Psychological Wellbeing Benefits of Simulated Exposure to Five Urban Settings: an Experimental Study From the Pedestrian's Perspective

Abstract

The potential health benefits of walking in attractive, predominantly built-up urban settings have not received much attention from scholars, despite the global need to increase walking levels in cities. The current experimental study assessed the affective outcomes associated with several urban walking settings, with a focus on the presence of motor-traffic and architectural styles from different historic periods. We employed a mixed within-between subjects design (n = 269) with employees and students from Bristol (UK) and measured relaxation and hedonic tone experiences, perceived restorativeness, and environmental perceptions following exposures to one of five urban settings. Results identified three categories of affective outcomes, rather than the classic dichotomy 'urban vs natural': the simulated walks in areas with greenery rated significantly better than the others; however, the pedestrianised settings were associated with neutral or positive affective outcomes and perceptions, with statistically significant differences with an area with traffic. These results suggest that walking in high-quality urban settings can have positive outcomes, and highlight the negative role of traffic and the potential benefits of historic elements in the affective walking experience. From a policy perspective, findings strengthen the case for traffic removal, and indicate that exposure to high quality urban design that includes some natural elements can offer the same affective benefits offered by large green spaces.

Key phrases and keywords:

- Walking
- Affective benefits
- Psychological wellbeing
- Built environment
- Virtual walk experimental methodology
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1. Introduction

There is growing consensus on the notion that built environments have an impact on the health and psychological wellbeing of individuals living or working in cities (e.g., Frank et al., 2016; Frumkin, 2003). Research has shown that urban living is associated with increases in mood and anxiety disorders compared to rural living (Gruebner et al., 2017; Peen et al., 2010). The global trend is for populations to urbanise, with 66 percent of the global population likely to live in cities by 2050 (United Nations, 2014). Therefore, understanding how built environments can support psychological wellbeing is a priority for research and practice, and strategies to improve urban dwellers' psychological wellbeing are needed. Walking is an activity that entails psychological wellbeing benefits (Gatrell, 2013; Robertson et al., 2012). Thus, exploring what factors can increasing urban walking could serve as a public health strategy that might subsequently have positive implications for the psychological wellbeing of individuals that reside in urban locations.

However, settings vary in the extent to which they support particular activities, and the benefits of walking are moderated by the environments in which this is performed (e.g., Johansson et al. 2011). In this respect, a rich body of research attested that walking in natural spaces entails psychological wellbeing benefits (Hartig et al., 2003; Tilley et al., 2017; Van den Berg et al., 2003). Nevertheless, opportunities to visit green spaces during everyday life are limited for urban dwellers, and experiencing nature is a 'rarity' for most, as attested by a British research (Cox et al., 2017). It is, therefore, increasingly important to explore which characteristics of current built environments support psychological wellbeing in everyday situations, specifically during walking. The current study addresses part of the gap in the literature by comparing experimentally the moderating effect on psychological variables of virtual exposure to five urban walking settings in the city centre of Bristol, UK. The virtual walk experimental methodology is well established in psychological research, with numerous applications in the investigation of the affective benefits of walking in natural settings within psychology and public health research (e.g., Gatersleben and Andrews, 2013; Van den Berg et al. 2014). However, it has hitherto had limited application in the field of transport studies (with some exceptions: e.g., Johansson et al., 2016). The experimental virtual walk methodology offers an effective way to study the impact of built environment characteristics on walking experiences and health outcomes. The findings offer practical recommendations for planning and design strategies to improve the affective walking experience in cities.

The affective construct is a specific aspect of the umbrella term psychological wellbeing (Ekkekakis, 2013), and refers to the so-called hedonic wellbeing (Ryan and Deci, 2001). Examining immediate wellbeing responses is important because positive affect can be beneficial to long-term health (Consedine and Moskowitz, 2007; Fredrickson and Braningan, 2005). In addition, affective experiences influence subsequence activities, with two general forms of behaviour elicited: approach (desire to stay and explore) or avoidance (desire to leave) (Mehrabian and Russell, 1974). Therefore, examining affective walking experiences produce important implications for the promotion of sustainable transport, as they might influence walking intentions and behaviours (Gatersleben and Uzzell, 2007; Johansson et al., 2016).

In environmental psychology, Russell's circumplex mode of affect (Russell, 2003; Russell and Barrett, 1999; Russell and Pratt, 1980) offers theoretical insights on the influence of environments on affective states, and defines core affect as "the most elementary consciously accessible affective feeling" (Russell and Barrett, 1999, p. 806). An environment is automatically perceived in terms of two dimensions: *valence* (degree of pleasantness) and *arousal* (degree of intensity). Core affect can be unconscious and free-floating, or directed at something such that emotions originate (Russell and Barrett, 1999). Affective and emotional states include, for example, stress, energy, and happiness (Russell and Barrett, 1999).

In parallel, Ulrich's Stress Recovery Theory (SRT) (Ulrich, 1983; Ulrich et al., 1991), looks specifically at the stress-relieving and *restorative* properties of environments, hence focusing on stressed individuals. Restorative environments are defined as those settings that contribute to stress recovery and to positive affect in individuals with a depleted mental state. While Russell does not advance a hypothesis on the types of settings that support affect, according to Ulrich (1983), it is exposure to natural settings that promotes restoration, as opposed to exposure to urban environments. This idea is based on the psycho-evolutionary hypothesis that, having evolved over a long period in natural environments, humans have an innate inclination towards natural environments (Ulrich et al., 1991). SRT is complemented by Kaplan and

Kaplan's Attention Restoration Theory (ART) (Kaplan, 1987; Kaplan and Kaplan, 1989), which rather than looking at affective outcomes focuses on attention fatigue (the depleted capacity to direct attention). ART holds that exposure to natural environments can promote greater cognitive restoration than exposure to built environments. Despite the focus on cognition, measures of perceived attention restoration are generally positively associated with affective restoration (e.g., Fornara 2011; White et al., 2010); hence, perceptions on cognitive restoration are likely to say something about the affective potential of settings. According to Kaplan and Kaplan (1989), several properties can make an environment restorative, and these include: *being away* (feeling away from routine or demanding activities), *fascination* (being engaged without effort), *compatibility* (good fit between environments and one's purposes), and *scope* (the environment has sufficient content that it can occupy the mind for an extended period).

