

CASE STUDY



Field analysis of psychological effects of urban design: a case study in Vancouver

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ABSTRACT

City densification is associated with increased social isolation and poorer physical and mental health. As an important environmental and social context, the urban environment has great potential to shape residents' experiences and social interactions, as well as to mitigate social isolation by promoting trust and sociability. The current study examines the effects of urban design interventions, such as colorful crosswalks and greenery, on participants' mental well-being, sociability and feelings of environmental stewardship. Participants were led on walks of Vancouver's West End neighborhood, stopping at six sites (three intervention and three comparison sites) to indicate their emotional response to and perception of the environment using a smartphone application. Spaces with greenery and spaces with a colorful, community-driven urban intervention were associated with higher levels of happiness, trust, stewardship and attraction to the sites than their more standard comparison sites. Our findings demonstrate that simple urban design interventions can increase subjective well-being and sociability among city residents. Further, our experiment presents a novel environmental-psychological field methodology for collecting empirical affective and cognitive data on how individuals respond to urban design.

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Introduction

In 2016, Canada's three largest metropolitan areas, Toronto, Montreal and Vancouver, accounted for more than a third of the Canadian population (Statistics Canada 2017a). Despite being home to over 2.3 million people (Statistics Canada 2017b), social isolation was reported as one of the top concerns in 2011 for residents of Vancouver (Vancouver Foundation 2012). Social isolation has been linked to a myriad of physical and mental health concerns such as anxiety, depression and immune function (House et al. 1988, Baumeister and Tice 1990, Cacioppo et al. 2006, Uchino 2006). It is also argued to be a risk factor for mortality comparable to that of more well-established risk factors such as obesity and substance abuse (Holt-Lunstad et al. 2015), increasing it to the level of a significant public-health concern for Canadian cities.

As an important environmental and social context, the urban environment has great potential to shape residents' experiences and social interactions, as well as to mitigate social isolation by promoting trust and sociability. Thus, urban design interventions in shared or public spaces comprise one possible avenue toward reducing social isolation and its associated health concerns in large metropolitan areas. Research in urban design and environmental psychology offers a sense of what specific design

interventions may be beneficial to mental and physical well-being. Here, we outline three environmental features and design aspects that offer potential to be used as urban design interventions to improve sociability in public spaces.

One well-researched aspect of the environment, which has been documented extensively to positively influence people's feelings, health and sociability, is greenspace. Exposure to natural environments has been shown repeatedly to improve people's mood and well-being, reduce their stress levels and to have a psychologically restorative effect, compared to urban environments (e.g. Kaplan and Kaplan 1989, Hartig et al. 1991, Ulrich et al. 1991, Bowler et al. 2010, Park et al. 2010, Horiuchi et al. 2013). Exposure to nature, even through static images, has been shown empirically to lead to more cooperative and prosocial behavior (Jackson 2003, Zhang et al. 2013, Zelenski et al. 2015). Although studies highlighting the beneficial effects of nature exposure have typically compared natural environments to urban ones, these effects have also been shown using urban greenspace. For example, Nisbet and Zelenski (2011) found that walks through urban nature resulted in more positive moods compared to walks along an indoor path in the same area (see also Kaplan 1995, Fuller et al. 2007, Zelenski and Nisbet 2014).

Beyond greenspace, environmental preference and behavior may also be affected by environmental features that support the basic human needs to understand and explore one's environment. These features are rooted in Kaplan and Kaplan's (1989) well-cited model, which states that four environmental features reflecting immediately apparent and inferred information about one's environment predict environmental preference. These features are complexity (a scene's visual diversity and detail), mystery (what a scene offers through exploration), coherence (how organized a scene appears) and legibility (the ease with which a scene may be navigated and remembered) (Kaplan and Kaplan 1989). Complexity and mystery represent the immediate and inferred needs to explore one's environment, respectively, whereas coherence and legibility represent the respective immediate and inferred needs to understand one's environment. Although it is uncertain how reliably these features can predict environmental preference (Stamps 2004), the model is ubiquitous in the field of environmental psychology and remains an important framework for understanding environmental preference.

A third more subjective aspect of urban space with social implications is place attachment (Von Wirth et al. 2016). Studies have found that increased place attachment may promote social trust (Stefaniak et al. 2017), encourage prosocial attitudes and behavior (Da Silva et al. 2004) and predict environmental stewardship (Wakefield et al. 2001, Halpenny 2010). Although research on the environmental factors that can lead to increased place attachment is sparse, Von Wirth et al. (2016) found that perception of urban change, when both positive and familiar, can strengthen one's attachment to a place. Urban design interventions promoting place attachment may then reduce social isolation by promoting trust and prosocial behaviors among city residents.

