



An examination of the temporal effects of environmental cues on pedestrians' feelings of safety



C.S. De Silva ^{*}, E.J. Warusavitharana, R. Ratnayake

Department of Town & Country Planning, Faculty of Architecture, University of Moratuwa, Sri Lanka

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ABSTRACT

Although plans are made with people as the target, plan-making processes in most instances are dominated by top-down approaches, giving very little regard to how people perceive or feel about the cities they live in. The perceptions urban areas trigger and how these cause behavioural changes reflect the implications of planning and decision-making upon them. Prior studies indicate that environmental factors can trigger affective reactions in people. Thus, throughout this study, it was attempted to understand how environmental factors affect University students' perceptions of safety, which were quantified on the basis of their arousal, i.e. the calmness or stress felt, and walking speeds. Data on arousal were captured in real-time by a technically-sound, low-cost device assembled using free and open source software and hardware. The study could demarcate and rank the areas perceived to be "safe" and "unsafe" by the University students in real-time using the assembled device and identify which environmental factors have the most significant influence on their perception of safety. This study introduces the chance to determine unconscious reactions of people by triangulating data gathered by several measurement techniques that are directly measured in the field, which can be served as useful inputs for urban planning. Furthermore, the study confirms the value of the real-time sensing device as a tool beyond traditional methods in understanding feelings of safety in environmental settings.

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1. Introduction

People as users of cities encounter daily a vast array of environmental qualities belonging to environments of various sorts. These environmental qualities or cues contribute to the experiences people undergo in these different environments. Certain environments or places may grab the attention of the users and leave them feeling pleased or delighted, while some others leave the users feeling fearful or unsafe (Nasar, 1998). Although this subjective feeling of fear may not reflect the actual crime, it is said to be having harmful effects on individuals and communities (Nasar & Fisher, 1993). It has been found to limit activities, heighten stress, make people feel like prisoners in their homes and neighbourhoods, disrupt neighbourhood cohesion and worsen health (Ross, 1993; Taylor, 1989).

The feeling of safety can be attributable to the qualities of the particular environments, however, these feelings also depend on a number of dynamic and static contextual factors such as time of the day, gender, age, the accompanying persons and the familiarity of the environment (Nasar, 1998; Ratnayake, 2017). Further, fear of crime does not have

uniform distributions over space and time (Smith, 1989; Harries, 1980; Sherman, Gartin, & Buerger, 1989) and as a result, some of these effects have been found to be intensifying during different times of the day, especially when dark, among the physically or social vulnerable groups such as the poor, the elderly or females (Garafalo, 1981; Ratnayake, 2017; Skogan & Maxfield, 1981; Warr, 1990).

From a pragmatic point of view, the identification of unconscious decisions of people is important as they provide insinuations for planners to understand the city and improve areas that appear to be problematic. Accordingly, this research attempts to find answers for the following questions: first, whether anthropocentric methodologies combining free and open source hardware and software capable of assessing the effects of environmental cues on pedestrians' feelings of safety and second, which environmental cues have significant effects on pedestrians' perception of safety, and how the significance of these cues differs depending on the time of the day.

Methods of quantifying the people's perceptions in urban areas last boomed in the 1960s with Kevin Lynch's concept of mental mapping. Traditionally, methods such as questionnaire surveys, interviews, photo elicitations and narrated walks have been used in assessing the safety aspect of the built environment (Ratnayake, 2013). However, the main limitation of these methods is that the responses are not derived in situ. Safety, to be best understood, should be narrated while

^{*} Corresponding author at: Department of Town and Country Planning, University of Moratuwa, Katubedda, Moratuwa, Sri Lanka.
E-mail address: chathurthis@uom.lk (C.S. De Silva).

experiencing the environment. Therefore, sophisticated methodologies are needed to assess people's perceptions in real time. This study hence attempts to follow a methodology that uses a range of traditional and novel technologies to gather data which include photographic surveys, arousal measurements, walking speeds measurements and mapping tests. Data gathered by these means have been triangulated or cross-validated to ensure that the environment is assessed with maximum accuracy. Further, suggestions for environmental improvement have been made towards the end of the study based on the data gathered within the context of inquiry.

2. Theoretical background

Environments serve as habitats to many, causing a relationship to emerge between the environment and those who seek refuge within it. The Habitat theory, which was initially proposed by Darwin (1859), claimed that the relationship between a human being and the perceived environment is the same as the relationship between a creature and its habitat. In other words, it is about the ability of a place to satisfy the biological needs of human beings (Ramnujam, 2006). Subsequent to this finding, in 1975, Appleton (1975) extended this Habitat theory by adding an aesthetic dimension to it by stating that satisfaction of the environment stems from the spontaneous perception of environment features which, act as stimuli indicating the environmental conditions that are favourable or unfavourable for survival.

Habitats generally are expected to fulfil the biological needs of those within it to a certain degree, besides its primary duty of providing refuge. Among the many biological needs of living beings particularly humans, the physiological needs, safety needs, belongingness and love, esteem needs and self-actualisation are eminent (Maslow, 1943). However, recent studies indicate that out of the above needs, personal safety is the crucial factor of lifestyle options and is one of the main problems threatening the quality of urban life (Noll, 2000; Park, Curtice, Thomson, Jarvis, & Bromley, 2001). Studies suggest that the actual personal safety may differ from the perceived personal safety, but concerning behaviour constraints, it is the perceived danger or fear that influences behaviour (Keane, 1998; Riger & Gordon, 1981). Fear often elicits a stress reaction within people to avoid, reduce, or cope with a threatening situation (Keane, 1998; Riger, 1985; Riger & Gordon, 1981). It limits activities, makes people feel like prisoners in their homes and neighbourhoods, disrupts neighbourhood cohesion and worsens health (Ross, 1993; Taylor, 1989).

