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Urban Park Soundscapes: Association of Noise and Danger With Perceived Restoration

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EXECUTIVE SUMMARY: For the majority of Americans who live in urban areas, parks and other urban green spaces offer recreation environments that promote human health. To better understand how parks and urban green spaces enhance people's well-being, this study uses a cross-over field experiment design to analyze the impact of noise and danger on perceived restoration. Participants (N = 112) walked in a random order through two one-mile routes in natural (park) and artificial (street) environments. Participants self-reported their levels of perceived restoration, noise, and danger after walking through each environment.

Similar to previous studies, the natural (park) environment was perceived as significantly more restorative than the artificial (street) environment. Noise was a significant predictor of the significantly higher levels of perceived restoration. In contrast, although participants did perceive the artificial environment as more dangerous, this construct explained a relatively small amount of variation in perceived restoration and was not a significant predictor.

These results have implications for park agencies. In order to facilitate both physical activity and restoration opportunities for people recreating in parks, agencies should conserve and enhance the natural soundscape by maintaining and further developing sound buffering vegetation at the perimeter of parks. The effect of this landscaping could be enhanced by regulations minimizing the level of mechanical and human noise in the surrounding areas. Second, while repurposing city streets into temporary parks may offer excellent opportunities for outdoor physical activity, people recreating in such temporarily repurposed streets may experience less restoration than they would in a permanent park due to the relative absence of a natural acoustic environment. Third, pocket parks and other small parks may not have enough buffering landscaping on the perimeter of the park to facilitate a natural soundscape within the park. Moreover, if small parks promote physical activity by encouraging people to walk to the park, then

these parks may be leading people to walk in less restorative street environments that are replete with mechanical and human noise. Finally, although everyone may not be seeking restoration, agencies should include information about the quality of the soundscape in their marketing material to help users find the acoustic environment that best meets their needs. Overall, this study suggests that agencies consider using landscape maintenance, regulation, park design, and education to facilitate and promote opportunities for outdoor recreationists to experience restoration in urban parks.

KEYWORDS: *Perceived restoration, noise, danger, urban parks, urban green space*

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Most Americans live in urban areas (United Nations Department of Economic and Social Affairs Population Division, 2015). Parks and other urban green spaces are often accessible spaces for residents to be physically active and gain physical and mental health benefits (Gascon et al., 2015; Maas, Verheij, Groenewegen, De Vries, & Spreeuwenberg, 2006; Mitchell & Popham, 2008). Although the literature provides significant findings supporting the link between urban green space and human health, there is less evidence identifying what aspects of those environment are salutogenic (Hartig, Mitchell, de Vries, & Frumkin, 2014). This study analyzes the impact of two constructs, noise and danger, that have previously been found to individually be negatively associated with the restorative impact of environments (Gatersleben & Andrews, 2013; Jahncke, Eriksson, & Naula, 2015), but have not been examined together in the same study.

Literature Review

Urban green spaces, and vegetation more generally, offer positive health benefits. The restoration hypothesis is a major part of this research (Kaplan, 1995; Kaplan & Kaplan, 1989; Ulrich, 1983). Noise and danger are two factors that have previously been found to moderate the restorative impact of natural environments (Gatersleben & Andrews, 2013; Herzog & Chernick, 2000; Jahncke et al., 2015).

Impact of Natural Environments on Health

Historically, there has been a strong connection between the urban park movement and public health (Byrne & Wolch, 2009; Taylor, 1999; Ward Thompson, 2011; Williams, 2006; Young, 1993, 1996). Park developers, such as Frederick Law Olmsted, and public health advocates, such as Florence Nightingale, believed that urban parks served as cities' "green lungs" (Berto, 2005; Cranz & Boland, 2004; Walker & Duffield, 1983).

Early research studies investigating the impact of natural environments on health included Moore's (1981) and Ulrich's (1984) studies of individuals in public institutions. Moore (1981) found that prisoners with natural views out their window were less likely to report being sick. Ulrich (1984) reviewed the health care records of patients recovering from gall bladder surgery. In this study, patients that had a natural view out their window had significantly shorter postoperative hospital stays, received fewer negative nursing evaluations, and used fewer potent analgesics.

Since those early studies, research is continuing to report evidence that urban green space near where people live has health benefits. Maas and colleague's (2006) Dutch study concluded that the amount of near residence urban green space, both agricultural

and natural green, was positively associated with perceived general health. Mitchell and Popham's (2008) British study found a significant negative relationship between near residence urban green space and overall mortality. American studies have concluded that distance from residence to parks is significantly negatively correlated with perceived health (Payne, Orsega-Smith, Roy, & Godbey, 2005) and positively associated with BMI (Rundle et al., 2013).

Findings suggest that the impact of near residence urban green space is especially strong for more vulnerable members of society; including residents with lower levels of education (Maas et al., 2006) or income (Mitchell & Popham, 2008), and both elders (Maas et al., 2006) and youth (Maas et al., 2006). Mitchell and Popham (2008) speculated the strength of this relationship may be due to these groups relative inability to travel very far away from their residence. Similarly, Payne and colleagues (2005) found that lack of transportation was a major constraint to park use for older Americans.

