

PERCEPTUAL METRICS FOR LIGHT QUALITY IN SPATIAL ENVIRONMENTS

Enger J.¹, Wendin, K.^{2,3} and Hiller, C.⁴

1: University of Arts, Crafts and Design, Sweden 2: Kristianstad University, Sweden: 3: University of Copenhagen, Denmark; 4: RISE – Research Institutes of Sweden;

Abstract

1. Motivation, specific objective

Sight is the sense that gives us visual information about the world around us, and light is a prerequisite for this process. Light radiation can be measured physically with precision, but light as the experience created when light rays strike the retina of the eye is sensual, and thus both subjective, relative and complex. All the light we see is reflected from surfaces, unless you look directly into a light source. The properties of surfaces, their colour and texture in combination with the properties of the light source and the distribution of light, is what provides visual information about the room.

The established methods available to assess light quality in spatial environments are based on physical measurements, and thus insufficient as tools to capture perceived values. A consequence is that many lighting environments have poor perceived light quality, even though planned in accordance with recommendations.

With the aim to capture the perceived values, methods and a vocabulary for perceived light quality has been developed in an interdisciplinary research project that has been ongoing since 2016. The method presented here is based on two typologies for spatial environments, one for lighting principles that contain different varieties of evenly distributed and varied light, and one for achromatic colouring that builds different degrees of reflectance and contrast. A combination of the two typologies allows a systematic investigation of how the experience of a light environment changes in relation to light distribution and colour settings, which are decisive factors for perceived differences in contrast and also light level. Words describing perceived light quality have been collected in workshops with members of the lighting industry, and divided into the categories *Experience of the Room*, *Experience of the Light* and *Experience of the Shadows*. The vocabulary and the typologies have been refined through repeated pilot studies to the version that has been used in the study which is presented here.

We have applied methods from Sensory science, which is a well-established discipline originally developed in the beverage and food industries. The analytical sensory analysis leaves out personal preferences and the human senses are used as a measuring instrument. A panel of assessors is trained before the study to agree on consistent definitions of the words they are to assess in relation to the quality being assessed. Another method commonly used method, for e.g. psychological measures, is assessments with semantic differential rating scales. In this project we have used unipolar rating scales for assessments, since the word collection had no clear division between antonyms. In this second method the subjects did not undergo any training before the studies, meaning that the assessments were based on their individual interpretation of the words.

The specific objective for the study was to examine the general validity of the collection of words for perceived light quality in relation to a set of spatial environments designed according to the typologies for light distribution and colour contrast. Two different methods were applied in the study: common unipolar semantic rating scales and the analytical sensory analysis.

2. Methods

A selection of the typologies was combined and applied to 14 physical scale models with identical proportions and interior features. Five different light distributions were represented and combined with interior colour settings ranging from minimum to maximum reflectance, and from low to extreme contrast. Assessments were made with questionnaires containing 38 descriptive words divided in the categories described above, along with assessments for perceived contrast and perceived light level.

For the sensory analysis a panel of 8 people assessed the scale models in randomized order and in triplicates. A different group of non-trained subjects assessed the scale models in randomized order, with differential rating scales. This group consisted of 25 individuals with varying professional backgrounds in ages ranging from 23-86 years.

Lux levels were measured in each model and the achromatic colour setting specified with NCS codes.

3. Results

The results from both methods are generally surprisingly consistent, also compared with previously conducted pilot studies. An analysis shows that the words are distributed according to a clear pattern, where the type of light distribution and the degree of contrast determine which words are used.

For example, are words such as *Uniform* and *Monotonous* are used to describe the experience of the room in a white scale model with even light. The light is accordingly described as *Even*, but also *Flat* and *Clear*, whereas the shadows are *Soft* and *Diffuse*.

A scale model with a varied light and a contrasty middle-grey colour setting was described with words like *Varied*, *Spacious*, *Has depth* (the room), *Distinct*, *Varied* and *Descriptive* (the light), and *Dark*, *Descriptive* and *Distinct* (the shadows).

And as a third example: in a scale model with the same colour setting as in the second example but with even light, the room is again perceived as *Varied*, *Spacious*, and that it *Has depth*, which suggests that the experience of a room is created by combination of light and colour, and the amount of contrast. The light was on the other hand in this case was described as *Soft*, *Mild* and *Clear*, and the shadows as *Soft* and *Diffuse*.

4. Conclusions

The unambiguity in the outcome of this study is promising, taken together with the results from previous pilot studies, which in all have included over 100 individual assessments. It suggests that the collection of words has the potential to serve as a basis for a vocabulary for perceived light quality in spatial environments.

The collection of words we have used in the studies is taken from the informal terminology commonly used by practitioners to describe perceived light quality. The results indicate that the words are generally comprehensible and can be used for assessments even by lay people.

A future development of the vocabulary could be used both in practice and research, for planning, specifications and evaluations of light environments, as well as in comparison with both physical measurements, energy use, and assessments of experienced atmosphere and emotional response.