Human sensitivity to light zones in virtual scenes

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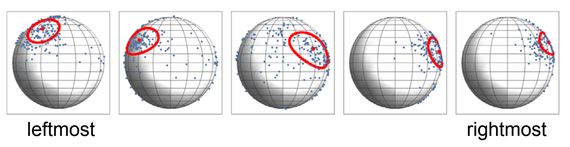
Introduction

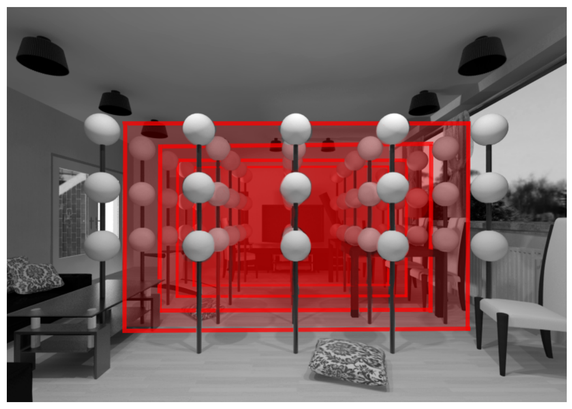
Previously [KRP*15], we found that observers' light inferences were rather consistent in paintings with uniform or diverging light, but showing striking individual differences in paintings containing spaces with different illuminations across the depth of scenes (inside and outside of a window, or with a second room visible in the back through a door opening). The most plausible explanation seemed to be that observers varied in interpretations between the borders of illumination volumes. In this study we investigate the perception of light in such volumes named light zones [Mad07] depending on their orientation with respect to an observer.

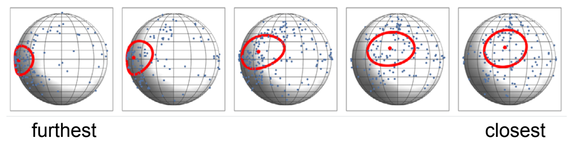
Experiment 1

In the first experiment of the study we tested whether observers could distinguish the differences in illumination between light zones.
The first row shows the two scenes used in experiment 1, each sliced in 5 parts. The second row shows the distributions of the directional settings per slice, with standard deviation ellipses and mean (red dot). Left the LR condition, right the FB condition. For condition LR the settings were highly consistent over observers, but for condition FB the results showed high inter-observer variability, suggesting that the participants varied in their estimations of relative sizes of the zones.