In contrast to body of research supporting a connection between urban green space and physical activity, there is less evidence about which aspects of parks and other urban green space are salutogenic. Hartig and colleagues (2014) concluded that "relatively little attention has been paid to the relevance of specific environmental characteristics, such as the type of greenery or the quality of the open space" when examining the relationship between urban green space on physical activity (p. 215).

Urban green space can serve as a site for individual or organized physical activity programming (B. Han et al., 2015; Hunter et al., 2015). Programming group activities in parks appears to offer a cost-effective way to support physical activity for the surrounding residents (Cohen, Marsh, Williamson, Golinelli, & McKenzie, 2012). Han and colleagues' (2014) American study suggested that programming and activities in a park may be a better predictor of physical activity in a park than the size and availability of facilities in a park. In their study of older American park visitors, Payne and associates (2005) found that most park users reported being physically active in parks. Ries and colleagues' (2009) study of American teens reported that park users have significantly higher levels of moderate and vigorous physical activity than non-park users.

The impact of urban green space on levels of physical activity appears to be mediated by accessibility. Studies have consistently reported a negative relationship between distance to parks and rate of visitation (Byrne, Wolch, & Zhang, 2009; Cohen et al., 2006; Cohen et al., 2007; Kaczynski, Potwarka, & Saelens, 2008; Mowen, Orsega-Smith, Payne, Ainsworth, & Godbey, 2007; Payne et al., 2005; Schipperijn, Stigsdotter, Randrup, & Troelsen, 2010; Wilson, Tierney, Kim, & Zieff, 2012). Similarly, the perceived or actual distance to parks has been found to be negatively correlated with physical activity (Cohen et al., 2006; Kaczynski & Havitz, 2009; Ries et al., 2009).

Physical activity is important; however, multiple authors have concluded that the health benefits of urban green spaces go beyond physical activity (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Triguero-Mas et al., 2015). Mitchell (2012) found in a Scottish sample that regular use of natural environments was associated with better mental health. In their Spanish study, Triguero-Mas and colleagues (2015) concluded that "the associations between self-perceived general health and green spaces, showed complete mediation by each of the mental health indicators" (p. 37-38).

Cohen-Cline and colleagues' (2015) study of American identical twins suggest that there may be a genetic differences that moderate the impact of urban green space on mental health. Their study found that across all study participants, access to green space was significantly negatively associated with depression, anxiety, and stress; however, the relationship was not significant within the twin pairs for stress and anxiety.

Much of the evidence about the relationship between urban green space and mental health is from cross-sectional correlational research designs (Hartig et al., 2014); however, a longitudinal study by Alcock and associates (2013) suggests a causal relationship between near residence urban green space and mental health. This study found that moving to a green area was significantly associated with better mental health alone, two, and three years after moving to a new location. Conversely, moving to a less green area was associated with

significantly worse mental health. Although there was no random selection and assignment in this study of English residents, the study participants reported very similar reasons for moving. The authors concluded that public policy supporting near residence green space could better support public mental health (Alcock et al., 2013).

Multiple studies have found a strong connection between being in nature and increased levels of happiness (Capaldi, Dopko, & Zelenski, 2014; Chiesura, 2004; MacKerron & Mouato, 2013). MacKerron and Mouratou's (2013) massive British study (21,947 participants; 1,138,481 responses) concluded "study participants are significantly and substantially happier outdoors in all green or natural habitat types than they are in urban environments" (p. 992).

Part of the reason for those increased level of happiness may be increased feelings of relaxation and decreased levels of stress. Research participants have reported that an opportunity to relax is one of the primary reasons they seek out nature (Chiesura, 2004) and that experiencing nature leads to higher levels of relaxation than viewing and listening to non-natural scenes and sounds (Emfield & Neider, 2014). Ulrich, Dimberg and Driver (1990) speculated that "leisure environments, especially those which are predominantly natural, may help prevent certain types of stress from existing or reduce their levels, particularly when the source is in the physical environment" (p. 159). Since then, studies have found that people with poorer levels of access to green space have higher levels of stress (Stigsdotter & Grahn, 2011), nature buffers individuals against the impact of stressors (Brown, Barton, & Gladwell, 2013), and helps people recover after exposure to stressors (Van den Berg, Jorgensen, & Wilson, 2014).

There are two major parallels between the findings on physical activity. First, urban green space appears to be an effective low-cost public mental health solution for urban residents (Martínez-Soto, Lena, & y Vázquez, 2014). Second, despite the evidence supporting the relationship between urban green space and mental health, there is a lack of evidence distinguishing which qualities of urban green spaces most effectively promote mental health (Gascon et al., 2015).

Restorative Environments

A primary framework for starting to understand which aspects of nature benefits human health is the restorative environments thesis. Hartig (2011) defines restoration as the "renewal or recovery of resources or capacities that have become depleted in meeting the demands of everyday life" (p. 41).

