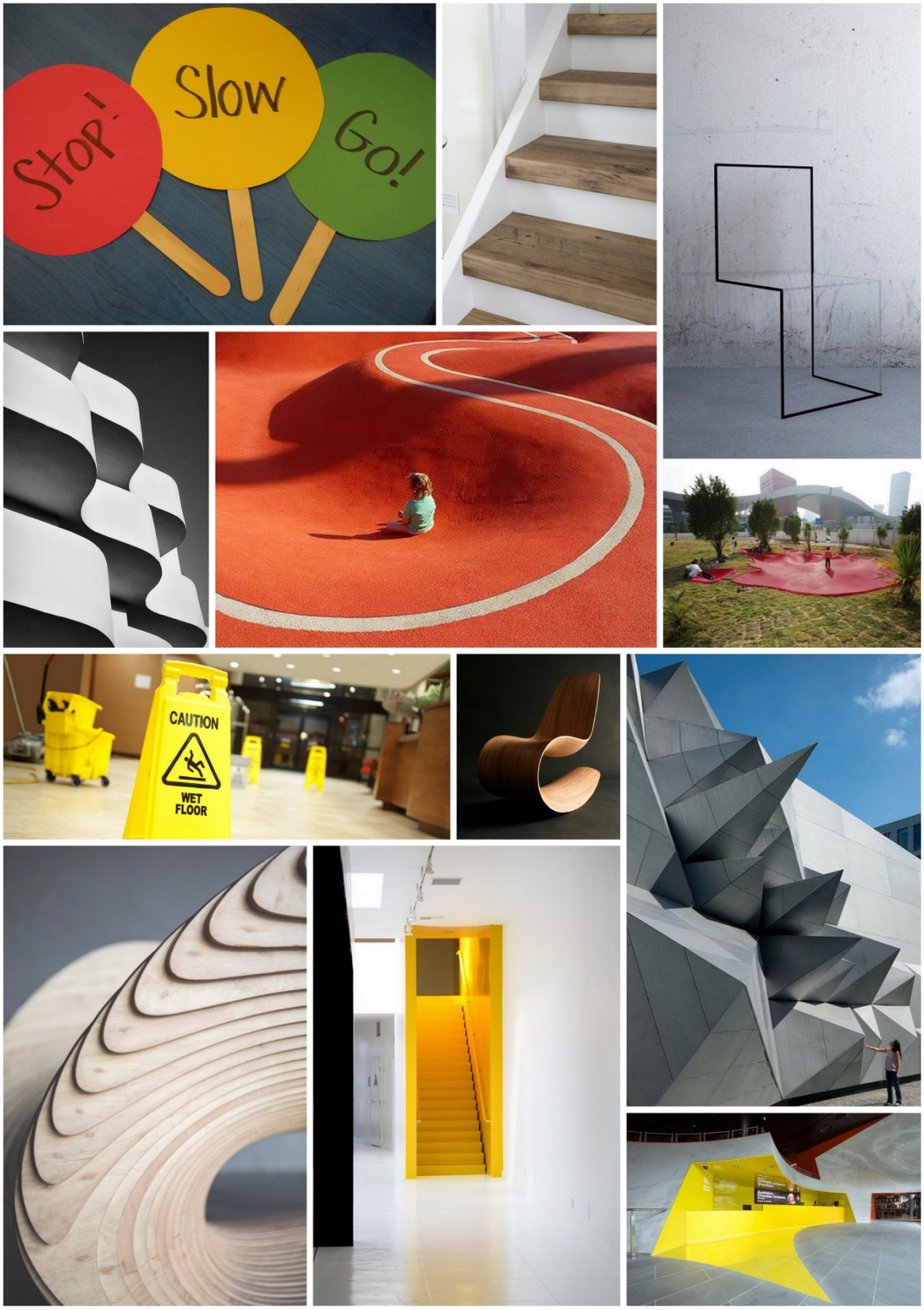


Fig. 5 - Real Images of Triangulation B

5.4.- Triangulation C

5.4.1.- Citations (C)

THE MEMORY ILLUSION, Book
DANCING WITH BEE, Chapter three

Node is an individual concept or word in the brain that can be linked to another to create complex ideas. So that, once we activate a node, the energy we send out to it can be conceptualized as radiating out from that original source and then activating other related nodes automatically. As an example; whenever you think about swimming, mostly you automatically activate memories which are associated to water, pool, and bathing suit. (Shaw, 2016, p. 68)

COLOR; THE SECRETE INFLUENCE, Book
COLOR AND PSYCHOLOGY, Chapter five

"(…) red is the most common color signal in nature, arising from the fact that red contrasts well with both green foliage and blue sky. Also, because it is the color of blood, it is easily accessible by animals for the purpose of changing their coloration. Problem arises from the ambiguity of its signal: It can signal either approach through sexual display or edible food, or it can signal avoidance through aggressive behavior or warning of a poisonous substance. According to Humphrey the response to red is a reflexive one, serving the purpose of preparing one to take some form of action that is defined by the context." (Fehrman & Fehrman, 2000, p. 101)

COLOR; COMMUNICATION IN ARCHITECTURAL SPACE, Book
HUMANS AND COLOR, Chapter four

"The human being's "primal experiences" of color in nature are stored as mutual, collective fundamental experiences, as primal images and archetypes, in our "genetic memory." They contribute to our personal experience of color. Color symbolism grew out of the generalization of color's effects on the emotions, and the tradition of meanings associated with color. Symbolic and psychological effects of color are thus closely linked." (Meerwein, Rodeck, & Mahnke, 2007, p. 28)

5.4.2.- Concept (C)

Due to the fact that a memory can be activated by recalling a node, color associations can be triggered in our brains by observing a specific color. This is the reason why red is known as the most common color signal in the nature, because it has many various associations with our memory; such as fire, blood, etc. However, it signals approach through sexual display. It is used to trigger different emotions and actions. Also, responses towards it are reflexive so that, the context of using this color determine the type of the reaction. As color symbolism is connected to our genetic memory, they are formed through the color effects on our emotions. Genetic memory originated from primal experiences towards color, when people were still directly connected to the natural environment.

5.4.3.- Preposition (C)

Some color nuances have stronger associations with our memories. Therefore, depending on the context, it is important to use nuances that have stronger associations with our traditions and symbols while designing and expecting a specific reaction. This might explain the reason why some attempts in color design of products, packaging, and logos fail.

5.4.4.-Abstract Images of Triangulation C



Fig. 6 Abstract Images of Triangulation C

5.4.5.-Real Images of Triangulation C



Fig. 7 Real Images of Triangulation C

PHASE 3

The third and final stage of the project research corresponds to the development phase of the project. Following the previous phase, one of the triangulations was chosen to be developed, resulting in a proposed theory. This one is demonstrated, implemented and validated with the help of schemes and three-dimensionalizations, demonstrating the way as the idea can be applied in different environments.