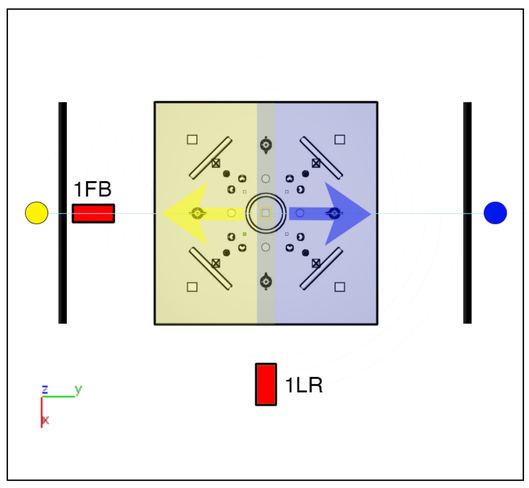
leftmost rightmost

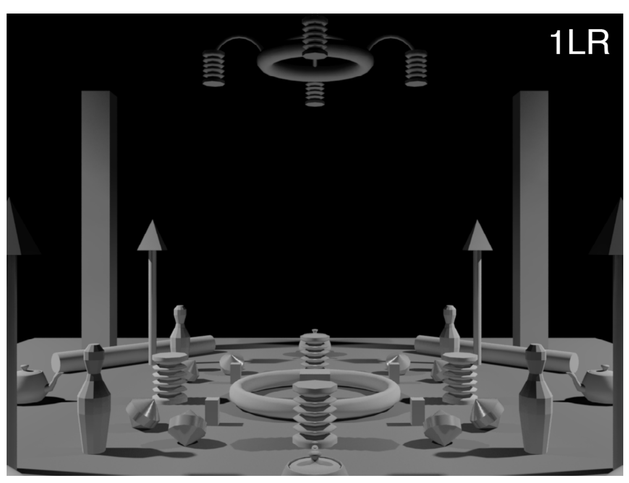


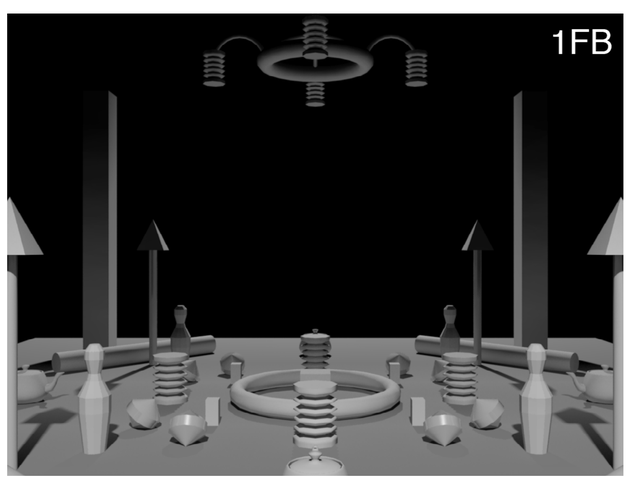


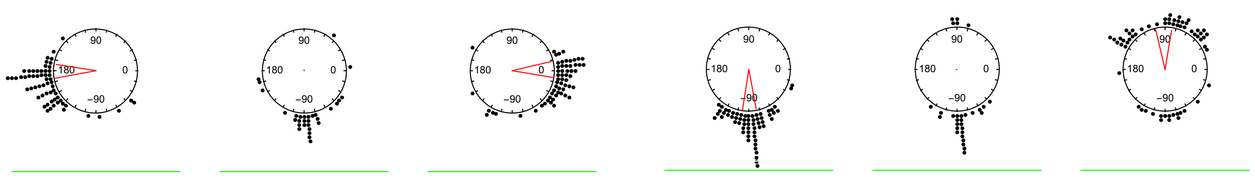
furthest closest

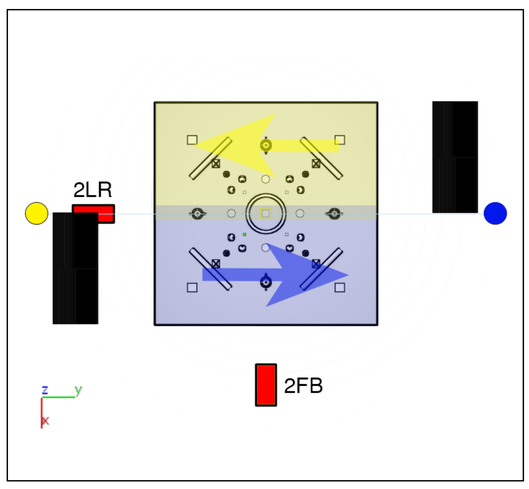
Experiment 2

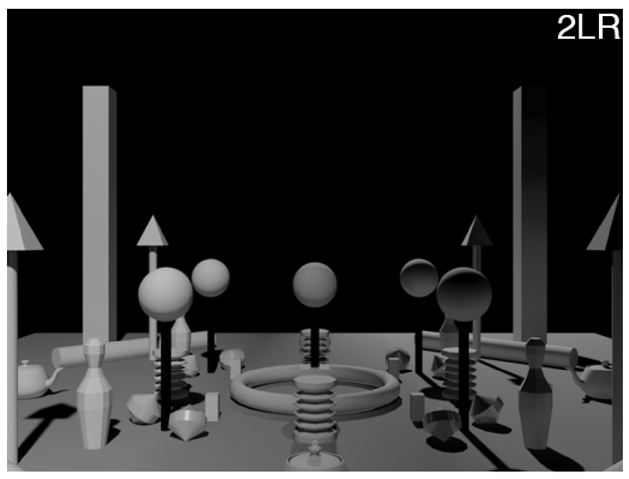


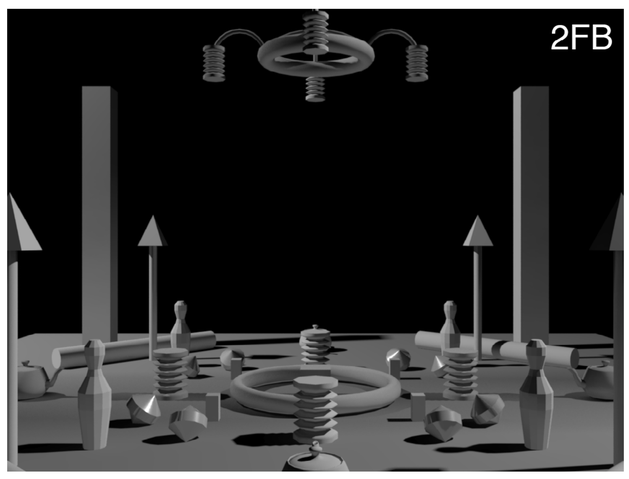


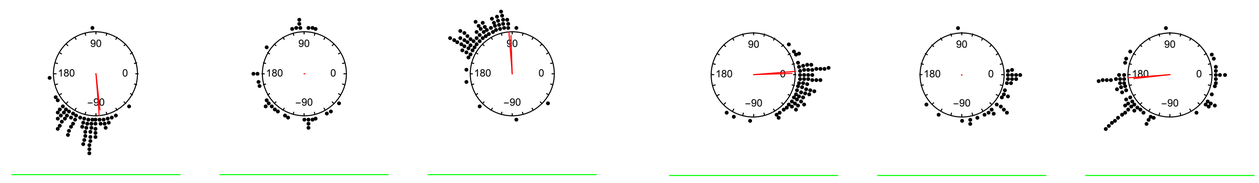












Next, we focused on the question whether the orientation of the light zones (in the picture plane versus in depth) influences the light inferences.

Each configuration created adjacent light zones that were viewed from two perpendicular directions (see Figure 1, top row). The symmetry of the scene allowed very systematic testing, changing the arrangement of light zones relative to a viewer, but keeping the observed geometry of the scene the same.

On the right see schematic representations of the of the scene (top view), the resulting test images, and circular histograms of the direction settings (top view). Left histogram shows the settings made on the two probes in the left or front light zone (for LR or FB respectively), the middle histogram shows the settings on the middle sphere, and the right histogram shows the settings made in the right or back light zone (for LR or FB respectively)

Results showed higher deviations and variations between and within observers for back zones of FB conditions. It appeared that the participants often made the settings in the back light zone of the FB conditions in accordance to the illumination in the front light zone of those conditions.

Discussion

Our findings show that human observers are less sensitive to light properties variation in depth of the scene than in the picture plane. This has implications for lighting design, namely that scenes with lighting variations will be much better "readable" if those occur in the picture plane than in depth. Earlier we have shown that human observers neglect subtle variations in the light direction [KSR*16], suggesting grouping into uniform, diverging and converging structures. Additionally, the light zones concept can be used for segmenting scenes, for example for precomputed lighting and as a lighting design tool.

References

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Acknowledgements

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