With these results in mind, the current study explores urban design interventions – the addition of greenspace, a comparison of two different kinds of greenspace, and a place-making initiative promoting place attachment – that may help promote trust and sociability, and thus mitigate social isolation. In collaboration with Happy City, a Vancouver-based design, planning and architecture consultancy with a focus on health and well-being, we undertook a field study using a smartphone application to directly test the effect of these three interventions on affective and cognitive measures – with a specific focus on how these interventions affect trust and sociability – in Vancouver's West End neighborhood. We predicted that urban areas with greenery and community-driven tactical interventions would

be associated with greater feelings of social trust, happiness, stewardship and other indicators of well-being than standard comparison sites.

Our study builds on foundational work in environmental psychology examining human response to the urban environment, such as Nasar's (1994) general principles on evaluative responses provoked by building exterior qualities and Hillier's (1996) framework of how spatial configurations influence human behavior. The present study contributes to knowledge in this field through its novel methodology allowing us to collect empirical data on affective response to the built environment. Our experimental field approach allows us to capture responses to different environmental stimuli in ecologically meaningful ways that are not possible with laboratory methods. Though the details of our field study are specific to Vancouver, we believe that any major metropolitan area, especially those experiencing increased density, may benefit from our findings.

Methods

Participants and procedure

Our final sample consisted of 102 participants (68 women; Mean age = 39, $SD = 12$) who were led on one of two route versions (*standard*, $n = 52$, 37 women, Mean age = 38, $SD = 10$; *reverse*, $n = 50$, 31 women, Mean age = 41, $SD = 14$). An additional four participants were excluded due to three files being unavailable due to technological error, and one participant with an incorrect route programmed on their Android device.

Participants were invited to join walks of Vancouver's West End as part of a workshop at Project for Public Spaces' Pro Walk/Pro Bike/Pro Place conference, held in September 2016. This convenience sample was employed as a convenient, low-cost method of recruitment, though we acknowledge here and elsewhere in the paper the usual possibility of bias when such samples are employed. When participants arrived at the workshop, they received a short briefing in which experimenters explained how to use an Android phone to answer questions based on their location.

Each walk, led by a trained guide, took approximately 1 h. Volunteer guides were recruited from the Vancouver Public Space Network and were trained in how to set-up the smartphones, how to obtain informed consent and how to guide participants along the walking route. During the walk, participants were stopped at six predetermined locations, where they were asked to respond to the same set of questions about their moods and their perception of the environment (see Table 1 for the

Table 1. Survey questions asked at each site with response ranges.

| Question | Response Range |
|---|----------------------------------|
| How would you rate your current level of arousal? | Relaxed – Aroused |
| How pleasant is the current location? | Unpleasant – Pleasant |
| How interesting is the current location? | Uninteresting – Interesting |
| How would you rate your current level of attraction to the site? | Want To Avoid – Want To Approach |
| If I noticed a piece of litter here, I would place it in a nearby trash receptacle. | Agree – Disagree |
| I would be upset if someone vandalized this space. | Disagree – Agree |
| Rate your happiness in this moment. | Unhappy – Happy |
| I feel people in this place can be trusted. | Agree – Disagree |
| If you were to lose your wallet at this location, how likely do you think it would be for a stranger to return it to you? | Very Unlikely – Very Likely |
| I want to come back here again in the future. | Disagree – Agree |
| This is the kind of place where I would like to meet with friends. | Agree – Disagree |

Note. All questions were rated on a 1–5 Likert-type scale.

questions asked at each site). This brief survey, rather than a set of standardized scales, was employed because of the time constraint of the walk, as well as for the comfort and safety of participants. Note, however, that the questions that we included in our brief survey were rooted in some standard instruments that have been used to measure place-based affect (Mehrabian and Russell 1974), social trust (Helliwell and Wang 2011) and attraction to natural spaces (Kaplan and Kaplan 1989). Two items were created to measure environmental stewardship, which reflects a responsibility to care for and maintain an environment. At each site, participants were instructed to face a particular direction. They observed the site silently for 1 min before completing the questionnaire using a smartphone application on the Android devices. Following the return to the conference, participants received a debriefing session and an opportunity to discuss the study with other members of the tour and with the tour guide. This study received ethical approval from the University of Waterloo's Office of Research Ethics (ORE #21,651, approved 12 August 2016).