SELECTION AND VALIDATION OF THE PROJECT

6

In this chapter, triangulation (A) was selected as the concept to be translated in the project. The idea expressed in this concept, introduces a new point of view that regards applying colors in different environments around us, in order to raise the efficiency of the function.

PROJECT 7

The project starts with an introduction to the problem identified, presented in the triangulation. The proposition presents a direction to the solution, which will be developed with the help of a hypothesis retrieved from the previous research.

This chapter presents the development from the initial concept to the final idea, expressed in a theory. Furthermore, this theory will be validated through implementation in various real environments.

7.1.- INTRODUCTION TO THE PROJECT

Color designing by considering the impacts of color on our bodies and emotions over time is a critical task, which is usually disregarded by designers. Although, colors influence us psychologically and physiologically, the physical impacts of color are temporary. This is the reason why we can not rely on physiological impacts of color after a length of time. In other words, although body shows a reaction towards a strong area of color, after a period of time it returns to the initial status or shows a counter-reaction. However, psychological effects of color are always with us, which results in creating under or over stimulating atmosphere after a long exposing towards a color. For example; the user becomes anxious, or passive and dull, after staying for a period of time in a room painted in red, or blue, respectively. Consequently, both cases bring about impaired functions.

7.2.- DEVELOPMENT OF THE PROPOSED IDEA

As it is already discussed in the preposition of the triangulation, by applying colors in one phase before an action expected to happen, we can make a balance between under and overstimulation, resulting in the creation of the necessary conditions to improve the performance of the function in question. So that, in the first phase, the user enters into a room painted in red or blue and becomes stimulated or calm respectively by exposing to them for a while. Then, the user leaves the space painted in red or blue and enters the next space, wherein an action is expected to occur. As a result, the user has been impacted by the colors psychologically and physiologically, and carrying the impacts of color by itself to the next phase. Besides, the user does not get anxious or bored because of the stimulating and calming effects of red and blue after staying towards those colors for a long time.

It is considerable to mention that, the reason of choosing red and blue colors in all examples indicated in the proposed idea is due to the characteristics of them. According to the studies, red is considered as a representative of stimulating colors, whereas, blue in known as a representative of soothing colors. As it is already

indicated, stimulating colors raise perspiration, blood pressure, pulse rate, and respiration. While, calming colors have reverse effects by lowering blood pressure and pulse rate.

Furthermore, it is experimented that some colors are associated with some emotions and feelings. They are results of strong connections between specific colors and memories of a place or objects that recalling them triggers the same feelings. This is the reason why blue color is mostly keeping us calm psychologically and reminds us of sky and see. While, some colors like red arouses us and we recall memories of fire, blood, love and passion when we see it. Therefore, in all upcoming examples red is applied whenever boosting energy and stimulating effects are required. While, blue is applied in places where soothing impacts are required.

According to *"Inverted-U"* hypothesis retrieved from the book *"The Memory Illusion"*, in order to do any task optimally, our body needs to reach at specific arousal level. So that, at the extremes, at no arousal or incredibly high arousal, the performance is impaired. It is mentioned scientifically that being aroused means; increasing the heart rate, sweating, blood pressure or other physiological indicators relatively in our bodies. Moreover, it is experimented that our level of arousal plays an important role in our ability to encode, store and retrieve memories. So that, it turns out that an increase in arousal is associated with an increase in memory performance. (Shaw, 2016, p. 41)

By taking advantage of *"Inverted-U"* hypothesis, the chosen preposition can be developed. By merging the presented theory and *"Inverted-U"* hypothesis, a new theory is created. This notion builds a space with a new approach to color. This theory can be contributed to design different places with various functions, wherein specific tasks and actions are required to happen only by applying colors in proper places. So that, red and blue colors are applied is spaces in order to reach at optimum level of arousal which result in performing tasks optimally. As an example, we can extrapolate that concept which could be very functional to be implemented in designing a school. Allocating red color in a space just before getting into the classroom can make the students more alerted and concentrated only by exposing

them to this color for a period of time. As a result, students in the classroom are ready to learn due to reaching an optimal level of arousal which brings about the optimal performance. Conversely, keeping the example of the school; a blue room before getting into the classroom, makes students relaxed. If they are stressed-out before taking exams, exposing towards blue color, makes them calm and less distressed. Consequently, performance - taking exams - is happened optimally in the classroom. The three-dimensional concept of the school is demonstrated in the following part.

By implementing this new approach in design, not only we will have different color palettes for any space, but also we will have modifications in architecture plans. So that, architects must consider additional places painted in stimulating or soothing colors in order to obtain efficient functions in spaces.

7.3.- SCHEMES

In this section, schemes are presented to demonstrate how the proposed theory can be implemented in different situations. Schemes display how body reacts towards spaces painted in red and blue, as stimulating and calming colors, respectively. Additionally, these schemes explain how arousal level of the body plays an important role in performing tasks optimally. In all examples color red is used whenever the higher arousal level is required, while blue color is applied to spaces where lower arousal level is needed in order to do an action efficiently. Red and blue colors are applied in one phase before the phase an action is happening. As a result, the body reaches the optimum arousal level in the next phase, that helps the task to be done optimally.

Red

Increases Heart Rate

Raises Blood Pressure

Excites Brain Waves

Raises Respiration

Very low arousal level causes impaired performance

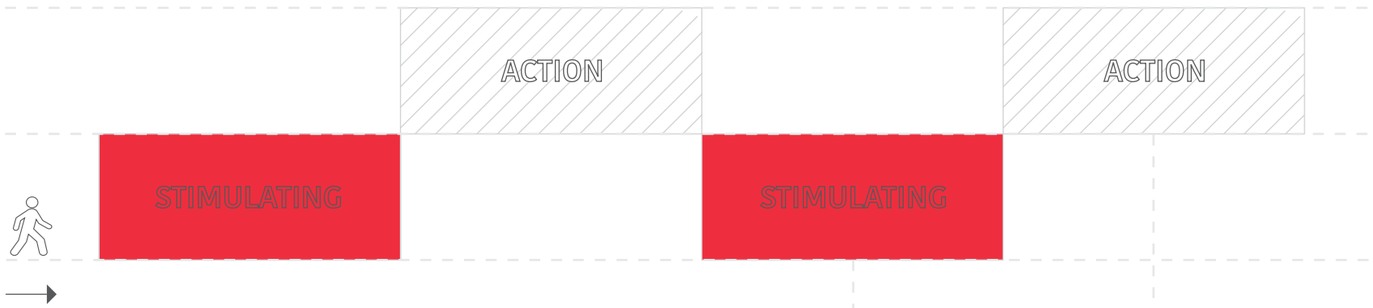
Moderate arousal level produces optimal performance





Red is a stimulating color, which can be applied whenever alertness, consideration and boosting energy are required. Applying this color in one phase before a phase where an action is expected to happen, makes user more aroused and alerted. So that, it raises the arousal level, blood pressure and other physical indicatores.