The two primary restoration theories are the Psycho-Evolutionary Theory (PET: Ulrich, 1983) and Attention Restoration Theory (ART: R. Kaplan, 1984; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995). Ulrich's (1983) theory of restoration focuses on stress. PET is focused on stress recovery and posits that humans' evolutionary development has led to autonomic responses to certain environmental characteristics. In contrast, Kaplans' (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995) theory focuses on the recovery of directed attention. ART is based on the theoretical division between voluntary (i.e., directed or effortful) attention and involuntary (i.e., fascination) attention first suggested by William James (1892). Direct Attention Fatigue (DAF) has been associated with reduced sociability (e.g., failure to recognize interpersonal cues, irritability) and ability to solve problems (e.g., increased errors on attention tests, inability to plan, reduced self-control) (Hartig, 2011; S. Kaplan, 1995). ART has four theoretical dimensions; fascination, being away, compatibility, and extent. Fascination refers to those features of the environment that capture involuntary attention. Being away is comprised of both physical and psychological distance from individual's mundane reality. Compatibility is the fit between a user's goals and the affordances of the environment (Herzog, Hayes, Applin, & Weatherly, 2011). And finally, extent refers to the scope and coherence of the environment (S. Kaplan, 1995).

Restoration Findings

Studies have used multiple methods to collect restoration data. This includes self-report, performance, and psychophysiological data.

Self-report data. Natural stimuli is consistently perceived as more restorative than artificial stimuli (Berto, 2005; Hernández & Hidalgo, 2005; Herzog, 1989; Herzog & Chernick, 2000; Herzog, Maguire, & Nebel, 2003; Home, Bauer, & Hunziker, 2010; Laumann, Gärling, & Stormark, 2001; Lindal & Hartig, 2015; Nordh, Hartig, Hagerhall, & Fry, 2009; Tyrväinen et al., 2014). In his study of American college students, Herzog (1989) found that the research participants perceived scenes of tended nature as the most restorative and images of unkempt old buildings as the least restorative. Other studies have found that self-reported perceived restoration increases with higher levels of perceived nature (Carrus et al., 2013; Hernández & Hidalgo, 2005) and biodiversity (Carrus et al., 2015; Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Sandifer, Sutton-Grier, & Ward, 2015). Finally, there is some evidence from a Finnish study that perceived restoration increases with longer participant exposures to the natural environment (Tyrväinen et al., 2014).

Perceived restoration appears to be moderated by the dimensions of Attention Restoration Theory (ART) (e.g., Jahncke et al., 2015; Korpela & Hartig, 1996; S. R. Payne, 2013; von Lindern, Bauer, Frick, Hunziker, & Hartig, 2013). ART theorizes that people prefer nature because of its restorative properties (R. Kaplan, 1984). Empirical research consistently finds that people prefer natural scenes over images of built environments (e.g., Berto, 2007; Home et al., 2010; Lindal & Hartig, 2015). Moreover, people choose to look at nature images longer than artificial built scenes (Berto, 2005). However, preference for urban versus natural scenes appears to mediate the perceived restoration of nature (Wilkie & Stavridou, 2013). In their Finnish study, Korpela and Hartig (1996) found that participants' favorite places tend to be natural places and favorite places had higher levels of perceived restoration. Furthermore, travel destinations that are rated as being more natural are perceived as more restorative (Lehto, 2012).

Performance data. Research participants' performance on tests of attention supports the evidence found from self-report data. Multiple studies have identified improvements on the Necker Cube Pattern Control Task (NCPCT) in relation to exposure to natural environments (Tennessen & Cimprich, 1995; Weng & Chiang, 2014). Gatersleben and Andrews (2013) found increased performance on the NCPCT for individuals walking through a high prospect (extensive views) and low refuge (limited possible hiding spots for predators or criminals) natural environment, decreased performance when walking through a low prospect and high refuge natural environment, and no change for those viewing videos of such walks. Berman and colleagues (2008) found significant improvement on the Backward Digit Span task for participants that either walked through natural areas or viewed natural scenes. The study concluded, "To consider the availability of nature as merely an amenity fails to recognize the vital importance of nature in effective cognitive functioning" (Berman et al., 2008, p. 1211). In contrast, Tennessen and Cimprich (1995) failed to find a significant difference between environmental types using the Backward Digit Span task; however, found significant differences on enough of the performance tasks (Symbol Digit Modalities Test, Necker Cube pattern Control Test) and self-report data (Attentional Function Index) to conclude, "The findings support the hypothesis that dormitory residents with more natural views from their windows would have a stronger capacity to direct attention than those with less natural or built views" (Tennessen & Cimprich, 1995, p. 83). Berto (2005) reported that participants viewing natural scenes performed significantly better on multiple parts of an attention task; including sensitivity in the detection of a target, reaction time, and number of correct responses. The authors concluded, "that nonrestorative environments really have negative and disturbing effects on performance and it is better to avoid them" (Berto, 2005, p. 257).

