

Lighting and Emotions: A Brief Review

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Submit Date: 2022-11-26 13:52:23 | Revise Date: 2023-01-06 15:07:41 | Accept Date: 2023-01-19 16:43:17

DOI: 10.21608/jdsaa.2023.177046.1240

KEYWORDS:

Emotion, Lighting Design, Emotional Design.

ABSTRACT:

Emotion is a key factor in human life. Every day we pass various things that impact our emotions and one of these things is lighting. Lighting plays a key role in human life as it enables us to perceive our surroundings. Emerging lighting with emotion in design allows designers and users to get the maximum benefits from lighting systems. In this paper, we explored the potential of emotional design and lighting design. Emotions were investigated by reviewing various resources that define, describe, and analyze them. The relationship between lighting and emotions was analyzed as they are very relevant. This can be noticeable in mood changes due to lighting conditions. We selected two different case studies to be a guide in emotional lighting design. The first case study was a famous lamp design, the Hanabi lamp, and the second one was the lighting design in the National Museum of Egyptian Civilization (NMEC). The distinct factor in these case studies is that they are successful in performing their function.

1- Introduction

The question of “what is emotion?” was and still is a confusing query for scientists and philosophers through time. Chapman and Nakamura (Chapman and Nakamura, 1998) suggested that there is no agreed definition for emotion as emotion often is defined according to a list such as anger, pleasure or sadness (Cabanac, 2002). Many kinds of literature attempted to find out a singular definition for emotion. Kleinginna and Kleinginna (Kleinginna & Kleinginna, 1981) surveyed 92 different definitions and presented their one. Most of these definitions considered that emotion can't be defined “except in terms of conflicting theories” (Kleinginna & Kleinginna, 1981). Creamer & Guide (Creamer & Guide, 1996) didn't present a clear definition of emotion. Also, Lewis et al. (Lewis et al., 2016) in the Handbook of Emotion avoided presenting a specific definition for the term emotion but deal with it from a different point such as sociology and psychology, and its relation to other domains such as music, literature, and economy. Cunningham and Kirkland (Cunningham and Kirkland, 2012) suggested this difficulty in defining emotion is related to the attempt to define it “in contrast to cognition”.

The emotional design aims to prevent bad emotions and stimulate good ones. This is considered the ultimate goal of emotional design. Many approaches were developed to design emotional products. Some approaches investigated the interaction between products and users in the usage phase (Hummels, 1999; Forlizzi & Batterbee, 2004; Desmet & Hekkert, 2007). Others concentrated on the user to find out their emotional needs (McDonagh et al., 2002; Brinkman & Fine, 2005; Khalid & Helander, 2006). On the other hand, many studies paid more attention to the design and the inspiration process (Dunne, 1999) while others studied the emotional response of the user (Cupchik, 1999). This approach led to the development of several

measuring tools to measure the emotional response of the user towards products.

Lighting design is one of the most important domains for people as lighting has an essential role in our life. As lighting's basic function is to help us see clearly, it has a dramatic role in daily life. To understand why light impacts our mood, we should understand why it impacts our bodies. The human body operates according to various biological systems, one of which is the circadian system. This system uses lighting cues to regulate other systems in the body and influence processes such as the release of chemicals into the brain. These chemicals are responsible for our feelings and emotions throughout the day. Before artificial light, natural periods of daylight helped regulate our biological clocks. Now that we're exposed to many forms of artificial light, things have changed. Artificial light impacts our circadian rhythms in many ways, both positively and negatively.

In this paper, we explored and reviewed the role of emotions in the design process and how emotional design terms were coined. After that, lighting design was investigated to be aware of the functions and various variables in the lighting domain. This led to more understanding of how lighting can evoke emotions. Lighting has many factors that can be controlled to change the mood of the user in different situations. Finally, two case studies have been analyzed to show how lighting impact emotions in different locations.

2- Emotion and Emotional Design

Through decades, researchers and psychologists generated various definitions for the term “emotion”. In 1981 Kleinginna and Kleinginna (Kleinginna & Kleinginna, 1981) surveyed 92 definitions and 9 sceptical statements of the term emotion. After analyzing this collection of definitions, Kleinginna and Kleinginna defined emotion as “a complex set of interactions among subjective and objective factors, mediated by neural-hormonal systems”.

The American Psychological Association (APA) defined emotion as “a complex reaction pattern, involving experiential, behavioural and physiological elements.” (APA, 2022). An individual’s emotion reflects the human ability to subjectively experience certain states of the nervous system (Barrett et al., 2016). Emotions are a mental state brought on by neurophysiological changes according to situations that an individual faces (Panksepp, 2004). Emotion is a positive or negative experience that is associated with a particular pattern of physiological activity (Pinker, 1997).

