Observations of spatial atmosphere in relation to light distribution

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Design and emotion: Methodological issues

Abstract

The aim with this design research is to increase the understanding of lighting quality by supplementing existing illumination knowledge with visual evaluation of light distribution in three-dimensional rooms. This paper is based on a pilot study including observations of twelve different lighting situations in two comparable scale-model rooms. The discussion that follows focuses the relation between light distribution and experienced spatial atmosphere. The primary purpose with the pilot study was to investigate methods to observe, as well as to develop hypotheses, about spatial atmosphere experience in relation to light distribution. Additionally, descriptive concepts are formulated. Furthermore, the consequences for spatial atmosphere experience are discussed in terms of light-pattern, rhythm and the experience of being enclosed or excluded by the light-room. A main result is how light distribution seems to affect if a room is experienced as understandable or confusing, calm or active. Light patterns on walls and in the ceiling seem to be more important than on the floor, yet a light patched floor may have large impact on the whole room atmosphere. Moreover the findings indicate a relationship between hard or soft light contrasts and warm or cold colour experiences.

Keywords: light distribution, spatial atmosphere, spatial enclosedness, light design, lighting quality.

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Importance of luminary placement for spatial- and atmosphere experience

The main question for a light designer is where to place the luminaries and which consequences this has for our spatial experience. The luminary placement gives the room a specific light distribution that affects where it is darker and where it is brighter and how we perceive distances and relations between surfaces and shapes. The light-patterns affect our perception of room size and shape, and influence the atmosphere experience. On the one hand, light distribution deals with where to place the luminaries and on the other with what we shall light up. The distinctness of the room is related to visibility and clearness of where the room begins and ends, and what choices of further paths there are.

A research based on visual evaluation

Lighting quality belongs to an area between arts and science. Illumination knowledge is so far mostly based on quantitative research of light level, vision acuity and light colour (Gibson, 2001; Liljefors, 1997). Spatial experience and light distribution, factors that are better suited for visual evaluation than calculation, are less researched. As the central vision functions better in a uniform light, norms and recommendations are based on light everywhere (task light). Conversely, spatial experience depends on the peripheral vision that is facilitated by a varied light, rich in contrasts (Liljefors, 1997). Therefore an awareness of the visual perception of light distribution is important.

Architects and light designers usually work with visual analysis more than calculation. Nevertheless, there must be a way for a design researcher to use their profession skills to gain more knowledge, instead of just adopting research methods from other fields. This means that qualitative methods will be used when approaching a traditionally quantitative field. Architects and light designers are used to interpret architecture and spaces, to

choose what they wish to enhance or diminish with light. Accordingly, they do have a lot of theories about light in rooms. Some of this knowledge may have its base in facts or practise-based experience and some may be merely ruled by conventions and fashion trends. This practise-based architect knowledge will be a point of departure for the research questions. A research built on visual evaluation will complement the existing quantitative knowledge with an increasing understanding of our spatial atmosphere.

This pilot study is a work in progress with the purpose to investigate methods and define more precise questions to study further. The aim is towards an understanding of how and why a spatial phenomenon occurs. Accordingly, in this paper the influence of light distribution on spatial atmosphere is discussed. The spatial atmosphere was observed visually in a pilot study with twelve different luminary placements in two identical scale-model rooms. The findings will be a foundation for developing hypotheses and will give examples of what we can learn from observations like these. The study started with observations of spatial dimensions, such as the room height, size, shape and spatial enclosedness together with a parallel discussion about what we regard as a room. In this text, observations of spatial atmosphere are developed to a reflection of light-pattern, rhythm and the experience of being enclosed or excluded by the light-room. From the scale-model studies, a selection of interesting phenomena will be chosen to study in full-scale and real environments.

Terminology: Relation of spatial perception and atmosphere experience according to light distribution

In this text, distinctions are made between the words; *perception of space* and *experience of space*. *Spatial perception* is used to address how we perceive and understand the direction, size, shape and colour of the space. The term comprises also how we get an overview of the room, how we orientate, how we see connections to other spaces, and read the functions within the room as daylight openings, entrances and exits. *Spatial experience* refers to what makes a room atmosphere to seem warm, enclosed, and

moreover how intense the light contrast is and if the light-patterns seem to be active or calm.