Building on the theories outlined above, extensive empirical research has assessed the affective benefits of walking in natural areas. This growing body of evidence has confirmed that walking in natural settings supports affect and restoration (e.g., Hartig et al., 2003; Roe and Aspinall, 2011; Tilley et al., 2017). Studies have also shown that incorporating natural elements in cities elicits affective and restorative outcomes (White et al., 2010; WHO, 2016) and improves perceived restoration of built settings (Lindal and Hartig, 2015; White et al., 2010; Nordh et al., 2009). Hence, there is general agreement on the notion that natural settings support walking and psychological wellbeing relatively more than built-only settings do. In addition, despite a discussion on the daytime-night time perspective was beyond the scope of the current research, it should be noted that the literature on the affective benefits of walking in natural settings refers to daylight situations, while walking in natural spaces at night time is likely to trigger safety concerns (e.g., Gatersleben and Andrews, 2013).

However, little attention has been given to the affective potential of walking in the full range of typically encountered non-natural built settings (as noted by Karmanov and Hamel, 2008; Velarde et al., 2007). Specifically, research studies assessing affective and restorative outcomes of walking in urban settings have tended to select locations with attributes defined negatively in sociocultural terms, e.g., urban *grey settings* such as commercial and industrial areas (Johansson et al., 2011), urban outskirts (Hartig et al., 2003), or streets with heavy motor-traffic density (Kinnafick and Thøgersen-Ntoumani, 2014; Tilley et al., 2017; Van den Berg et al., 2014). Hitherto, and to the best knowledge of the authors, no current experimental study has involved comparing the psychological wellbeing potential of different urban walking settings including a *non-grey setting*. One exception is the study by Lindal and Hartig (2013), which examined the role of architectural variation and building height in several residential streetscapes on judgments of restoration likelihood. However, the study did not assess how these characteristics influence affective outcomes. The general lack of comparisons between different urban settings is partially related to the fact that urban settings were included as comparison groups in studies examining the affective and restorative potential of natural settings, rather than being the focus of research. As a consequence, the potential for some urban environments to offer affective benefits has been effectively ruled out despite there being a limited knowledge base, as already noted by some scholars (Karmanov and Hamel, 2008; Velarde et al., 2007). The current study aimed to reassess this generalisation about urban environments by focusing on two factors that might contribute to positive affective experiences in urban settings.

The first factor is motor-traffic. The literature indicates that walks in areas with traffic is associated with negative affective responses (e.g., Hartig et al., 2003; Johansson et al., 2011; Van den Berg et al., 2014). However, affective outcomes of walking in urban areas without traffic seem to have received little attention. Ulrich et al.'s (1991) research seems to be the only existing study comparing affective outcomes between pedestrianised areas and streets with traffic. However, Ulrich et al. (1991) found no significant differences between the two conditions in terms of fear, positive affect, sadness, and attentiveness, although there was a non-predicted difference in anger recuperation, which surprisingly was higher in the setting with traffic. Nevertheless, it is here hypothesised that exposure to urban environments with traffic will elicit negative affective responses, while exposure to pedestrianised urban environments will elicit positive affective responses.

The second factor of interest is the architectural style of built environments, specifically historic styles. Previous research has suggested that places with a strong historic value are perceived as restorative (Fornara, 2011; Hidalgo et al., 2006). These have included museums (Kaplan et al., 1993), houses of worship (Herzog et al., 2010), and historic urban settings (Fornara, 2011; Galindo and Hidalgo, 2005). For example, Fornara (2011) reported that an urban historic-panoramic setting was perceived as restorative as an urban park, and more relaxing, pleasant, and restorative than a shopping mall. Along the same lines, Roe and Aspinall (2011) found that an urban walk had affective benefits among individuals with poor mental health, and speculated that the historic character of place might have played a role. The current study sets out to test Roe and Aspinall's (2011) suggestion that exposure to historic areas can support psychological wellbeing.

Addressing these two factors together, the current study employed an experimental design to compare affective outcomes of virtual exposure to several urban walking environments with different characteristics relative to motor-traffic and architectural style. It was hypothesised that urban settings without traffic would elicit affective benefits (H1) and would be perceived as restorative (H2), attractive and interesting (H3) as opposed to a *grey setting* (a commercial road with traffic). Among pedestrianised settings, it was expected that an historic environment would elicit greater affective benefits than a modern setting (H4).

2. Materials and methods

2.1 Participants

An online experiment was conducted with adults who work and/or study in Bristol, UK. Participants were 269 individuals (69.1% females) ranging from 18 to 67 years old (M = 31.69, SD = 13.63) and mainly White British (82%). One-hundred and twenty nine were undergraduate psychology students and 140 were employees of public and private organizations based in Bristol city centre. While the involvement of student samples is popular in restorative environments research (e.g., Van den Berg et al., 2014; Johansson et al., 2011; Karmanov and Hamel, 2008; Hartig et al., 2003), some study has highlighted that it presents some limitations, as results might not be generalizable to other populations (e.g., Bowler et al., 2010). Related to this, the current study involved an employee sample, in addition to the student one, in order to compare the findings with previous studies, whilst at the same time extending the existing body of research.

