Journal of Environmental Psychology 32 (2012) 260–276

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

# Effects of signals of disorder on fear of crime in real and virtual environments

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A R T I C L E I N F O

*Article history:*
Available online 23 April 2012

*Keywords:*
Public disorder
Fear of crime
Virtual environment
Ecological validity
Simulation
Public safety

A B S T R A C T

Despite the fact that virtual environments are increasingly deployed to study the relation between urban planning, physical and social disorder, and fear of crime, their ecological validity for this type of research has not been established. This study compares the effects of similar signs of public disorder (litter, warning signs, cameras, signs of vandalism and car burglary) in an urban neighborhood and in its virtual counterpart on the subjective perception of safety and livability of the neighborhood. Participants made a walking tour through either the real or the virtual neighborhood, which was either in an orderly (baseline) state or adorned with numerous signs of public disorder. During their tour they reported the signs of disorder they noticed and the degree to which each of these affected their emotional state and feelings of personal safety. After finishing their tour they appraised the perceived safety and livability of the environment. Both in the real and in the simulated urban neighborhood, signs of disorder evoked associations with social disorder. In all conditions, neglected greenery was spontaneously reported as a sign of disorder. Disorder did not inspire concern for personal safety in reality and in the virtual environment with a realistic soundscape. However, in the absence of sound disorder compromised perceived personal safety in the virtual environment. Signs of disorder were associated with negative emotions more frequently in the virtual environment than in its real-world counterpart, particularly in the absence of sound. Also, signs of disorder degraded the perceived livability of the virtual, but not of the real neighborhood. Hence, it appears that people focus more on details in a virtual environment than in reality. We conclude that both a correction for this focusing effect and realistic soundscapes are required to make virtual environments an appropriate medium for both etiological (e.g. the effects of signs of disorder on fear of crime) and intervention (e.g. CPTED) research.

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## 1. Introduction

Computer simulations have become indispensable tools to communicate design and planning impacts and to investigate human perception of built environments. Virtual environments are also increasingly deployed to study the effects of environmental qualities and interventions like CPTED ("Crime Prevention Through Environmental Design": Cozens, Neal, Hillier & Whitaker, 2004; Cozens, Neal, Whitaker & Hillier, 2003; Cozens, Waters & Neale, 2002; Kavakli, Kavakli & Gao, 2004) on human behavior and feelings of safety in built environments (Cozens et al., 2004; Cozens, Neal, et al., 2003; Cozens, Neale, & Hillier, 2003; Cozens et al., 2002; Park, Calvert, Brantingham, & Brantingham, 2008; Park, Spicer, Guterres, Brantingham, & Jenion, 2010; Smith & Carter, 2010). However, the ecological validity of virtual environments for this type of studies has not yet been established. A simulated environment can be considered ecologically valid when it evokes cognitive, emotional and affective user responses that are similar to those that would be evoked by a real equivalent. In practice, most simulations are still shown on desktop systems in uncontrolled conditions, where full ecological validity is seldom achieved (Bishop & Rohrmann, 2003). However, full ecological validity is not strictly required to study the effects of physical or social interventions in a built environment on human behavior. For most purposes it suffices if the virtual interventions affect relevant human emotions and behavior in a similar way as their real-world equivalents (van Hagen, 2011). Moreover, too much realism may even work counterproductive when small deficiencies in the simulation distract the users (an effect which is similar to the Uncanny Valley effect for simulated human characters: Mori, 1970).

The affective appraisal of built environments has previously been investigated through drawings, photographs and slides, interactive panoramas, and (static or dynamic) virtual environments (Nasar, 2008). Studies indicate that responses to color slides or photos reflect on-site experience more accurately than responses

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doi:10.1016/j.jenvp.2012.04.001

to drawings or black-and-white photos (Nasar, 2008; Stamps III, 1993). Photographs and slides have been used to assess for instance the impact of urban design (e.g. Stamps & Smith, 2002), darkness (Hanyu, 1997, 2000; Herzog & Flynn-Smith, 2001) and graffiti (Austin & Sanders, 2007) on feelings of safety. Although the responses to photographs correlate with on-site evaluations (Stamps, 2010), they are highly viewpoint dependent (Palmer & Hoffman, 2001). Also, photographs fail to capture the dynamics of a real environment and its context (Austin & Sanders, 2007). The context and viewpoint dependency issues can partly be resolved by the use of Quick Time Virtual Reality (QTVR) technology, in which various 360° panorama photographs, taken at different locations can be stitched together to create a virtual representation of an environment. QTVR technology has been used to probe passengers' feelings of personal safety in railway station environments (Cozens et al., 2004, 2003; Cozens, Neale, et al., 2003; Cozens, Neale, Whitaker, et al., 2003; Cozens, Neale, Hillier, et al., 2003). However, these simulations do not allow continuous walkthroughs, do not include ambient sounds, and have not been validated against data obtained in corresponding real environments. Smith & Carter, 2010 used a desktop virtual environment to train awareness of anti-social behavior prior to real-world exposure. Their simulation represents an urban area with added indicators of anti-social behavior like graffiti, damaged bus shelters and buildings, litter and rubbish, escort cards in phone boxes, and abandoned cars. However, the rendering of the environment is not fully photo-realistic and the simulation includes no sound. Also, the simulation has not been validated against a similar real-world environment. A recent series of studies used virtual environments to investigate the effects of environmental cues signaling high risk of victimization on personal feelings of safety (Park, 2008; Park et al., 2011, 2012, 2008, 2010; Park & Calvert, 2008). One of these studies addressed the ecological validity of a virtual environment for this type of research (Park et al., 2010). It was found that the effects of graffiti, murals, and boarded-up broken windows on feelings of personal safety of local residents were similar in reality and in a virtual model of the area. The degree of impact of the signs of disorder differed between the real and simulated environments, since people paid more attention to their surroundings in the virtual than in the real environment. However, the simulation does not include ambient sound.

