Evoking positive emotions through lighting design

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This paper investigates how human nature influences our reaction to a new environment with respect to lighting. Research indicates a preference for directional/peripheral lighting, opposed to diffuse lighting, as the former facilitates the observer with environmental cognition, whilst maintaining their involvement in the space. It is suggested that meeting these basic human demands is possible through the appropriate installation of directional lighting with a high element of control.

Human Nature to the Environment

In order to find out how light is used to connect oneself to the environment, research into human nature is required. A basic human requirement exists in the need to dwell. To meet this requirement people establish a place of residence to inhabit. Regardless of the comfort, or permanency of a residence, a central human act is to connect oneself to its environment. This is not an easy task, modern cities and the residences within them were not built to form an ideal stress free habitat. Instead, they were developed out of convenience and efficiency for a productive society. As Moore (1977) states, we need allies in habitation to help establish a residence in which we belong and one of our strongest allies in this is light.

Biological and innate factors embedded in the human psyche play an important role of how a space is perceived. Through this, human perception of a space can change depending on how it is illuminated. One theory, proposed by Jay Appleton (1975) is the prospect-refuge theory. This theory involves the aesthetic values and survival advantages of environments. It suggests that humans prefer environments that have both prospect and refuge features. Prospect features are elements allowing the detection of enemies and prey, whilst refuge features are elements that provide cover, shelter and allow the user to hide. Empirical studies of this theory have been conducted in several disciplines such as psychology, architecture and urban planning. Lighting conditions in relation to the prospect-refuge theory have been detailed in studies by Barazawa & Hanyu (2011), Barazawa & Hanyu (2013) and Flynn (1977). These studies detail a preference in human nature for non-uniform lighting stating that people can occupy the darker area of an environment, whilst facing brighter areas in order to clearly identify objects or threats whilst remaining out of sight. Barazawa & Hanyu (2013) also discovered that when people are communicating with one another, they will have a more positive impression when the persons involved are equally illuminated. This study outlines how establishing an non-uniform, luminous environment through the use of directional lighting can be used to strengthen the cohesion of an area for improved interaction, or to facilitate the separation of a space.
Numerous studies have been conducted on the premise that a high degree of individual control over an environment enhances quality of life. A wide array of these studies support the theory that the absence of control, regardless of the situation, may lead to emotional, cognitive or behavioural deficits in an individual. Barnes (1981) argued that a stress-free environment stems from the perception that a person controls their environment, and that they are able to construct the conditions deemed satisfactory. The degree of control is relevant in this statement: Whilst a person may welcome control, too much control can be considered overwhelming.

**Human Response to a New Environment**

Directional lighting can also be used to create a positive emotional response in an environment. It has been shown (Kaplan and Kaplan, 1988) that humans display a preference for a balance between coherence and complexity in their environment and surroundings. When a human enters a new environment, a primary goal is to establish a cognitive match in his/her memory in order to interpret and understand his/her surroundings. Coherence of an environment may be related to risk perception, whereby a person may use their knowledge and experience, along with various heuristics, to determine the threat of the current environment. As Kaplan and Kaplan noted, an environment can be designed to provide visual cues to the user. However if the cues are not important the environment can be perceived as confusing;

"It is ... important that a change in texture or brightness in the visual array is associated with something important going on in the scene. In other words, something that draws one's attention within the scene should turn out to be an important object or boundary ... If what draws one's attention and what is worth looking at turns out to be different properties, then the scene lacks coherence." (Kaplan and Kaplan 1988, p. 49)

As a result, Kaplan and Kaplan (1988) identified the second variable that controls preference of a new environment to be ‘complexity’. Humans require involvement with their environment which stems from a desire to explore and engage with our surroundings. An element of mystery or complexity within an environment generates novelty which leads to higher involvement. Complexity can be created by leaving areas of shadow and mystery, through the use of directional lighting. Similar to coherence, high complexity with low familiarity leads to the observed being overwhelmed and confused, hence a negative reaction.

