

Color analysis of birth space ambiances

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ABSTRACT

Color is an integral component of architecture. It is an expressive element which deals with lighting distribution and many other aspects. It has a preponderant role in defining and personalizing the character of space and its ambiances. In this study, we will focus on women in labor and how users perceive colors in such specific spaces through the sensitive experience carried out in birth institutions, how color can be integrated in the birth space, how it takes part of a special event, and how it modifies women perception. Our research is at the crossroads of several disciplines. It focuses on analysis of stress levels for women in labor in different obstetric spaces, using Electrodermal Activity (EDA) tracking that evaluates the arousal via skin conductance measurements. This quantitative study will be correlated to a qualitative one which is based on a descriptive approach that consists in the analysis of the role of color in birth ambiances by using photos of different birth spaces and information collected in different surveys. Thus, the goal of this paper is to identify ways of choosing colors in the obstetric space and search for appropriate ambiances to improve a well-being experience of giving birth without stress and anxiety.

KEYWORDS Ambiances, Birth Space, Color, Birthing Women, Electrodermal Activity

RECEIVED 15 October 2019; **REVISED** 28 November 2019; **ACCEPTED** 04 December 2019

1. Introduction

Through cultures, color manifests itself as a deep inherent quality linked to the substances of objects and not as a superficial mark (Tornay 1978). It is used to identify groups, to convey symbolic meanings and to experience an aesthetic pleasure. It is a component of the social and physical world around us. It doesn't occur taken alone but it is associated to objects and events. Its perception depends heavily on the context (social, spatial, temporal, ambient, functional).

Color takes shape only when it begins to be perceived as a quality of a specific context. It is an expressive element in the design of life space which deals with lighting distribution. In primates, space perception is multisensory. Ambiances solicit different senses, essentially through visual perception; color gives a sensual visual perception of space. It is one of different aspects of visual perception through which, in other primates, the exploration of any space begins. Indeed, colors have an influence on the ambiance. An ambiance is born so of singular relationships between materials, lights, colors and individuals (CAUE de l'Ain 2011:4). That is how it contributes to shaping the living environments.

Color is considered as a tool that influences the user's perception and behavior (Tofle et al. 2004, Dalke et al. 2006, Çiçek and Gökçakan 2016). Thus, color has an important role in the user's space experience. Color reveals certain meanings and symbolism in a close relation to psychological and physiological effects that it produces. Each color is associated with a certain mood, a certain environment that affects the user's space perception and emotion. It plays a role in creating an ambiance of pleasure, excitement, content and comfort for a user that supports the function of a space.

Popular culture suggests that color prompts different human responses: psychological, biological, and behavioral (O'Connor 2011). Color can be considered as a therapy. It can play a role in the healing process. Some architectural and interior design books, such as Kopacz (2003) and Mahnke (1996), and technical reports such as those by Hill (2008), provide information related to the role of color psychology and color therapy in architecture (O'Connor 2011).

Color is a specific architectural variable that can be modeled to provide different space ambiances. Nowadays, we notice the use of colors in healthcare environment. There is considerable agreement among architects, interior designers, and medical doctors that color may promote the well-being of the hospital users. Indeed, color facilitates the spatial orientation and

wayfinding of patients in the hospital (Dalke et al. 2006). According to Smets (1969), colors can affect the time experience of a hospital stay that is felt by patients. He compared the time spent under two different lights, red and blue. Patients under the red light reported a shorter estimate of time spent than those who were under the blue light (Ghamari and Amor 2016).

Several studies have been conducted on the effects of color on the user's ambiance perception. Küller et al. (2009) and AL-Ayash et al. (2015) demonstrated that a red room is more psychologically arousing than a blue room, which is perceived as pleasant, calming, and interesting. Thus, color is important since it has the ability to heal and to comfort. Yellow and red promote exchanges and excitement, while blue and green soothe and relax patients (Sternberg 2009:40).