Psychophysiological data. A third source of restoration data comes from psychophysiological data. The *Shinrin-yoku* or *forest bathing* body of research originating from Japan offers multiple studies showing the impact of sensing nature through vision, smell, hearing, and touch on the autonomic nervous system (e.g., heart rate variability, blood pressure, pulse rate, salivary amylase) and stress response benefits (e.g., salivary cortisol, Immunoglobulin A) (e.g., Lee, Park, Tsunetsugu, Kagawa, & Miyazaki, 2009; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010; Tsunetsugu et al., 2013; Tsunetsugu,

Miyazaki, & Sato, 2007; Tsunetsugu, Park, & Miyazaki, 2010). Other researchers, such as Chang and colleagues (2008), have found that viewing natural scenes promotes positive changes in muscle tension, brainwave activity, and blood volume pulse. Gatersleben and Andrews (2013) found that heart rate decreased during the more restorative high prospect-low refuge walking route through nature than the low prospect-high refuge route through nature. In contrast, Tyrväinen and colleagues (2014) failed to find evidence to support the thesis that salivary cortisol would decrease in more natural conditions, but speculated it may be an artifact of their primarily middle-aged female sample.

Results from self-reports, performance tests, and psychophysiological measures support the restoration hypothesis. Natural stimuli are perceived as more restorative, result in better tests of attention and performance, and lead to psychophysiological results that support the claim that nature is more restorative than artificial environments.

Factors Limiting Restoration

Despite the dominance of findings that nature is more restorative than artificial environments, there is less understanding of what aspects of the environments support restoration and how those aspects interact (Hartig et al., 2014). Two variables that have individually been found to have a significant negative impact on restoration are noise (Jahncke et al., 2015) and danger (Gatersleben & Andrews, 2013; Herzog & Rector, 2008). There is some evidence that suggests these two constructs may interact with one another. For example, controlling for level of sound, noise is rated as more annoying when there is a fear of danger from the noise source (Fields, 1992; Miedema & Vos, 1999). However, both perceived danger and sound have yet to be tested as simultaneous predictors of perceived restoration.

Noise. A soundscape is a, "composite of all sounds at a specific locale, as perceived by park visitors" (Pilcher, Newman, & Manning, 2009, p. 426). Noise is considered those aspects of the soundscape that are unwanted and are perceived as sound pollution (Mace, Bell, & Loomis, 2004).

Similar to visual scenes, people consistently prefer natural sounds over human or mechanical sounds (Alvarsson, Wiens, & Nilsson, 2010; Hellström, Nilsson, Becker, & Lundén, 2008; Irvine et al., 2009; Jahncke et al., 2015; Liu, Kang, Behm, & Luo, 2014; Pilcher et al., 2009; Szeremeta & Zannin, 2009). Jahncke and colleagues (2015) reported that the presence of natural, human, or mechanical sounds moderated the impact of visual stimuli on perceived restoration. The authors of the article concluded that their experiment, "gives support to the idea that an urban park surrounded by noise might not be that restorative as a setting which is quiet, or where natural sounds are prominent" (Jahncke et al., 2015, p. 9). Saadatmand and colleagues (2013) found that patients using mechanical ventilation had significantly lower blood pressure, anxiety, and agitation if they listened to natural rather than mechanical sounds. Individuals that associate natural sounds or silence with natural environments tend to be more sensitive to and critical of human or mechanical noises in green spaces (Botteldooren, Filipan, Boes, & De Coensel, 2014). Furthermore, human and mechanical sounds have been found to reduce the levels of natural sounds that participants have reported hearing in urban green spaces (Liu et al., 2014).

The sound of motorized vehicles is one source of noise pollution that may be particularly acute in urban areas. Evidence suggests that traffic noise depresses short-term memory (Benfield, Bell, Troup, & Soderstrom, 2010). The restorative qualities of individual home environments (Von Lindern, Hartig, & Lercher, 2014) and the availability of nearby green areas (Gidlöf-Gunnarsson & Öhrström, 2007) have been identified as moderating the impact of vehicle noise on resident health.

Danger. Byrne and Wolch (2009) stated that parks are "paradoxically described as crime havens, treasured family refuges, and oases for urban residents and wildlife alike" (p. 743). Dangerous animals (Bixler, Carlisle, Hammit, & Floyd, 1994), deviant behavior (Hansen, 2013), and menacing people (Cohen et al., 2010) are just a few of the reasons people may fear green space. Perceptions of safety have been found to differ by

race, sex, age, and socio-economic status (Cohen et al., 2010; Ghimire, Green, Poudyal, & Cordell, 2014; Johnson, Bowker, & Cordell, 2001; Lo & Jim, 2011; Virden & Walker, 1999; Wilhelm Stanis, Schneider, Chavez, & Shinew, 2009).

Lapham and colleagues (2015) found that individuals were 4.6 times more likely to visit a park if they perceived it as safe. Cohen and colleagues (2015) found in their American study that park renovations significantly increased perceived park safety. However, studies led by Cohen (Cohen, Han, et al., 2012; Cohen et al., 2013) have reported mixed findings when regarding perceived safety and park use.

Herzog and Chernick (2000) found that natural scenes were perceived as less dangerous than urban scenes. However, multiple studies have found that the perceptions of danger in natural environments is moderated by the opportunity to see relatively long distances (openness or prospect) and relatively few places for dangerous people or animals to hide (refuge) (Gatersleben & Andrews, 2013; Herzog & Chernick, 2000). Gatersleben and Andrews (2013) found that perceived danger reduced the perceived restoration gained from exposure to natural environments.

Hypotheses. The research suggests that both noise and danger will negatively impact perceived restoration. However, there is less evidence about a possible interaction between these predictors. Therefore, this study has three hypotheses.

