

The Effects of Light Devices on Human Behavior

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Spring, 2021

On my honor as a University Student, I have neither given nor received
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Introduction

Light is no longer a natural resource; light has become a commodity that can be controlled or manipulated. This emergence of light, the commodity, comes with users and with these users, designers appear. Designers try and find new creative ways to provide these users with light and have started to introduce smart tech into lighting. Smart lighting can provide different types of lighting for different scenarios or people. The lighting devices used in smart home devices allows for complete control over the light inside. This is just one instance of smart lighting. Another instance of smart lighting is automatic street lighting where light turns on based on motion detection; which saves energy since now the light does not need to stay completely on the whole night. Retail stores have also introduced smart lighting in their businesses, specifically the ability to highlight certain windowsill items if a customer is looking at that item. These examples discuss when we're worrying about artificial light, but what about natural light. Is there any way to provide smart tech for something like natural light? Obviously, it is going to be yes. Blinds are the answer; if there is a way to incorporate smart tech into blinds then it would be possible to control natural light inside a home. Smart blinds will allow homeowners to control the amount of light entering, creating set states for specific times in the day, or including motion detection for privacy are some of the abilities of smart blinds that were included in the technical design. However, how would these devices light, artificial or not, create enjoyment or disturbance on users lives. This paper will discuss this topic of light and light devices from a social perspective.

Why do we need to contextualize light devices in a social aspect? Well, this aspect gives a better perspective and understanding of the impact that light has on the different stakeholders. Even for these builders there are differences culturally and behaviorally within each group. Since

light has become a commodity one of the builders present are those who made light into a commodity, the engineers. These engineers are making these smart light devices easy to use for companies, stores, schools, and the general public, giving them the control instead of having difficulty with these devices. There are many actors involved in smart lighting, there are ways to group these actors that will provide an insight on their perspective for the social meaning of light. This paper will contextualize and discuss light's meaning from a social perspective, providing an understanding of the impact of light. A framework is introduced to discuss the perspective of designers and the means they can use to keep the users' problems in mind while designing the product. The technical design will be used within this framework to walkthrough and discuss ways to modify the design process.

Research Question

With the introduction of artificial light humans have conquered the night and have brought light into the market making it a commodity. What societal effects can light devices cause for the users? Are these effects detrimental, can they be beneficial, or is it both? This thesis will explore the effects of light on different cultures and the standard of lighting for different individuals. This will give a broader perspective to the different interpretations of light that occurs in our society and understanding this can help positively modify the technical design.

Literature Review

Light Effects on Human Behavior

There are three types of light to discuss; sunlight, artificial light, and darkness or no light. There is a preconceived association that a sunny day equates to happiness while a rainy/cloudy day equates to sadness. This association is not baseless, sunlight has a proven effect on humans. One example is sunlight's exposure to the skin, this produces vitamin D which has been found to

change serotonin levels, the “happiness hormone”, and “lower levels of vitamin D could be responsible for increases in negative affect and tiredness” (Denissen, 2008). This study suggested that it is possible that exposure to sunlight (i.e., a sunny day) can increase levels of happiness within individuals. Humans are social creatures and they need interactions with the environment and other people or a sunny day to provide a reason to be outside. If the weather is nice, people are more likely to go outside and do activities like tennis, visiting a farmers’ market, hiking, swimming, eating out, and many other activities. A study by Ohio State University hypothesized there would be some correlation between weather and customer recommendation of a restaurant. The study stated that there was a “positive relationship between mood induced by sunlight and increased consumer spending” (Bujisic, 2019). This study shows that there is a positive correlation between customers moods and the amount of sunlight during the day. The increase in the number of recommendations to the restaurant infers that when the weather is sunny people are more likely to spend more time outside and with other people. Sunlight provides humans with positive effects, but is not the only source of light that can affect humans.