In terms of ambiance, color creates 'welcoming', 'homey' and 'pleasurable' ambiances to ease the stress of patients by the use of warmer colors, to improve satisfaction and help patients sleep (Dalke et al. 2006). Birth space and birthing women represent a pertinent research case and we will explain in this paper how color design influences the sensitive experience of birthing women.

2. Method

This study is at the crossroads of several disciplines. In order to understand the deep relationship between color in birth space, the event of birth and women perception, we varied the methods. Our research is composed of two parts: a qualitative study which will be correlated to a quantitative one. When choosing the fields of study, two different cultures are taken into consideration to explore a diversity of color space experiences, which are the French and the Tunisian ones (Fig. 1).



Fig. 1. Hospital birth space in two different cultures: French (left) and Tunisian (right).

2.1. Qualitative approach

The qualitative study is based on a descriptive approach. The descriptive method is adopted to analyze the colors used in three different French birth spaces situated in Grenoble. We chose to analyze a delivery room and a maternity room of a hospital maternity, a clinic maternity and a birth center. The process of analysis begins with collecting photos and information in a survey. The process depends on the identification of the properties of colors used, its ambiance as well as its effects on women during the birth event. Further, and by adopting a transposition of the results of the French qualitative study, we selected Tunisian maternities that have the same architectural and ambient characteristics as identified in the French ones.

2.2. Quantitative approach

We carried out our quantitative study that focuses on the analysis of stress levels (Hussein et al. 2015, Hussein et al. 2016) for women in labor in the Maternity and Neonatology Center of Tunis, using Electrodermal Activity (EDA) tracking that evaluates the arousal via skin conductance.

In this second part of our study, a multidisciplinary experimental protocol of two components is applied. It is organized as follows: A spatial characterization consists of analyzing colors used and capturing the emotional state of women in labor using Electrodermal Activity tracking. In addition, the sensitive experience of women in labor has been recorded through surveys.

To realize this experimental protocol, a wearable biosensor device called E4 was used that measures emotional states (stress, excitement, happiness, and more). Its data can be visualized by the software 'E4 manager' (Fig. 2). Our target population was five women in labor aged between 25 and 32 years.

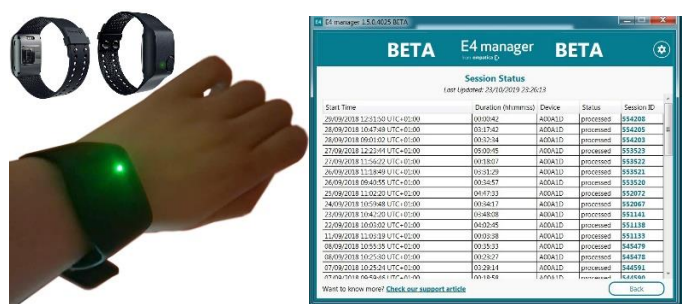


Fig. 2. Wearable biosensor device 'E4' (left) and its software 'E4 manager' (right).

In this paper, we will present the results of one case that is representative of all those studied, and which shows how we can detect objectively the effect of an ambiance (light, color, odor, sound) on women in labor, and how an

architect can model a conception of space taking into consideration those parameters. The E4 sensor was worn by each woman in the delivery room and the measurements stopped when she was transferred to a maternity room. The itinerary chosen to be analyzed was during the transfer from the delivery room to a maternity room. It takes about ten minutes. During this time, a record of the woman's feelings toward the ambiance, and specially the colors, was done by taking notes and comments.

3. Results and discussion

In our field study, we focus on the sensitive experience of birthing women in birth space in two different spatial, social and cultural contexts.

3.1. French experience

During our qualitative study in the French field, we visited, photographed and analyzed from the architectural and ambient viewpoints three different types of space. We carried out surveys and did ethnographic observations to identify the relationship between space, color and the user's perception. The French maternities were: Maternity of the University Hospital Center, Maternity of Clinic Belledonne, and the Birth Center 'La Maison'.