H_1 The natural (park) environment will be perceived as more restorative than the artificial (street) environment.

H_2 The soundscape in the artificial environment will be evaluated as noisier (louder and less desirable) than the natural environment, and this will be a significant predictor of perceived restoration.

H_3 The level of perceived danger will be higher in the artificial environment than the natural environment and this will be a significant predictor of perceived restoration.

Methods

This field experiment had participants walk through both a natural (park) and artificial (street) environment. Self-reported data were collected using Han's (2003) Short-version Revised Restoration Scale (SRRS) and other items from previous studies measuring sound and danger. Measures of reliability, repeated measures ANOVA, and multivariate regression were used to analyze the data. The study was approved by the authors' institutional review board.

Design

As called for by multiple researchers looking at the impact of environment on health (Abraham, Sommerhalder, & Abel, 2010; K.-T. Han, 2003), this study used a cross-over field experimental design. All study participants walked through both the park and street environments. Participants were randomized into two groups using Microsoft Excel's (2013) *RAND* function. Group A first walked through the natural environment and then through the artificial environment. Group B walked through the environments in opposite order; first through the natural environment and then through the artificial environment.

In line with previous work on the salutogenic effects of nature (Astell-Burt, Feng, & Kolt, 2014; Bowler et al., 2010; Lachowycz & Jones, 2014; Marselle, Irvine, & Warber, 2014; Martens, Gutscher, & Bauer, 2011) and many restoration studies in particular (e.g., Berman et al., 2008; Gatersleben & Andrews, 2013; Hartig, Mang, & Evans, 1991; Johansson, Hartig, & Staats, 2011), walking was chosen as the activity with which participants experienced the two environments. Walking tends to be one of the most frequent motivators for using green spaces (Child et al., 2014; Cohen et al., 2007; Irvine, Warber, Devine-Wright, & Gaston, 2013) and has been found to be one of the most popular outdoor recreation activities in parks (Payne et al., 2005). Moreover, walking is the activity

that has been found to provide some of the highest levels of restoration (Weng & Chiang, 2014).

Site

The experiment location was San Francisco, California. The Trust for Public Land (Harnik, Martin, & O'Grady, February 2014) reported that San Francisco is a high-density city with 825,863 residents living in a 29,999-acre city with 5,685 acres of parks. San Francisco has slightly below the median number of park acres per 1,000 residents for high-density cities (6.9 vs. 7.1); however, it has the highest percent of residents of any American city that live within walking distance to a park (Harnik et al., February 2014).

Single exemplars of natural and artificial environments were used (Hartig, 2011). The natural environment was a one-mile paved walking trail through an urban park, Stern Grove and Pine Lake. This park features a lake, off-leash dog area, stone amphitheater, and grass fields surrounded by forests of established trees. The majority of the path is at a significantly lower grade than the surrounding urban streets. This landscape coupled with the surrounding forest and bushes blocks much of the sound from and views of cars and buildings. In contrast, the artificial walking route was on the sidewalk adjoining a busy six-lane highway that goes through the city, SR1 *Pacific Coast Highway*. On the opposite side of the sidewalk, an urban university, shopping mall, houses of worship, and residences lay along the route. Research participants encountered other people (including research monitors) and dogs along the route.

Procedure

This study used both a naturalistic condition, final exams, and a controlled induction, reading and quizzes, as conditions designed to create Directed Attention Fatigue (DAF) (Hartig, 2011). First, all of the participants were undergraduate students. Data were collected at the end of the semester before the final exam period. Studying for exams, creating projects, and writing papers are all demanding tasks and would likely have led most students to be experiencing stress and fatigue. Secondly, a controlled induction was used. Participants read two-pages of dense information focused on the content of their class immediately before their first walk. Participants were told that they would be tested on the material and that they should remember as much of the reading as possible. The quizzes were given after all of the other measurements at the end of each walk. The results of the quizzes are not part of this study and were only used as a DAF induction method.

Research participants were given instructions and then released to individually walk along the path through the first environment assigned to them. The routes were each approximately one-mile long. Assuming a walking pace of three miles per hour, each route was estimated to take about 20 minutes to complete. This is half or less of the duration in some previous studies (e.g., Berman et al. (2008) 50–55 minutes; Johansson et al. (2011) 40 minutes, Hartig et al. (1991) 40 minutes), but longer than others (e.g., Gatersleben and Andrews (2013) 10 minutes). After walking through the first environment, each participant completed a survey and quiz. Immediately after this, participants walked through the second environment and completed an identical survey and a parallel quiz with a different set of items about the reading.

In order to theoretically maximize the impact of the environment, participants were instructed to not socialize with other people on the route or remotely via texting or talking on cell phones. Furthermore, they were requested not to surf the internet on their phones or listen to music. Although research participants likely could not distinguish between them and other people along the route, there was a research assistant along each route to monitor the participants' progress.

Sample

Similar to many studies looking at the impact of the environment (Botteldooren et al., 2014), the participants were 112 undergraduate students in a general education class. Seven participants were not included because they did not give permission for their data

to be used in this study, failed to put their unique identifier on each survey (making it impossible to link data from the two surveys), or failed to complete the surveys.