The way people perceive cities usually depends on a number of dynamic and static contextual factors. Skogan and Maxfield (1981) and Wilson and Kelling (1982) cited that two types of environmental cues that may imply a breakdown in the social order: "social incivilities" such as public drunkenness, gangs and prostitution, and "physical incivilities" such as vandalism, boarded up buildings and litter. Research has also shown that these incivilities arouse general anxiety about potential victimisation creating a climate of fear (Nasar, 1983; Perkins, Meeks, & Taylor, 1992; Taylor, Shumaker, & Gottfredson, 1985; Warr, 1990). Schroeder and Anderson (1983) found that graffiti, signs of abuse, vacant buildings, abandoned buildings, broken windows and litter are associated with judgements of little security regardless of the actual crime rates in these areas. Herzog and Miller (1998) reported that people judged alleys with sharper curves as less dangerous than straighter alleys. However, an ironic finding from this body of research is that many of the same physical features that have been found to be positive indicators of preference are also positive predictors of fear of crime in urban settings (Fisher & Nasar, 1992; Loewen, Steel, & Suedfeld, 1993; Nasar & Fisher, 1993; Nasar & Jones, 1997). In other words, their results highlight the paradoxical role that environmental variables can play in contributing to affective response, depending on the context in which the variables operate (Herzog & Miller, 1998). On a different note, Nasar and Jones (1997) stated that the presence of people or groups of people reduced fear because busy places are seen to be places

where people would be less likely attacked. Further, Sayin et al.'s study in 2015 contributes to this social presence literature by focusing on the role of vocal sounds in the sense of social presence. Sayin et al. (2015) also showed that vocal sounds that are not perceived to be threatening increase the feeling of safety (as opposed to instrumental sound or no sound at all) by increasing perceived social presence. Additionally, they indicated that increased perceived safety translates into positive consumer responses for public places such as car parks and metro stations. However, when the vocal sounds are perceived to be threatening, increased social presence no longer positively affects perceived safety and other consumer responses (Sayin, Krishna, Ardelet, Decre, & Goudey, 2015).

Apart from the physical factors, feelings of safety or fear may be influenced by demographics such as age and gender. In recent years, many research findings prove that women feel less safe than men when they use public settings (Australia and Statistics, 2016; Ratnayake, 2014). It needs to be emphasised that even though women usually have the highest fear of crime (Ratnayake, 2017), in reality, women have lower victimisation rates than men in public spaces. This is known as a fear-gender paradox. Women's feelings of safety are associated with environment and experiential factors such as experience with stranger, sexual harassment in public and semi-public settings. Similarly, although victimisation rates are lower for the elderly persons, they are more fearful about their likelihood of becoming a victim in public spaces (Garafalo, 1981). This may be due to their weak physical strength that makes them feel situations are uncontrollable.

More recently, a study was carried out in Australia which examined the influence of fear of crime on walking (Foster, Knuiman, Hooper, & Christian, 2014). Here, both the fear of crime and walking were measured using a series of questionnaires and self-reported measures. The study indicated that an increase in fear of crime was indeed associated with a decrease in residents' walking inside the local neighbourhood. Further, the authors conclude that for each increase in fear of crime, the total walking decreased by 22 min per week, recreational walking by 13 min per week and transport walking by 7 min per week (Foster et al., 2014). Despite these significant findings, the authors indicate several limitations that existed in the methodology. They claimed that there were limitations associated with questionnaire surveys as such measures can overestimate fear and struggle to capture the nuances of "fear" relating to time, location and social context (Farrall, Bannister, Ditton, & Gilchrist, 1997). Further, self-reported walking measures were shown to predispose to over-reporting and recalling biases (Giles-Corti et al., 2005).

On the basis of Kevin Lynch's ideas (Lynch, 1965), in the recent past, scientific research has been conducted by integrating technical and human sensors in combination with direct feedback from people through real-time participatory communication channels such as social media to determine what areas trigger various emotions (Zeile, Resch, Exner, & Sagl, 2014). Zeile et al. (2014) concisely stated that this human sensory assessment approach focuses on a new and human-centric perspective to the city in which humans as "users of a city" represent the primary sensing element.

Although several types of research subsequently integrated this human sensory assessment method in capturing people's feelings and perceptions, the idea initially was a brainchild by the artist Christian Nold (Nold et al., 2009), who developed the concept while working on his art project: Bio Mapping. To practically explore the subject, Nold invented a device that was portable and wearable and recorded data from two technologies: a simple biometric sensor measuring the Galvanic Skin Response (GSR) and a Global Positioning System (GPS). The trained sample was then asked to walk around an area predetermined by Nold to test their emotional responses to the environments of the particular area. Subsequently, in an attempt to understand how the brain engaged with natural and urban settings, Roe, Aspinall, Mavros, and Coyne (2013) employed the use of electroencephalography (EEG) to capture indicators of emotional response. Much recently, a study

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