Beginning with the Maternity of the University Hospital Center (Fig. 3), the colors used in the delivery and labor rooms were white, a warm shade of yellow and a grey with low value of blackness. When asked, a woman who was giving birth there said, "Yellow is a brilliant and happier color, the color of the sun, of joy; it makes the room shine." While another woman explained her dissatisfaction with the grey color: "The spaces are good enough... apart from the delivery room. It is grey and austere. It depressed my husband too."

Some research done by Nikolic and Nikolic (2012) and by Tofle et al. (2004:58) proved that yellow evokes energy, dynamism and excitement, and its brilliance is most often associated with the sun. It stimulates the activity of women in labor. By contrast, another study highlighted that yellow should not be used in maternity units as it hinders the diagnosis for jaundice (Dalke et al. 2006).

In physiologic delivery rooms, a light blue-green color was added to previous colors. It is a great choice for creating a natural ambiance. The light blue-green color gives the impression of being in a garden. It has a calming effect. Research shows that green, the color of plants and nature, represents growth and life (Tofle et al. 2004). In the maternity rooms a light pink color was chosen for the walls with white and grey for the flooring.

This combination creates a pleasant ambiance. It symbolizes nature and flowers, creating a calm and fresh ambiance.

In the Maternity of Clinic Belledonne, which is a private healthcare space (Fig. 4), shades of a light pink color were used for the delivery room in order to offer to women in labor an ambiance of intimacy and warmth, in the opinion of midwives. Pink is one of the warmer colors traditionally recommended for maternity units (Dalke et al. 2004). One of the reactions of a birthing woman was: "The delivery room has very bright colors, it has different colors: a pink, a green and the blue turquoise; beautiful colors."



Fig. 3. The use of colors in the Maternity of the University Hospital Center, Grenoble: a. labor room, b. delivery room, c1. and c2. physiological delivery rooms, d1. and d2. maternity rooms. Photo: Ichraf Aroua, 2017.

In the physiologic delivery room, a dominance of grey is observed with a touch of green. Indeed, studies of Nikolic and Nikolic (2012) showed that the green has a positive effect on the reduction of anxiety and pain. On the contrary, greenish colors were not prescribed in a lactation room because they were linked to an operating theater (López-Tarruella et al. 2018). Grey is a neutral color; it is used to create a neutral ambiance, to highlight

the green color. In order to create a more upbeat ambiance (Dalke et al. 2004:17), it is not recommended to use it as a single color in a hospital space.

For the maternity rooms, orange was used. This color is particularly popular and recommended for maternity units. It symbolizes energy and power; it evokes warmth, comfort, and reassurance (Tofle et al. 2004:50, Dalke et al. 2004:20). A recent study about the influence of environmental color in lactation rooms showed that warm colors, especially yellow and orange, tend to score highly for cosiness. As well, they are considered to be the homiest colors (López-Tarruella et al. 2018).

In spite of the positive effects of orange color in a birth space showed by some studies, its perception is still subjective. For example, a woman giving birth there was not satisfied with the use of orange. She said, "The orange paint on the wall... It's really very concrete; it is not something that is warm and welcoming... It is orange... like it explodes in my face."

This showed that the color effects on a woman are something personal, related to one's taste and background.

