The Social Light Field at Illuminated Footpaths

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Fig. 1 Examples of face-shaped light probes under varying light conditions.

Abstract—The light field describes the light in a given space, capturing spatial and form-giving visual qualities of light, such as the direction and diffuseness, in addition to conventional intensity-related metrics. In urban mobility, this is connected to social aspects, as these lighting qualities impact how objects or people appear. We tested how these lighting qualities vary objectively, optically, in real conditions and whether they influence a social factor like the subjective, perceived friendliness of a face, and how well-lit a face and surroundings appeared. The results showed that how well-lit, friendly, and comfortable faces and environments were rated, did not correlate to light intensity. The results instead indicated the importance of factors related to the modelling effects of the lighting like diffuseness and light vector.

Keywords—Light field, Social light field, Footpath lighting, Cubic light measurements, Walkability.

I. Introduction

Danish architect and urbanist Jan Gehl formulated, in his book "Cities for People" [1], the concept of the "social field of vision," addressing how the perception of faces relates to social interaction at varying distances in daylight. We question how this "social field of vision" changes at night when electrical street lighting serves as the primary light source. Figure 1 shows how face appearance can change as a function of the spatial and angular variations of local light distributions. The properties of the actual light, direct from the artificial light source plus reflected by the environment, are captured by the light field, as coined by Gershun in 1939 [2], and later by Cuttle [3,4], and further developed into the Delft light field framework [5,6,7,8]. Since the light modelling of the face [9] and thus the appearance of oncoming pedestrians changes according to the lighting and where the person is situated in relation to light poles, in this work, we relate the light field concept to the "social field of vision" and synthesized those to the "social light field". We optically measured the light fields