The study was approved by the faculty's Ethics Committee. Students involved in this study participated through an undergraduate psychology degree research methods course. Students who participate in studies receive a contribution to their course credits, but can choose which studies they participate in from a wide range. They could withdraw at any time and request deletion of their data up until an agreed date. Employees were approached via key contacts in organizations, such as staff travel managers, who facilitated the forwarding of an invitation email to internal staff lists, and did not receive an incentive to take part.

2.2 Materials

Five environmental simulations involving different videos, each of a walk in a single location were used. These consisted of five predominantly non-residential, recognizable areas in the city centre of Bristol (UK) that reflected one of five environmental conditions. Settings were selected to be equivalent in levels of maintenance and upkeep, complexity, and openness (Nasar, 2008). Three non-*grey*, relatively luminous, open and complex, clean and well-kept urban settings included:

Pedestrianised Historic Environment, hereafter *PedHist* (Figure 1). A cobbled, historic street (Corn Street) located in Bristol's Old Town. It is dominated by neoclassic buildings, of which four are listed as national heritage. The area has no evident greenery, apart from five small flowerpots that are attached to the Corn Exchange building.

Pedestrianised Modern Environment, hereafter *PedMod* (Figure 2). A modern street (Millennium Promenade) built as part of the Harbourside Masterplan. The area is a modern complex of residential buildings, cafes and restaurants. It has no evident greenery, with sporadically placed plants on the side of the road.

Pedestrianised mixed environment, hereafter *PedMixed* (Figure 3). A stone-paved pedestrian/cycle route (Deanery Street) located in the public open space of College Green. The route is framed on one side by Bristol Cathedral, and on the other side by a semi-open area with grass, trees, and lampposts. The route has some greenery, with trees and grass on the left side of the path.

Two settings were included as comparison stimuli: one was a *grey setting*, e.g., a commercial area with traffic, hereafter *CommTraf* (Figure 4). Located in the Broadmead shopping area of Bristol, it has many high street retail outlets and cafes. The road is one-way and supports bus stops, taxi ranks and special needs parking. Traffic is moderate, flow variable, but with a high density of diesel-powered buses, delivery vehicles and taxis. The other was an inner city urban park, hereafter *Park* (Figure 5). The environment is clean, well kept, and luminous, with sporadic trees on the side of the path.

Figure 1: PedHist

Figure 2: PedMod

Figure 3: PedMixed

Figure 4: CommTraf

Figure 5: Park

A one-minute video of a simulated walk was filmed for each environment, a tool which has been extensively used in the literature (Gatersleben and Andrews, 2013; Laumann et al., 2003; Van den Berg et al., 2014). Videos were filmed with a GoPro HERO 35mm camera during several weekday afternoons (1 pm to 4 pm) with cloudy but dry weather outside of busy commuting times in October 2015. The number of pedestrians was similar across locations, with settings not crowded (5 to 10 pedestrians per video). Videos were accompanied by an audio file containing the original naturalistic sounds, as the aural dimension is an integral part of the restorative experience (Conniff and Craig, 2016).

The goal of each video was to give the feeling of movement whilst avoiding vibrations and bumpy recordings that are not representative of natural walking. To this end, the camera was mounted on a bicycle with the experimenter pushing it whilst walking at a slow steady pace, akin to a comfortable walking speed. The video length reflected the standard time needed to walk through the case study areas (approximately 200-meter long streets). While previous research has presented the urban street condition as a collage of areas with varying traffic levels and architectural styles (Laumann et al., 2003; Van den Berg et al., 2014), the goal of the current research was to identify specific micro-qualities related to traffic and architectural style that could influence affective experiences. Hence, segments were purposively short in order to isolate such specific characteristics, whilst at the same time allowing for emotional reactions – which last “seconds to minutes” (Ekkekakis, 2013, p. 47).

2.3 Measurements

Measured affective states included *relaxation* and *hedonic tone*, from the University of Wales Institute of Science and Technology Mood Adjective Checklist (UWIST MACL scale) (Matthews et al., 1990). The two variables were selected due to relevance of stress/relaxation and pleasure/displeasure dimensions in the travelling experience (Anable and Gatersleben, 2005). The scale is based on Russell's circumplex model of affect (Russell and Pratt, 1980). Each dimension is made up of four items measured on a 4-point Likert scale: hedonic tone (*hedtone*) is measured by happy, sad, content, sorry; relaxation is measured as relaxed, nervous, calm, edgy. Each variable (*hedtone*, *relaxation*) ranges from 4 to 16, with 16 corresponding to the maximum value given to each item. Measures were taken before and after watching the video.

Perceived restorativeness was measured by the Perceived Restorativeness Scale – short version (PRS scale) (Berto, 2005). The scale was included to compare the judged restoration likelihood of built-only settings to that of natural settings. It has four statements, each corresponding to one of Kaplan and Kaplan's (1989) restorative properties, rated on a 7-point Likert scale. Measures were taken after watching the video. Statements were adapted to the walking context (Being away: "*Walking in this setting allows me to get away from it all and relax";* Scope*: "Walking in this setting feels like being in a world of its own, where I can get completely involved and not think about anything else";* Fascination*: "When I walk in this setting my attention is drawn without effort and my interest is engaged";* Compatibility*: "Walking in this setting makes me feel comfortable and at ease*").

Environmental perceptions included measures of attractiveness and interestingness (Karmanov and Hamel, 2008): *attractiveness* (ugly–beautiful, unpleasant–pleasant, unfriendly–friendly, unenjoyable–enjoyable, repulsive– inviting) and *interestingness* (uninteresting–interesting, average–exceptional, dull–exciting), both measured on a 5-point Likert scale. The scales were included to assess differences in environmental preferences between the non-grey and grey settings. Socio-demographic questions (age, gender, ethnicity) were also included.