Site selection

Three pairs of sites were selected, with each pairing differing on one design element (see Figure 1 for photographs of each site). The first pairing between a green residential laneway (Figure 1(a)) and a standard residential laneway (Figure 1(b)) was selected to examine the effect of greenspace on affective and cognitive measures. The green laneway featured several gardened spaces, whereas there was no greenery in the standard, hardscaped laneway.

The second site pairing compared a community garden (Figure 1(c)) with a formal greenspace (Figure 1(d)) in front of the conference venue. Both were greenspaces, but they differed in their formality and management: The formal greenspace was well-manicured, maintained by hotel staff and monitored

by security personnel; the community garden was wilder, maintained by community volunteers and not formally monitored. This site comparison was selected to examine the effects of two commonly encountered types of greenspace with a diversity of plant life, and, therefore, differing levels of visual complexity, coherence, legibility and mystery.

The third site pairing compared a rainbow-painted street intersection (Figure 1(e)) with a standard crosswalk intersection (Figure 1(f)), with both intersections located in Vancouver's lesbian, gay, bisexual, transgender and queer (LGBTQ+) district. This pairing was selected to highlight the effect of a place-making initiative at the rainbow-painted crosswalk.

On the *standard* route, sites were visited in the following order: Formal greenspace, green laneway, standard laneway, rainbow intersection, standard intersection and community garden (see Figure 2 for a map of the site locations). The *reverse* route visited these sites in reverse order.

Results and discussion

Univariate outliers were Winsorized to within 3.29 standard deviations of the mean, after which all z-scores were < 3.29 and > -3.29 , skew for all variables < 3 , and kurtosis < 10 , indicating normally distributed data.

Reliability analyses indicated that our items achieved acceptable reliability (Tavakol and Dennick 2011), with Cronbach's alpha estimates for all items except arousal¹ ranging from .81 to .87 between locations.

A mixed-factorial 6 (Location) \times 2 (Route Order) repeated-measures analysis of variance (ANOVA) test was carried out on each self-reported variable to determine whether location had a significant effect on these variables, as well as to investigate and control for order effects. All main effects of location were significant at the $p < .001$ level (see Table 2). Post-hoc tests were then carried out between each of the three site pairings to investigate the significant