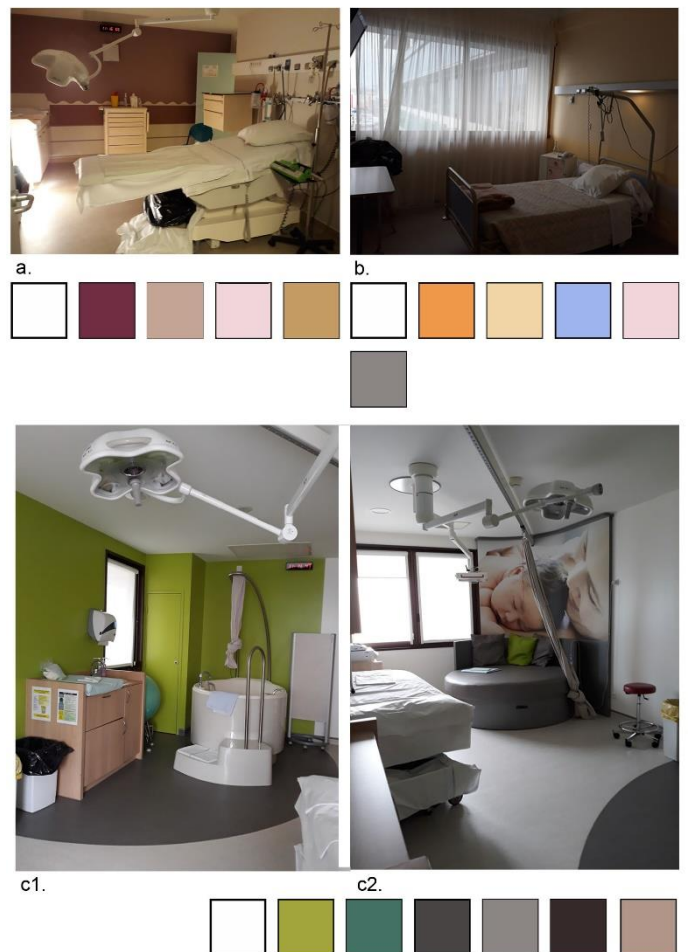


Fig. 4. The use of colors in the Maternity of Clinic Belledonne, Grenoble: a. delivery room, b. maternity

room, c1. and c2. physiological delivery rooms. Photo: Ichraf Aroua, 2017.

In the two previous maternities, the medical ambiance was really present. White dominated the walls and furniture. It had a clinical appearance; neutral and without vitality. Other colors were used partially. While among patients, 'whiteness' connoted cleanliness and hygiene (Dalke et al. 2004:19).



Fig. 5. The use of colors in the Birth Center 'La Maison', Grenoble: a1. and a2. delivery rooms, b1. and b2. living rooms. Photo: Ichraf Aroua, 2017.

The Birth Center 'La Maison' (Fig. 5) is considered as the recent form of birth space, which is seen as an alternative to giving birth at home. In this space, childbirth is considered as a natural process. It is characterized by a familiar and warm ambiance by using residential furniture. Adding to that, the use of green, blue, pink and orange creates a welcoming and homey ambiance. The choice of color responds to these needs. The wall covered with wallpaper has a variety of shades ranging from white to grey. While interviewing the architect Isabelle Chamero of the Birth Center, she justified her

color choice by the fact that this variety of colors gives a woman in labor a sense of security and tranquility. A study confirms that it is recommended to ensure a distinct variety of colors to provide enough visual interest (Dalke et al. 2004:19). An interviewed woman was satisfied with the chromatic ambiance: "I found the maximum of privacy in this room; it is warm and colorful."

3.2. Tunisian experience

Since a safe and satisfying birth experience depends strongly on the level of stress experienced by the birthing woman, we had to verify objectively the impact of color parameter in modeling birth space ambiances, and thus affecting the perception of birthing women. Observations collected from our qualitative study on the French fields had to be completed by a quantitative study based on stress level evaluation. Detecting situations of stress due to an obsolete control of colors and light in birth environments is the ultimate goal of this correlation between qualitative and quantitative parts of our research.