2.4 Procedure

The web page contained general information about the study and a section to confirm participant consent to a) take part in the experiment and b) data being saved anonymously. Applying a between-subjects design, each participant was randomly assigned to one environmental condition. Participants were initially asked to complete the affective scale, and then to watch the video (with the following instruction: "*Please watch this 1-minute video. Imagine you are taking a walk in this environment during the daytime. Make sure the sound is switched on and set at a comfortable audible volume. If you can, please wear headphones*"). After the video, participants completed the affective scale for the second time ("*You just experienced an urban walk through watching the video. How did it make you feel?*") and the rest of the questionnaire. Data were analysed using SPSS 23.

3. Results

3.1 Initial Conditions

Despite the data not being normally distributed, analysis of variance (ANOVA) was used, as it assesses post-hoc comparisons between more than two groups. ANOVA is "robust" to violations of normality when there are at least 40 degrees of freedom and when group sizes are roughly equal (Field, 2009, p.360). The assumption of homogeneity of variances was met (Levene's test) for all variables in all settings (p > .05). Partial eta square values were used to interpret size of effects (small effect with η_p^2 = .01; medium effect with η_p^2 = .06; large effect with η_p^2 = .14, Cohen, 1988).

Within the current study, hedtone, relaxation, and PRS scale had very good inter-item reliability (Chronbach's alpha: α = .789; α = .827; α = .896 respectively). A series of one-way between-subjects ANOVAs and Chi-squared tests showed that there were no statistical differences between the five experimental groups in terms of socio-demographics and pre-test affective states (Table 1).

Table 1: Pre-test differences in socio-demographics and affective states between the five experimental groups

Variable	*p*	Test
Socio-Demographics		
Age	.343	One-way ANOVA
Gender	.122	Chi-squared
Ethnicity	.110	Chi-squared
Pre-test affective states		
Hedonic tone	.800	One-way ANOVA
Relaxation	.639	One-way ANOVA

3.2 Affective Experiences

In order to test whether some built settings offered affective benefits (H1), a mixed 5 (setting – between participants) x 2 (test time: pre- and post- simulated walk – repeated measure) ANOVA was conducted on relaxation and hedtone (thus also addressing H4). Results are summarised below.

3.2.1 Relaxation

The mixed ANOVA revealed that the main effect of time was not statistically significant, $F(1, 241) = 1.807$, $p = .180$, $\eta_p^2 = .008$, but there was a statistically significant main effect of setting with medium effect size, $F(4, 238) = 7.689$, $p = .008$, $\eta_p^2 = .114$. Relaxation decreased in the commercial area with traffic ($p < .000$) and increased in the pedestrianised mixed environment ($p < .000$). In Park ($p = .123$) and the pedestrianised historic setting ($p = 1.000$) the increase in relaxation was non-significant. In the pedestrianised modern setting there was a non-significant decrease of relaxation ($p = .144$). There was a statistically significant setting group x test time interaction with a large effect size, $F(4, 238) = 23.858$, $p < .000$, $\eta_p^2 = .286$. Bonferroni post-hoc tests indicated that the walk in the commercial area with traffic led to a decrease in relaxation that was statistically different from the increase in the pedestrianised historic ($p < .000$), modern ($p < .000$), mixed environments ($p < .000$), and Park ($p < .000$). The walk in the pedestrianised mixed environment led to a relaxation increase that was statistically different from the relaxation decrease in the modern one ($p = .001$) (Figure 6).

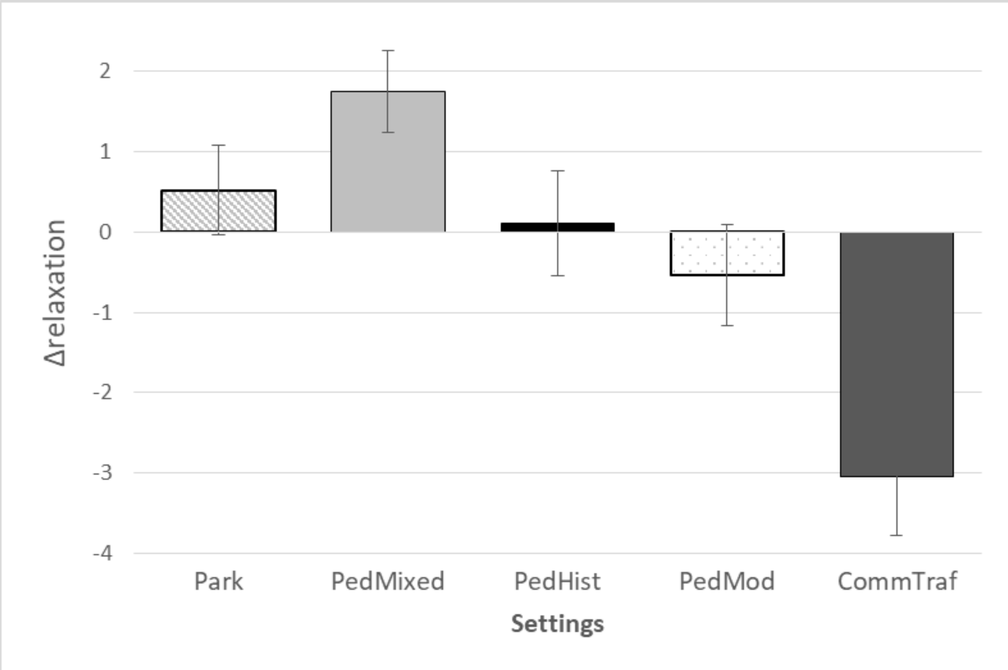

Figure 6: Δrelaxation per setting

Note: Difference between pre–post scores on relaxation scale in five settings. Maximum score is 16. The y-axis shows the change in relaxation (post *minus* pre-test scores); a bar above the y-axis represents an increase in relaxation. Error bars (95% confidence intervals) are shown. Park = inner city park; PedMixed = pedestrianised setting with green and historic elements; PedHist = pedestrianised historic setting; PedMod = pedestrianised modern setting; CommTraf = commercial area with traffic.