Moderate arousal level produces optimal performance. In this phase, in some levels body reaches the optimal arousal point which is proper for doing any task.



Repetition of red keeps the optimal arousal level

Optimal arousal level creates optimal performance

Blue

Calms The Nerves

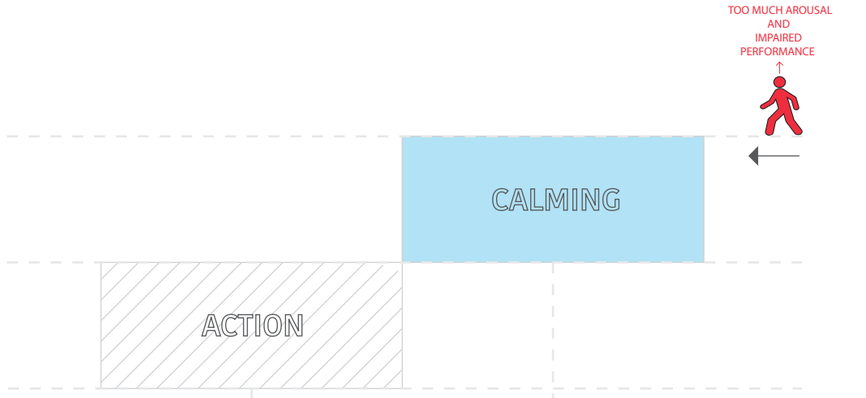
Decreases Heart Rate

Lowers Blood Pressure

CALMING

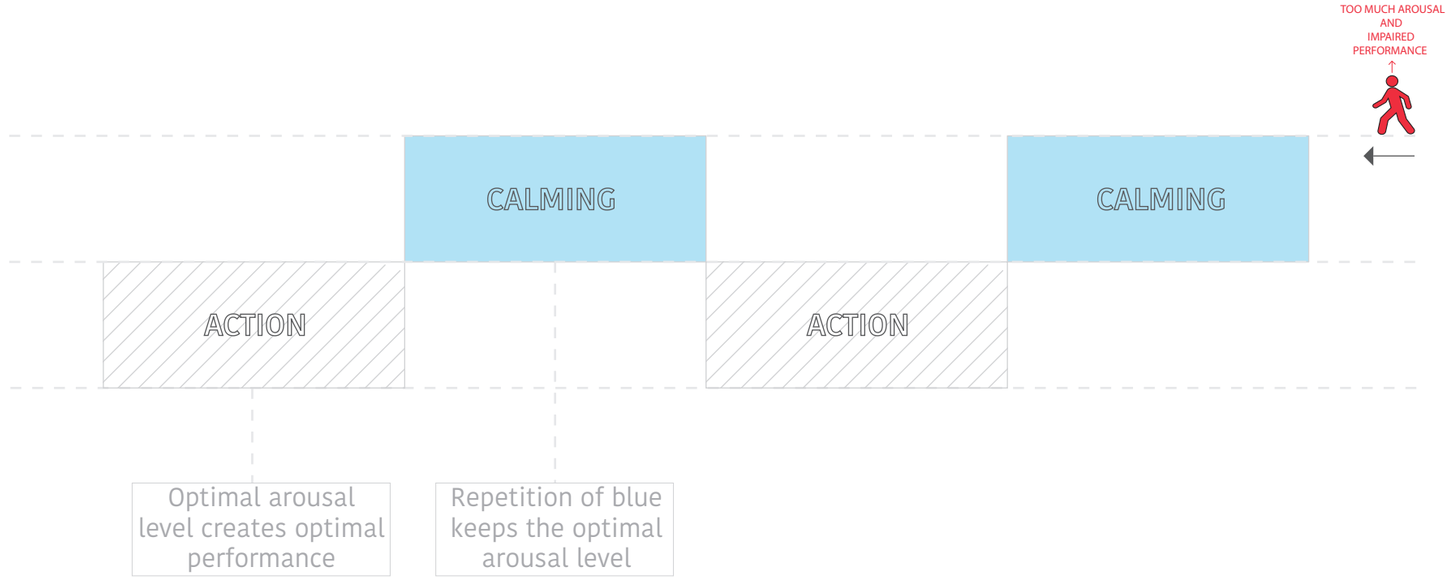
Too much arousal level causes impaired performance

Moderate arousal level produces optimal performance



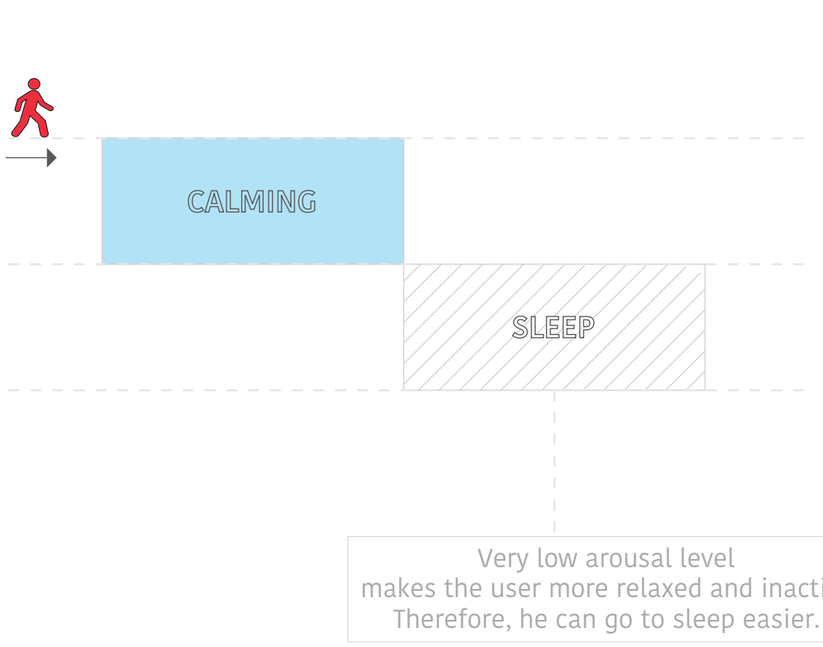
Optimal arousal level produces optimal performance. In this phase, in some levels body reaches the optimum arousal point which is required for doing any task efficiently.

