Understanding View Direction in Relation to Glare in Daylit Offices

LIPID | Interdisciplinary Laboratory of Performance-Integrated Design

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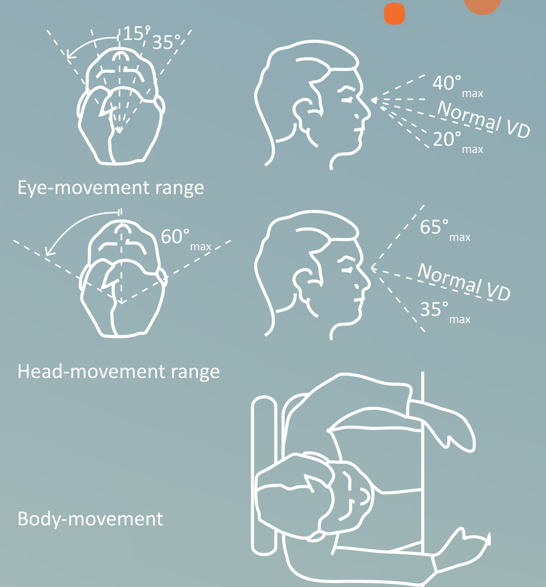
This study addresses a question common to fields of architecture, building technology and psychophysics: are there objective relationships between perceived comfort, view direction patterns (a visual response), and lighting conditions that impose glare sensations ?

View direction is where we direct our gaze by mutually moving our body, head and eyes. Glare assessments are made with the assumption of a fixed view direction.



A major limitation in discomfort glare indices is that they all ignore its dependencies on view direction. Glare sensation varies greatly depending on the angular displacement of the glare source to the view direction.[3,4,5] Depending on the occupants' direction of view, light distribution in the field-of-view (FOV) can range from interesting highlights to visually discomforting situations.

[1]OSTERHAUS, W. 2005. Discomfort glare assessment and prevention for daylight applications in office environments. Solar Energy. 79,148-158.
[2]WIENOLD, J. 2009. Daylight Glare in Offices. Freiburg, Fraunhofer Institute for Solar Energy Systems
[3]LUCKIESH, M. GUTH, SK. 1949. Brightness in Visual Field at Borderline Between Comfort and Discomfort (BCD). Illuminating Engineering Society, 44, 650-670.
[4]IWATA, T., SOMEKAWA, N., TOKURA, M. SHUKUYA, M. KIMURA, K. 1991. Subjective responses on discomfort glare caused by windows. Proceeding of 22nd Session of the CIE Division 3. Melbourne, Australia.
[5]KIM, W. HAN, H. KIM, JT. 2009. The position index of a glare source at the borderline between comfort and discomfort (BCD) in the whole visual field. Building and Environment , 44, 1017-1023. 108-109.

Glare is one of the major concerns for integration of daylighting strategies in workspaces. The most common type of glare experienced in daylit offices, is known as discomfort glare.

The initial challenge with this phenomenon:

- Creates only subjective negative responses
- Creates no immediate visual strain
- Creates no known physiological origins

Studies concerning quantification of discomfort glare have used conventional human assessments through questionnaires and they have been able to develop several different glare indices. Despite these efforts, predicting visual comfort in indoor environments still poses important challenges in design[1,2].

Understanding the dynamics of view direction (VD) as a result of light variations across the FOV is a pathway to eliminate the major limitation common to glare-risk prediction indices. The adopted methodology in this study relies on experiments where the eye-movements of human participants are measured in a parameterized office-like room under day-lit conditions.

The hypothesis is that there are clear VD distributions patterns under different lighting conditions which will ultimately have a significant effect on evaluations of discomfort glare and lead to better integration of glare-free daylight solutions in buildings design.

Findings presented here are the outcomes of a series of experiments, fig. (a), Table 1 , where we investigated the view direction distributions in relation to "view outside the window" and "office task" . We gathered photometric and view direction data during each trial , fig. (b,c).

Experimental Protocol		
#Daylight condition 1 [Low contrast variations]		**#Participants 23**
#Task-support 3	**#Task phase 4**	**#View 2**
Monitor	Input	Southwest
Paper	Thinking	West
Phone	Response	
	Interaction	

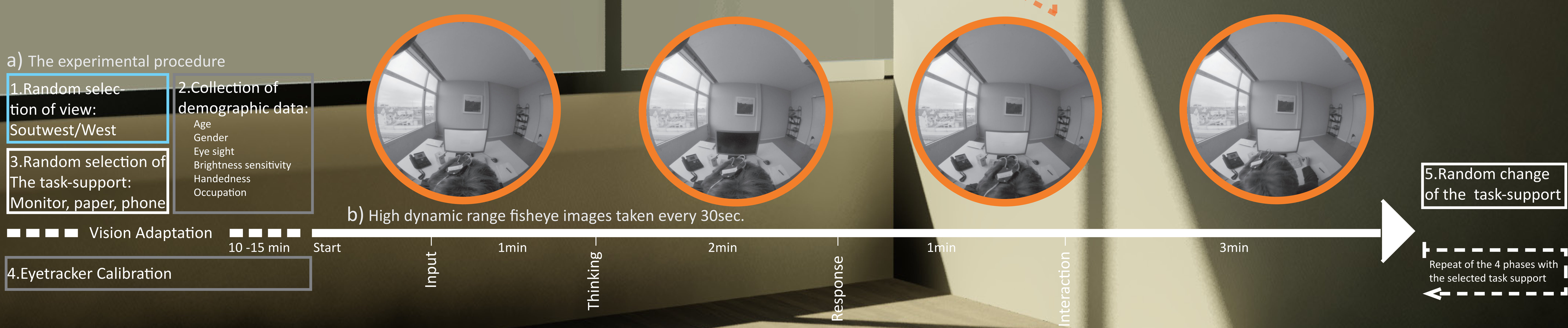
Table 1

The results show that, the main inclination of VD is towards the "view outside the window" when the participants are not focusing on the task area. Also, neither the different task-supports, nor the two selected views had a significant effect, fig.(d).