3.2.2 Hedonic tone

The mixed ANOVA revealed a statistically significant main effect of time with medium effect size, $F(1, 226) = 26.338$, $p < .000$, $\eta_p^2 = .104$, and setting, $F(4, 226) = 5.407$, $p < .000$, $\eta_p^2 = .090$. Hedonic tone increased in the pedestrianised historic setting ($p = .001$), pedestrianised mixed setting ($p < .000$) and Park ($p < .000$) and decreased in the commercial area with traffic ($p < .000$). In the pedestrianised modern environment, the effect was non- statistically significant ($p = .113$). There was a statistically significant setting group x test time interaction with a large effect size, $F(4, 226) = 13.637$, $p < .000$, $\eta_p^2 = .194$. Bonferroni post-hoc tests indicated that the walk in CommTraf led to a decrease in hedonic tone that was statistically different from the ones relative to the pedestrianised historic ($p < .000$), modern ($p = .001$), mixed environments ($p < .000$), and Park ($p < .000$). In addition, there was a statistically significant difference between the walk in PedMod and PedMixed ($p = .015$), with PedMixed associated with a larger increase in hedtone (Figure 7).

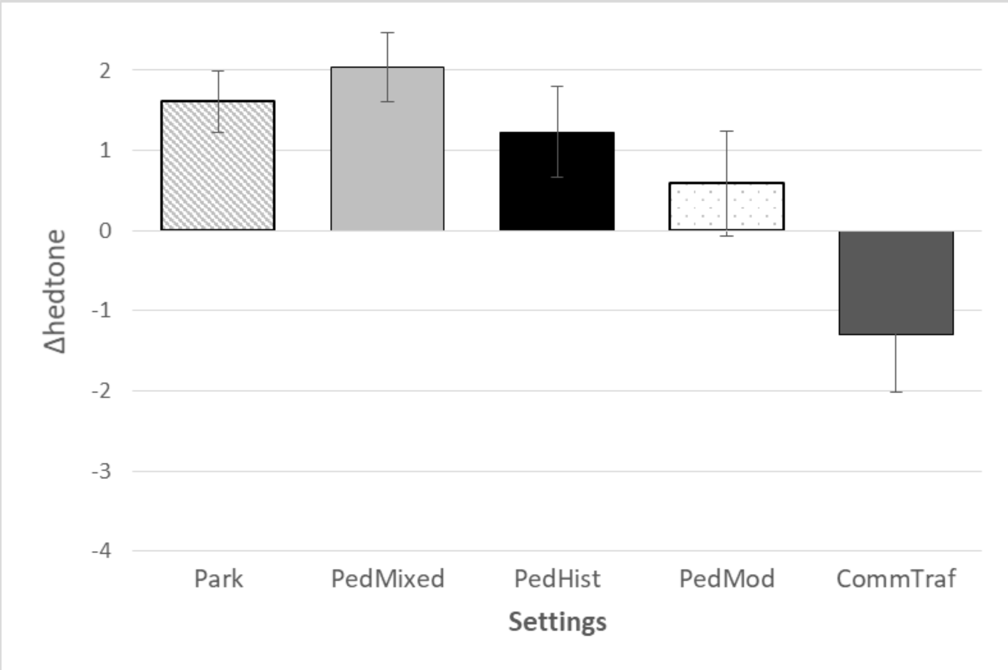

Figure 7: Δhedtone per setting.

Note: Difference between pre–post on hedonic tone scale in five settings. Maximum score is 16. The y-axis shows the change in hedtone (post minus pre-test scores). Error bars (95% confidence intervals) are shown. Park = inner city park; PedMixed = pedestrianised setting with green and historic elements; PedHist = pedestrianised historic setting; PedMod = pedestrianised modern setting; CommTraf = commercial area with traffic.

3.3 Perceived Restorativeness

In line with H2, a high PRS score in the three *non-grey* urban settings was expected, and a lower score in the commercial road with traffic setting. This was confirmed, as participants rated positively the three pedestrianised settings, while the commercial area with traffic was rated negatively. In line with the literature, the park was also rated positively. In other words, all the non-traffic conditions were associated with perceived restorativeness, as opposed to the traffic condition (Table 2).

Table 2: Mean ratings (standard deviations) for PRS score, attractiveness, and interestingness across the five setting conditions

	M (SD)		
Setting	**PRS**	**Attractiveness**	**Interestingness**
CommTraf	2.98 (1.18)	2.41 (.72)	2.33 (.77)
PedMod	4.09 (1.25)	3.33 (.87)	3.04 (.89)
PedHist	4.15 (1.14)	3.48 (.60)	3.29 (65)
PedMixed	4.95 (1.11)	3.96 (.68)	3.59 (.49)
Park	4.96 (1.18)	3.71 (.72)	3.01 (.62)

Mean (Standard Deviation)

PRS rated on 7-point Likert scale

Attractiveness and Interestingness rated on 5-point Likert scales.

Park = inner city park; PedMixed = pedestrianised setting with green and historic elements; PedHist = pedestrianised historic setting; PedMod = pedestrianised modern setting; CommTraf = commercial area with traffic.