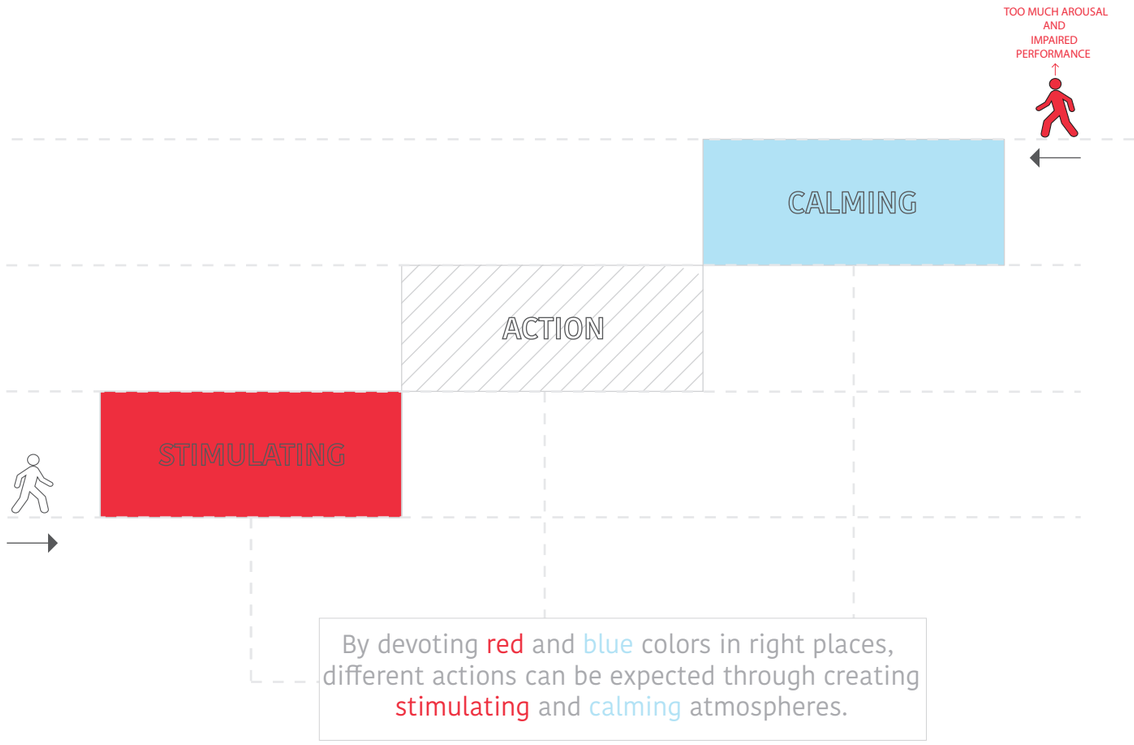
Too much arousal causes impaired action. Blue color is applied whenever lower arousal level is required. So that, by using blue in one phase before a phase where an action is expected to occur, arousel level reaches the lower point. Consequently, blood pressure and other physical indicatores decrease.

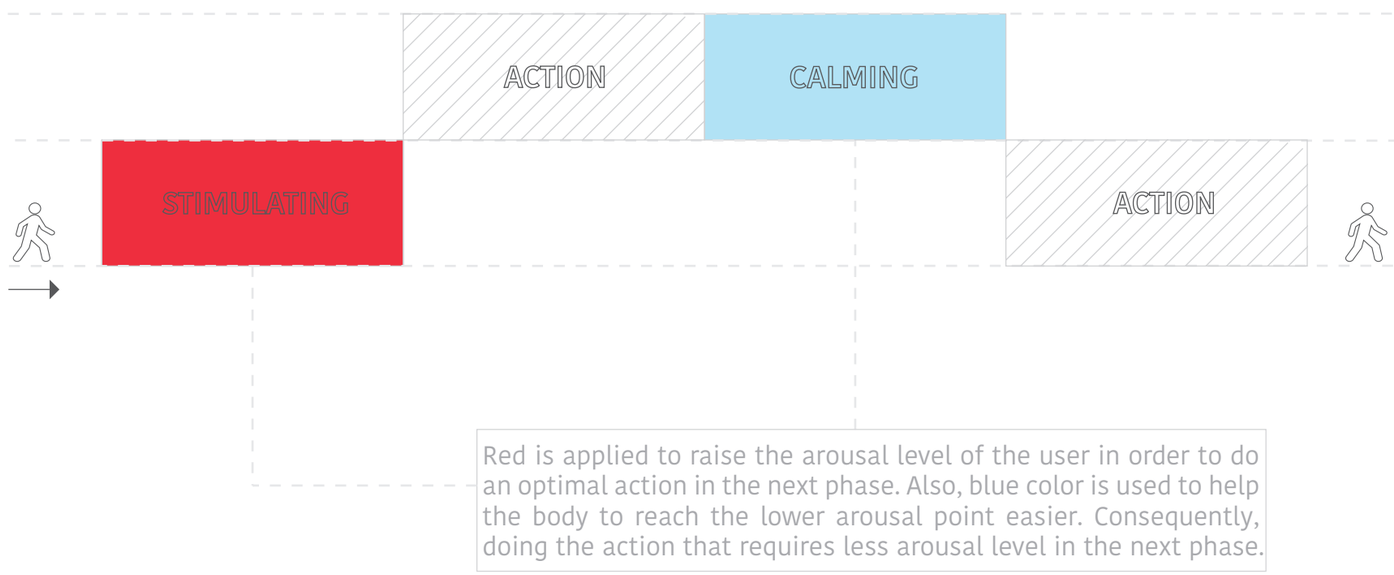


Optimal arousal level creates optimal performance

Repetition of blue keeps the optimal arousal level


CALMING
SLEEP
Very low arousal level
makes the user more relaxed and inactive.
Therefore, he can go to sleep easier.


TOO MUCH AROUSAL
AND
IMPAIRED
PERFORMANCE
CALMING
ACTION
STIMULATING
By devoting red and blue colors in right places,
different actions can be expected through creating
stimulating and calming atmospheres.


ACTION
CALMING
STIMULATING
ACTION
Red is applied to raise the arousal level of the user in order to do an optimal action in the next phase. Also, blue color is used to help the body to reach the lower arousal point easier. Consequently, doing the action that requires less arousal level in the next phase.

7.4.- THREE-DIMESIONALIZATIONS

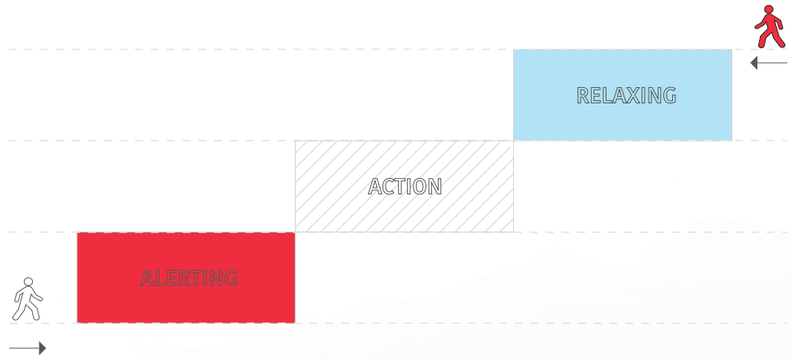
This section presents 3D visualizations that implement the proposed solution in different spaces. In examples, some spaces are painted in red or blue colors, which are considered stimulating or calming colors, respectively. Moreover, the color of other spaces must be neither red nor blue: their color could be any neutral color, avoiding stimulating or calming ones.