According to the Swedish dictionary "*Stora svensk-engelska ordboken*", the Swedish word "*rumslig*" should be translated into *spatial* (Petti & Rudman, 1989). Consequently, the Swedish word "*rumslighet*," in its definite form may be translated to "*spatialness*". The environmental psychologist Rickard Küller translated the Swedish "*rumslighet*" into "*spatial enclosedness*"(Küller, 1972, 1975). That could be a good word to use sometimes, but not everywhere since the word *enclosed* means more like surrounded (Swedish "*sluten*"), compared to *spatialness* which seems more with a character as being a room (Swedish "*rumslig*"). Nevertheless, the concepts are closely related. The Swedish word "*rumslighet*" (=spatial enclosedness, spatialness) seems to contain a valuation of how close, –to what extension; a room, a place or interspaces will be experienced upon as a space. With a comparison between two extremes, one may say that the closed middle-aged square has more spatial enclosedness than the open field. In this text, the term spatial enclosedness is chosen as it seems to be more established. An important issue in this context is how neutral one can be in avoiding value judgements. Most words have a value that may be more or less positive, and words must be used. Positively loaded words can in this context be such as: enclosed, embraced, obvious, glitter, sparkling and light, while negatively words may be: shut in, excluded, rejected, chaotic, irrational, glare and darker. One may question if it is possible to say that spatial enclosedness is a neutral word.

Merete Madsen has investigated daylight fields within the room as representing smaller rooms in their own right: "*light-zones*" (Madsen, 2003, 2006). In this text, her term "*light-zone*" is adopted to stand for as a small room of light. Moreover, when talking about a "*light-room*" here, means a larger light-zone that seems to be more important than the constructed room, so it becomes what we may interpret as "the room". Furthermore, in this text corresponding small dark-rooms are addressed to as *shadow-zones*.

When the term *light level*, is used in the following text, it alludes to the degree of brightness and shadow that one can visually experience in the room. As light radiation only becomes visible when it hits a surface, like dust particles; Anders Liljefors states that we must be clear when we talk about the physical light rays that surfaces reflect, in contrast to our visual experience of surfaces with different brightness (Liljefors, 2003).

Methods used in the pilot study

In the pilot study, two identical model-rooms in scale 1:75 were used. The measures of the room in scale 1:1 would be 5, 40 x 4, 20 x 2, 40 metres. The models were illuminated by end-glowing fibre optics equivalent to “down-light luminaries”. In each model, fibre cables were attached to a projector with a 50W low wattage halogen lamp. The illumination in the room where the observations took place was switched off. Twelve different luminary placements were tested. In every illuminated room the same amount of luminaries and the same added amount of light was used. The only variable is the luminary placement with a sideway variation. The perceived light level may however vary, depending on how much light the model-room surfaces reflect, which is related to the luminary placement. The luminary placements are chosen because they represent common light design solutions. The illuminated rooms, standing side by side, were compared two by two: A-B, C-D and further on. Each observation session took around 20 minutes for a room pair and one to two pairs were studied each day. In this pilot phase all observations were done by the author. The hypotheses developed from the findings will further on be tried on test persons. It is important that the room models are observed in reality and not on pictures. In this paper, the experience of the scale model rooms is discussed as if it would be possible to be inside the models. Actually, the size of the models allows a part of the observer head inside.

When the observations were preformed, the rooms were studied in relation to the questions below:
Which rooms are experienced as warm/cold? Why?
Which rooms are experienced as hard/soft? Why?

What is the importance of lit walls and corners for the spatial experience? Why? How?
How are complexity, plainness and spatial enclosedness experienced?
Does the illumination co-operate or counteract with the room shape?
Does the illuminated room give any associations to ordinary functions and room-types?

In this pilot study, striking thoughts from one room to another are written down spontaneously, however with the questions in mind. This quick survey is not meant to answer all the questions, but to see what kind of answer we possibly can receive. After analysing the pilot study, the plan is to redo the observations in a more systematic way.

Figure 1: Picture of the scale models.