A one-way between-subjects ANOVA was conducted to test for possible differences between settings in perceived restorativeness, and this identified a statistically significant main effect with a large effect size, $F(4, 265) = 25.774$, $p < .000$, $\eta_p^2 = .283$. Scheffe post hoc analyses indicated that the commercial area with traffic was perceived as statistically less restorative than the pedestrianised historic ($p < .000$), pedestrianised modern ($p < .000$), pedestrianised mixed ($p < .000$), and Park ($p < .000$). In addition, PedMixed was perceived as more restorative than PedMod ($p = .009$) and PedHist ($p = .021$). Park was perceived as more restorative than PedMod ($p = .006$) and PedHist ($p = .014$) (Figure 9).

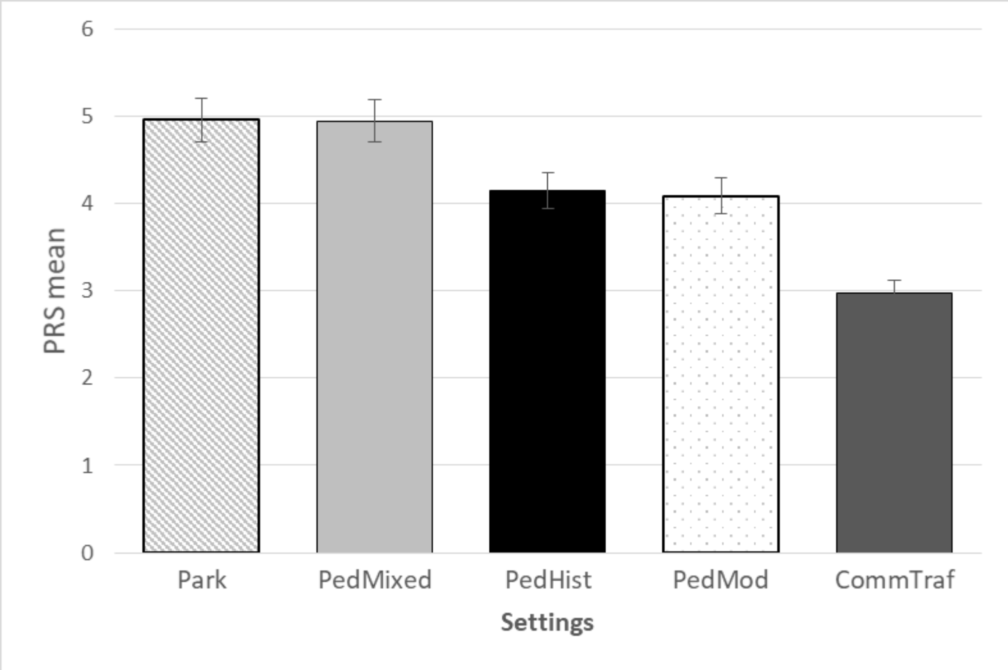

Figure 9: Perceived Restoration by setting and between-groups differences.

Note: PRS maximum score is 7 (single-column figure). Park = inner city park; PedMixed = pedestrianised setting with green and historic elements; PedHist = pedestrianised historic setting; PedMod = pedestrianised modern setting; CommTraf = commercial area with traffic.

3.4 Environmental perceptions

In line with H3, it was expected that the *non-grey* urban settings would be perceived as attractive and interesting as opposed to the commercial road with traffic. H3 was confirmed, as participants regarded PedHist, PedMod, and PedMixed as attractive and interesting, while CommTraf was perceived as not attractive nor interesting (Table 2).

Two one-way between subjects ANOVAs were conducted to test for possible differences between settings in terms of attractiveness and interestingness. These identified a statistically significant main effect of attractiveness also with a large effect size, $F(4, 268) = 35.485$, $p < .000$, $\eta_p^2 = .350$, and of interestingness with large effect, $F(4, 268) = 23.421$, $p < .000$, $\eta_p^2 = .262$. Scheffe post hoc analyses indicated that the commercial area with traffic was perceived as statistically less attractive than the pedestrianised historic *(p < .000)*, modern (*p* < .000), mixed environments (*p* < .000*)*, and Park (*p* < .000*)*. CommTraf was also perceived as statistically less interesting than PedHist (*p* < .000*)*, PedMod (*p* < .000*)*, PedMixed (*p* < .000*)*, and Park (*p* < .000*)*. In addition, the pedestrianised mixed environment was perceived as statistically more attractive than CommTraf (*p* < .000*)*, PedMod (*p* = .001), and PedHist (*p* = .026), and statistically more interesting than PedMod *(p* = .004) and Park (*p* = .001).

4. Discussion and Conclusions

The current study set out to investigate the immediate psychological wellbeing benefits of virtual exposure to different urban walking settings employing a mixed within and between-subjects experimental design. Settings included two pedestrianised streets with no evident natural elements (PedHist and PedMod), a predominantly built-up area with historic and green elements (PedMixed), one *grey setting* (an area with motor-traffic, CommTraf) and an urban park (Park). Results confirmed H1, as the simulated walks in PedHist, PedMod and PedMixed promoted an increase of hedonic tone, with the simulated walk in PedMixed also increasing relaxation levels. Conversely, the walk in the area with traffic decreased both relaxation and hedonic tone. H2 and H3 were also confirmed, as participants attributed higher perceived restorativeness, attractiveness, and interestingness to the simulated walks in the two pedestrianised settings compared to the traffic setting. Finally, H4 was partially confirmed, as PedHist scored relatively better than PedMod in relaxation and hedtone measurements, even though no between-settings differences were detected on any measure. These findings have relevance given the public health needs to create urban settings that support psychological wellbeing and to increase walking levels in cities. The implications are discussed in more detail below where they are placed in the context of the existing literature.