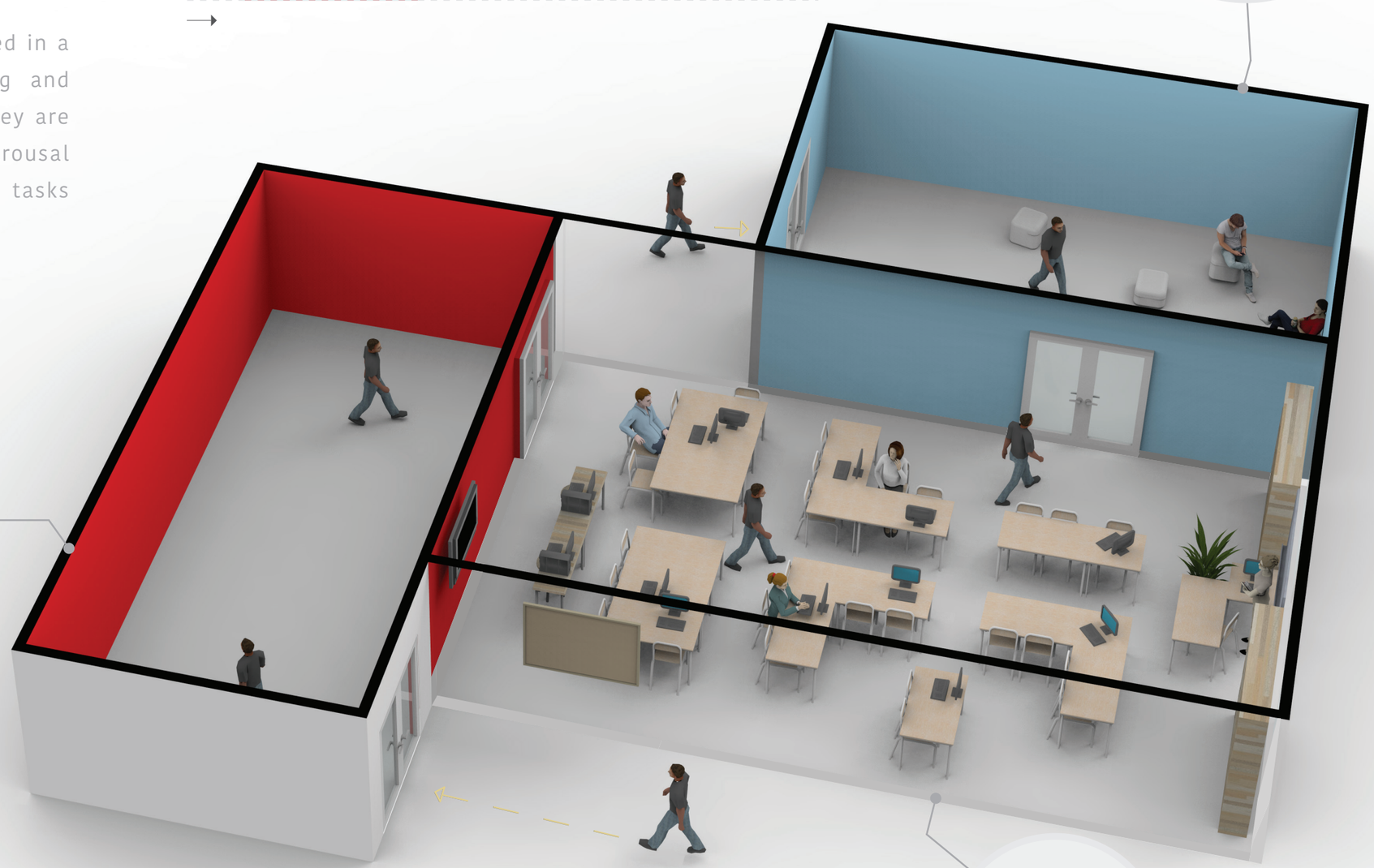
In the following examples, red and blue colors are applied in one phase before the phase where the action is required to happen. Red is assigned to places whenever boosting energy, alertness and concentration is needed. Whereas, color blue is applied when relaxing and calming effects are expected.

In the upcoming 3D examples, the impacts of red and blue colors on a school, a home, a gym, and a hospital are represented.

ALERTING **RED** AND RELAXING **BLUE** IN A SCHOOL

Red and blue rooms are considered in a school through their stimulating and calming features, respectively. They are used whenever higher or lower arousal level is required in order to do tasks optimally in the next phase.





3
Exposing to blue color decreases stress and lessens anxiety

Red room increases alertness and concentration
1

Students are concentrated and ready to learn
2

Red room is used to increase alertness and is useful for students to get more concentrated in order to learn more efficiently.



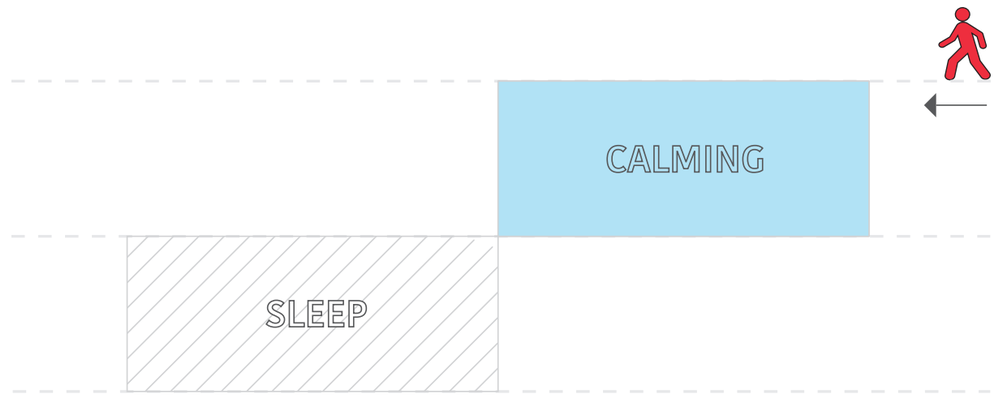
Blue room is used to calm the nerves whenever students are highley stressed-out and excited. For example; to get rid of stress before taking exams.





CALMING EFFECT OF BLUE ON SLEEPING

Blue color has a calming effect on human psyche and body. It decreases arousal level by reducing the blood pressure and heart rate. So that, very low arousal level makes you relaxed and inactive. Applying blue in a place where you spend time usually at nights before going to bed, prepares you to sleep much easier. For example; by spending time in a blue TV room for a period of time before going to bed, your body and nerves get relaxed, which results in sleeping easier.



