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WHAT ARE YOU LOOKING AT? TESTING NANCY'S RULES FOR PEDESTRIAN INTERACTIONS

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Abstract

To establish optimal lighting for inter-personal evaluations between pedestrians it is desirable to know what visual cues are used. An experiment was conducted to test two proposals. One, the widely made assumption (in lighting research) that the face is an important cue. Two, the hierarchy of factors proposed by a lighting designer. This was investigated using category rating with a series of images containing actors embedded into an outdoor scene.

Keywords: Pedestrians, Safety, Other People, Visual Cues

1 Background

Imagine that you are walking alone along a road after dark and see another pedestrian ahead: at some point a decision is made whether it is safe to keep walking towards the other person or whether they should be avoided. There is a contribution to this decision from visual cues, in which case one aim of road lighting should be to enhance these visual cues.

Lighting guidance and, until recently, most lighting research, has tended to focus on facial recognition, more precisely known as Facial Identity Recognition (FIR). CIE115:2010 states that "high colour rendering contributes to a better facial recognition" and the P lighting classes add "Additional requirement if facial recognition is necessary". BS EN 13201-2:2015 includes as additional requirements, the SC (semi-cylindrical illuminance) classes for "improving facial recognition".

One aim of past FIR studies has been to determine whether the task is affected by changes in light source spectrum, with some suggesting a significant effect (Knight, 2010, Yao et al 2009) while other experiments have not revealed any effect (Alferdinck et al 2010, Boyce and Rea 1990, Rea et al 2009). These differences can be explained by variations in experimental design (Lin and Fotios 2015, Dong et al 2015), a question not raised in these past studies.

FIR is not the only evaluation we make of other people, nor is it likely to be the most important. Familiar faces are easily recognised even when severely distorted. FIR may be inappropriate because identity does not say anything about intent. There is some reason to consider that the face is an important cue. Identity judgements made when looking at the face only are of similar accuracy to those made when looking at the whole body (whilst body-only judgements are significantly worse) (Burton et al 1999, Hahn et al 2016). Recordings of gaze behaviour using eye tracking whilst looking at images has shown that observers will tend to look at other people if present in a scene with a frequency significantly greater than chance when weighted by area: when looking at other people, viewing time on the face is greater than that on the body (Fletcher-Watson et al 2008). There is some evidence that approachability judgments are driven by facial expression (Willis et al 2011). A review of ecological validity and procedures concluded that Facial Emotion Recognition (FER) was a more appropriate task for research of lighting effects than FIR, operationalised as the ability to discriminate emotion as conveyed by facial expression (Fotios and Johansson 2019). In three studies using FER to evaluate the effect of changes in lighting (luminance and spectrum), there was no evidence of a significant effect of spectrum (Fotios et al 2015, 2017, Yang and Fotios 2015).

However, FER still uses the face as the target and it is not yet known whether that is the most appropriate visual cue. Before optimal lighting conditions for evaluating other people are

adopted, there is a need to establish what it is pedestrians tend to look for in other people: we need to know what to light before we can determine how to light it.

This question was discussed within the IESNA committee on Lighting for Outdoor Public Spaces. An anecdotal hierarchy of factors was proposed by committee chair, Nancy Clanton (see Table 1). These are only intended as first-stage ideas. It is recognised that the hierarchy may be different for different observers and there will be interactions between the factors. This article presents an experiment conducted to explore the validity of these proposals.

Table 1 – Proposed hierarchy of factors which influence threat judgements about other pedestrians.

Hierarchy	Factor	Decision
1	Gender	Females (or, a male/female combination) are less threatening than a male.
2	Quantity	One person is more threatening than two (or more) people
3	Gaze direction	A person looking towards me (in apparent act of scoping me out) is more threatening than a person who is looking elsewhere.
4	Walking direction	A person walking towards me is more threatening than a person walking away from me.

2 Method

The aim of this experiment was to compare judgements of safety made when looking at photographs of actors embedded in a background outdoor night-time scene. The actors were manipulated to compare the effect of different factors as described in Table 1 and also to determine the influence of face visibility.

These were actors (male and female) posing in front of a green screen, and subsequently embedded into the photographs of an outdoor location at night. Individually, they stood facing towards and away from the camera: for some photographs, the target's face was partially hidden by wearing a hood. Sixteen images were generated, providing combinations of gender, singles and pairs (the pairs being mixed gender in every case), face visibility, direction of light and direction of travel (Figure 1). Due to the small size of features involved, this experiment did not examine gaze direction.