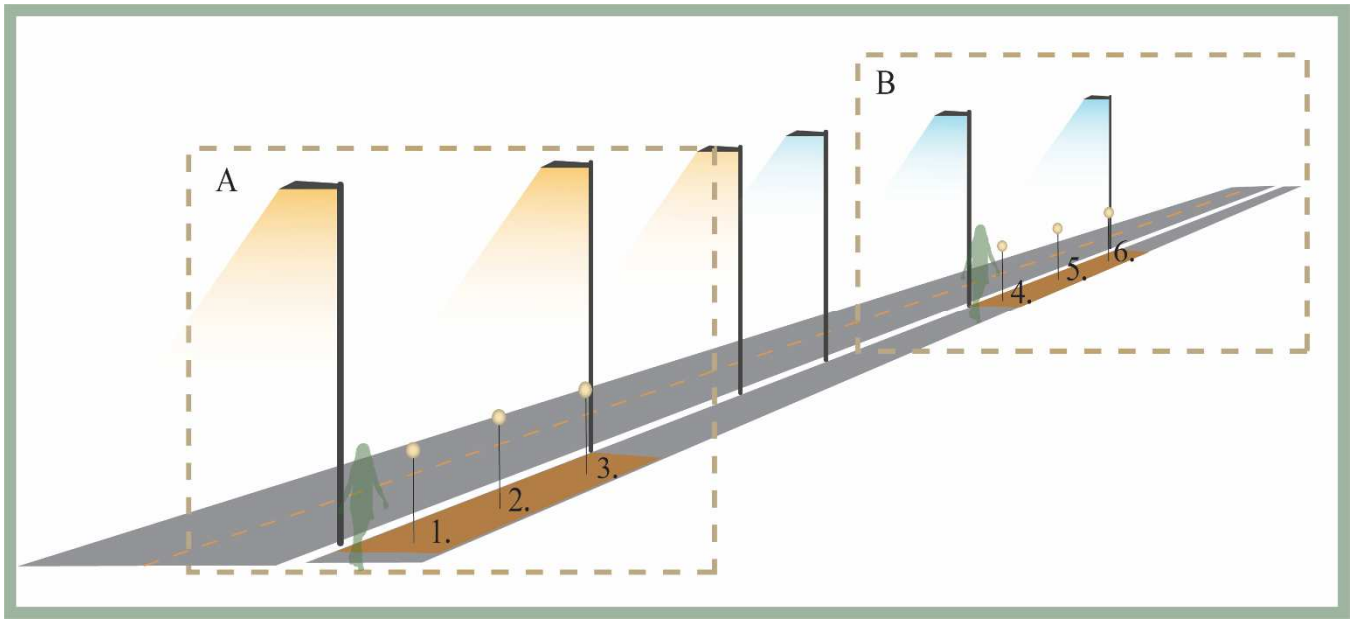

Fig. 2 Two light conditions, A and B, were studied. A light probe was placed between two light poles in each condition (P1-3 and P4-6). In the experiment the respondents moved with the probe, always standing two meters in front of the probe.

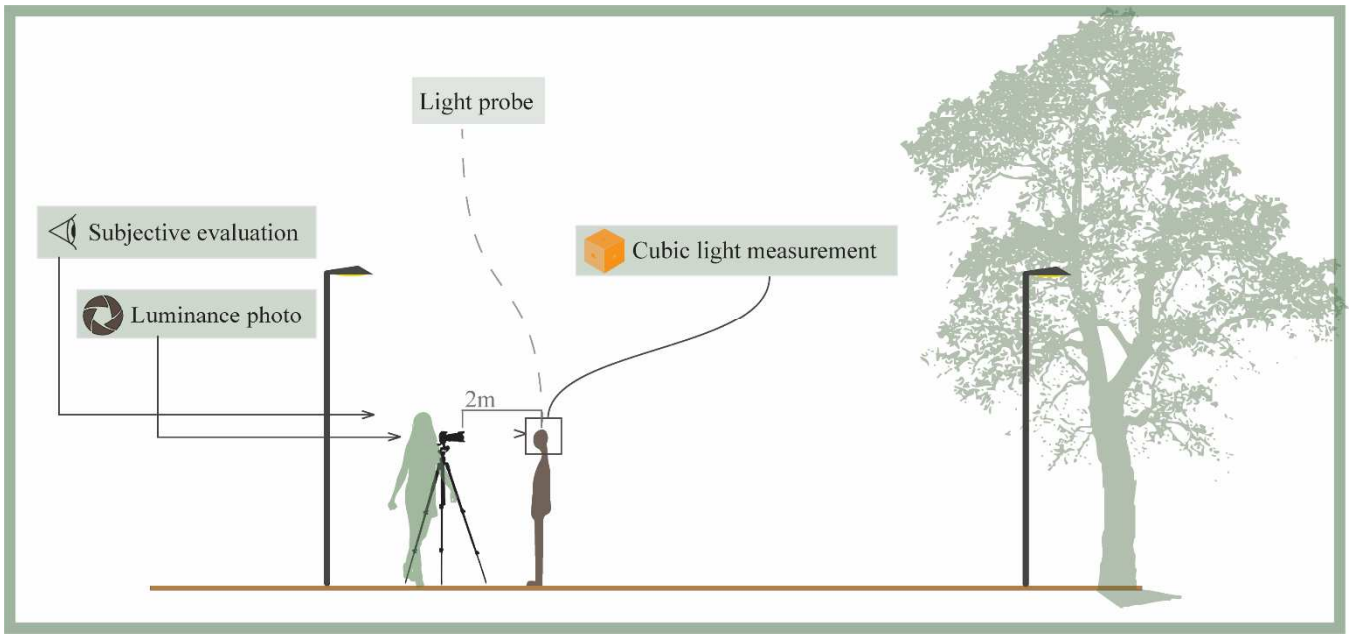

Fig. 3 The light probe was evaluated using cubic light measurements, luminance measurements and subjective ratings of the probe.

of two lighting settings and compared it to subjective ratings for questions pertaining to face- and environment appearance.