1

Applying blue color in one phase before going to bed, makes the user calm and relaxed

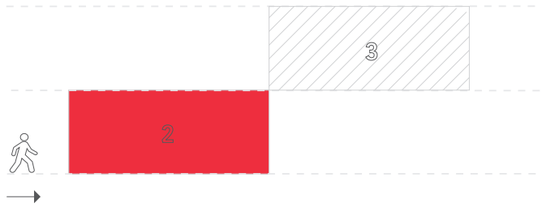
The user's body is relaxed and he can go to sleep easier

2



ENERGETIC RED AND CALMING BLUE IN A GYM

In a gym red and blue spaces are used in order to increase energy and relax gymgoers, respectively. So that, by spending a period of time in the red room they get more energetic. Consequently, they reach the optimal arousal level to work out efficiently in the next room. Moreover, the blue room helps body to lower the blood pressure and heart rate- which have been already increased due to the exercising- much easier.



Gymgoers enter locker room after passing the reception room

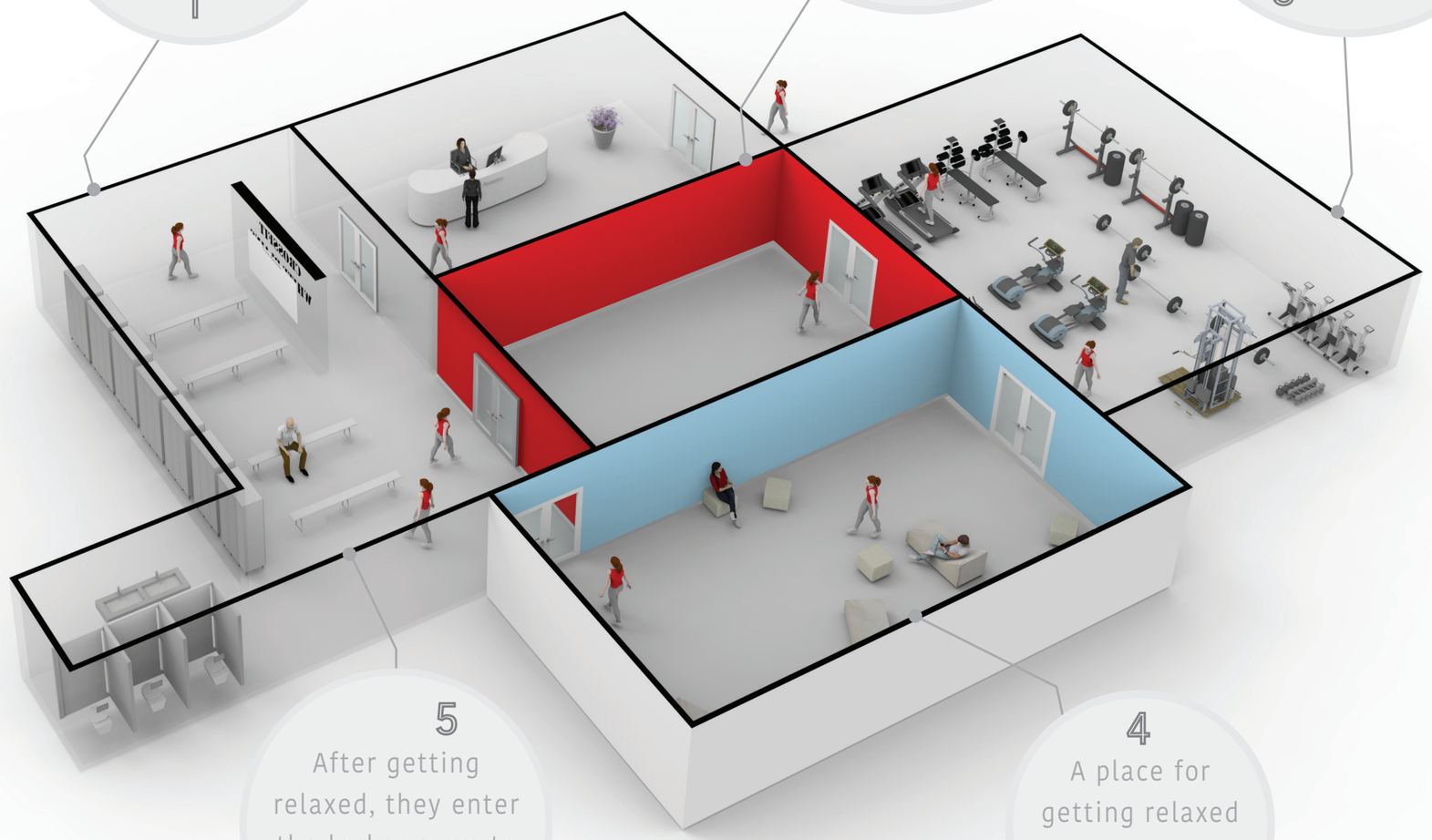
1

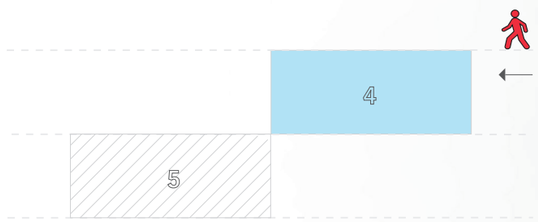
2

Passing through the red room prepares gymgoers for workingout. So that, they become aroused and more energetic before getting into the exercise room

After exposing to the red room, they reach the optimal arousal level which is proper for workout

3





5

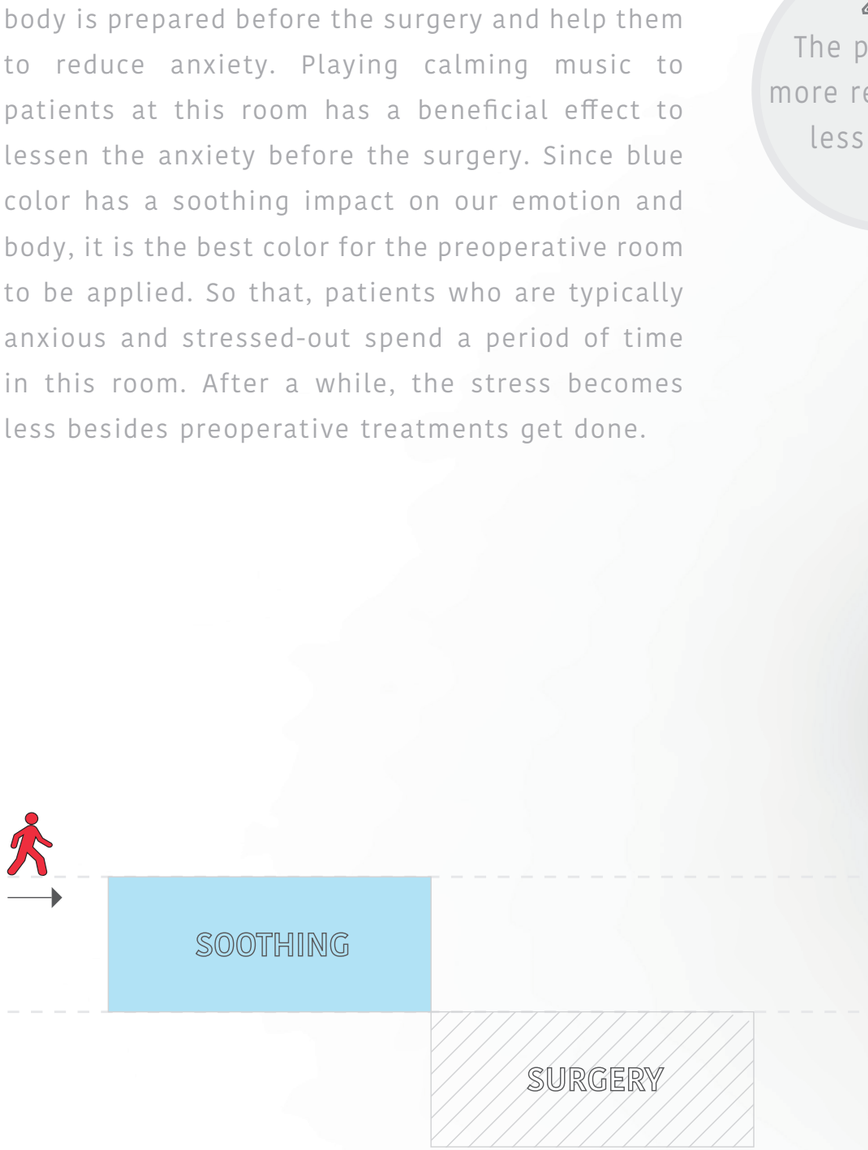
After getting relaxed, they enter the locker room to change their sportswears

