Reasonable use of Indoor Lighting in Human Living Environment

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Abstract. In today's life, lighting design has become a very important part of the indoor environment, affecting not only the presentation of the design, but also human health. In current lighting designs, there is still a lack of attention to the use of lighting, resulting in visual and health discomfort for occupants. Based on the original light research, this paper analyzes and applies the light to explore the most scientific direction of light use. Analysis of color temperature, light flux, illumination, and other data of lighting types on the market, and investigation of the effect on human perception. The types of lighting should also not be harmful to the eye and safe to use for long periods of time. Reflective materials are another alternative method to reflect natural lighting to the room to bring spaciousness when there is no available natural lighting directly. In the future, there should be experimental lighting that may mimic or replace lighting in nature, or lighting that is fully adapted to the user's senses, emotions, and fatigue. This paper looks forward to finding more appropriate ways to use interior lighting and is dedicated to addressing unreasonable lighting designs in interior design.

Keywords: Interior Lighting; mood; perception; environments; living space.

1. Introduction

From cavemen using torches to cosmopolitans in modernized cities bathing under fluorescent lights. The use of different colored lightings is a growing trend in modern interior design. Lighting could affect the feeling, mood, emotions and actions. Many inadequate lightings designs lead to dimness in areas, emotions of fear, general unsatisfactory of lighting placement and possible health issues. Modern day people contain themselves mostly in indoor environments under artificial lighting. Lighting does not only emit images, but it also evokes physiological and biological phenomenon that can possibly affect human behavior, emotions and mood [1]. Research conducted in 1993 showed that humans tend to have a more positive mood under 2000 lux than under 300 lux; and “The mood shift for woman was strongly negative for “bright” conditions and near zero “dim” conditions. This is one of much evidence that show interior lighting and colors could affect physiological mood of humans. A large amount of people is facing issues where lighting damaging their eyes, generating inadequate scenes because of the lighting’s directions and luminosity. The objective of this research paper is to analyze the effects of how different lighting placement and color could affect the mood and perception of people. Lighting is an inseparable part of interior design and bad lighting would lead to damage in users’ eyes and unsatisfactory of lighting because it did not bring the feeling or mood that they had wished of, ruining the sensation that a properly designed room would give [2]. That is why we want to solve this problem and bring advancements towards better interior designs with the help of refined interior lighting; mostly will be on to improve a bedroom lighting.

There were similar studies done on this subject, such as how three colors of lighting on the impacts of perception [3] or luminosity impacts on human mood and choices [4]. These generally talk about how either it affects the mood or only perception, but few or none have done them both in one and fully analyzing both at the same time and using modern 3d tools to interpret the idea. The missing

area is how this information of lighting on the impact of humans could be used on interior designs in homes, restaurants, shops etc. With the aid of 3d modeling devices that can process heavy lighting, the affects would be more visible and can be better implemented into real life to help people's health and interior looks. The advantages of this are that it can better help to build a comfortable environment faster and more suitable since the rendered image is available on a computer and is able to get in production very fast.

This paper will be heavily focused on researching and analyzing large amounts of different information and combining it into a whole. The contents will be discussing the types of lighting, reflection and refractions of the lighting, how light is created, the atmosphere different lightings gives and medical impacts of interior lightings. There will also be diagrams and photos of rendered images that will better display the research and production process.

2. Introduction to Light Classification

2.1. Type of light

In nowadays market, there are many types of lights, such as Light Emitting Diode (LED), Incandescent Bulb, Halogen Lamps, Fluorescent Lamps. They each have different functions and uniqueness; For example, LED lights are up to 90% more efficient than older counterpart, incandescent bulbs and provide smoother lights with lesser risk of it going into a short circuit [5].

2.1.1 Color temperature and color rendering

Most of the lights one usually sees in the market have a warm color temperature, and warm lights are used most of the time. Warm temperatures can affect people's mood and health. In humans, diastolic blood pressure rises at light color temperatures below 7500K [6]. Different color temperatures have different effects on the environment. In the average home, we usually use lamps with a color temperature of 2000K-3000K. In some shopping malls, stores or supermarkets, color temperatures of 4000K-6000K are often used for greater brightness. Color rendering determines the use of lighting. In art galleries or museums, more attention is paid to restoring the sense of reality of objects, so lighting with the best color rendering will be used. Generally, the color rendering of incandescent light is 99-100, so galleries and museums tend to use Incandescent Bulb [6].

2.1.2 Brightness

Brightness is also an important part of lighting. Brightness determines the intensity of the effect on human vision and affects human perception at the same time. With a color temperature of 2000-3000K, a brightness of 50-100LX will feel comfortable, and people start to feel hot and fidgety when the light reaches more than 200LX. Brightness also determines how much light an object is exposed to. The brighter the light, the lighter the object reflects. In the room, too high brightness will cause visual fatigue, or affect human visual system damage [7].

