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PERCEPTION OF LIGHT QUALITIES – A DESIGNED STUDY ON LIGHT SOURCES IN COMBINATIONS

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Abstract

1. Motivation, specific objective

The design of indoor environments is important for comfort, well-being and, in the long run, health. The qualities and design of the lighting significantly contribute to the overall room experience and are dependent on the properties and performance of light sources. To achieve an attractive light environment with desired atmosphere, physical requirements should be fulfilled, however human perception must be considered. Further, many light environments are lit with different light sources that varies in placement, light distribution, and colour temperature, which all have impact on the visual quality of a space.

Two fundamental and interacting factors for the perception of light character are light level and contrasts. Contrasts can be achieved through a direct light distribution creating distinct light, shadows, highlights, and reflections/sparkle in different materials. The variation of perceived contrast is directly linked to the properties and the placement of the light source and may result in either diffuse or distinct transitions between highlighted and shaded areas. Colour temperature is important for perceived light qualities and overall experience, for example the perceived light colour. To evaluate perception in an objective way, analytical sensory methodology can be used. Sensory analysis of lighting products is new, however previous studies have shown that it can be applied to the perception of lighting.

The specific objective of this study is to evaluate, by sensory analysis, the perception of combinations of two different light sources varied according to a factorial design. In all, 16 different combinations were studied.

2. Methods

Light sources: 16 different combinations of two light sources were varied according to a factorial experimental design. The design factors were the following: light sources (direct/omnidirectional), placement (general/point), and colour temperature (2700K/4000K). All the lighting products were white LED lightings found in retail stores. The combinations of light sources were installed in separate test booths (ISO standard) equipped with different items such as a frame, a magazine and a golden bow.

Method: The evaluation method was descriptive analytical sensory analysis, a non-subjective method. Analytical sensory methods aim to obtain objective assessments of perception, where personal preferences and hedonic responses are not considered. The assessments are performed by panellists who are selected for their well-developed subtle senses and then trained for each occasion of evaluation.

In this study the panel consisted of 8 panellists who individually assessed each combination of the two light sources. The evaluation was performed in triplicate and in a randomized order. The training of the panel included the establishment of a set of sensory attributes, i.e., the light qualities, to be evaluated, as well as training on evaluation scales for each attribute. After the training the actual assessments took place.

Statistics: Data was analysed by descriptive statistics. To find out whether the lighting combinations sets differed significantly regarding the evaluated attributes, two-way ANOVAs

(analysis of variance) were performed with products and panellists as fixed factors. After the ANOVAs, Tukey's pairwise post hoc tests were applied (p<0.05). A principal component analysis (PCA) was carried out to give an overview of the results.

3. Results

The resulting data was clearly divided into four different clusters. According to the PCA plot, PC1 and PC2 explained 88.6% of the variation of the resulting data. The clusters could mainly be divided between the describing attribute "distinct" on one side and "diffuse" on the other, which refers to the design factor light sources being direct or omnidirectional. Further, the placement of the light sources had a significant impact.

- The first cluster that could be described as the most distinct, and consisted of directional light sources, both as point and general lightings. This cluster could also be described as having sharp and distinct multiple shadows, and further to give reflections.
- The second most distinct cluster consisted of directional light sources as point lighting and omnidirectional sources as general lighting. The shadows were sharp, but the reflections were less distinct than in the first cluster.
- The third cluster consisted of omnidirectional light sources as point lighting and direct light sources as general lighting. This cluster could be described as being more diffuse than distinct, having less sharp shadows, but still clear reflections.
- The fourth cluster was the most diffuse, having unsharp shadows and less reflections. It consisted of omnidirectional light sources both as point and general lighting.

Looking into the different clusters, significant differences could be found between different combinations of light sources, mainly when it came to shadows. Further, the division of the four clusters were not related to the assessment of the attribute warm light colour. However, significant differences between the combinations could still be found, which were related to the design factor colour temperature. As expected, the least perceived warm light colour were found in combinations where both point and general light sources were 4000K and the warmest light colour were perceived in combinations where both light sources were 2700K. For the combinations of 4000K and 2700K light sources, the combination where the point light source was 2700K and the general was 4000K, was evaluated as warmer than the opposite combination of light sources.

The panel evaluated, consequently, the combinations of light sources based on the design factors and where the main design factor was directional/omnidirectional light sources.

4. Conclusions

All design factors had significant impact on the perceived light qualities. Of main interest are the combinations directional and omnidirectional, but also placement and colour temperature are of interest. It could be concluded that the light distribution of the point lighting is the most decisive for whether the light is perceived as diffuse or distinct. Direct light sources give light perceived as distinct, which is reinforced if both point and general lightings are direct. In addition, the point lightings have a greater impact on perceived light colour than the general lighting.