The outdoor scene was a city centre location in Sheffield, the photograph being taken after dark when there were no other people nearby (Figure 2). The photographs were digitally manipulated so that targets were either front lit or backlit, and so that target was sized to resemble location at a distance of approximately 9 m from the observer. Example images are shown in Figure 3.

Figure 1 – Examples of the actor photos. These are (from left to right) a single female walking towards the observer and wearing a hood; a single female walking away; a single male walking towards; and a single male walking towards the observer and wearing a hood.

Figure 2 – The outdoor scene into which target actors (Figure 1) were embedded

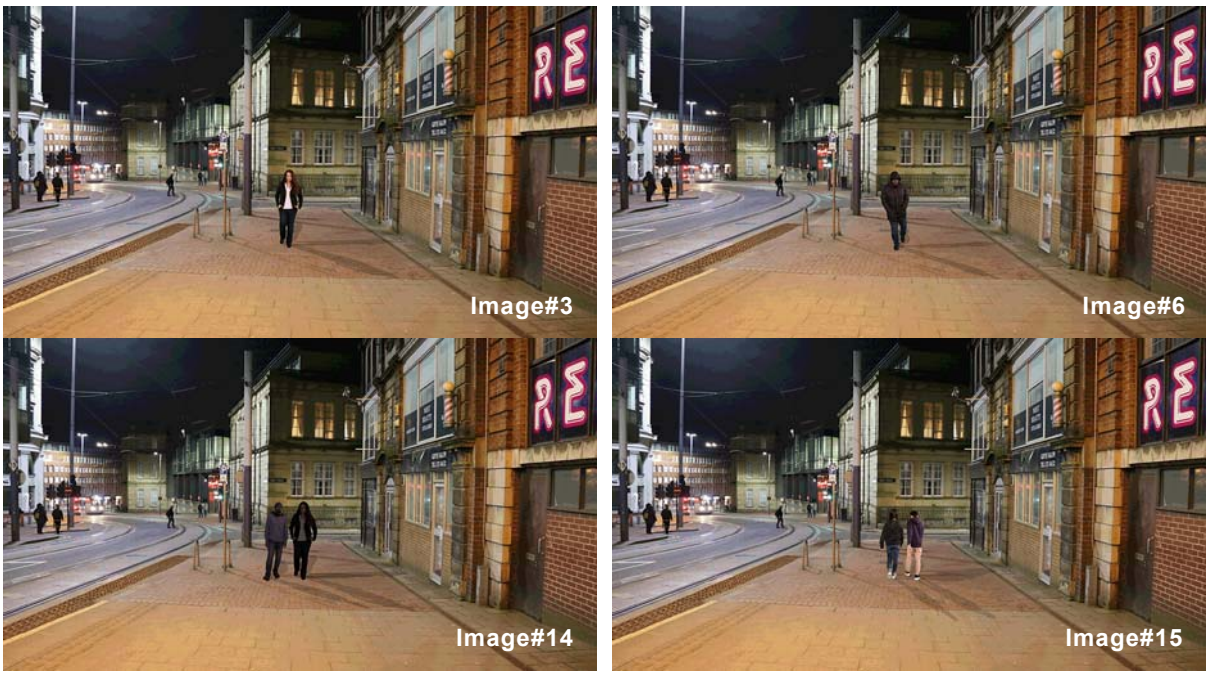

Figure 3 – Examples of the 16 test images. Note that when there were pairs of actors (images #14 and #15) they were always mixed male and female.

The images were displayed on a personal computer (PC) screen. In trials, the test participant was seated in a darkened test room. Two test procedures were used, category rating and paired comparison. In the category rating trials the 16 images were observed separately, in a randomised order, for 0.5 seconds each; the degree of safety indicated using a 5-point response scale (1 = very unsafe, 5 = very safe). For the paired comparison trials, the 16 images were evaluated in all 120 possible pairs (together with a further 16 null condition trials): test participants reported which of the two scenes was considered the safer. The results presented here are from 32 test participants (equal balance of male and female, aged 18 to 34 years) who each conducted both procedures. Approval to run this experiment was gained from the ethics committee and each participant provided written consent to participate.

3 Results

We present here results and analyses of the category rating data: analyses of the paired comparison data are ongoing.

The ratings for each scene are shown in Table 2. Median ratings are shown because the distributions were not suggested to be normal according to analyses of dispersion and statistical testing. The purpose of this analysis is not to establish absolute thresholds, as this would be limited by stimulus range bias, but to test differences within each type of variable.

Table 2 – Average ratings of safety for each scene. (Note: 1 = very unsafe, 5 = very safe).