Artificial light garnered a lot of admiration and praise as one of the greatest inventions ever created. It was this device that led humans to hold control over the night, turning it into the day. It is not uncommon now for people to work “graveyard” shifts allowing for a 24-hour work day for companies. There are health studies that found positive effects in artificial light. Light therapy or exposure to artificial light (sunlight as well) is used as treatment for seasonal affective disorder or a skin condition (Mayo Clinic, 2017). Light exposure has some negative effects since humans were meant to experience light in the day and makes our bodies believe we should be awake. Artificial light has many uses some positive effects which can relate to health, work and other activities. Additionally, negative effects are present and with over populated cities the

amount of artificial light oversaturates the darkness which has been found to have inverse effects, light pollution being one case.

Artificial light has made it easier for us to complete tasks at any point in the day no matter what the weather was, but this eclipse of light in the night has led to light pollution. Light pollution, the excessive use of light in the night environment, has resulted in research to find a way to “delineate the bad or detrimental aspects of artificial light at night” (Stone, 2017). This light pollution consumes a large amount of energy (Stone, 2017) as there are numerous street lamps to provide light converge for the majority of cities. This amount of light being on even with motion sensors still incur a hefty cost for the amount of energy used. The circadian rhythm of people can get disrupted by artificial light (Stone, 2017), since humans have a trigger in our bodies to believe they should be awake when there is light present. Even though artificial light is beneficial in some cases it is better to use in moderation, there is evidence that access to light at night can shift the desire to sleep by an hour (Peters, 2020). This increase amount of light can cause insomnia (Peters, 2020) and with this there are detrimental effects that appear. These effects contribute to the behavior that the person may experience such as frustration, sluggishness, and poor memory or a lapse in judgement. Light can trigger human behavior in positive ways (energy, socializing, health) though there are clearly instances that it provides detrimental effects to human behavior. There has to be a limit to the amount of light inside a place to decrease the instances of these detrimental effects.

Standards for Lighting

Moderation is the key for standards of lighting, as the lighting in a setting depends on the people present and the work that’s being accomplished. Lux, which measures luminous flux per

unit area, is used to determine this threshold of light that is required for residential buildings, complexes, or companies. Good lighting, according to Airfal International, can increase productivity and allows for fewer errors or accidents. Levels of illumination depends on several components: average age, size of details that need to be observed, the contrast of objects, and the movement of monitored objects (Videocreacion, 2016). An increase in illumination or lux will make it easier for people to keep track and accurately view detailed objects. For homes the average amount of illumination is about 150 lux, these levels are good enough for daily tasks and aren't harsh on the eyes. For specific work areas this level increases to compensate for some of the components that were listed previously. Office-based typing work and average mechanics require 500 lux minimum; while fine mechanics, engraving, or artists require a 1000 lux minimum (Illuminance, 2016). Engineers however, which have to accomplish precision tasks require a 1500-2000 lux minimum to be able to conduct work because of the nature of the tasks that need to be performed (Illuminance, 2016). These are the standards that are used for certain industries or business, but there are people that don't conform to these standards.

Cultural and Societal Differences

There are individual differences between groups when relating to light and the differences of meanings also exist between them. Some factors that can contribute to these differences in response to light exposure include physiological, genetic, cultural, and behavioral differences. Light sensitivity, a physiological and genetic difference, can be present in adults, children, and the elderly which can cause discomfort if the environment is too bright. However, muscles that control the pupils weaken while aging and with the elderly this allows less light to enter the eye requiring more light to be present (Münch, 2020). In regards to the cultural aspect,

urban and rural areas have cultural differences in regards to religion and ethnicity in addition to day-to-day differences. Those in urban areas are less likely to get adequate exposure to sunlight. This is due to “factors of the built environment but also due to indoor lifestyles in cities” (Mendes, 2019). In contrast, since most occupations in the rural lifestyle require them to be outdoors (farming, tree trimming, handyman, etc.), they are exposed to an adequate amount of sunlight.

