



An exploratory study of perceived safety in a neighborhood park using immersive virtual environments

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ABSTRACT

Spatial configuration and physical characteristics of landscape features can strongly influence perceptions of fear and danger. This study examined how situational characteristics, particularly spatial enclosure shaped by surrounding vegetation, are related to perception of safety in a park setting. Study stimuli involved eight 360° immersive virtual environments (IVE) representing low, medium, and high spatial enclosure situations based on the degree of visual and locomotive permeability shaped by the physical arrangement of vegetation. Forty-eight students experienced the IVEs wearing a head mounted display device and then indicated on a 5-point scale how safe they would feel walking alone in that location during the day. Immediately after rating each IVE, participants indicated the main reasons they would feel either safe or unsafe in that particular location. Analysis results indicated that subjects perceived high enclosure environments as significantly less safe than medium and low enclosure environments. In addition to enclosure formed by vegetation, attributes that contributed to perception of safety were presence of non-threatening people and paths. Results indicated that gender differences in perceived safety were significant for the high and medium enclosed environments only. Study findings would allow urban planners and park managers to better understand how the spatial characteristics of existing or planned urban greenspace are likely to influence perceived safety and consequently use patterns and the attainment of social and psychological benefits provided by urban parks. Such an understanding can help generate evidence-based guidelines for improving safety while preserving desired aesthetic and ecological properties of the landscape.

1. Introduction

Urban parks provide space to engage in leisure-time (Giles-Corti and Donovan, 2002) and utilitarian physical activities (Zlot and Schmid, 2005). They support social well-being (Tinsley et al., 2002) and enable users to have positive psychological experiences (Nordh et al., 2009). Typically, urban parks are available without charge to individual users and thus are particularly important in enabling “active living” across diverse population groups. In addition to size, attraction, and accessibility (Baran et al., 2014), use of urban parks is highly dependent upon how safe users feel there. Perception of danger or feelings of fear likely influence individuals’ preferences (Herzog and Kutzli, 2002) and

discourage use (Madge, 1997; Molnar et al., 2004). This may compromise the ability of parks to facilitate positive experiences and limit their optimal utilization (Giles-Corti and Donovan, 2002; Gatersleben and Andrews, 2013).

A number of studies have focused on perceived safety in relation to spatial attributes of landscapes in a variety of open spaces, specifically in forest and urban settings (e.g., alleys, college campus) (Fisher and Nasar, 1992; Herzog and Miller, 1998; Herzog and Kutzli, 2002; Herzog and Kropscott, 2004; Chiang et al., 2014). This body of research indicates that, in general, people prefer landscapes that are open and offer a wide view of the surroundings. Enclosed spaces tend to evoke feelings of insecurity and fear (Herzog and Kutzli, 2002; Stamps, 2005a; Skår,

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2010). In enclosed spaces, obstructed views are associated with higher levels of anticipated threats, while the lack of visible horizontal area (i.e., limited ground surface that can be seen around an observer), can be interpreted as restricting movement and limiting individuals' ability to escape in case of danger (Stamps, 2010a, 2012). For urban landscapes (e.g., college campus), a small body of research suggests buildings, walls, or vegetation that could conceal potential offenders (Fisher and Nasar, 1992, 1995) may be perceived as threatening. Research on safety in urban parks is limited (Madge, 1997; Jorgensen et al., 2012). Indeed, Jansson and colleagues (Jansson et al., 2013) highlighted the need for further research to understand the role of physical environment, particularly vegetation's appearance in a spatial context, on perceived safety in urban green spaces such as parks and residential areas. To address this knowledge gap, the present study offers an examination of how different situational characteristics, particularly spatial enclosure shaped by the arrangement of vegetation, play a role in perception of safety in a park setting. We utilized Immersive Virtual Environment (IVE) technology to create realistic representations of a range of park settings and compared perceptions of safety across varying levels of spatial enclosure.

1.1. Landscape and perception of safety

The majority of studies focusing on a physical environment's role in perceived safety have been informed by Appleton's (1975) prospect-refuge theory (Fisher and Nasar, 1992; Loewen et al., 1993; Herzog and Kirk, 2005) and Stamps' (2005b, 2010a) permeability theory (Stamps, 2005a). According to Appleton's theory, people naturally prefer prospect and refuge, where *prospect* is defined as an open view that enables a person to see what is ahead and *refuge* is the presence of features that afford protection (Appleton, 1975). Fisher and Nasar (1992) complemented Appleton's theory by developing a general typology for evaluating individuals' perceptions of safety. They found people favor a second level of prospect and refuge, which occurs when a person observes a place ahead offering prospect (an open view) or refuge (a place of protection). In other words, the degree to which a space affords fleeing a potential attack plays a key role in individuals' perceptions of safety.

