Published paper

Fotios, S. and Raynham, P. (2011) *Correspondence: Lighting for pedestrians: Is facial recognition what matters?* Lighting Research and Technology, 43 (1). 129 - 130. ISSN 1477-1535

http://dx.doi.org/10.1177/1477153511400158

Correspondence

Lighting for pedestrians: Is facial recognition what matters?

Steve Fotios[1], Peter Raynham[2]
[1] School of Architecture, University of Sheffield, UK
[2] The Bartlett School of Graduate Studies, University College London

Fotios S & Raynham P, Correspondence: Lighting for pedestrians: Is facial recognition what matters? Lighting Research & Technology 2011; 43(1): 129-130.

The lighting of residential streets and public spaces, such as parks, is designed primarily to meet the needs of pedestrians. One of the most important of these needs is safety after dark. One widely accepted objective of lighting relevant to pedestrian safety is facial recognition at a distance. This is because recognition of a face at a distance allows an alert pedestrian to take evasive or defensive action should it be thought necessary. The minimum distance for facial recognition is usually given as 4m with 10m being suggested as the ideal distance.

A number of studies have been done seeking to identify what illuminance is required for facial recognition and to determine if this illuminance can be traded-off against the spectral power distribution of the lighting, with mixed results. All such studies indicate that the higher the illuminance on the face the greater the distance at which facial recognition occurs until the acuity limit is reached. As for the trade-off against light spectrum, some studies have found that facial recognition occurs further away when better colour rendering lamps are used to provide the specified illuminance but some have not. We suspect that the reason for this confusing state of affairs is that the methodology used in many of these studies leads to imprecise measurements and, even if it did not, simple facial recognition is not what is needed to ensure lighting makes its contribution to safety on the streets after dark. We want to propose a different method for measuring the combined effects of illuminance and light spectrum on another and more relevant aspect of facial recognition.

So what is wrong with the way facial recognition has been measured in the past? There are two answers to this question. The first concerns the variability of the stimulus presented to the observer being asked to recognize the face. The conventional approach to facial recognition under different lighting is to measure the distance at which a face is correctly identified. Often, this is done in the field using a real lighting installation and real people as targets. The variation in distance is achieved by having either the target or the observer move closer until correct recognition is achieved. The problem with this method is that the stimulus presented to the observer is always changing. Regardless of anything else, with decreasing distance the details of the face increase in size. If the position of the observer is fixed and the target walks towards the observer, the amount and distribution of light on the target's face can change and the positions of the luminaires relative to the face may change thereby altering the amount of glare for the observer. Even if the target is fixed relative to the lighting, movement of the observer can again alter the amount of glare perceived by the observer. In addition to the variability of the stimulus, this method is subject to large errors because different targets and observers walk at different speeds and different observes take different amounts of time to make up their mind. Consequently, any delay in deciding that a face has been recognised can have different consequences.

The second problem with the conventional method is that the ability to recognize a face from a limited list of others is not what matters to people who are concerned about safety on the streets at night. What does matter is the ability to recognise the intent of people approaching. There are seven fundamental facial expressions that are universally recognised; happiness, sadness, fear, anger, disgust, surprise, and possibly neutral or contempt[1,2]. It is from such expressions and the associated body language that intent may be inferred. Therefore, what needs to be measured for a meaningful assessment of lighting for pedestrians is the extent to which the intent of someone approaching can be accurately recognized.

Having criticized the conventional methodology we would like to propose a more precise and relevant method for measuring the impact of lighting on the ability to recognise the facial expression, and thus intent, of other pedestrians. The proposed procedure follows that used by Etcoff and Magee[2]. It uses a simple identification of emotion task where an observer is shown a series of faces lit in different ways, in a random order, and asked to categorize each face as either friendly or non-friendly. The data can be analysed using signal detection theory to identify the conditions required to optimize performance of the task. Of course, this approach is not without its own problems. For example, a number of faces each with a number of different but repeatable expressions will have to be created and the relationship between the inferred intent and the perception of safety or, even better, behaviour, will have to be investigated. But the effort would be worthwhile. The proposed method can be used to examine a wide range of interesting variables with the target seen at different distances and for different times. Obviously, the interaction of illuminance on the face and light spectrum is the subject of much current interest but the effects of light distribution patterns, including glare should also be explored. The target's gender, age and race are certainly of interest as are the observer's gender, age and culture. The method could even be extended to examine body language as well as facial expression. The essential points are that the proposed method avoids the uncertainties inherent in what is currently the conventional method of examining the effects of lighting on facial recognition and provides data that should be more relevant to what matters to pedestrians. We expect that this approach to lead to a more consistent understanding of how lighting can be used to enhance safety on the streets and encourage other researchers to adopt it or something similar in their own investigations.

We appreciate also the need for field trials in real streets. The proposed method employs faces shown to subjects under controlled conditions, whereas in a real street the conditions are always fluctuating. For example, as two people approach each other the illuminance and modelling of their faces is constantly changing as is the glare that they experience. Thus we have a method of reliably investigating different lighting parameters which may affect facial recognition, but we will need to check the findings on real streets to ensure that we can create better night time environments.

1. Chen W and Liu CH, Transfer between pose and expression training in face recognition, *Vision Research*, 2009; 49; 368-373

2. Etcoff NL and Magee JJ, Categorical perception of facial expressions, *Cognition*, 1992; 44; 227-24