2.1.3 Light-emitting principle

The four common ways of lighting on the market are quite different, and they also have their own advantages and disadvantages. According to Table 1, it shows that Different types of lights and their actual effect analysis. Among the four kinds of light commonly seen in our daily life, the most common LED light is also harmful to human eyes. Prolonged exposure to this kind of light will cause the eyes to perceive light is not obvious. And the Fluorescent lamps used in some old buildings now have different degrees of strobe, which can be caught by our eyes, so it is also very harmful to our eyes.

Table 1. Analysis of different lights

	LED	Halogen Lamps	Incandescent Bulb	Fluorescent Lamps
Advantage	Small size, low power, long life, high brightness and low heat	low cost, brightness easy control, good color rendering, high color temperature	Uniform light, good color rendering, small size, low cost	High luminous efficiency, high lumen maintenance rate, and low luminous decay, long life
Disadvantage	Toxic element content, narrow luminous sur-face, harmful to the eyes	Low luminous efficiency, light source is not concentrated	High power consumption, low optical performan-ce, short life	Size large，bad color rendering, stroboscopic, electromagnetic interference

2.2. Lighting method

In interior design, the angle of the light is also important. Some chandeliers shine directly from top to bottom, while some lights are directed to the wall, relying on the reflection of the wall to show the lighting effect. Indirect lighting is also used as an auxiliary method, where the brightness of the reflected light is usually reduced considerably, and warm-colored lights are generally used to enhance the brightness of the corners. Some designers will choose to put bulbs inlaid in the ceiling grooves to create a kind of ambient light. Their lighting effect is not obvious, and they mainly play a role in promoting the atmosphere [8].

2.3. Material irradiation effect

The design of interior lighting is not only about the light, but also about the materials used in the interior. Different materials have different reflectivity, and they also affect the effect of indoor lighting. In some textured design situations, cement will be used as the wall material. Cement is less reflective and casts a darker light, so it accentuates the texture and simple atmosphere. In stark contrast to the cement is polished tile, a material that reflects light well, resembling a mirror. Usually used in large hotels or some high-end establishments, full reflection will make the environment look more ornate and brighter. At the same time, the uneven surface texture of the material will also affect the reflection of light, very smooth materials will not refract light in different directions, but some uneven materials or there are some small holes we cannot see, which will affect the direction of the reflected light. This affects the whole interior light atmosphere. The area in which the material is used also affects indoor lighting. The use of reflective materials over a large area will make the area of reflected light larger, which will make it brighter. Table 2 can well show the different effects of lighting on walls of different materials.

Table 2. Different material reflectance

Material	White cement	White Polished tiles	Wallpaper	White Marble	Wood	Coarse white paper
Reflection rate	75%	80%	61%	60%	<10%	30%~50%

3. Analysis of experimental effect

3.1. Analysis of lighting display effect

The first experiment conducted has showed that the participants tend to feel more tension and anger inside red-cold-lighted room than the white and blue cold-light. With the warm white and blue lights, the anger and tension of the participants were lowered. The anxiety level also had an increase with both cool and warm red lights. The participants did not feel much perception change (except people who felt anxiety thought the room was smaller), instead, felt more mood change during the experiment. It can be inferred that both light color and warmness of light can both affect a human's mood and feeling; thus, red lighting should be avoided, and more white warm lighting should be considered when dealing with interior design. If a user constantly feels in anxiety inside of a room, then the mood of the user will not be positive, and the living quality could go down [9].

3.2. Interior effect Lighting on choices

The experiments result show that having an open window to a room made participants feel significantly more spacious and open of the area (Fig. 1). On the other hand, having no windows and lit only by artificial lightings gave people a sense of security. The brightness of lighting also had an impact on the results, the rooms with artificial lightings gave more sense of clarity and order. An idea can be interpreted from this experiment is that both artificial lighting and natural lighting need to be occurred at the same time to bring spacious as well as clarity and order [10]. This example can be found in our lives, being underground can give feelings of security but fairly dull and hard to breath; whilst in a large, modern house with large amounts of sunlight and glass gives spaciousness but also emptiness and small sense of insecurity.