Data Collection

The primary dependent variable in this study was Han's (2003) Short-version Revised Restoration Scale (SRRS). Although there are numerous scales measuring perceived restoration in the literature (Bagot, 2004; Bagot, Kuo, & Allen, 2007; Berto, 2005; Hartig, Kaiser, & Bowler, 1997; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2008; Laumann et al., 2001; Norling, Sibthorp, & Ruddell, 2008; Pasini, Berto, Brondino, Hall, & Ortner, 2014; Van den Berg et al., 2014), SRRS was chosen because of its theoretical breadth and previously reported strong validation evidence (Gatersleben & Andrews, 2013; K.-T. Han, 2003, 2007, 2008, 2010; Vassiljev et al., 2007; Vassiljev et al., 2010). The current study reduced the number of SRRS' response options down from nine to seven in order to be consistent with the other scales in this study. This is consistent with the classic Perceived Restoration Scale (PRS: Hartig et al., 1997) response options. SRRS' Emotional dimension was measured by semantic scales ranging from grouchy/good natured and anxious/relaxed at the extreme points. The three other dimensions were measured by agreement with a scale from "Not at all" to "Very much." The Physiological dimension question stems were, "My breathing became faster" and "My hands began sweating." "I was interested in the scenery," and "I felt attentive to the scene" measured the Cognitive dimension. Finally, the Behavioral dimension was measured with the question stems "I would like to visit that route more often" and "I would have liked to stay there longer."

Two items measuring perceived noise were adapted from Irvine et al. (2009): "How loud was the route?" and "What did you think of the noises you heard on the route?" The semantic anchors for these two item were "Very quiet" to "Very noisy" and "Very bad" to "Very good."

The perceived danger items were from Gatersleben and Andrews (2013); "How frightened were you walking through this environment?," "How scared were you on this route?," and "How uneasy were you walking through this environment?" The semantic anchors for these items were "Very few" to "Very much so."

Data Analysis

All data were entered into and composite scores created in Excel. Descriptive analyses, Cronbach's alpha, repeated measure ANOVA, and multiple regression analyses were conducted using IBM SPSS Statistics 23.

Results

The reliability of all of the scales were relatively high, especially when considering the low number of items in each scale (Nunnally, 1978). The overall reliability of the Short-version Revised Restoration Scale (SRRS) (Cronbach's alpha = 0.867) was relatively high, but lower than reported by Han (2003) (0.919) and Vassiljev and colleagues (2007) (0.945 and 0.932). For each individual dimension, the measure of internal consistency showed the same pattern as found by Han (2003), but were lower in each case; Emotional (0.874 vs. 0.976), Physiological (0.771 vs. 0.867), Cognitive (0.930 vs. 0.998), and Behavioral (0.934 vs. 0.998). In his survey development article, at the same time as calling for replication studies using field experiments, Han (2003) also warned that "field experiments lose some degree of the control over exogenous variables as compared with laboratory experiments" (K.-T. Han, 2003, p. 228). Therefore, the consistently lower levels of reliability are likely due to the current study being a field experiment rather than a more controlled lab experiment design used by previous studies. Similar to the restoration scale, the reliability of the noise (0.865) and danger (0.864) scales were relatively high.

Two extraneous variables were checked for their impact on perceived restoration, speed of walking and environment order. The assumption that individuals would walk an average of three miles per hour and complete each one-mile walk in about 20 minutes was correct (nature μ= 21 minutes and 30 seconds, artificial environment μ= 22 minutes 0

seconds). The duration of the walk through the park and street routes did not significantly differ ($p < 0.05$). Similar to other studies (e.g., Berman et al., 2008), the composite SRRS scores did not significantly differ whether the participants walked through the natural or artificial environment first ($p > .05$).

With the exception of one item ("My hands began sweating"), the average scores for each item, dimension, and the entire SRRS were significantly higher in the natural compared to the artificial condition (Table 1).

Table 1

SRRS Means, Standard Deviation, and Significance of Difference by Scale and Item

	Park	Street	Sig.*	η^2
SRRS	5.11 (0.95)	3.22 (1.07)	<0.01	0.467
Emotion	6.19 (1.00)	4.78 (1.55)	<0.01	0.224
Grouchy	6.34 (0.95)	4.83 (1.70)	<0.01	0.229
Anxious	6.05 (1.22)	4.74 (1.63)	<0.01	0.171
Physiological	3.02 (1.53)	2.55 (1.40)	<0.01	0.026
Breathing	3.52 (1.71)	2.77 (1.55)	<0.01	0.051
Hands	2.53 (1.71)	2.32 (1.53)	NS	0.004
Cognitive	6.10 (1.23)	3.40 (1.60)	<0.01	0.475
Interested	6.14 (1.24)	3.27 (1.71)	<0.01	0.483
Attentive	6.03 (1.30)	3.49 (1.70)	<0.01	0.414
Behavioral	5.45 (1.50)	2.49 (1.53)	<0.01	0.490
Visit	5.74 (1.53)	2.75 (1.72)	<0.01	0.460
Stay	5.15 (1.72)	2.23 (1.45)	<0.01	0.460

All items were measured with a seven-point Likert scale.
*Although the means and standard deviations are at the variable level, the test for significance of difference between the two environments is within-subjects using repeated measures ANOVA. Significance equal to or greater than .05 was considered not significant.