Image#	Image characteristics					Rating results		
	No. of people	Gender	Walk direction	Light direction	Wearing a hood	Median	Mean	Std dev
1	1	M	Towards	Front-lit	No	4.0	3.75	0.94
2	1	M	Towards	Front-lit	Yes	3.5	3.28	1.01
3	1	F	Towards	Front-lit	No	4.0	4.31	0.73
4	1	F	Towards	Front-lit	Yes	4.0	3.91	0.80
5	1	M	Towards	Back-lit	No	3.0	3.31	1.16
6	1	M	Towards	Back-lit	Yes	3.0	3.09	0.95
7	1	F	Towards	Back-lit	No	4.0	3.88	0.78
8	1	F	Towards	Back-lit	Yes	3.0	3.34	0.99
9	1	M	Away	Front-lit	No	4.0	4.09	0.68
10	1	M	Away	Front-lit	Yes	3.0	3.25	0.97
11	1	F	Away	Front-lit	No	4.0	4.25	0.66
12	1	F	Away	Front-lit	Yes	3.0	3.22	1.02
13	2	M&F	Towards	Front-lit	No	4.0	3.72	0.94
14	2	M&F	Towards	Back-lit	No	3.0	3.19	0.88
15	2	M&F	Away	Front-lit	No	4.0	4.28	0.80
16	2	M&F	Away	Back-lit	No	4.0	3.94	0.75

The Friedman test suggested significant differences in safety ratings ($p<0.001$) across all 16 images.

The effect of gender was determined using the Wilcoxon test to compare six pairs of images (1v3, 2v4, 5v7, 6v8, 9v11 and 10v12), these were chosen so that factors other than gender were consistent. In 3 of 6 cases, this suggested a significant effect ($p<0.01$) (pairs 1,2,3) with the female target being considered as safer. In all three cases, the target is walking towards the observer so gender should be identifiable. In the remaining three cases (pairs 4,5 and 6), while the results display a tendency for females to be rated as safer, the effect of gender is not significant ($p>0.05$): in these three cases, gender identification may have been hindered through the face being partially hidden by the hood (pair 4) and the targets facing away from the observer (pairs 5 and 6). If we can see gender, we tend to consider females as safer than males.

The effect of group size was examined by comparing evaluations of images with two people against images with only one person. For matching conditions (same walking direction, light direction and hand/face visibility), there were two one-person images for each two-person image, and hence ratings of the one-person images were averaged for each test participant. This provided three pairwise comparisons (13 v 1&3; 14 v 5&7; 15 v 9&11). In each case, the ratings suggest single people to be considered safer than pairs, but this difference was significant only for the first ($p<0.01$) and second ($p<0.001$) pairs, but not the third ($p=0.62$).

The effect of walking direction was determined by testing six pairs of images (1v9, 2v10, 3v11, 4v12, 13v15 and 14v16). In the first three pairs, the differences were not suggested to be significant. In the latter three pairs, the differences were significant ($p<0.01$) suggesting a greater feeling of safety when people are walking away rather than towards.

The effect of light direction was examined through six pairs of images (1v5, 2v6, 3v7, 4v8, 13v14 and 15v16). In all six pairs, the front-lit targets were considered safer than backlit, and this difference was significant in five cases ($p<0.05$ pairs 1 and 6, $p<0.01$ pairs 3, 4 and 5).

The effect of wearing a hood was examined through six pairs of images (1v2, 3v4, 5v6, 7v8, 9v10 and 11v12). In all six pairs, the targets not wearing the hood were rated to be safer than

those wearing a hood, and this difference was significant in five cases ($p<0.05$ pair 2, $p<0.01$ pairs 1, 4, 5, 6).

4 Conclusions

Two experiments were conducted to examine judgements about the apparent threat of other pedestrians, one using category rating and the other paired comparisons, of 16 images observed on a PC screen. Results from the category rating experiment revealed consistent and significant effects of light direction and face visibility: the observed people were considered to be safer when front-lit (rather than back-lit) and when visibility of their face was not impaired by wearing a hood. In those images where gender was more readily apparent (i.e. targets facing the observer), there was a significant effect of gender, with females considered to be safer than males. There was a tendency for single people to be considered safer than pairs and for people walking away to be safer than if walking towards, but the significance of these differences was not consistent.

Results from the paired comparison procedure appear to be similar, but these have yet to be analysed.

Overall, the results suggest that visibility of the face is important: if face visibility is reduced by clothing (wearing a hood) or lighting (back-lit rather than front-lit) then the degree of safety is reduced.

This work should be considered as a pilot study. Further experiments will be conducted to address the limitations, including variation of the background scene, variation in the choice of actors, and giving consideration as to the mode of presentation (e.g. using immersive 3D virtual environment rather than a 2D target on a PC screen).

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