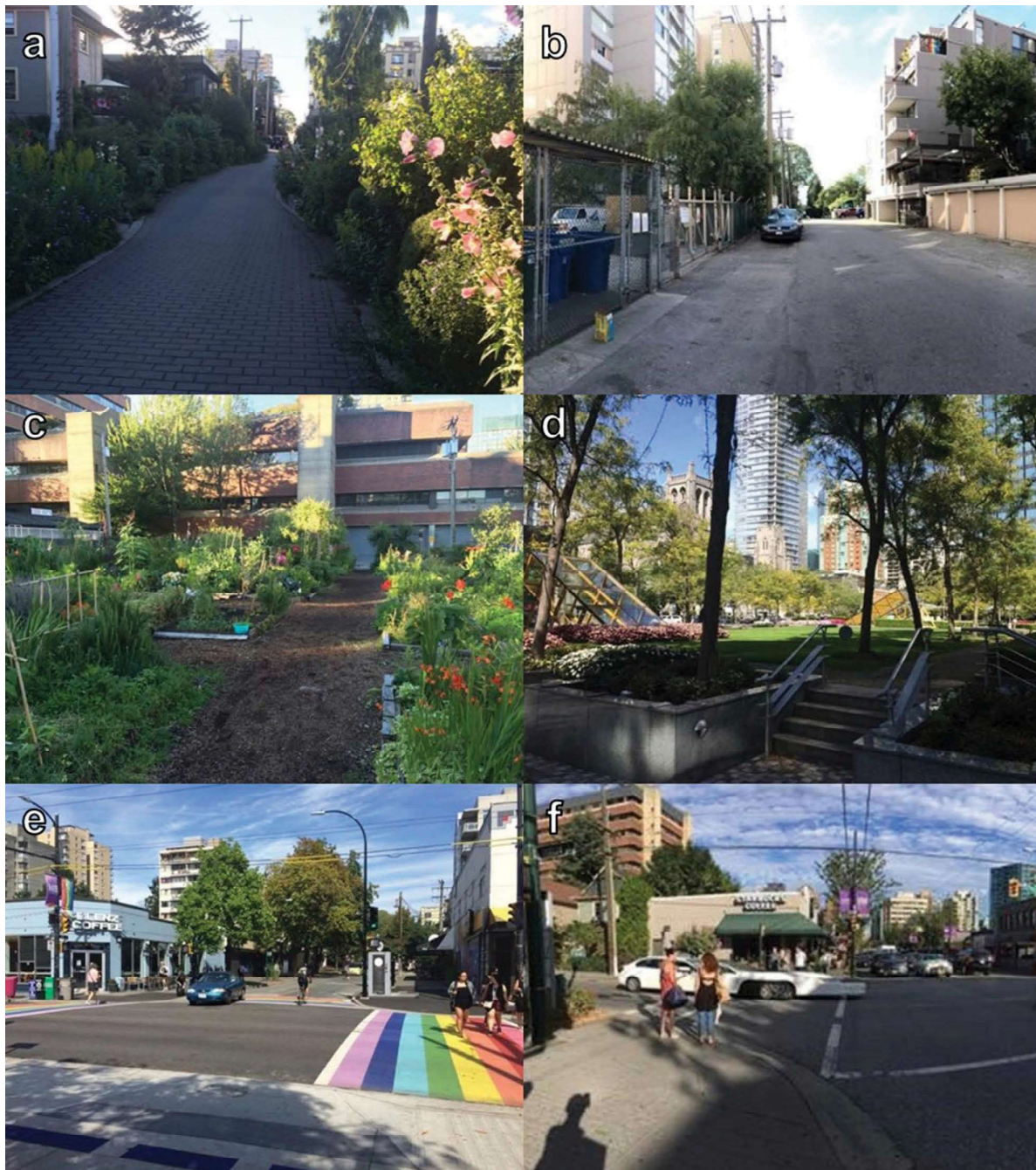


Figure 1. The six sites visited on the walking tour, arranged by pairing: (a) community garden, (b) formal greenspace, (c) rainbow intersection, (d) standard intersection, (e) green laneway and (f) standard laneway.

omnibus ANOVA results, with a Bonferroni correction of $\alpha = .02$ applied to reflect the three site comparisons (see Figure 3–6 and Table 3).

In general, our results confirmed what we had predicted: We found that spaces with greenery and spaces with a colorful, community-driven urban intervention were associated with higher levels of happiness, trust and attraction to the sites than their more standard comparison sites.

The green laneway consistently produced more positive ratings in comparison with its site pairing, the standard laneway. Examination of the affective

variables (see Figure 3) showed that participants were happier at and found the green laneway to be more pleasant and attractive than the standard laneway. Participants found the green laneway to be more interesting but less arousing than the standard laneway (see Figure 4). The decreased self-reported arousal at the green laneway may speak to the restorative effects of greenspace, which can reduce stress levels (see, e.g. Jiang et al. 2016). The greenery also appeared to foster feelings of stewardship (see Figure 5), as participants were more willing to pick up litter at the greenway and indicated they would be more upset if the green



Figure 2. A map of the guided walk, with site locations and viewing directions indicated.

Table 2. Mixed-factorial repeated-measures ANOVA results examining the effect of location and route order on self-report measures.

| Variable | Main Effect of Location | | Main Effect of Route Order | | Interaction | |
|------------------------|-------------------------|------------|----------------------------|------------|------------------------|------------|
| | <i>F</i> | η_p^2 | <i>F</i> | η_p^2 | <i>F</i> | η_p^2 |
| Trust | 55.56*** | .37 | 0.35 | .004 | 2.14 | .02 |
| Wallet Return | 61.25*** | .38 | 7.35** | .07 | 5.28*** ^a | .05 |
| Desire to Meet Friends | 81.15*** | .46 | 6.60* | .06 | 4.45*** ^a | .04 |
| Desire to Return | 121.93*** | .56 | 2.96 | .03 | 1.92 | .02 |
| Litter | 120.09*** | .56 | 3.03 | .03 | 4.14*** ^e | .04 |
| Vandalism | 93.66*** | .49 | 2.44 | .03 | 1.81 | .02 |
| Happiness | 61.31*** | .39 | 7.67** | .07 | 3.93*** ^a | .04 |
| Pleasantness | 140.51*** | .59 | 22.24*** | .19 | 2.29 | .02 |
| Attraction to Site | 105.48*** | .52 | 12.26*** | .11 | 1.12 | .01 |
| Interest | 106.55*** | .52 | 7.50** | .07 | 3.30*** ^{a,f} | .03 |
| Arousal | 78.20*** | .44 | 1.81 | .02 | 4.30*** ^f | .04 |