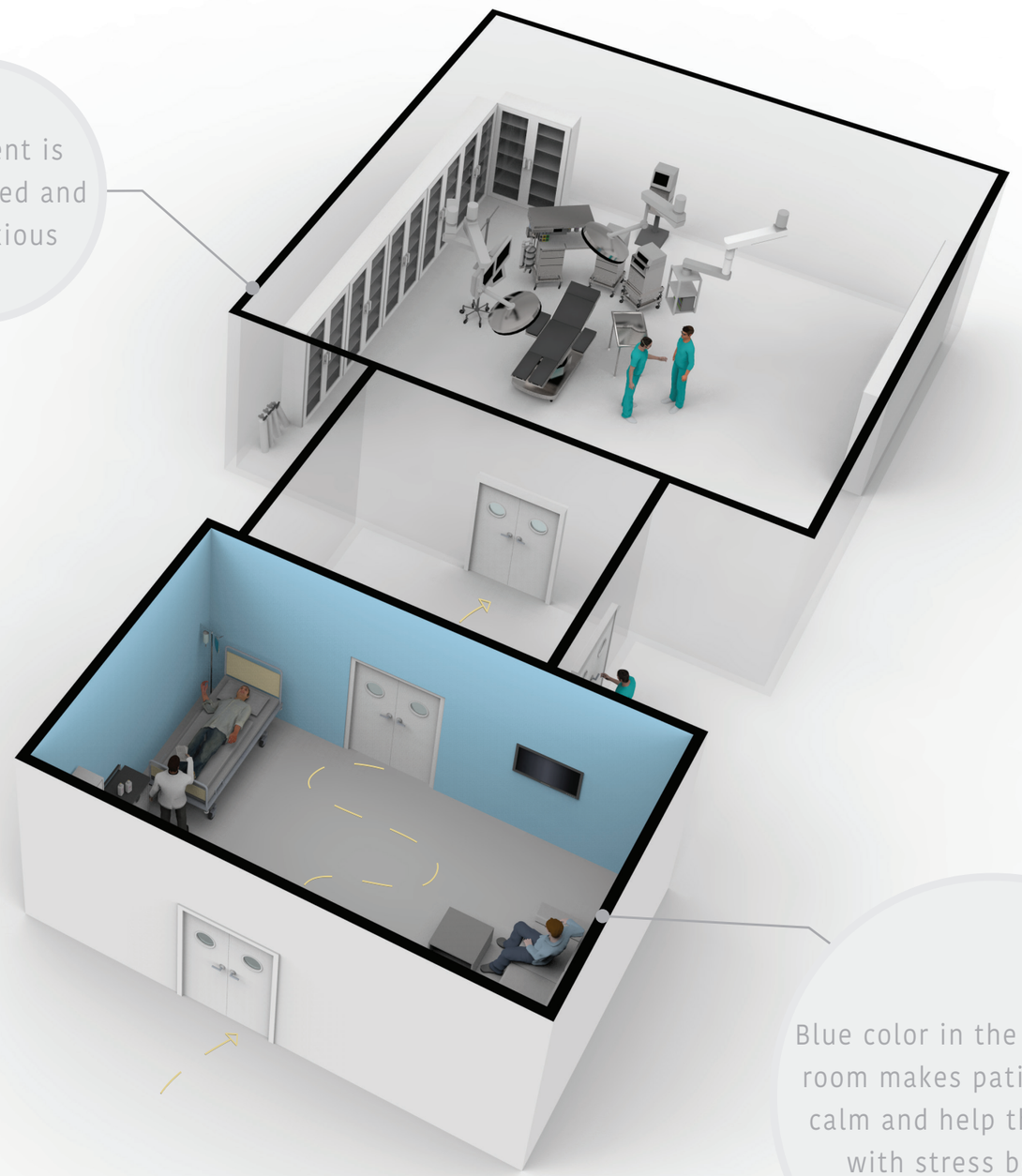
4

A place for getting relaxed after a hard workout

SOOTHING BLUE IN A HOSPITAL

The preoperative room is a place wherein patient's body is prepared before the surgery and help them to reduce anxiety. Playing calming music to patients at this room has a beneficial effect to lessen the anxiety before the surgery. Since blue color has a soothing impact on our emotion and body, it is the best color for the preoperative room to be applied. So that, patients who are typically anxious and stressed-out spend a period of time in this room. After a while, the stress becomes less besides preoperative treatments get done.





2

The patient is more relaxed and less anxious

1

Blue color in the preoperative room makes patients' nerves calm and help them to cope with stress before the surgical operation

FUTURE STUDY

As it is already explained, the main project discussed the impacts of colors in space in order to improve the efficiency of the function. In this section, we open a new perspective to this theory, which can be extended as a new project in the future. The idea and notion is to investigate the influences of colors on objects. Studies demonstrate that different colors convey different meanings, which leads to change our perceptions towards products. So that color can even define the function of the object.

Due to the fact that colors have various association with our cultures, symbolism, memories, and etc., each color can transmit a specific meaning and emotion. Hence, it is vital to consider color carefully in the first step while designing a product. To do so, further exploration and analysis are required in order to obtain sufficient information and knowledge. Following, a successful product design is a happy marriage of form and colors, future studies demand investigations of the relationship between these two important elements too.