II. Method

A face-shaped light probe sequentially put at six positions (P1-6), placed between two groups of LED luminaires (A: newly installed luminaire, considered more environmentally friendly due to lower CCT and luminance, 2200K, 4820 lm, 38 W, h: 8m and B: 10 years old conventional luminaire, 4000K, 14000 lm, 132 W, h: 9m,) along a snow-covered footpath. Cubic measurements were captured at all six positions (Figure 2, P1-6) at 1,5 m height, and analyzed to determine the light density E_{scalar}, light diffuseness D, mean illuminance, light vector (E_x, E_y, E_z) and its magnitude |E|, vertical- (E_{x+}), and horizontal illumination (E_{z+}) [5,6,7],10]. To capture the social aspects of the lighting [11,12], 30 participants were invited through facebook groups and mailing lists in the area, to rate their level of agreement on four statements about the lighting of the face and environment, at each of the six positions, from a four-meter distance. The subjective and objective data were compiled using descriptive statistics, correlation analysis and ANOVA to determine trends.

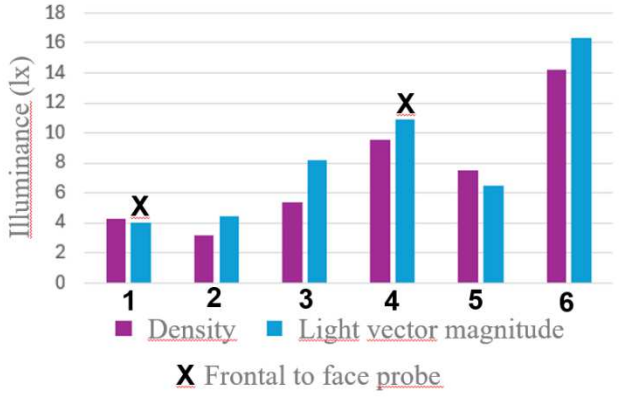

Fig. 4 Results for light density and light vector magnitude, derived from cubic light measurement numbers corresponding with numbers in figure 2. X indicates when the average lighting direction is frontal to the face.

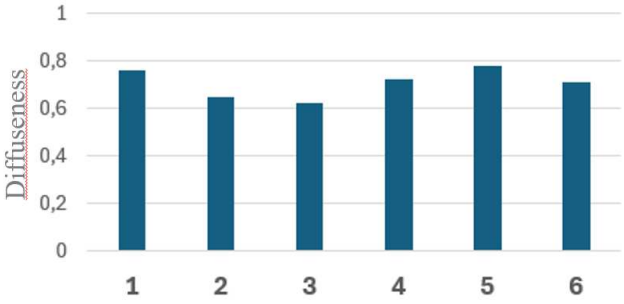

Fig. 5 Results for diffuseness, derived from cubic light measurements, numbers correspond with numbers in Figure 2.

III. Results

As expected, the cubic measurements showed that the light density, mean, horizontal, and vertical illuminance were higher for conventional luminaire type B, and the highest light level and strongest light vector magnitude for P6.

The overall light diffuseness was high due to the snow cover. It decreased from the first to the last position for each luminaire type, with luminaire type B exhibiting a slightly higher diffuseness. The rating experiment (statements used for the rating experiment are put in parentheses for Q1-4) showed that for Q1, (*The face is well-lit*) the highest average ratings (on a 7-points-scale) were found for P1 (5,6) and P4 (6.0), while the lowest for P2 (4.3), P3 (4.4) and P6 (4.3). For both Q1 (*The face is well-lit*) and Q2 (*The face looks friendly*) P6, with the highest light level, had the lowest ratings. For Q3 (*The environment is well-lit*), the middle positions for both luminaires were rated lowest: P2 (4.2) and P5 (5.4), and overall lower for luminaire A. For Q4 (*I feel comfortable in this environment*) the average ratings showed similar trends but less articulated.

IV. CONCLUSION

Light levels were not found to be positively correlated to perceived social aspects of the walking experience. The results demonstrated, despite the lower illuminance and color temperature of luminaire A (considered more environmentally friendly) no strong differences in the subjective results for the two luminaire types. The strongest differences were observed between positions for each luminaire type, with overall, less contrasty light being judged more positively. Overall, the diffuseness was found to be quite high, between 0.6 and 0.8, and constant for these snowy conditions. This shows the importance of considering the modelling light metrics like diffuseness and light vector when designing the social light field. In future work, the experiment will also be conducted in non-snowy conditions and compared with the current data.

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