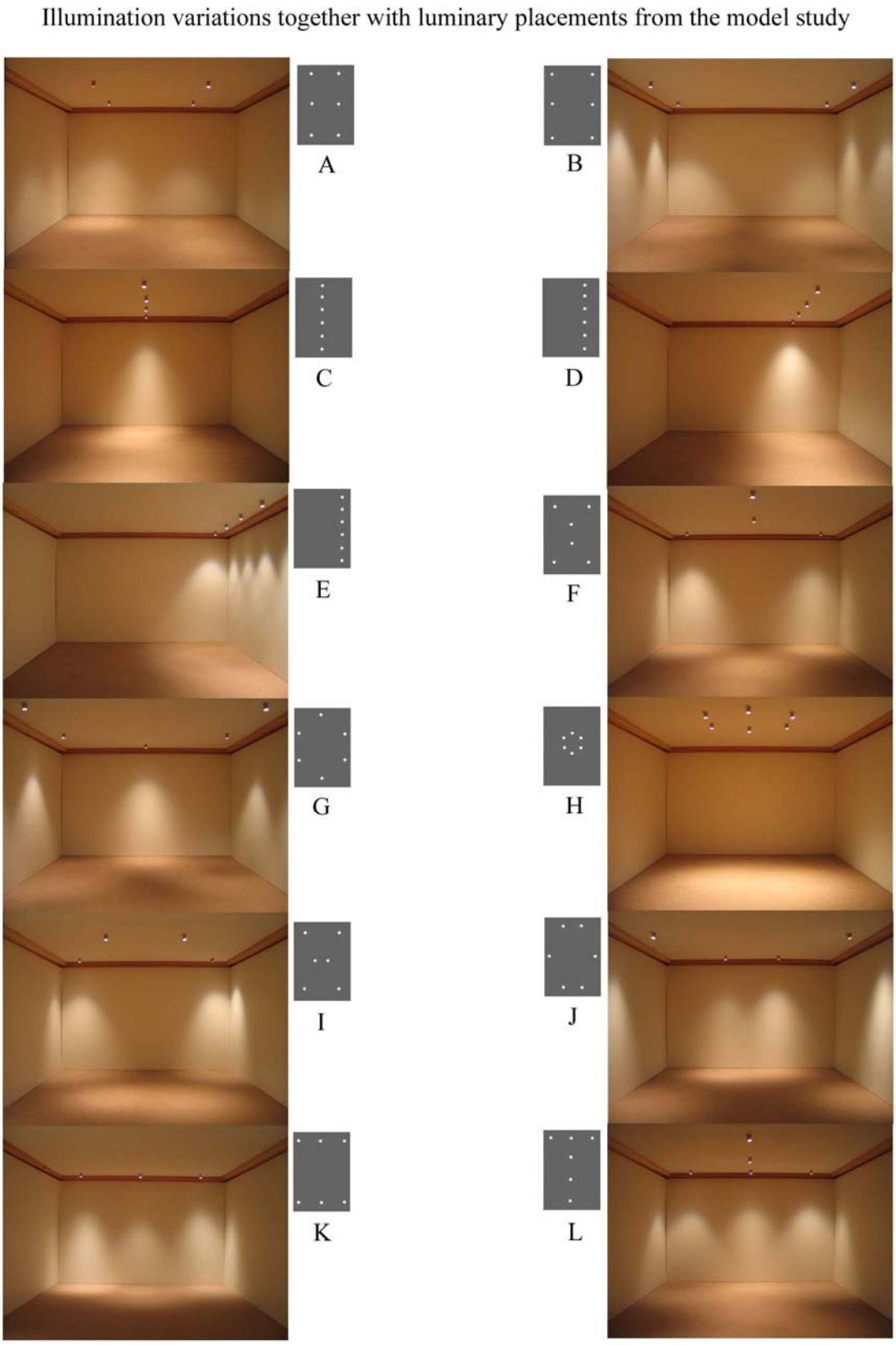

Figure 2: Pictures of all illumination variations and luminary placements.

Light-pattern in rooms as a result of light distribution

The light contrasts can result in a visual interesting room as well as in visual gloominess. Well known from the gestalt theory is that we tend to read together single spots to patterns and figures (Farné, 1947). We also know that light is very useful to direct someone's attention, as we automatically look for the largest contrasts and the brightest part of our vision field (Liljefors & Ejhed, 1990). David Loe writes that there is a proofed preference for a light-pattern on walls, that appears light and interesting; this is likely to be a criteria also for other interiors than the commercial type that he referred to, yet with other proportions of lightness and interest (Loe, 1997).

Light contrast patterns affect spatial enclosedness

One clear effect of light distribution is shown when luminaries are placed so the light reaches important room-surfaces like walls. If the walls are visible the room seems to be easier to understand, but this depends also on the whole contrast situation within the room. Even lit corners and other lit light-zones as well as shadow-zones within the room may be enhancing spatial enclosedness. A surface next to a light source that is lit, may work as a gradient that softens the contrasts and decreases the glare risk. On the contrary, a wall lit from a closer distance may be observed to have harder contrasts than one lit from a longer distance. The illuminated room B (from the model study), seems to have harder contrasts compared to room A, even though B seem to have a more uniform light than room A. The softer contrasts in A do not seem to make up for the fact that the walls are not reached by the light to the same extent as in room B. Both rooms seem to be patched. This is more obvious in A where the light spots on the floor seem to lack correspondence on the walls.