Kaplan and Kaplan (1988) state that a high level of familiarity in a new environment is associated with pleasant, comfortable reactions, and identified this as a preference for ‘coherence’. Zhao and
Meyer (2007) also found that humans mentally visualise large spaces from small fragmentary images, and that through this process humans consistently overestimate the appeal of the space if they have a positive reaction from the initial fragment. Therefore, in order to provoke an initial positive reaction, directional lighting should be used to ensure the visual fragment first seen is positive and of high familiarity with the observer. However, solely relying on high familiarity leads to an environment that lacks stimulation or excitement. This can be countered by using directional lighting to add visual complexity to the observer.

How human emotions are affected from different forms of lighting can be linked to the emotional theory of human response to a new environment. Research into emotions has been used to recognise human emotional response in order to predict its influence on behaviour and identify means that can help control it. The circumplex model (Russell, 1980) suggests that emotions are distributed in a two dimensional space, defined by valence and arousal. Valence encompasses positive and negative, defined as pleasant or unpleasant emotions; whilst arousal defines the level of neurological activation or physiological arousal. For example, if a person experiences an emotion high in both the valence and arousal when entering a new space, it may be considered exciting. This supports Kaplan and Kaplan (1988) results indicating a human preference for adequate levels of coherence and complexity, whereby a positive correlation to a familiar environment can be considered pleasant, and a complex environment can be considered arousing.

Therefore, for a person to perceive a new environment in a positive manner, adequate levels of coherence and complexity must be evident. To achieve high coherence, the environment must aid the person in establishing a cognitive match within their memory by making it easy to identify important boundaries or objects within a space. To achieve adequate levels of complexity, the environment must maintain a sense of the unknown and involve the observer. An effective method of achieving both aspects is through the use of directional lighting to place emphasis on key aspects within a visual array whilst maintaining darkness in nonessential sections for complexity.

**Human Response to Lighting**

In order to understand how to use directional lighting to achieve positive reactions in a space, it is required to understand how an observer perceives a luminous environment. Thus, a substantial amount of research has been devoted on this subject. One definition by Cuttle (2008) states:
“The luminous environment generates the retinal image which is the stimulus for the process of vision which provides information to enable the visual perception process to recognize the objects and surfaces that form the visual basis for the perceived environment.”

A luminous environment encompasses the complex arrangement of visual stimuli, in which the observer must process in order to interpret and understand their surrounding environment. On a basic level, an observer processes the following factors (Boyce, 2014):

1. **Brightness** - perception of light distribution and intensity of a surface or scene relative to the luminous environment;
2. **Lightness** - perception of surfaces that are seen by having light reflected;
3. **Visual clarity** - perception of the quality of the light source relative to the desired task; and
4. **Colour** - perception of the colour appearance of a surface or scene relative to light source.

Directional lighting within a space has the ability to control and influence the factors listed above to provide cues that an observer can use to interpret the space. Relating these factors to a subjective judgment has been the subject of most studies within the field. This is known as the correlation method, which involves establishing a relationship between the observer’s subjective judgement of a light source, and a physical measure of the lighting. This may be achieved by asking the observer to rate different scenarios on a scale, or allowing them to adjust a variable to match their preference. The subsequent data can be analysed from a larger distribution to establish a common higher-order perceptions. This is identified as a one-dimensional method as observers are correlating a single variable to an emotional response. An example of this is a study from the University of Toronto, Scarborough, showed that human emotion, whether positive or negative, is felt more intensely under bright light. The study asked participants a wide range of questions under different lighting conditions in order to document their emotional response. In the brighter room, participants felt better about positive words and worse about negative words.

A multidimensional method can be considered more accurate as the observer provides a number of subjective judgements of a lighting arrangement with respect to different dimensions. The main dimensions to be analysed were: emotional response, perceptual clarity, and spaciousness. This data can be analysed to derive the minimum number of underlying independent dimensions or factors on which the observers were basing their responses.

One of the more prominent researchers, John Flynn, has conducted a number of studies using a multidimensional method. Flynn identified four attributes, which he designated ‘lighting modes’. Each mode is defined by the extremities of a lighting attribute; bright/dim, uniform/non-uniform,
Evoking positive emotions through lighting design.

central/perimeter, and warm/cool. It was stated that modification to any lighting mode would result in a change to the human response with respect to their perception of the space. Individuals may place a different importance on each attribute, which in turn defines their response to a mode change. Some individuals may react strongly to one mode whilst ignoring others; however, most respond to a combination of modes.