However, in some places even being outside and exposed to sunlight may not result in an adequate amount of sunlight. Clothing habits due to religious and cultural preferences are an important influencing factor to the exposure of light (Mendes, 2019), specifically Middle-Eastern veiled females (burqas). The indoor behavior of ethnic groups can provide some input on their behaviors, African American adults had a larger number of individuals watching tv per day than White American adults (Mendes, 2019). Additionally, the “research has suggested that western dwelling Asian populations are likely to practice sun avoidance” (Mendes, 2019). The study shows that non-White individuals don’t view sunlight to be as important to them as White individuals or do not need as much exposure. This does not necessarily mean that white people are happier, but suggest that non-white individuals require a less amount of sunlight. There are cultural differences between these groups in relation to light and these differences have different behaviors that are caused from it. There are difference ways these groups view sunlight or light in general. However, even with these differences the amount of people outdoors increases in correlation to the amount of sunlight that is present in the day.

Engineers have to account for these inter-individual differences when making devices or products that change the level of lighting for the users. For the technical project the level of illumination that passes through the blinds depends on the user. The users have the ability to

control the rotation of the blinds and their set points. This makes it easier for the engineer to conform to the needs of the user and have the user content with the device.

STS Framework

The appearance of light devices occurred because of the actions of humans, they required light to accomplish tasks at night. These light devices had been introduced, modified, and evolved by the different actors that contribute to these devices. The relationship between the actors or stakeholders that contribute to light devices can be difficult to visualize and requires the analysis of different social groups. A Social Construct of Technology, or SCOT, model argues that technology does not determine human action, but human action shapes technology. This model describes this relationship using a network to connect the different social groups and analysis each group respectively and where they contribute to these devices.

The data analysis will come from a secondary source detailing the effects that light may have on the behavior of individuals moods as it relates to seasonality. This study delves into light therapy which was previously stated and what are the possible effects that this might cause. This will help analyze the stakeholders that could be present in the context of light devices and what those stakeholders are contributing. This case study will provide unbiased data about the effects that light has on the behavior of people, positive or negative.

Data Analysis

Case Study: Light Administration on Interpersonal Behavior

Light therapy has been seen to help improve those with seasonal changes in mood or behavior, commonly known as seasonal affective disorder or SAD. The patients that suffer from SAD or winter depression experience “hypersomnia, increased appetite, weight gain, lack of energy, and loss of interest in socialization” (Hsu, 2013) and these symptoms appear during the

winter time, but disappear by spring. The content light therapy consists of usually one or two hours of light at 2500 lux administered during the day. This specific study conducted by the University of McGill had participants sit in front of a light box for a duration of 30 minutes and to gather data the staff used a wrist watch which they gave each participant to measure light levels and motor activity every 2 minutes (Hsu, 2013). Some of these participants were under a placebo (they were exposed to negative ions) to remain as a control group. The participants were recruited from the Montreal, Canada community using local advertisements, but were required to be mildly or moderately seasonal according to the Global Seasonality Scale (Hsu, 2013) and through narrowing down the size pool to get a general demographic for behavior they ended up with 38 participants. They determined behavior based on items developed by Moskowitz to measure the 4 behavior dimensions of quarrelsomeness, agreeableness, dominance, and submissiveness (Hsu, 2013), the study details the approach and examples for each item, but to determine the effects of light therapy on behavior these 4 dimensions will be enough.

Results

For the study, light did improve the mood of the entire group as well as the behavior of people with some degree of seasonality. More specifically for behavior, the study discussed the results of each of the 4 behavior dimensions. First the greatest different of behavior that occurred was quarrelsomeness, which was mostly seen in participants interaction with romantic partners. The difference between the light treatment and placebo was significant (Hsu, 2013). Agreeableness, for the whole group, had no significant change whether the participant was under treatment or not, but in one group the treatment was seen to decrease agreeable behavior in comparison to the placebo participants. Additionally, dominant behavior revealed no significant effects for either side with all the groups experiencing the same relation. However, submissive

behavior was analyzed to have a significant effect on behavior. Light decreased submissive behavior (Hsu, 2013), but this does not mean that dominant behavior saw an increase as was previously stated.

