

## Challenging current urban lighting policies

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# CHALLENGING CURRENT URBAN LIGHTING POLICIES: CASE FOR A SHIFT OF FOCUS TO ALERTNESS

## keywords

arousal, alertness, anxiety, urban lighting, safety

## ABSTRACT

Current research on street lighting for pedestrians is heavily focused on visual performance. We argue that more research is needed on other psychological concepts also important for pedestrians' attention and safety – alertness, arousal and anxiety.

## INTRODUCTION

Urban street lighting plays an essential role in ensuring people's safety after dark. Yet, given the current environmental issues and threat of climate change, there is a growing demand for more sustainable urban lighting. Such sustainable lighting should be more efficient in energy consumption and minimize the negative outcomes of light pollution. Research on street lighting for pedestrians has therefore focused on minimal required illuminance for various visual performance tasks, such as the effect of lighting on obstacle detection [2,3] or face recognition [2,3,4,5]. However, it could be argued that it is pedestrians' general attentiveness to their environment, rather than their visual performance, that is important for their safety. Despite this, the psychological concepts related to individual's attention, such as alertness and arousal, have not been considered in street lighting research to date. Lighting policies based on research overlooking such concepts might be incomplete. We make a case for considering a shift in urban lighting research to focus on concepts important for pedestrians' attention and safety; alertness, arousal and anxiety.

## THEORETICAL FRAMEWORK PROPOSAL

### 2.1 Alertness

Alertness can be defined as a cognitive state of readiness and openness to respond to stimuli and to process incoming information [6,7,8]. A person is very alert if they notice any minor changes in their environment and adjust their behaviour accordingly. Conversely, someone is not alert if they fail to notice and respond to something important happening in their surroundings. Therefore, a person's attention is strongly, although not exclusively, influenced by their level of alertness.

Overall, increased alertness is associated with performance benefits; an increase in alertness has been linked with enhanced processing speed of incoming stimuli (i.e. faster response time) and with greater efficiency of such processing (i.e. increased response accuracy) [6,7].

### 2.2 Arousal

Arousal is defined as a general state of both cognitive and physiological nature, whereas alertness is explicitly a cognitive state [7]. Thayer [9,10] introduced a two-dimensional model of arousal. The energetic dimension is tied in with circadian rhythm and voluntary motor activity and ranges from feelings of drowsiness to vigour. The second dimension, which is labelled tense arousal [10], is expected to be connected with various emotions and stress reactions, in particular with anxiety. To the best of our knowledge, no investigation has been done yet on how these two dimensions of arousal are related to alertness and attention.

### 2.3 Anxiety

Heightened arousal—in particular tense arousal—can be related to concepts of fear or anxiety. Anxiety is a long-term and future-oriented state of readiness to expected or potential unspecified threat [11]. The evolutionary function of anxiety is to detect and deal with threats [12,13]. As such, anxiety is associated with increased arousal and physical readiness (i.e., the flight or fight response; [9]), but also with increased alertness (i.e., heightened cognitive readiness, and maximal

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receptiveness; [11,13]), with threatening information being processed faster, and with ambiguous information more likely to be considered as threatening [12].

Anxiety thus facilitates stimuli-driven and reflexive attention [13,14], much like increased extrinsic alertness. This begs the question if alertness and anxiety are not in fact the same function of the organism, changing in their definition only by the context of the situation.

### **THEORETICAL FRAMEWORK APPLICATION**

Above we have described three different concepts: alertness as a cognitive state of enhanced readiness and openness to stimuli, arousal as a more generalized and both physiological and cognitive state, and anxiety as an emotional, future-oriented state of readiness to unspecified threat. From the previous discussion, it becomes clear that all three psychological constructs--alertness, arousal, and anxiety--are interrelated and have their influence on attention and, consequently, safety (e.g., attentiveness may prevent trips and accidents).

Research on the relationship between these psychological concepts and light has been scarce. To our knowledge, only Burt [1] focused on such a relationship, in particular between uniformity of light and attention. According to Burt, mere range of individuals' sight is insufficient for their safety if they are also not attentive to their surroundings and able to react to possible dangers. Therefore, to test pedestrians' performance under different lighting conditions, he employed an auditory two choice task, a short memory task, and a motor coordination task in a field study with a subsequent controlled laboratory experiment. In general, his findings suggest better performance on all three tasks under non-uniform lighting conditions. In Burt's explanation, these positive performance outcomes were caused by two factors. First, by changes in the intensity of illumination through which the pedestrians walked. Second, by the alternations between the illuminated areas under the lamps and the dark, unlit, regions in between them.

Burt's study, despite asking relevant research questions, received little attention. In particular, no replication of Burt's study, or its parts, has been done to our knowledge. We therefore conducted a conceptual replication of Burt's outdoor experiment (currently under review). We measured participants performance in an auditory two choice task (i.e. their response speed and accuracy) while they were walking alone after dark along four streets with different lighting conditions. Results from our pilot study suggest similar relationships to those reported by Burt; the fastest reaction times were measured on the street with the lowest uniformity of light.

Applying the proposed theoretical lens to Burt's experiment and our pilot study, we could argue that perhaps the changes in illumination and the contrast created by alternative bright and dark regions led to an increase in the participants' arousal, which might have then benefitted their attention - measured through the speed and accuracy of their responses. But we are still in the dark about the nature of such arousal. The areas in the shadow might have increased the tense arousal dimension and/or the lit areas might have promoted alertness. We will need a better understanding of the influence of different dimensions of arousal on individual's attention and safety and whether these results were mediated through increases in alertness, anxiety or both. This would also have implications for both social and traffic safety of pedestrians.

### **CONCLUSIONS**

In this paper we pointed out that psychological constructs such as alertness, arousal and anxiety are prone to mixed use and to being loosely defined. More importantly, they are not considered, at the moment, in pedestrian lighting research and we do not yet understand the psychological mechanisms behind them. In doing so, urban lighting policies are neglecting concepts related

to pedestrian's attention and safety. A focus on concepts of alertness, arousal and anxiety may boost understanding of both the attention of pedestrians (i.e., higher traffic safety) as well as their perceptions of personal safety. Findings from our pilot study suggest that this shift of focus might be worth of further research.

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