To identify stress situations due to color and light parameters in birth spaces, we selected a Tunisian field of study where architectural design represents most of the recommendations picked up in French maternities: Maternity and Neonatology Center of Tunis. It deals with medical aspects needed in labor/obstetric spaces and friendly and warm ambiances needed in maternity rooms. Figure 6 shows the time-space interval chosen to be studied in this part, which is the time of transfer of a woman from the maternity room to the labor room, because of the variety of color and light ambiances. The delivery room is painted white. In the hall of the delivery block a linear touch of pink is added to the white walls. In the corridor, most of the walls are covered with traditional blue faience. Finally, in the maternity room, only white is present.

A 25-year-old birthing woman who had a vaginal delivery without epidural is chosen as a case study to detect stress situations due to specific color and light ambiances. Figure 7 represents the curve of her Electrodermal Activity (EDA).

In this EDA curve, we identify different stress peaks due to an increased stress level in the delivery room; some are related to the colors used, others to many physical parameters (mainly some sounds of clinical staff and monitoring machines). At the same moment of those stress peaks, the birthing woman complained about the white color. It was confirmed by the comments of the birthing woman. When interviewing her about the space ambiance, she showed her dissatisfaction with the white color frequently used in delivery rooms: "White color

makes me feel cold and its neutral aspect is not cheerful; it is unpleasant.” The white color and bright light characterizing the hospital birth environment increased anxiety and fear for birthing women.

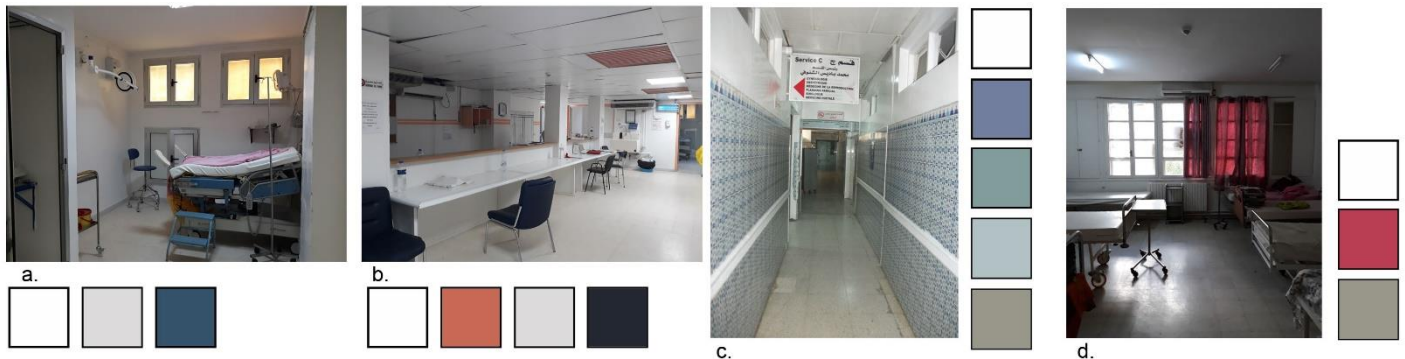


Fig. 6. The use of colors in the Maternity and Neonatology Center, Tunis: a. delivery room, b. hall, c. corridor, d. maternity room. Photo: Ichraf Aroua, 2018.

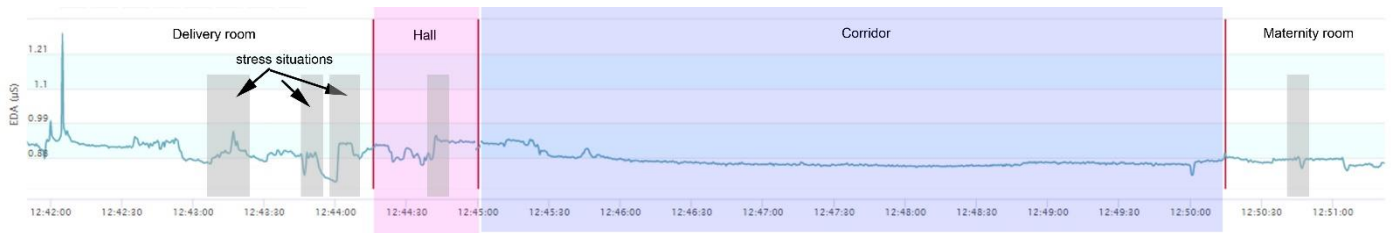


Fig. 7. Electrodermal Activity (EDA) curve of a birthing woman.