Emotions were divided into two categories: basic and complex emotions. Basic emotions are associated with recognizable facial expressions and tend to happen automatically (Keltner et al., 2019; Levenson, 2011). Paul Ekman (Ekman, P. 1992) identified six basic emotions that could be interpreted through facial expressions. They include happiness, sadness, fear, anger, surprise, and disgust. Complex emotions have differing appearances and may not be as easily recognizable, such as grief, jealousy, or regret. They are defined as any emotion that is an aggregate of two or more others (APA, 2022).

Emotions are a greatly foremost and conjoined part of human life. They give meaning to everything that happens in our lives and help us to evaluate our surroundings and situations (Josephs, 2005). Products are an essential part of human life and buying decisions are extremely affected by buyers’ emotions. The emotional design indicates that design should stimulate consumers’ emotions to be a successful product in the marketplace. This can happen by adding emotional characteristics to the design of the product (Moradi, 2015).

Emotional design is a term that has been coined by Don Norman (Norman, 2004) in his book “Emotional Design: Why We Love (or Hate) Everyday Things” published in 2004. Norman emphasized the role of designers to concentrate on the emotional responses of users towards the product during the design process. This mechanism considers the importance of emotional aspects in the product as well as other aspects such as functions, aesthetics, and ergonomics (Nurminen, 2016). Various approaches and strategies were developed by researchers and designers to apply emotional design to products. Gharib (Gharib, 2017) classified emotional design approaches into four

categories: interaction, user, designer, and theory-based approaches.

Interaction between the consumer and the product often happens physically or visually (Alibage & Jetter, 2017). This interaction usually stimulates specific emotions. The quality of the interaction plays a key role in the emotions evoked. Context of the usage phase affects how emotions are evoked (Hummels, 1999). Various studies attempted to investigate how interaction can impact the satisfaction of the consumer such as Forlizzi and Batterbee (Forlizzi & Batterbee, 2004), Desmet and Hekkert (Desmet & Hekkert, 2007), and Lim et al. (Lim et al., 2008). Understanding this relationship can support the designer through the design process.

The user is the main factor in the design process as his or her satisfaction is the ultimate goal of the process. Understanding the real needs of the user, the consequence of the usage process, and the positive or negative emotions which can be evoked through the usage are important factors in the emotional design. Designers use various methods to investigate the emotional needs of the user such as cultural probing. Cultural probing (Tang et al., 2022; Jääskö & Mattelmäki, 2003; Gaver et al., 1999) is a technique used to inspire design ideas from peoples’ lives, values, and thoughts. It is one of the prominent approaches that designers use to involve users in the design process.

The creativity of the designer plays a key role in emotional design (Hughes et al., 2018). It depends on the designer’s skills, thinking, and sense. In this approach, innovation and the designer’s talent led the design to dazzle the user with the beauty, abilities, and novelty of a product (Beltagui et al., 2012).

The theory-based approach in emotional design depends on investigating the emotional responses of users towards final products. It can be used also with prototypes and sketches to understand how users react emotionally before pushing the design into the manufacturing phase. There are various methods to measure the emotional reaction of users such as PrEmo (Desmet, 2003) and Two-dimensional emotion space (2DES).



Figure 1 shows the different emotions representations of PrEmo

3- Lighting Design

The ultimate aim of lighting design is to support visual comfort for users in internal and external environments (Van Den Wymelenberg & Inanici, 2014). It also attempts to achieve the best visual performance in different situations (Jay, 2002). Lighting design is as old as the existence of humans. The beginning of it was the invention of fire which allowed humans to get an artificial source of lighting that revealed the mystery of night (Ganslandt & Hoffmann, 1992). Lighting was developed through time to suit the needs of mankind. Now, artificial lighting plays a key role in modern life, and it is used all day to allow us great opportunities in various fields (Karlen et al., 2017; Shikder et al., 2012).

Many artificial lighting sources were developed in the last century. These sources can be categorized into five sources:

- Incandescent lamp
- Compact fluorescent lamp
- Fluorescent tube
- Discharge lamps
- Light Emitting Diode (LED)

Each source type has various collections of lamps that can differ in their design, function, and wattage. Lighting also can be divided into two types of lighting: internal and external. In this research, we focus on internal lighting design for its importance and variety. There are three types of internal lighting to adapt to users' needs (Gordon, 2015):

1- Ambient lighting:

It is also called general lighting or mood lighting. Ambient lighting is used to provide overall

illumination for a room and is intended to create a uniform light level throughout the space in which is used. To design an efficient ambient light, five factors should be considered: placement, color temperature (Wang et al., 2017), color rendering index (Houser et al., 2016; Davis & Ohno, 2009), dimmers (Gillette & McNamara, 2019), and accent lighting (Gunter, 2004; Fielding, 2000).