As noted above, the analysis revealed that there was a significant difference in affective outcomes, restorativeness perceptions, and environmental ratings between the simulated walks in the traffic environment and the two pedestrianised settings respectively. In ranking the five settings according to their affective and restorative potential, three categories of affective and restorative outcomes, rather than two (e.g. the classic dichotomy ‘urban vs natural’, e.g., Karmanov and Hamel, 2008), were highlighted. First, the two areas with green elements (Park and PedMixed). Second, the two pedestrianised areas with no evident greenery (PedHist and PedMod). Third, the *grey setting* with traffic (CommTraf). Importantly, the only simulated walk that was associated with negative effects and perceptions was the one in the area with traffic. Hence, the role of traffic emerges as key element linked to psychological wellbeing outcomes of walking. Arguably, motor-traffic could be the critical factor that caused the reduction in reported wellbeing in urban settings as identified by previous studies, as these were performed in areas with medium to heavy traffic (e.g. Hartig et al., 2003; Johansson et al., 2011; Tilley et al., 2017). Several observational studies have attested the negative influence of traffic exposure on affective variables in the urban (Knöll et al., 2017) and residential context (Von Lindern et al., 2016). The current results suggest that traffic could also have a role in immediate affective walking experiences and be one of the common denominators for those studies that identified negative psychological effects following walks in urban settings.

On the other hand, the simulated walks in the two pedestrianised settings with no evident natural elements (PedMod and PedHist) were associated with neutral or positive affective outcomes, and were perceived as mildly restorative, attractive, and interesting, as opposed to the *grey setting* with traffic. This finding contradicts Ulrich et al.'s (1991) research that found that virtual exposure to an area with traffic was associated with higher anger recuperation compared to a pedestrianised area. Arguably, their results might have been related to the fact that the pedestrianised street was an outdoor shopping mall with a relatively high pedestrian flow (7 to 35 pedestrians passing/min, Ulrich et al., 1991, p. 211), which might per se elicit stress and negative feelings for some participants (e.g., Evans, 1984). Hence, the current study reveals that exposure to some pedestrianised, non-crowded urban walking settings can support wellbeing despite the absence of major natural features. It should also be noted that the only walks associated with an increase in relaxation levels contained natural elements – a result which confirms theoretical and empirical claims on the stress relieving properties of nature (Kaplan, 1987; Ulrich, 1983).

Turning to H4, it was expected that virtual exposure to the pedestrianised historic environment (PedHist) would elicit greater affective benefits than exposure to the pedestrianised modern environment (PedMod). This was partially confirmed, as PedHist was associated with a significant increase of hedonic tone, while in the modern setting the increase was not significant. In addition, ratings for relaxation, perceived restoration, attractiveness, and interestingness were higher for the historic setting – even though no significant difference was detected between PedMod and PedHist on any measure. Hence, these findings are mixed, making it difficult for final conclusions to be drawn. However, both settings with historic elements (PedHist and PedMixed) scored positively on affective measures and environmental ratings. These results partially confirm the idea that the historic character of place might contribute to restoration (Fornara, 2011; Galindo and Hidalgo, 2005; Hidalgo et al., 2006), and extend previous research by attesting that such benefits also seem to take place in urban walking settings. The fields of urban planning and heritage studies hold that historic places offer an engaging and symbolic narrative linked to the relational value of cultural heritage (Hayden, 1997; Lynch, 1981; Smith, 2006). Based upon some of the current findings, it is suggested that such a narrative may elicit affective benefits and relieve attentional fatigue. In fact, scholars have already claimed that historic architectural styles reflect individuals' place identity (Fornara, 2011) and hence support place attachment (Cerina et al., 2016).

In addition, H4 is also partially corroborated by scores in the pedestrianised settings with historic and green elements (PedMixed). In fact, in PedMixed the affective outcomes and PRS ratings were comparable to those in the park setting, against expectations. Previous research has found that the presence of grass, trees, and bushes in pocket parks (Nordh et al., 2009) increase restoration likelihood. However, the current study has found that PedMixed was as restorative as the park setting, a result which perhaps comes as a surprise considering that PedMixed is a predominantly built-up urban setting, whilst the park is predominantly natural. Indeed, in contrast, some authors have associated the amount of grass surface and park size with restoration likelihood (Nordh et al., 2009). Hence, it is possible that the historic character of PedMixed, which was also significantly more interesting than the Park setting, contributed to its affective and restorative benefits. This warrants future investigation to try to establish the degree of natural elements combined with the degree of historic elements that are required for an environment to have such an effect on wellbeing during walking.

4.1 Limitations

There are limitations to the current study that need to be discussed. The first is related to the fact that this research was based on a simulation. Watching a video remains a proxy of walking, and the sensory experience is limited to the visual and aural dimensions, while research has indicated that other senses might represent important aspects of restorative and affective experiences (Conniff and Craig, 2016; Shaw et al., 2015). However, compared with photographic slideshows (Van den Berg et al., 2003;

Berto, 2005) using videos has the advantages of containing sound and reproducing the movement of walking in a more realistic way. In line with this, differences in affective measures between areas with and without traffic were significant and most had large effect sizes, giving an indication that the simulated walking paradigm was effective enough to elicit differences. Some previous research suggests that simulations offer a valid evaluation of restorative potential (Velarde et al., 2007) but are likely to underestimate restorative and affective benefits (Mayer et al., 2009). Hence, the current post-test assessments of affect might have *underestimated* both the negative effects of actual walking in areas with traffic and the benefits of actual walking in green areas. This could also explain why the increase in relaxation in the park setting was not significant. Future research could try to possibly extend these findings in a real-world scenario. A natural experiment (e.g. comparison in same area with traffic and during road closure) could also be performed to further test the effects of traffic on psychological wellbeing.