We note on the EDA tracking that stress peaks persisted in the hall of the delivery block despite the use of a pink touch. It might be as a consequence of the use of white color and bright light. This was confirmed by the comment of the woman: “Despite the presence of the pink, it feels white and pale. I cannot forget that I am in a hospital.”

In the corridor, a slight decrease of the intensity of the EDA is observed; then it stays constant until the entrance of the woman in the maternity room. In the corridor, there exists a combination of white and blue colors but the light is less bright and less intense. The wall cladding is a typical design used in many Tunisian homes, so color did not play a major role here in decreasing anxiety of a birthing woman. Architectural materials evoking home design also played a role. These results are confirmed by the woman’s comment: “For me, the corridor is more pleasant by the faience colored blue which makes me feel at home.”

In the maternity room, we detected on the EDA tracking a peak of stress and it might be a consequence of artificial

light. At this moment, the birthing woman asked to turn off the light and to open the window. Many scientific studies showed that artificial light stimulates the cortex, provoking the release of adrenalin and inhibiting the physiology of birth (Silva and Shimo 2017, Jenkinson et al. 2014). Being able to adjust the lighting also provides the opportunity to change the mood. More than half (56%) of women placed high importance on being able to control the brightness of the light in their birth room (Newburn and Singh 2003:6). Thus, brighter light can encourage activity and lower lighting can create a greater sense of privacy.

Color and light are an intrinsic characteristic of the visual sensations since they shape the relation between birthing women and their surrounding environment. They are a powerful factor in the recognition of objects and their delivery experience.

4. Conclusion

In this paper, we highlight a pertinent and original approach of detecting stress situations in birth space experienced by birthing women. There is the need for specific architectural design recommendations. In the light of the interest given to the question of birthing women and the birth experience in maternities, this study is pertinent as it shows the importance of careful coloring and lighting design in making the birth environment less or more clinical, affecting strongly the sensitive experience of such specific space users.

The analysis of the comments of women highlights that the perception of colors in space is more subjective than objective. It depends on the woman's personal experience, her background and her culture. In the case of the Tunisian maternity, women disapproved the use of white. For them it was cold and unpleasant, while a French woman perceived it as a symbol of hygienic and aseptic ambiance. We also observed that the use of monochromatic color schemes represents a bad choice for birth space because the positive effects of color are closely associated with there being several colors in the same space.

According to the results of the measurement of stress levels, we observed that every color creates a particular ambiance in a birth environment. It has a significant role in shaping the mood of women: stimulating or calming. The complexity of the hospital space showed that the stress situations can be caused not only by colors but also by other components such as sounds and smells, which may contribute to creating an uncomfortable ambiance.

The affective dimension of this study represents a new response that shows potential on the perceptual dimension of a given category of birth space users. The aptitude to personalize a given color design while considering age, culture, physical and mental capacities of birthing women is an important step forward. Such an objective would be aligned with a global well-being.

5. Conflict of interest declaration

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

6. Funding source declaration:

Financial support was provided by the Tunisian Ministry of Higher Education and Scientific Research.

7. Acknowledgment

We are particularly grateful to Professor Jean-Pierre Péneau for framing this study, and to Signals and Systems Team (U2S) from the National School of Engineering of Tunis (ENIT) for providing the E4 device and helping to analyze EDA data.

8. Short biography of the authors

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Both authors are affiliated with the Research Team on Ambiances (ERA) from the National School of Architecture (ENAU), Tunisia.

Their interests are focused on the altered perception in the urban and architectural space and the complexity of ambiances.

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