Whereas for perceived restoration the scores were consistently higher in the natural condition, the scores for noise and danger were all significantly higher in the artificial condition (Table 2).

Table 2

Means, Standard Deviations, and Significant Differences by Scale and Item for Other Items

	Park	Street	Sig.*	η^2
Noise	2.21(1.05)	5.04(1.16)	<0.01	0.622
Loud	2.36 (1.28)	5.45 (1.35)	<0.01	0.575
Evaluation	2.06(1.22)	4.67(1.29)	<0.01	0.722
Danger	1.48(0.87)	1.88(1.22)	<0.01	0.035
Frightened	1.57(1.26)	1.85(1.30)	NS	0.011
Scared	1.25(0.60)	1.67(1.20)	<0.01	0.045
Uneasy	1.61(1.21)	2.13(1.46)	<0.01	0.036

Three regression equations were computed with noise and danger as individual predictors (Table 3).

Table 3

Regression Equations with Perceived Restoration (Composite SRRS) as the Dependent Variable

Model	IVs	β (Sig)	R^2 (Adjusted)	Sig
1.	Noise	-0.533 (<0.01)*	0.479 (0.477)	<0.01*
2.	Danger	-0.261 (<0.01)*	0.041 (0.037)	<0.01*
3.	Noise	-0.542 (<0.01)*	0.480 (0.475)	<0.01*
	Danger	0.048 (NS)		

Noise was a significant predictor for perceived restoration both when it was the only independent variable ($\beta = -0.533$, $p < 0.01$) and continued to be significant when both noise and danger were combined as predictors ($\beta = -0.261$, $p < 0.01$). Danger was a significant predictor of perceived restoration when it was the only predictor ($\beta = -0.533$, $p < 0.01$); however, it explained a relatively small amount of variance in perceived restoration ($R^2 = 0.041$, adjusted $R^2 = 0.037$). Moreover, when both noise and danger were included as independent predictors, danger lost significance ($\beta = -0.048$, $p > 0.05$).

Discussion

The results of this study supported the first two hypotheses, but failed to fully support the final hypothesis. First, as expected, the composite for the entire SRRS and each dimension of the scale indicated higher levels of perceived restoration in the natural (park) environment. Second, the soundscape in the artificial (street) environment was evaluated as significantly noisier (negative and louder) and this was a significant predictor of perceived restoration. Third, although levels of perceived danger were higher in the artificial (street) environment, danger explained a relatively small amount of variance in perceived restoration when it was the only predictor and failed to continue to be significant predictor of perceived restoration when both danger and noise were included as independent variables.

The findings here reinforce previous findings that higher levels of perceived restoration are associated with walking through a natural environment compared to walking through artificial environments (Bowler et al., 2010). The results of this study provides evidence that, although walking along a busy street may provide an opportunity for physical activity, it does not appear to support restoration. Park agencies and other organizations can use this information to increase general awareness of the restorative benefits of recreating in natural environments (both visual and sonic) and attempt to counteract the general public's underestimation of the benefits of spending time in nature (Capaldi et al., 2014; Dustin, Bricker, & Schwab, 2010).

The most significant predictor of perceived restoration was Noise. Noise explained almost half (48%) of the variance in Perceived Restoration. Trees and other vegetation on the perimeter of parks may provide essential sound barriers against human and mechanical noise pollution from the surrounding urban space. Irvine and Colleagues found that "the outer-edge space, hedges and trees as well as homes and gardens, acted as a buffer effectively minimizing the impact of continuous and monotonous external sounds in the green space" (Irvine et al., 2009, p. 169). The importance of sound barriers is magnified by the finding that "visitors to natural settings are sensitive to low levels of human-caused noise and that noise detracts from the enjoyment of the experience" (Mace et al., 2004, p. 22).

The findings from this study have multiple implications for park design. The provision and maintenance of trees and bushes on the perimeter of the park, repurposing

city streets into temporary parks, and the choice of building small parks are all impacted by the conflicts between noise and danger.

The implementation of sound barriers may be challenged by management practices that attempt to reduce perceived danger. Madden's (2010) longitudinal analysis of New York City's Bryant Park described how the park removed buffering brush and trees on the perimeter of the park so that the protective gaze of the surrounding business and traffic could freely scan the interior of the park and increase perceived safety. Moreover, Herzog and Chernick (2000) concluded parks should be a "relatively open area liberally endowed with well-tended natural elements that do not hinder visual access" in order to minimize fear (p. 38). However, managers should consider that the provision of open views may come at the cost of opportunities for visitor restoration when undesirable mechanical or human noise is prevalent in the surrounding area.