Note. Greenhouse-Geisser corrections were used on all measures, as Mauchly's tests revealed sphericity violations. * $p < .05$. ** $p < .01$. *** $p < .001$. ^{a, e, f} Route comparison was significant at the $\alpha = .01$ level by independent samples *t*-test; locations are labeled consistently with Figure 1. All comparisons saw higher scores for the reverse route compared to the standard, except for self-reported arousal.

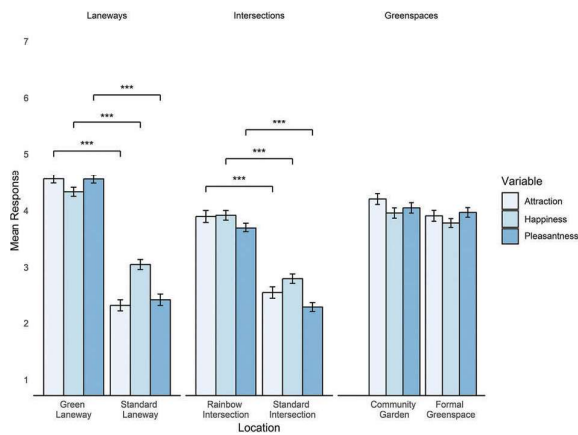


Figure 3. The three pairs of sites compared on affective measures of attraction, happiness and pleasantness. Error bars represent ± 1 standard error of the mean (SEM). Significant differences are denoted with asterisks. *** $p < .001$. No other differences were significant after applying the Bonferroni correction, all $p > .032$.

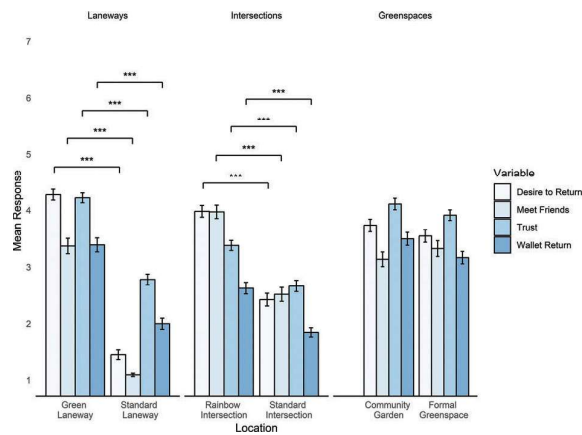


Figure 6. The three pairs of sites compared on sociability measures of desire to return, meet friends, trust in strangers and likelihood of a lost-wallet return. Error bars represent ± 1 SEM. Significant differences are denoted with asterisks. *** $p < .001$. No other differences were significant after applying the Bonferroni correction, all $p > .019$.

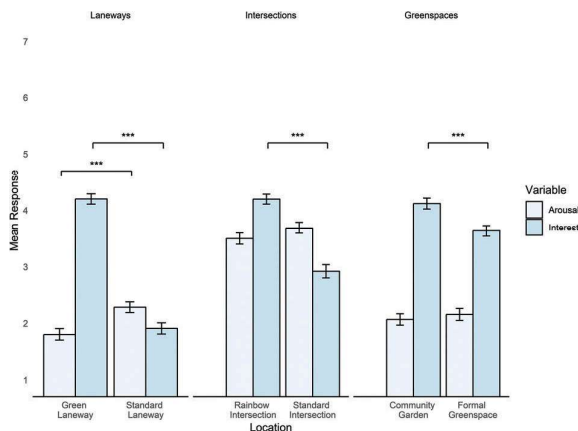


Figure 4. The three pairs of sites compared on cognitive measures of arousal and interest. Error bars represent ± 1 SEM. Significant differences are denoted with asterisks. *** $p < .001$. No other differences were significant after applying the Bonferroni correction, both $p > .10$.