2- Task Lighting:

Task lighting is direct lighting used specifically for certain tasks, such as reading, writing, cooking, sewing, or other intricate work. It provides increased light for specific tasks in a room that may already have some ambient light (Newsham et al., 2005; Konstantzos et al., 2020).

3- Accent lighting:

Accent lighting is used to focus light on a specific area or object (Karlen et al., 2017). It is typically three times as bright as ambient lights. It draws attention to a feature, such as artwork, furnishings or architectural details, converting them into focal points. There are four types of accent lighting: wall lights, recessed spotlighting, track lighting, and wall-mounted picture lights.

4- Lighting and Emotions

Interaction between lighting and users happens on three levels of interactions. These levels are lighting psychology, environmental cognition, and emotional response. Lighting psychology (Flynn et al., 1979) helps us understand how people respond cognitively

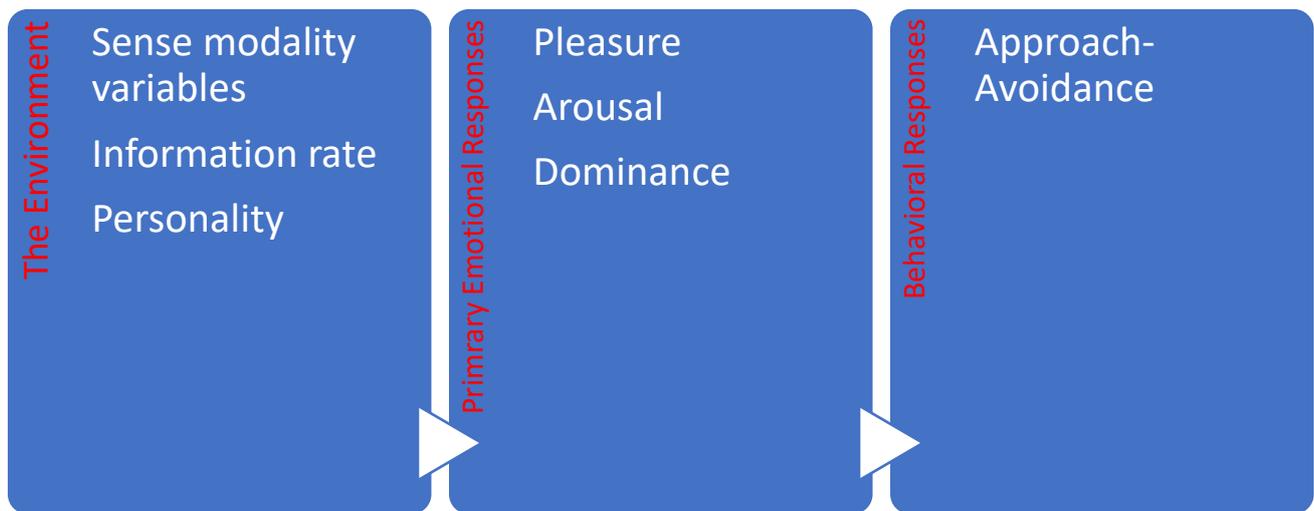


Figure 2 shows emotional response factors

and emotionally to light. Once a designer knows how different lighting choices impact people, he can adjust them to reflect the purpose of the space. It is related to lighting modes and subjective impressions (Cuttle, 2008).

Environmental cognition studies how a human makes preferences for the environment. Some factors control this process of cognition. One factor is the desire to make sense of our surroundings (Kaplan & Kaplan, 1989). When a user enters a new environment, his previous experience plays a key role in the cognition of the new space. A second factor is an interaction with the user's desire to make sense of the environment in determining his preference. The last factor is the purpose of involvement in the new environment which gives meaning to the whole process.

The emotional response is related to emotions stimulated by the interaction between the user and the environment or the space because of the lighting. Many researchers developed models to explain how this action happens. Kaplan and Kaplan (Kaplan & Kaplan, 1989) explained that three factors work together to stimulate the emotional response. These factors are:

- 1) Sense modality variables such as color and temperature of lighting.
- 2) Information rate that characterizes the spatial and temporal relationship among the stimulus components of an environment.

- 3) Characteristic emotions associated with personality.