Patterns composed by light or luminaries - for an obvious room

In addition to the pattern light on room surfaces constitute, light fitting-openings form patterns too. These interior elements often form figures, most commonly in the ceiling,

with a more or less clear shape. Luminaries in court halls and churches are often placed in a circular shape to enhance the community of people within. The luminary pattern does not always correspond to the light-pattern of lit surfaces, or to the room shapes. If the luminary pattern does not answer to the light on room surfaces, as in room G, the result becomes confusing. The illumination G, seems to counteract with the room instead of co-operate. In room G, sparsely distributed light fields surrounded by dark areas, do not seem to form a meaningful pattern; the pattern has no correspondence to the angular room. Wider beam angles could possibly have given another result, as a wider light-zone could connect to other light-zones. The luminary placement in room J forms a circle of similar size, but with a light-room that tend to be more enclosing, as the dark corners seem more united. In G, the shadow-zones in both corners and in the middle of the long sides seem to be of equal importance. When the light spots are close enough to form a figure like the light cross-shape in room F, this seems to give a stronger identity to the room.

Patterns with rhythm: dynamic and activity– for calm or a restless atmosphere

When comparing room A to room B, where the luminaries were closer to the walls, the differences in contrast levels seem to impact the experienced atmosphere of activity. Despite the patched expression of the floors, the ceiling in A seems calm and harmonious. This seems to make the whole room glittering, yet calm and subdued. Consequently, room B is experienced as a room to stay inside. This leads to a hypothesis that light-patterns on the walls and the ceiling are more important than light patterns on the floor.

Room G seems to be dynamic and rhythmic, yet restless and irrational. This is because the room is patched with too large contrasts. There seems to be nothing for the eyes to rest upon. The illumination-I, tends to give an even more splintered and patched room than G and the room seems to lack sense of a whole. The idea behind the luminary placement “I” was that a common solution should give a uniformly distributed light, but in this scale and in this room the effect becomes the opposite. The corners are heavily

marked in relation to the walls. In room G, the accent along the walls seems like a dynamic movement. This movement has nothing to do with an intended function of the room; it is only an experience of the light-pattern itself. On the other hand, illumination “I” seems more static, as if it stops in the corners. The light spots in the floor centre seem to be disturbingly spotted. In addition, the luminaries centred on the sidewalls direct light downwards in the middle of the long sides, which also can contribute to the patched expression.

The X-shaped light-pattern in room F seems dynamic. However, the unlit long sides seem to be both large and calm, and the room seems easy to read. The “movement” seems to stop in the room and accordingly it is experienced as a room to stay inside, in contrasts to room E, where the light-pattern of the walls may to give associations to openings to walk towards. The dynamic light-pattern in F tends to bring the observer in to the room centre. As an opposite of room F, where the light-zones seem to create an x-shaped image, the shadow-zones in room J form a similar figure. However, this negative dark shape on the floor seems to give simplicity and rest from the other lit areas, instead of activity. Within the variation of light and darkness in room K there seems to be movement as well as static, activity and rest.

An enclosing or excluding atmosphere

What I regard as a room with a high level of spatial enclosedness has a lot to do with if the room is enclosed or not. A room is usually delimited of walls and if they are visible or not seem to affect our spatial experience to a high degree. Rooms can also be indicated just by corners. Furthermore, two surfaces next to each other, like when walls meet in corners can form a three-dimensionally unit which in itself take the shape of a room. The light beams can likewise provide own rooms within the room, either separately or in connection to other light beams. These can be experience as enclosing or excluding, as the observer has an opportunity to step into the light or stand outside. When light falls on the floor it may also fall on people within the light beam. A feeling of being inside or

outside is then easy to visualize. Interesting in this context, possibly a subject for further studies, is where the border between being enclosed to be shut in is located.

Enclosing light-rooms within the room

When light forms rooms in the centre of a room (as in C and H), in addition to when light reaches the walls or only one of the walls (example D), constitutes examples of room-within-the room. There is place enough to imagine being able to step both into and out of the light-rooms. Accordingly, room C, D and H seem to be experienced as having a clear "being inside or outside" atmosphere. The light-room in E does not give the same distinct "inside/outside" atmosphere as room D gives. While the light-room in E is even smaller and more accentuated to the wall, it becomes a too small room to be inside. E seems to be a room suited for a wall-exhibition, as the sharp contrasts gives associations to exposure. Rooms K and L remind a lot of each other, despite of the more divided light-zone in each short end of room K. In K it is very clear that one can be inside or outside. The continuous light-zone from front to back in room L seems to give visual guidance into the room and to the back wall. Nothing is exposed and there exist no division in "outside/inside" atmosphere, and no "we- and them-experience".