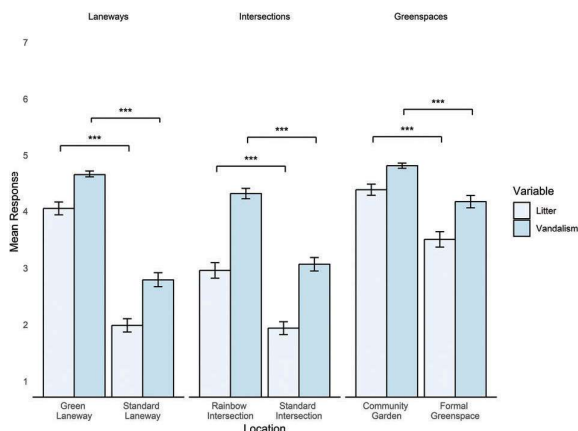


Figure 5. The three pairs of sites compared on stewardship measures of litter and vandalism. Error bars represent ± 1 SEM. Significant differences are denoted with asterisks. *** $p < .001$.

laneway were vandalized as compared to the standard laneway. Finally, the green laneway elicited higher scores on all sociability variables (see Figure 6) compared to the standard laneway. At the green laneway, participants were more trusting of strangers and more likely to believe a lost wallet would be returned to them. Furthermore, compared to the standard laneway, participants were more eager to return to the green laneway and to meet friends there.

The comparison between the rainbow intersection and standard intersection yielded similar results to the laneway comparison. Compared to the standard intersection, participants were happier at the rainbow intersection and found it more attractive, pleasant and interesting. Participants reported a greater sense of stewardship at the rainbow intersection and were more likely to wish to return to it and to meet friends there than at the standard intersection. Participants also reported greater trust in strangers and greater likelihood of a wallet return at the rainbow intersection compared to the standard intersection.

The comparison between the formal greenspace and community garden yielded the smallest differences of all the site pairings. We found that participants were significantly more interested in the community garden, were more willing to pick up litter at this space and had higher objections to vandalism in this space than at the formal greenspace. The results here perhaps reflect a more diffuse responsibility rooted in community, as opposed to a more concentrated management of the formal greenspace, which is managed by hotel security and staff. These findings support Krasny and Tidball's (2017) suggestion that community gardens facilitate environmental stewardship and civic engagement through the restoration of land that is typically neglected, and through the building of relationships

Table 3. Means and standard deviations for all variables at each site.