Second, findings are based on immediate self-reported data, which may be subject to response bias and may not reflect an enduring affective state. Nonetheless, previous research indicates that self-reported and physiological measures are generally consistent (Johansson et al., 2011). Future research could employ physiological measurements (e.g., Roe et al., 2013) and/or include stimuli with a longer time span in order to assess medium-term affective benefits. However, recent research has illustrated some challenges of using physiological measurements such as electroencephalogram (EEG), as these are not always consistent with participants' verbal accounts, so are best supported with participant interviews (Tilley et al., 2017). Therefore, mixed-methods designs that also include qualitative research are especially recommended. In addition, among the students it was not possible to determine whether participating in research was guided by intrinsic motivation. However, students who participated could choose from a wide range of research studies. In addition, the majority of respondents were from the employee group, and results extend previous research on psychological experiences of walking that was based exclusively on student samples (e.g. Johansson et al., 2011; Karmanov and Hamel, 2008), thus representing a strength of the current study.

Third, no significant differences between PedHist and PedMod were detected, against expectations. This is possibly due to the fact that PedMod was a high quality setting that can partially support wellbeing too, which is a finding in itself. Nonetheless, the current study did find that a setting with historic elements and little or no natural elements was associated with immediate affective benefits, thus confirming the potential of historic elements to support affect. Importantly, the current findings revealed that an urban street with traffic is not representative of all urban settings, as already noted by Staats et al. (2016). These results also warrant further research on the affective potential of the full range of urban settings, other than streets with traffic. Different kinds of environments in each category could be taken into account to extend these findings, with the ultimate aim of further improving the affective walking experiences in cities.

Fourth, it is possible that the affective outcomes were triggered by specific elements of the video stimuli. Despite settings were equivalent in terms of visual characteristics, number of passing pedestrians, and weather, city environments include a multitude of different sensorial features that are often unpredictable and uncontrollable, even more so than natural environments. In this sense, the simulation, as opposed to a field experiment, offered higher internal validity; future research might also employ virtual simulations to minimise confounding effects. Also, it is possible that perceived safety in particular might have influenced the experimental effect, as a trafficked road might be perceived as more dangerous that a traffic-free setting. In addition, despite participants were randomly assigned to the experimental conditions, it is possible that personal connections to place might have influenced the affective experience (see Ratcliffe and Korpela, 2016). For future investigations, qualitative research can offer useful insights to assess which specific elements of the experimental simulations – whether related to specific senses, perceived safety, or personal connections with place – have influenced the outcome (see Author hidden 2018a and 2018b).

Finally, it is possible that results might not generalise to rural inhabitants or non-Western cultures due to the varying values and conceptualisations of nature, motor traffic, and historic environments. For example, ethnic minorities or non-Western groups might have different perceptions over the historic features of the urban realm. In addition, results might not be generalizable to different age groups such as older adults, who may have different perceptions of safety and comfort, and to night time situations, with recent research showing that at night walking perceptions are also influenced by the type of artificial light (Johansson et al., 2014). Therefore, future research could focus on different socio-demographic groups, geographical contexts, and light conditions. The affective outcomes of walking in urban settings at night time are particularly relevant, considering that walk commuting takes place in the dark for many urban dwellers.

4.2 Conclusions and Implications

The current experimental study revealed that three daytime simulated walks in pedestrianised built-up settings led to a positive affective response and that the three settings were perceived as restorative, as opposed to a simulated walk in a *grey* setting – an area with motor-traffic. These results affirm the potential of some quintessentially urban walking settings to support immediate psychological wellbeing. In particular, exposure to a pedestrianised historic built area with no major natural elements elicited positive changes in hedonic tone and was perceived as more restorative than one area with traffic. Also, exposure to a pedestrianised area with historic and natural elements elicited an increase in relaxation hedonic tone, and was perceived as restorative as a park. Scholars and policy makers are already aware of the benefits of walking in nature as well as possible negative effects of walking in certain urban settings. This study, employing a simulated walk methodology, has shown that exposure to some urban pedestrianised walking settings have the potential to support affect, which is also among the predictors of behaviours (Mehrabian and Russell, 1974). This represents a first, important step in the examination of the psychological wellbeing outcomes of walking in urban, non-natural settings. Whilst previous research has attested that walking to work is associated with increased leisure time satisfaction (Chatterjee et al., 2017) and long-term psychological wellbeing (Martin et al., 2014), the current findings stress the importance of verifying the long-term effects of walking in positive urban settings, for example with longitudinal analysis on transport modes, environmental features, and health and wellbeing variables.

Practical implications related to public health, transport, and urban planning are also identified. First, the findings suggest that some of the benefits of being in nature can be offered by the highest quality traffic-free, pedestrian-priority urban environments with greenery (such as PedMixed). Hence, when it is not possible to include large green spaces in the urban fabric, high-quality urban design can still promote psychological wellbeing. Related to this, the results also confirm that incorporating natural elements in predominantly built settings is a successful strategy for improving wellbeing and the daytime walking experience. Second, policymakers and planners, when designing the management of traffic and allocation of space for pedestrians, should consider the psychological wellbeing benefits associated with exposure to pedestrianised settings, as opposed to settings with traffic. This is particularly relevant in locations within urban areas with high existing levels of walking, or in neighbourhoods in which there is little access to natural and/or public open spaces. Third, walking practitioners and tourism bodies should consider the added benefits on psychological wellbeing of walking in historic places, and encouraging daytime walks in old towns and historic parks.

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