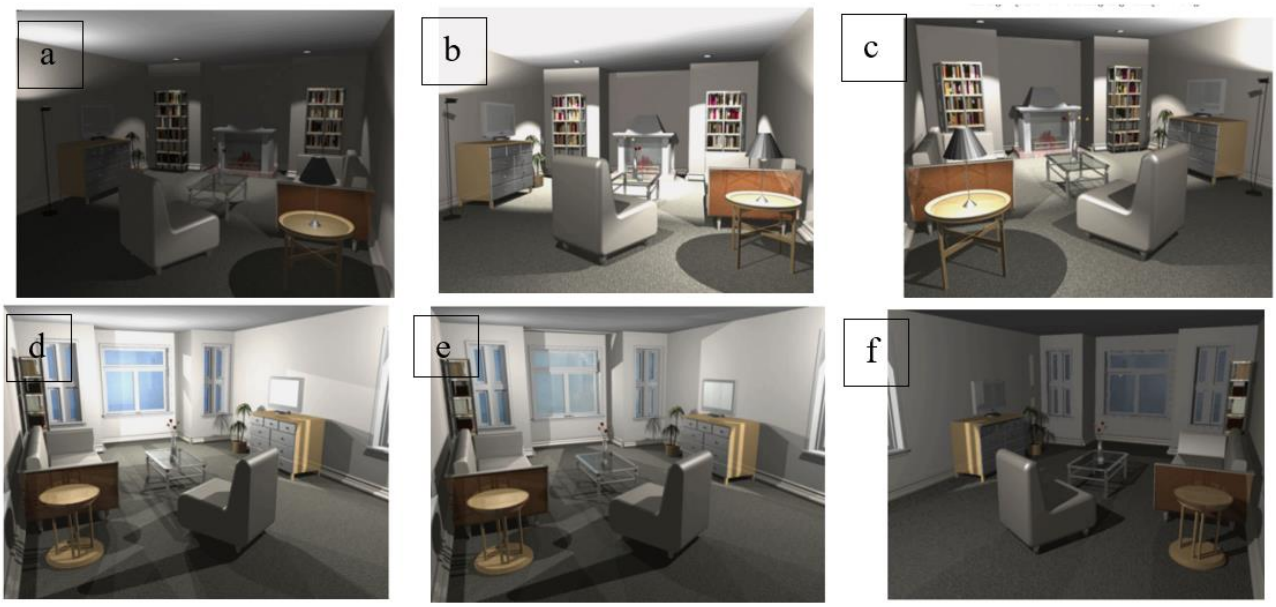

Figure 1. Room with no windows and dim artificial lights (a), Room with no windows and bright artificial lights (b), room with no windows and medium lights (c), room with bright natural dull natural lights and window (d), room with medium natural lights and window (e), Room with dull natural lights and window (f) [9].

3.3. Human perception analysis

The human body's perception of light is obvious. When outdoors, if the sunlight is strong in the past, ultraviolet, infrared radiation and visible light will damage our eyes to a certain extent. So, experts don't recommend reading in bright light outdoors or staring at a place for a long time. This is also very common indoors. For example, in the study room at home, under the light of a desk lamp for a long time, staring at a book or computer for a long time, we will feel dry eyes. Or feel irritable

with a headache. In today's life, a very common situation is that at night, young people will stay up late, and the day and night will be reversed. However, you need to use lights at night, staying up late plus light exposure can induce breast cancer. In one study, researchers conducted an observational study. From the experimental results, they concluded that exposure to artificial bright light at night inhibits the secretion of melatonin, while prolonging sleep latency and increasing sleep alertness, resulting in a decrease in sleep levels. In severe cases, it can cause psychological, cardiovascular health and metabolic disorders [11].

4. Suggestions

4.1. Lights use suggestions

In interior design, the design of lighting completely affects people's life and health. Based on multi-angle light analysis, the final conclusion is drawn. In home decoration design, should completely avoid the color temperature is too high or too low light, and illuminance more than 200LX and less than 50LX light, otherwise it will cause discomfort to residents. Different locations in the home should also choose different lights. In the bedroom, try to avoid lights that are too bright to create more atmosphere. Use bounce lights or fill lights. Long-term exposure will affect human health and increase the risk of breast cancer. Excessive light will affect people's vision, and exposure to strong light before bed will increase diastolic blood pressure and affect people's sleep. In the study room or some places that need to be in contact with the light for a long time, you need to be more careful in the use of light, and the color temperature should generally be kept at 2000K-3000K. If it is too high, it will irritate our eyes and easily cause visual fatigue. The illumination should be controlled at 100-200LX, which is the most comfortable range. In public places, when there are many people, the illumination can be appropriately reduced to avoid making the body feel dry and hot.

4.2. Material use suggestion

The use of materials is more of an auxiliary lighting function. According to Fig. 1, in some designs that require a dark environment, or the lighting is too bright, the use of materials with low reflectivity such as wood can effectively achieve the design purpose and reduce visual damage. In some designs that use a lot of auxiliary lights or wall reflection lights, choose materials with a relatively balanced reflectivity for wall design. That is, it can ensure the illumination of light, and at the same time, it can also play the original advantages of reflected light. In public places such as supermarkets or large shopping malls, marble is a very good material, the reflectivity can reach 80%-90%, and it has a very good reflective effect, so as to not increase the color temperature and illuminance, and do not harm the premise of human health. to achieve higher lighting intensity.

5. Conclusion

Lighting is a major part in interior design and finding what’s the best way to interpret it is crucial. The paper discussed types of lighting, methods of lighting, medical areas and analyzing similar projects and possible future suggestions for interior lighting design. The lighting in interior design should be mostly using warm lights with combinations of artificial light and natural light from windows. The types of lighting should also not be harmful to the eye and safe to use for long periods of time. Reflective materials are another alternative method to reflect natural lighting to the room to bring spaciousness when there is no available natural lighting directly. Furthermore, there should be minimal use of red light since it has been experimented and researched to cause anger, increase in tension and anxiety. In the future, there should be experimental lightings that may possibly mimic or replace nature lighting in places where is don’t really shine; there could also be lighting that adapts fully towards the users feelings, emotions, fatigue and be able to manipulate itself to bring the best experience to the user. This paper’s purpose is to give ideas and possible future extension points for better interior lighting designs and bring people a greater experience.

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