| Variable | Site | Mean | SD | N |
|------------------------|-----------------------|------|------|-----|
| Trust | Green Laneway | 4.22 | 0.88 | 102 |
| | Blank Laneway | 2.78 | 0.94 | 100 |
| | Community Garden | 4.11 | 1.02 | 100 |
| | Formal Greenspace | 3.91 | 0.96 | 102 |
| | Rainbow Intersection | 3.38 | 0.90 | 102 |
| Wallet Return | Standard Intersection | 2.67 | 0.98 | 102 |
| | Green Laneway | 3.39 | 1.24 | 102 |
| | Blank Laneway | 2.00 | 1.00 | 102 |
| | Community Garden | 3.50 | 1.16 | 102 |
| | Formal Greenspace | 3.17 | 1.11 | 102 |
| Desire to Meet Friends | Rainbow Intersection | 2.63 | 1.01 | 102 |
| | Standard Intersection | 1.85 | 0.82 | 102 |
| | Green Laneway | 3.37 | 1.38 | 102 |
| | Blank Laneway | 1.09 | 0.29 | 100 |
| | Community Garden | 3.14 | 1.31 | 102 |
| Desire to Return | Formal Greenspace | 3.33 | 1.40 | 101 |
| | Rainbow Intersection | 3.97 | 1.21 | 102 |
| | Standard Intersection | 2.52 | 1.25 | 102 |
| | Green Laneway | 4.28 | 0.97 | 102 |
| | Blank Laneway | 1.44 | 0.85 | 101 |
| Litter | Community Garden | 3.73 | 1.07 | 101 |
| | Formal Greenspace | 3.55 | 1.10 | 100 |
| | Rainbow Intersection | 3.98 | 1.05 | 102 |
| | Standard Intersection | 2.43 | 1.13 | 101 |
| | Green Laneway | 4.05 | 1.13 | 101 |
| Vandalism | Blank Laneway | 1.99 | 1.17 | 101 |
| | Community Garden | 4.38 | 0.99 | 102 |
| | Formal Greenspace | 3.50 | 1.36 | 101 |
| | Rainbow Intersection | 2.96 | 1.38 | 102 |
| | Standard Intersection | 1.94 | 1.13 | 101 |
| Happiness | Green Laneway | 4.67 | 0.63 | 102 |
| | Blank Laneway | 2.79 | 1.27 | 102 |
| | Community Garden | 4.82 | 0.45 | 101 |
| | Formal Greenspace | 4.17 | 1.09 | 101 |
| | Rainbow Intersection | 4.31 | 0.91 | 101 |
| Pleasantness | Standard Intersection | 3.07 | 1.20 | 102 |
| | Green Laneway | 4.33 | 0.79 | 101 |
| | Blank Laneway | 3.05 | 0.87 | 102 |
| | Community Garden | 3.96 | 0.89 | 101 |
| | Formal Greenspace | 3.79 | 0.77 | 102 |
| Attraction to Site | Rainbow Intersection | 3.92 | 0.83 | 101 |
| | Standard Intersection | 2.80 | 0.82 | 102 |
| | Green Laneway | 4.55 | 0.71 | 102 |
| | Blank Laneway | 2.41 | 1.01 | 102 |
| | Community Garden | 4.05 | 0.91 | 102 |
| Interest | Formal Greenspace | 3.97 | 0.84 | 102 |
| | Rainbow Intersection | 3.70 | 0.85 | 100 |
| | Standard Intersection | 2.28 | 0.80 | 102 |
| | Green Laneway | 4.55 | 0.74 | 102 |
| | Blank Laneway | 2.31 | 0.98 | 102 |
| Arousal | Community Garden | 4.20 | 0.94 | 100 |
| | Formal Greenspace | 3.91 | 0.95 | 102 |
| | Rainbow Intersection | 3.90 | 1.03 | 101 |
| | Standard Intersection | 2.54 | 1.01 | 102 |
| | Green Laneway | 4.20 | 0.90 | 102 |
| | Blank Laneway | 1.91 | 1.00 | 102 |
| | Community Garden | 4.12 | 0.95 | 101 |
| | Formal Greenspace | 3.64 | 0.96 | 102 |
| | Rainbow Intersection | 4.20 | 0.88 | 102 |
| | Standard Intersection | 2.92 | 1.18 | 102 |
| | Green Laneway | 1.80 | 1.05 | 102 |
| | Blank Laneway | 2.28 | 0.95 | 102 |
| | Community Garden | 2.07 | 1.01 | 102 |
| | Formal Greenspace | 2.16 | 1.07 | 102 |
| | Rainbow Intersection | 3.50 | 1.00 | 102 |
| | Standard Intersection | 3.69 | 0.99 | 101 |

within the community that is required for maintaining these spaces.

However, the two sites did not differ significantly on any other measure. When devising the site pairings, we did not anticipate the effect of the conference, which was hosted at the hotel behind the formal greenspace; with the conference came a temporary transformation

of this formal greenspace, and many more visitors to the space than normal. These anomalies may have thus affected our measures. Prior to the start of the conference, the formal greenspace had little pedestrian traffic, seating or decoration. However, conference organizers and attendees had transformed the area into a more lively space, filling the front of the hotel adjacent to the formal greenspace with benches, colorful chairs and tables, plants and a set of oversized Jenga-type blocks (see Figure 7). We believe that this transformation of space into one with increased social meaning may have decreased the formality and altered the use of this space to more closely resemble that of the community garden, leading to our null findings. Notably, the pattern of non-significant differences in this comparison may be an indication of the power that such place-making activities can have on an otherwise lifeless public space.

Because participants were led on one of two versions of the walking route, order effects were analyzed to determine whether there were differences in any of the measures between the standard and reverse routes. Several of the self-reported variables showed significant interactions between route order and location; these significant interactions were investigated with post-hoc independent-samples *t*-tests (see Table 2). All post-hoc tests were adjusted with a Bonferroni correction of $\alpha = .01$ for the comparisons between the two route orders at each of the six locations. Pleasantness, interest, attraction, happiness, likelihood of a lost-wallet return and desire to meet friends all showed significant main effects of route order, with the reverse route scoring significantly higher than the standard route on all variables.