Russell (Russell, 1980) considered that human sensory systems process the environment and identify the relations between various aspects of the stimulus. Primary emotional responses are produced in three areas: pleasure, arousal, and dominance or control. Russell's model was initially directed into architectural environments, but he later explored human emotional responses to various types of stimuli. Russell's model was used in many applications and domains. In the lighting design domain, it was used in various applications such as the study of interactive lighting systems (Kim et al., 2013), retail lighting systems (Robert & John, 1982; Kenhove & Desrumaux, 1997), and stage lighting control (Hsiao et al., 2017).

Lighting psychology helps us understand how people respond cognitively and emotionally to light. Many psychological factors can influence how humans perceive light, the position of light as well as its brightness, and hue and saturation, are important ones to consider.

Lighting position plays a key role in impacting an individual's impression and experience (Fernández & Besuievsky, 2014). Lighting can create a more formal environment if it is positioned above eye level. On the other side, below-eye-level lighting can provoke a feeling of individual importance and create a more informal atmosphere. The location of lighting in the room also makes a difference.

Brightness is responsible for the most basic function of light: seeing things. The degree to which a light achieves this function has a psychological impact. Davis & Ginthner (Davis & Ginthner, 1990) argued that bright light helps humans to make sense of an environment. It makes the environment a more pleasant space. If a room doesn't have sufficient light, humans don't enjoy the space well. Brightness also can impact on behaviour patterns of individuals (Quartier et al., 2014; Heydarian et al., 2016) such as buying patterns (Singh et al., 2014; Ahmed & Riaz, 2018) or eating patterns (Svechkina et al., 2020).

Finally, the hue and saturation of lighting justify how lighting affects mood. Hue expresses the colour of lighting while saturation expresses the intensity of that colour (Gordon et al., 1994). Different lighting colours produce different effects. For example, white lighting gives a feeling of welcome. Blue light or daylight improves alertness and productivity. Warm or yellow light offers a relaxed atmosphere (Kuijsters et al., 2015).

5- Case studies

Three case studies were selected and analyzed to explore the emotional sides of the design and the design process. The following case studies reflect how lighting can affect the mood of humans.

5-1 Hanabi Lamp:

The Hanabi lamp is a lighting unit that was designed by Oki Sato for Nendo. Hanabi, the Japanese word for fireworks, literally means flower and fire (Bengisu &

Ferrara, 2018). Hanabi lamp made from shape-memory alloy opens like a flower shortly after being turned on; heat from the bulb causes the metal to spread its tendrils. Sato inspired his design from a

"I was sitting in an I by myself, which I usually do on the weekends," Sato explains, "having a glass of iced tea. The ice started melting, and then it moved and made that sound—do you know what I mean? Like when the ice starts to slide. It made that sound, and I started thinking, 'Couldn't I design something that would move or change according to a change in temperature?'"

(Hanabi lamp – Deco-trending. DECO, 2022)

The design of the Hanabi lamp was presented for the first time in 2006 at Salone del Mobile di Milano (Bengisu & Ferrara, 2018). The design aimed to create a kind of surprise for the perceiver to evoke a feeling of pleasure. The design succeeded in overcoming the monotony of minimalist style and added an emotional value to the process of lighting.

5-2 National Museum of Egyptian Civilization (NMEC):

NMEC focuses on the earliest civilization in history, the ancient Egyptian civilization. It offers the visitor a general overview of all the different historical periods that encompass Egypt. Lighting plays a key role in NMEC as it enhances the experience of visitors with light-driven visual contrasts that highlight the smallest details and evokes emotions.

Museum lighting design considers four factors: spatialization, visualization, optical engineering, and



Figure 3 shows Hanabi lamp



Figure 4 shows National Museum of Egyptian Civilization lighting system

emotionalization (Wang et al., 2019). These four factors were reflected in the lighting design in NMEC, especially in the mummies hall which includes 20 royal mummies from the 17th to 20th dynasties. Lighting in the mummies hall offers a unique experience for visitors that allows them to explore the world of mummies and their details. It evokes emotional responses that make the experience unforgettable.

6- Conclusion

This study investigated three key issues connecting lighting, design and emotions. These three issues are emotional design, lighting design, and the relationship between lighting and emotions. The study first explored how emotions arise. Then, it reviewed terms and methods of emotional design. Secondly, the domain of lighting design was investigated to understand how lighting systems work, the types of lighting, and their functions. Finally, the study explored the relationship between lighting and emotion to reveal how lighting can evoke emotion.

Two case studies were presented and analyzed to show how lighting can affect the emotion of the user. The first case study was for the Hanabi lamp, a lighting unit designed by Oki Sato for Nendo. It was made from smart materials that are affected by temperature to change its shape. The second case study was the

lighting system designed for the National Museum of Egyptian Civilization in Egypt. It was designed to allow a good experience for the user of the museum.

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