Permeability theory suggests that judgments of safety and danger run parallel to perceptions of spaciousness and enclosure (Stamps, 2005b, 2010a). Research on permeability theory rests on the notion that higher degrees of enclosure imply possible threats and concealment opportunities for an offender; therefore, highly enclosed locations evoke a sense of fear (Nasar et al., 1993). Among the multiple spatial indicators used to test permeability theory, visual and locomotive permeability are believed to be the most important (Stamps, 2005b, 2010a, 2011b, 2012). Visual permeability refers to the degree to which an individual can see the features of an environment without obstruction, while locomotive permeability refers to the ability to move through an environment (Stamps, 2010a).

A number of studies have examined the relationships between spatial enclosure and perceptions of safety and/or danger (e.g., Herzog and Miller, 1998; Herzog and Chernick, 2000; Stamps, 2005a). For instance, Herzog and Miller (1998) exposed respondents to series of unmodified photographs depicting 18 alleys and 18 field/forest scenes to observe variation in preference, mystery, danger, openness, and curvature; they reported perceived danger as highly correlated with perceived openness. Similarly, Herzog and Chernick (2000) examined perceived safety and danger using unmodified photographs of 48 urban and field/forest settings and found a strong negative correlation ($r = -.72$) between perceived openness and perceived danger. Likewise, Stamps (2005a) had participants rate 21 slides of artificial scenes representing different environments in three Greek cities and found a strong correlation ($r = .82$) between perceived enclosure and feeling safe in an environment. Relying on responses to site plans, on-site ratings and observed behavior in a college campus, Fisher and Nasar

(1992) found that fear of crime was highest in enclosed areas with refuge potential for offenders.

Stamps (2012) expanded permeability theory by studying the effect of proximate and distal boundaries on perceived enclosure. He argued that if perceived enclosure mediates safety judgments by indicating the distance to possible threats, the proximate boundary should have stronger effects on perceived spaciousness or perceived enclosure than distal boundaries. In a specific location, the distance between an observer and proximate/distal boundaries is tantamount to the size of horizontal area that one perceives ahead (i.e., the sight distance, Troped et al., 2006). The form of landscape elements, e.g., vegetation, can influence sight distance. For instance, in the case of bending or highly sinuous paths, although the vegetation along the approaching curve will appear to be distant from the observer, it will form a distal boundary that may influence perceived enclosure and consequently, perceived safety.

Across both urban and more natural landscapes, empirical evidence suggests strong associations between landscape attributes and perceived safety (A. Jorgensen et al., 2002; Jansson et al., 2013; Chiang et al., 2014). The scale, type, and density and foliage of vegetation, as well as the form of landscape elements, can moderate the sense of enclosure or spaciousness. Height of vegetation defines the proximate and distal boundaries in a setting and influences sense of enclosure (Stamps, 2012). A row of shrubs or trees with dense lower limbs can form a solid boundary and highly influence perceived enclosure, whereas trees with higher limbs can form more permeable boundaries (Stamps, 2012). For instance, Nasar et al. (1993) asked college students to mark on a map areas they avoid because they felt them to be unsafe. They found a positive relationship between fear of crime across a university campus and dense growth of shrubs and trees with low hanging limbs. Utilizing a mail questionnaire and semi-structured interviews, Jorgensen et al. (2007) examined sense of fear in a residential UK neighborhood. They found shrubs were considered to be visibility barriers, potential hiding places for assailants, and sanctuaries for incivilities. Similarly, studies on forest trails (Chiang et al., 2014) and field/forest settings (Herzog and Kutzli, 2002) suggest shrubs and other types of ground cover may hinder locomotive permeability and influence perception of safety.

The form of paths and trails within a park may influence perceived spaciousness and perception of safety, especially when considered in relation to other elements that form visual boundaries (e.g., trees, fences, walls, etc.). Paths and trails define horizontal areas that are highly correlated with perceived spaciousness (Stamps, 2011a) and locomotive permeability (Stamps, 2010a). Wide paths surrounded by permeable vegetation are likely to be perceived as more spacious than narrow paths with elevated boundaries. In addition, the elongation of a path, defined as the ratio of the visible length to its width, may be negatively associated with perceived spaciousness (Stamps, 2011a). Winding park paths and natural trails can increase the sense of fear, especially when surrounded by dense vegetation. Moreover, the path demarcation and surface material influence the landscape legibility, another factor likely to influence perceived safety. Landscape legibility is defined as the extent to which the environment provide cues for orientation and way finding (Kaplan and Kaplan, 1989). Unpaved trails, poorly defined paths, or undefined areas within urban parks may confuse and stress people. In addition, research indicates the presence of other people can be an important factor in mediating perceptions of safety (L. J. Jorgensen et al., 2012). In general, the presence of other non-threatening people increases perception of safety. Finally, research on gender's role in safety perception indicates that, in general, women tend to perceive greater safety risk relative to men (Madge, 1997; W. R. Smith et al., 2001), and that they are more fearful in green spaces than their male counterparts (Maruthaveeran and van den Bosch, 2014). Since, a higher degree of enclosure leads to higher perceived risk (Stamps, 2005b, 2010a) we expected there might be some differences in perceived safety between men and women relative to level of enclosure. However, extant research has not examined if differences in perceived

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