Wilson and colleagues (2012) posited that a ciclovia-style street event, Sunday Streets in San Francisco, could serve the role of a public "temporary park" by providing near-residence space for outdoor recreation. Given that streets often make up the majority of public space in most urban areas (Lindal & Hartig, 2015; Manville & Shoup, 2005), especially relative to urban space devoted to parks (Gardner, December 12, 2012), it seems logical that a city could serve most needs for recreational park space with just-in-time parks through the temporary repurposing of city streets. Indeed, multiple studies have found that trails, including paved trails, are one of the park features most associated with physical activity in parks (e.g., Besenyi, Kaczynski, Stanis, & Vaughan, 2013; Cohen et al., 2006; Kaczynski et al., 2008). However, this study suggests that while "activating" city streets by closing them to motorized transportation may increase opportunities for physical activity, some of the restoration benefits gained from recreating in a more natural soundscape may be lost. Streets may offer a limited number and variety of trees and other vegetation (Lindal & Hartig, 2015); however, it would be difficult to argue that the paved environment of the streets is more green than most urban parks. Moreover, human and mechanical noise from the surrounding buildings and streets may likely overwhelm the limited natural soundscape of the repurposed streets.

Third, small parks may not be large enough to provide a natural soundscape if there is significant mechanical or human noise surrounding the park. Cohen and colleagues (2014) argued that even the smallest parks could promote physical activity by encouraging people to walk to a park; however, this recommendation should be tempered by the knowledge that walking along city streets may not have the same restorative benefits as walking in the more natural soundscape of a park. Furthermore, the walking paths along the perimeter of the relatively large small parks in their study may have provided an opportunity for physical activity, but, given the location at the edge of the natural space, it is likely that the soundscapes experienced by the recreationists would be saturated by mechanical and human sounds from the surrounding area (Cohen et al., 2014).

All parks do not provide the same benefits. Therefore, although this study suggests that management should provide a natural soundscape when possible, it is perhaps just as important to help recreationalists find the type of park that best meets their intended outcomes. Therefore, park departments should create promotional material to guide recreationalists seeking health outcomes to parks with the most natural soundscapes. Furthermore, all of the implications here assume a loud and unappealing sonic atmosphere surrounding the parks. The noise experienced within parks could be minimized through regulations such as street closures, enforcement of limits on vehicle engine and radio noise, or a ban on the use of amplified sound in the park vicinity (Stack, Newman, Manning, & Fristrup, 2011).

Similar to Herzog and Chernick's (2000) laboratory experiment using images of different environments, the level of reported danger in the artificial condition was significantly higher than the reported level in the natural condition. Contrary to expectations, danger was not a significant predictor of perceived restoration when noise was included as an independent variable. These results superficially conflict with Gatersleben and Andrews' (2013) findings that danger was a significant predictor of perceived restoration; however,

Gatersleben and Andrews' (2013) study compared two relatively natural environments. The level of perceived danger within these natural environments varied based on the levels of prospect (views) and refuge (hiding places for dangerous people and criminals). Therefore, although danger was found by Gatersleben and Andrews (2013) to be a significant predictor of perceived restoration when comparing different natural environments, this study did not find it was a significant predictor when comparing exemplars of natural and artificial environments.

Both environments' mean scores for danger were relatively low (natural = 1.48, artificial = 1.88). If the relative levels of danger experienced during the two routes were more distinct, then danger may have been a more significant predictor. For example, it could be that danger would be a significant predictor of perceived restoration if the current artificial route was compared with a downtown park at night filled with intimidating people conducting asocial activities. Furthermore, it seems likely that the significantly higher levels of perceived danger reported after walking through the artificial route may be due to the six lanes of vehicles travelling adjacent to the walking route. The rumble of mechanical noises emanating from those vehicles may have caused people to be a bit concerned about all of those cars rushing past. Therefore, perceived danger may not have been a significant predictor because the noise from the identified hazard (i.e., vehicles) was directly leading to higher levels of perceived danger. In contrast, if there were relatively silent hazards on the path (e.g., venomous snakes), or the loud noise came from a source other than the perceived hazard, then it may be possible that danger would have significantly explained variance of perceived restoration beyond that explained by noise.

The results of the current field study are limited by using self-reports to measure the short-term impact of university students engaging in one activity in two exemplar environments (Bowler et al., 2010; Hartig, 2011). In contrast to lab experiments, the current study does not offer as much control over the variables; however, it does offer greater ecological validity and complements the findings from previous lab experiments. In addition to using a self-reported instrument used in this study, future studies may choose to use psychophysiological and performance measures of restoration. Future studies may want to vary the duration of exposure to the different environments. University students are commonly used as participants on restoration research; however, a greater diversity of participants could lead to a more sophisticated understanding of the impact of individual differences on perceived restoration. Additional information could be gained about the impact of noise and danger within natural and artificial environment categories by designing research with multiple natural and artificial environments that have significantly different levels of noise and danger.

Considering that over 80% of North Americans live in urban areas (United Nations Department of Economic and Social Affairs Population Division, 2015), urban parks are an important part of most North Americans' lives. While rural national park policies have been primarily focused on overflights of the parks (Mace et al., 2004), parks in urban areas may need a greater focus on the sounds of motorized land transport. Noise pollution may impact visitors' experience and reduce their associated health benefits. While managing the visual landscape, park managers should also consider the impact of landscape changes and regulation on the soundscape. Parks are both physically and socially constructed spaces (Taylor, 1999). If we, as a society, truly acknowledge the potential public health benefits of parks, then we need to construct both beautiful looking and sounding parks.

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