Even if the corners in the H-illumination are dark, they may represent rooms of their own beside the centred circular light-room. Therefore, H seems to have a clear "inside/outside" atmosphere. Illumination G shows an opposite situation where the circle of luminaries is too large to enclose an inner room so it will not be perceived as a room within the room. As a result, this illumination seems to counteract with the room. However, the illumination J, with a similar sized circle, seems to enclose the more obvious room. The main difference is that room J has two luminaries at each short side and one at each long side, opposite to the case in G. The corners in J are dark, different from the main part of the short side, yet still visible. On the contrary, the light beams in G become so obvious own shapes that they take focus from the impressions of the corners, seen from the short side. J is a room that seems to be without the atmosphere of being inside or outside (the limelight), no person within the room is exposed. It seems possible

that the light-rooms/shadow-rooms become more obvious when the contrasts between dark and light are large and the gradients are less soft.

A relation between spatial enclosedness, complexity and obviousness

In a further discussion about rhythm and variation, a relation between spatial enclosedness, complexity and obviousness may be found. The illumination H seems to give a room which is uncomplicated, very obvious and having more spatial enclosedness than room G, which seems to be more complex and indistinct as a room. In G, the light shapes do not help to make the room understandable, as the absence of visible corners is obvious. The walls are all lit, yet with such narrow beams that they form own figures rather than displaying the walls. Room H is simple and obvious with its bright centre enhanced by darkness. It is easy to grasp, as the extent of light reaches the major part of the room. These findings completely diverse from the initial hypothesis, that walls and corners should be bright for the highest level of spatial enclosedness.

Light colour impression related to light distribution

Even though the light sources and the illuminance were the same, the light distribution itself seems to matter for the experience of light colour within the room. Harder contrasts may influence that a room will tend to be cold, opposite to a room with softer contrasts that may look warmer. Room A, F, C and J seem to be warm and room B, D, E seem cold. Furthermore, room I and B seem to be hard and F and J seem to be soft. If a luminary is placed so that the light is reflected by a warm coloured surface it influences the whole colour impression of the room. However, in the models, the surface-colours seem to be less important than the contrast effects, for the experienced light colour.

Conclusion –and new hypotheses

From the model study several new hypotheses were formulated:

It seems possible to consider light distribution as a rhythm of contrast variation that influences the experienced spatial atmosphere. Furthermore, the luminary openings may form an own light-pattern that not always correspond to the light-pattern on room surfaces. A light-pattern can co-operate or counteract with the room, accordingly it seems to make the room understandable or confusing, calm or restless. In addition, the light-pattern seems to give an atmosphere experience of activity and movement. If patterns are connected, the room tends to be calmer. Consequently, a coherent light-pattern seems to give the room a stronger identity. A light patched floor seems important for the atmosphere experience of the whole room. Moreover, light-patterns on walls and the ceiling seem to be more important than on the floor. The light distribution seems to affect a room as being experienced as enclosed, excluding, shut in or exposing. Following, enclosing and excluding smaller light-rooms may co-exist within the built room. A relation between obviousness, complexity and spatial enclosedness may be found. Despite the fact that there was only one kind of light source in the study, variations in light colour seem possible to experience just through differences in light distribution.

Final discussion

Visual experience studies like these are very context-dependent, and the results will more likely answer to a similar situation in a light-culture equal to the culture of Western Europe. However, the findings shall not be regarded as a solution that one can take and use in another context, but as a way to increase our understanding of how the non calculative effects of light in room actually influence our spatial experience. The first free observation gave more answers than expected. Several times the result surprises. This circumstance indicates that the method works, at least for initial observations. Studying real models compared to pictures certainly influences the result. The most obvious factor is that in pictures, the lit/unlit foreground is not as visible as it is in the models. The camera cuts down the pictures and one cannot move around inside the room to get new views. When judging black and white photos the contrast becomes stronger than in

coloured pictures. Consequently, a full-scale study may also give other results. The scale of light, where the light beams in some cases tend to stand by themselves without interfering with each other, may look totally different with another luminary or with other distribution angles in a real room and in full-scale.

Future research

Further on, the plan is to continue with cross comparisons and comparing with a standard. A verification of the findings with a reference group of test persons, some spatially experience trained and some untrained, will follow. When a handful of design students during a lighting course answered questions about the room-model pictures, it become clear that there are many pitfalls in understanding what the questions truly mean and how one interprets rooms and pictures. Therefore, test persons will in the future be answering questions with the real models in front of them. Additionally, the plan is to use deep interviews instead of questionnaires, as it when will be easier to understand how test persons interpret the questions.

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