In order to determine which lighting arrangements create the most positive human response, a study at G.E.’s Lighting Institute was conducted by Flynn et al. (1973). This explored human response to six different lighting arrangements using wall-, diffuse-, directional-lights and combination thereof, within a small room with a central table. Participants were required to rate each arrangement for multiple dimensions.

The first dimension, evaluative, was used to analyse responses on scales such as pleasant/unpleasant, relaxed/tense, interesting/monotonous. The results revealed that participants exhibited the strongest negative emotions towards the two arrangements that were solely reliant on overhead diffuse lighting. These arrangements had opposite intensities, one low the other high. Consequently it can be concluded that the extent to which a room could be considered pleasant was related to two factors, the existence of peripheral lighting and non-uniformity of the light source, all of which can be satisfied by the use of directional lighting.

The second dimension, perceptual clarity, was perceived to be best when directional lighting was used. Flynn’s analysed the responses on scales such as clear/hazy, bright/dim relative to the illuminance of a table in the centre of the room. As expected, the high brightness arrangements were considered to provide greater perceptual clarity. Through another study, involving a greater number of participants by Veitch and Newsham (1998), revealed that directional lighting had a greater impression of brightness relative to indirect (diffuse) lighting.

The third dimension, spaciousness, was used to analyse responses on scales such as small/large, long/short. The results found that participants perceived arrangements that only provided light on the centre table, particularly at low brightness, made the room appear cramped. In contrast, arrangements with wall lighting were perceived more spacious. Similarly an arrangement with only opposing walls illuminated made the room appear longer.

Reinforcing Flynn’s conclusions, a similar study Hawkes et al. (1979) investigated human response to 18 different lighting arrangements using various wall-, diffuse-, directional-, task-lights, and combination thereof, within a small room with a desk. A variation from Flynn’s study was the illuminance on the work area (desks) that remained at 500lx regardless of the surrounding lighting.
which varied greatly. Participants exhibited the strongest negative emotions towards arrangements solely reliant on overhead diffuse lighting. Arrangements that were considered most pleasant contained an element of variety in lighting produced by directional or wall lighting.

Suggested Links to Lighting

The findings suggest that in order to facilitate the observer with environmental cognition and generate a positive emotional response, the factors mentioned within this paper on human nature and response to lighting should be taken into account. Factors influenced by human nature include theories on prospect and refuge, familiarity and complexity, fragmental bias, emotional response and environmental control. All of these factors can be beneficially altered through adequate consideration at the design phase of a space and the use of directional lighting.

<table>
<thead>
<tr>
<th>DESIRED RESPONSE TO ENVIRONMENT</th>
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<tr>
<td><strong>HIGH COHERENCE</strong></td>
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<td>Humans require familiarity with new environments, as a primary, natural goal is to establish a cognitive match in order to interpret and understand their surroundings.</td>
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<tr>
<td><strong>Complexity</strong></td>
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<td>Humans require involvement with new environments, stemming from a desire to explore and engage with their surroundings.</td>
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<td><strong>Directional lighting</strong></td>
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<td><strong>Directional lighting</strong> can be used to maintain complexity or mystery within a space by varying the levels of brightness. This results in the perception of high involvement, which translates to a positive response.</td>
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<td><strong>HIGH PLEASANTNESS</strong></td>
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<td>Observers experience positive correlations due to high familiarity with new environments, resulting in high pleasantness on valence dimension of emotion</td>
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<tr>
<td><strong>HIGH AROUSAL</strong></td>
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<tr>
<td>Observers experience involvement due to complexity of new environment, resulting in high levels of stimulation [neurological activation] or arousal [physiological].</td>
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The research within this paper indicates a preference for different forms of non-uniform lighting to facilitate the observer with environmental cognition and generate a positive emotional response. With respect to the appropriate installation of common forms of lighting, the following strong correlations between light type and impression is suggested below.
To achieve positive emotional responses through lighting designs, lights should be selected based on their ability to be controlled. There are current models on the market that can control certain aspects of lighting, including: colour temperature, beam angle, beam shape, brightness, glare and articulation.

Depending on the desired results, some aspects may have a higher importance than others. However, the selection of lights with a low-glare, directional beam, and a degree of articulation is the most effective means of ensuring any space creates a positive emotional response.
References


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