The upcoming moodboards present the effects of different nuances of colors - red and blue - on chairs. The chair is selected as a representative of objects to be worked on. This analysis is only made based on the color factor: different nuances of color red and blue transmit different meanings and impacts on chairs. Therefore, the chairs with specific colors can be located in different environments accordance with the function of the places.



POWER
&
STRENGTH





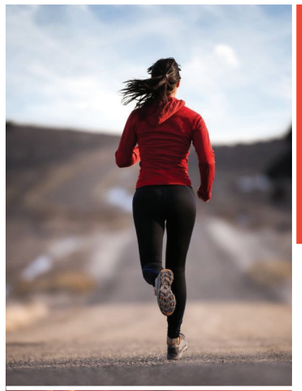


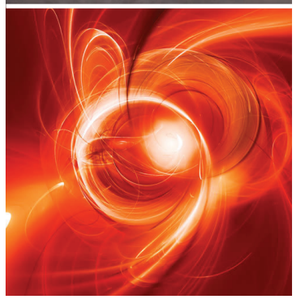


"Value [of color] has a negative relationship with the ruggedness (...)."
(Labrecque & Milne, 2012, p. 717)

"(...) when humans see red, their reactions become both faster and more forceful."
(Elliot & Aarts, 2011)

Fig. 8





ACTIVITY
&
ENERGY

"[Color red] is generally associated with the characteristics of activity (...) and stimulation (...)."
(Labrecque & Milne, 2012, p. 714)

Red is a stimulus that speeds up the heart and circulation, increases pulse and breathing rates, and raises blood pressure.
(Meerwein, Rodeck, & Mahnke, 2007, pp. 23-24)



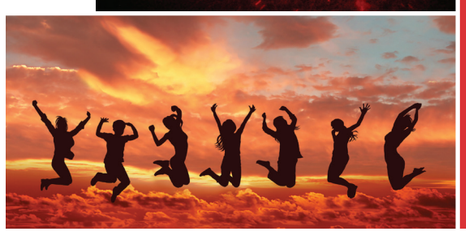
Fig. 9

"High saturation [color] increases arousal and excitement; high (versus low) levels of saturation exhibit a positive relationship with the excitement dimension (...)."
(Labrecque & Milne, 2012, p. 717)

"Research has consistently shown that longer wavelength hues (e.g., red, orange, yellow) induce states of arousal and excitement."
(Labrecque & Milne, 2012, p. 714)







JOY
&
WELL-BEING

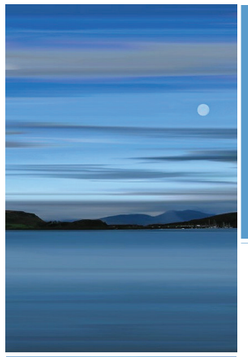
Fig. 10



Red stimulates the adrenal gland and the neurons.
(Staff, 2013)

(...) in the experiment subjects felt significantly warmer in the modified red chamber during two-hour exposure periods. However, these responses were psychological and there were no physiological changes on skin temperature.
(Fehrman & Fehrman, 2000, p. 112)

(...) red stands for (...) life and love.
(Meerwein, Rodeck, & Mahnke, 2007, p. 21)





SERENITY & PEACE



Fig. 11

Blue has a soothing effect on human mind as it helps to produce some calming chemicals in the brain.
(Staff, 2013)

"(...) blue colors decrease blood pressure, pulse, and respiratory rate."
(Jin, Yu, Kim, Kim, & Chung, 2009, p. 1972)



Fig. 13





Blue is associated with cleanliness, emphasizing the product's promise of clean (...)."
(Tornetta, Fox, & Blackbird, 2013, p. 3)





CLEANLINESS & COOLNESS

Bright blue is associated with cleanliness:
The origin of this meaning arises from the qualities of the ocean and inland waters.
(Morton, 2012)

Fig. 12



Experiments indicate that:

(...) subjects feel warmer in rooms in red or orange tones. While, they feel cooler in rooms painted in blue or green tones.
(Fehrman & Fehrman, 2000, p. 112)



LOYALITY & TRUST



"Blue is linked to competence, as it is associated with intelligence, communication, trust, efficiency, duty, and logic. It is also seen as a secure color."
(Labrecque & Milne, 2012, p. 714)

Blue is used a lot in cooperate sector as it denotes loyalty.
(Staff, 2013)

CONCLUSION

This project aimed to introduce a different and new point of view regards color design in space. Investigations indicate that color is one of the vital elements which enables us to evaluate a space. It is considered as an inseparable member of design and is as important as form. According to the studies, color influences on human bodies and emotions physiologically and psychologically, respectively. Since architectural spaces are created to fulfill individual needs, they should be designed in such a way that improve the quality of life, welfare, comfort of users. In addition, enhance the efficiency of functions in any environment. Interplaying color and space is one of the crucial and effective methods that can lead us to attain this objective. Hence, analyzing all the features of color scientifically prior to design a living environment is the most significant point which should not be ignored and have to be considered carefully in the beginning of the process of color designing a space.

To initiate the investigation, in the first phase, information was collected from four different areas of knowledge. They were cultural, scientific, experimental, and logistic knowledge. The main objective was to amplify the knowledge, searching a broader view of society that allowed a free reflection of the current constraints.

Next, three triangulations were created through connecting main ideas retrieved from the studied materials. Consequently, a set of concept and preposition was created for each triangulation. In the final phase, one of the prepositions was selected to be developed as a project – a model - materialized through three-dimensional spaces in four different environments such as; a school, a home, a gym, and a hospital.

The proposed project, presents a way to set a balance in environments, in terms of considering psychological and physiological aspects of color on humans over time in order to lead users to do optimum functions. According to studies, *“Inverted-U”* hypothesis demonstrates that, in order to do any task optimally, our body needs to reach a specific arousal level. At the extremes, at no arousal or at incredibly high arousal, the performance is impaired. Therefore, we took advantage of this hypothesis and by relying on stimulating and calming characteristics of colors, we introduced a new method in color design. By applying stimulating and calming colors in one phase before a phase where an action expected to happen, we can

help the users to reach optimal arousal level, which results in optimal performance. This method aims to avoid users from getting under- and overstimulated due to the exposing towards constant colors, which both bring about impaired function.

By implementing this new approach in design, not only we will have different color palettes for every space, but also we will have modifications in architecture plans. So that, architects can consider additional places painted in stimulating or soothing colors, in order to improve the efficiency of space and create optimal performances in environments.

In the end of this thesis, there is an introduction that paves the way to the future subject which can be considered as a next project. While the main project discusses impacts of colors on space, further investigations can be focused on expansion of this subject to the influences of colors on objects. Studies demonstrate that, different colors and nuances have different associations with our emotions and perceptions. They convey various meanings and can even impact on judgment of the function of objects. By applying proper colors for objects, expected emotion can be transmitted in accordance with the function of products. Consequently, it is necessary to be aware of impacts of colors while choosing colors for products.

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