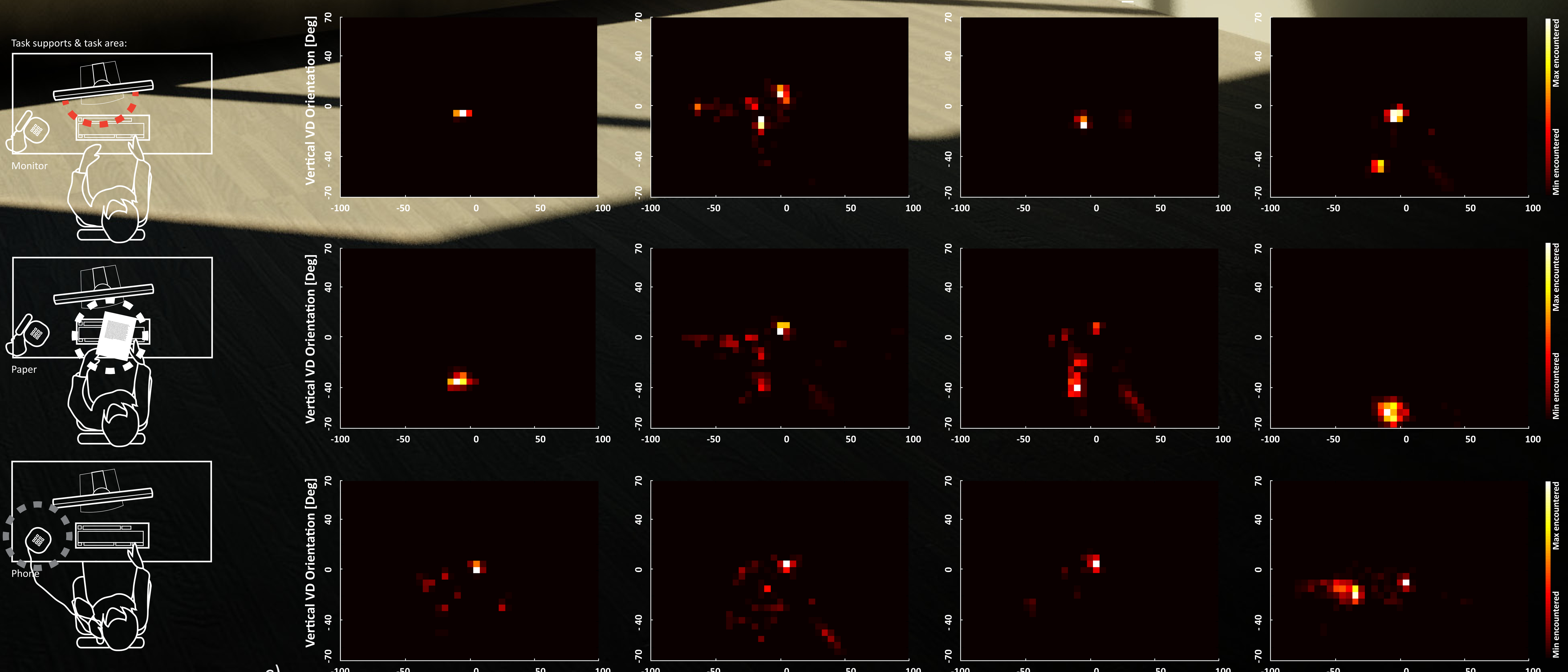
To conclude, based on the present findings, a second phase of experiments will be done with different daylight conditions, e.g. low vs. high contrast.

The findings on dominant VD will be used to identify the glare source displacements with respect to the line of VD and to recognize adaptation luminance in the actual FOV. Ultimately, analysis needs to be done to include dynamic VD together with participants' subjective evaluations in the assessments.

a) The experimental procedure

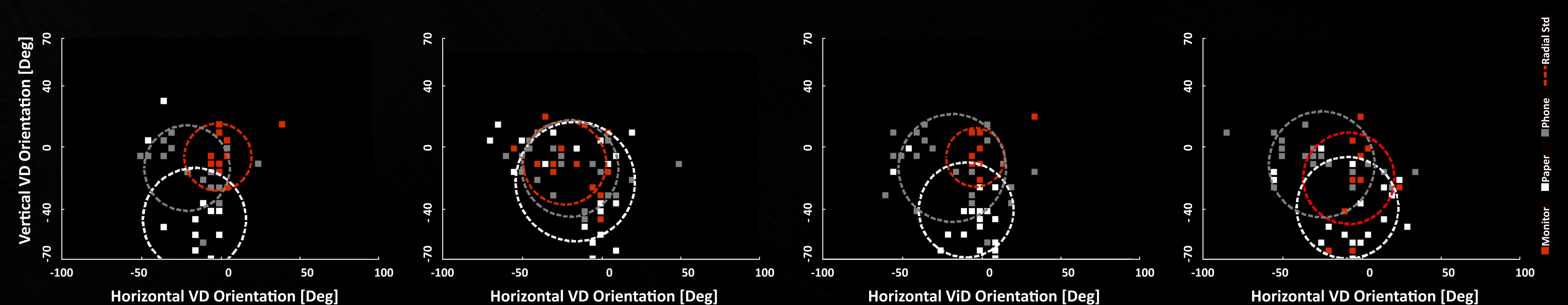


b) High dynamic range fisheye images taken every 30sec.



c)

c) VD data recorded by mean of a mobile eye-tracker



d)

d) Dominant VD distributions under each phase of the experiment.

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