Few studies actually compared human response to environmental interventions in both simulations and their real-world counterparts (Bishop & Rohrmann, 2003; Houtkamp & Junger, 2010; de Kort, IJsselsteijn, Kooijman, & Schuurmans, 2003; Schwebel, Gaines, & Severson, 2008; Wergles & Muhar, 2009; Zacharias, 2006). It was found that simulated lighting levels (Bishop & Rohrmann, 2003; Rohrmann & Bishop, 2002), path choices (Zacharias, 2006), and road crossing opportunities (Schwebel et al., 2008) evoke similar responses as their real-world equivalents. Hence, in many respects virtual interventions appear to affect relevant human behavior in a similar way as their real-world equivalents, even though human reactions to simulations and to corresponding real environments need not be identical in all aspects (van Hagen, 2011).

This study investigates how signs of disorder affect the subjective perception of the safety and livability of both real and simulated urban neighborhoods. The main hypotheses tested were that signs of disorder (H1) evoke associations with social disorder, (H2) inspire concern for personal safety, and (H3) degrade the perceived livability, in both real and simulated urban neighborhoods. In addition, the subjective experience of (orderly and disorderly) simulated urban environments was measured both with and without a soundscape. The hypothesis was that (H4) realistic ambient sounds increase the convincingness of the simulation, thereby amplifying the effects of physical disorder.

### *1.1. Disorder and perceived neighborhood quality*

Public disorder reflects erosion of social control and is typically associated with crime (Wilson & Kelling, 1982). Perceived disorder typically increases with observed disorder (Sampson & Raudenbush, 1999). As a result, signs of public disorder compromise the perceived livability of an area, and inspire fear of crime (Perkins, Meeks, & Taylor, 1992; Perkins & Taylor, 1996; Skogan, 1990; Taylor, 1997, 1999). Fear of crime is conceptualized here as an affective (mental) state reflecting safety related concerns about possible street victimization (Ferraro, 1994). Public disorder in urban environments is a robust ecological construct that can be reliably measured (Sampson & Raudenbush, 1999).

Public disorder encompasses both physical and social disorder. Physical disorder includes items like dilapidated housing, vandalism, litter and vacant lots, while social disorder includes phenomena like loitering youths, rowdy behavior, public drunkenness, drug sales and prostitution. This study investigates the effects of signs of public disorder (i.e. physical disorder and cues of social disorder such as warning signs and CCTV cameras) on the subjective appraisal of respectively a real and a simulated urban neighborhood. Both neighborhoods are appraised on dimensions like perceived livability, social disorder, and personal safety, both before and after the introduction of signs of disorder. If these interventions affect the appraisal of the virtual neighborhood similarly as the appraisal of its real counterpart, virtual environments may be ecologically valid instruments for studying the effects of different attributes on the affective appraisal of built environments. This would for instance enable the use of virtual environments to identify the relative importance of different incivilities, and to study the effects of litter and graffiti reduction measures, or the installment of decorations, benches or plantings, on fear of crime, avoidance behavior, and quality of life (Dunstan et al., 2005).

### *1.2. Sound and perceived simulation quality*

Auditory perception determines to a large extent the way we experience and emotionally respond to our environment (Irwin, Hall, Peters, & Plack, 2011), and may therefore be essential to provide a simulation that is ecologically valid. Auditory background noises and sound events are essential to establish a feeling of contact with and presence in an environment (Murray, Arnold, & Thornton, 2000). Presenting a virtual world with an improperly designed auditory interface is equivalent to creating a "virtual" hearing impairment for the user (Gilkey & Weisenberger, 1995). The absence of sound in physical environments induces irritation, aggression, stress, fear, anxiety, and feelings of isolation (disconnectedness with the world: Murray et al., 2000). Computer-mediated environments that lack sound may induce similar effects, since users expect that the visual events they perceive are accompanied by sounds, just like they are in reality. The absence of sounds is experienced as unnatural (i.e. it is a distracting factor). When inspecting soundless models of urban environments people spontaneously remark that they miss the common ambient sounds which typically make an environment 'realistic' or 'lively', like traffic noise or people talking (Houtkamp & Junger, 2010). Soundscapes that provide a faithful spatial representation of common real-world sounds may therefore enhance the user's experience of a mediated environment by increasing its naturalness, realism, and richness (Serafin & Serafin, 2004). Studies on virtual environments have indeed shown that the provision of sound enhances the acceptance and perceived realism of simulated environments, while the absence of sound is frequently perceived as a deficiency in the simulation (Rohrmann & Bishop, 2002; Rohrmann, Palmer, & Bishop, 2000).

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