STS Analysis

It is clearly shown in the analysis above that there are some behavior effects that can occur due to the presence of light. However, these light devices that provide this service for humans are introduced because of the necessity for them. In other words, the actions of humans have caused these light devices to be improved upon and used in different way to sate their needs. Let's re-introduce the SCOT model, which can be used to help discuss how the actions of humans or the different actors involved can influence the shape of the technology. The key stakeholders and relationships are between the artifact (light devices), general public, businesses, employees, and engineers. Engineers or designers are the main point of contact when discussing the possible modification and new devices that could be made and can provide all the other stakeholders with support. The rest of the stakeholders are mostly in the same place, providing feedback to the engineers, but each have other responsibilities that effect the device. Employees at different places may require different standards for lighting and as a result these differences can modify the existing device. Businesses on the other hand can find ways to incorporate energy saving lighting which can cut operational costs. The general public would mostly provide feedback, but if there is a general consensus on some type of device modification, much like smart blinds, that will be valuable input. While the effects that light devices have on people and users alike is the main point, the actions that humans make and effects that it can have on these light devices should not be overlooked.

Discussion

Effects of Light

The findings in the data analysis detail that there is some behavioral effect that happens in response to light. This thesis highlights the societal effects that light or light devices have on people and this finding clearly shows that there are some positive effects in behavior due to light. Some limitations of the study result from the observed actions, being only the 4 behavior dimensions, they did not dive into the effects on the participants likelihood to exercise, eat out, or hang out with someone. They only delved into the behavior that the participants have on interactions not if they would try to strive for these interactions. With this instance that light has some type of effect on the users the engineers need to have this in mind when discussing the possible modifications of existing light devices or creation of new light devices. These engineers now have to tackle how to provide the service of this light device catered towards the specific users without incurring some of the detrimental effects that could occur.

Ethical Framework

The way to tackle the ethical design of technologies, which they stated in the article *A Short Introduction to Mediation Theory*, is to first anticipate technological mediations when designing a product. Mediation theory can be used at any point using the designer's imagination to figure out some of the ethical dilemmas that might occur with the use of the designed product. In the case of the automated window blinds, the product our team created, we imagined some ethical points to address while designing the product without knowing that there was this theory for it. The points that were addressed did not have the structure that Mediation theory provides or the understanding on how our product could interact with the users. Now after reading the article, we can use this framework to discuss our product. First, let's describe the automated

window blinds using mediation theory; out of the four “relations” Verbeek describes our products fall into two of them. The background relation is the most prominent as these blinds are automated, so the user should not necessarily pay any attention to the device. Once the settings have been configured to their liking, it will work accordingly in the background. The other relation is embodiment, humans looking through the blinds into the world; using technology as a means to connect with the world outside. Next, the points of contact with the device which can be described as “behind-the-back” as the device is a background item that has an effect on humans’ actions and experiences. Also providing them with sunlight that can lighten the moods of most people and lower levels of stress and anxiety. The influence that the automated window blinds have on the users varies. It depends on the designer's explicit declaration of the possible effects of sunlight on the users which may not be common knowledge such as the increased levels of vitamin D or possible negative effects. This weak and apparent influence is described as persuasive as the automated blinds shows its influence without being overpowered.

These automated blinds provide humans with sunlight and a view of the outside. Some issues that we discussed beforehand include the possibility that some users may need more or less sunlight entering their rooms. Resolving this problem was the implementation of a way that the user could set their bounds or set points that the automated blinds switch between. However, this raised the question of whether multiple users in the same home might have different needs and how to account for that. Invasion of privacy that these automated blinds might cause is another issue that was discussed. This issue was one of the first topics discussed and led to the addition of a motion detecting attachment, which causes the blinds to close if movement is detected close to the blinds, i.e., intruder trying to look into the house. This theory worked well for the automated blinds as this device was created as a mediator in a sense. The automated

blinds are a technology that helps shape a relationship that the users can have with the world/environment.

Conclusion

This STS thesis details the effects that light devices has on the behavior humans and the need for it in our society. Light is positive, in a sense, towards society, conquering the night made humans feel more powerful and safe. Light made it easier to complete tasks, lets people enjoy the day and night, and can provides health benefits. Even though the required light level can differ between individuals no one is saying that the absence of light would be better than light altogether. There are standards that have to accounted for in each scenario that requires light. The most important thing to keep in mind is moderation, light pollution is emerging causing detrimental effects to people. We as engineers have to consider the effects that our device may cause the user and be able to cater to their needs with their privacy, safety, and health in mind.

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