These effects of route order were mostly driven by differences found at the green laneway in particular, such that responses were higher at the green laneway after arriving from the standard laneway (on the reverse route), as opposed to having arrived from the formal greenspace (on the standard route). All of the order effects may be characterized as stemming from participants' comparisons of sites, in that there are higher positive ratings of intervention sites (e.g. the rainbow intersection) after arriving from their paired standard comparison site (e.g. the standard intersection) than after arriving from a different standard comparison site (e.g. the standard laneway), as well as lower positive ratings of a standard comparison site after arriving from its paired intervention site as compared to arriving from a different intervention site.²

Limitations and future directions

The fact that many of our predictions were borne out is encouraging, but we are cautious to generalize these findings. One limitation of the study is our participant pool, which drew exclusively from

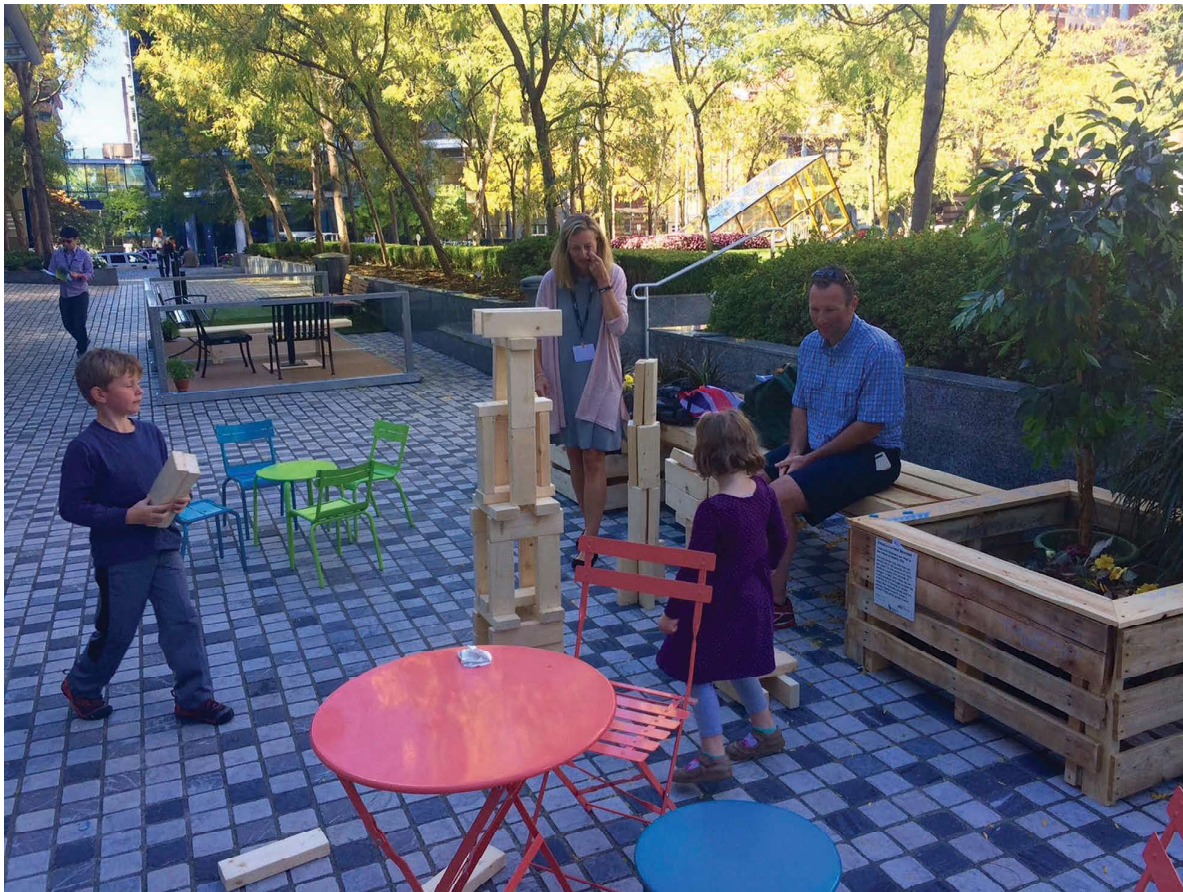


Figure 7. The area outside the conference venue next to the formal greenspace site.

attendees of an urbanist conference. Over a third (38.2%) of the participants indicated they work in the planning sector. Because our study employed self-report measures, it is possible that participants' preconceptions and biases influenced how they responded (though see, e.g. Gjerde 2011, which found preference for visual order in the urban environment among both architectural and planning professionals and lay people). It will be interesting to see whether and to what extent responses from a lay population will differ from the current sample. Although the generality of the current findings may be limited in this respect, the value and significance of our methodology remain unaffected and may be employed for other participant populations and include other measures.

Furthermore, because the participants were visitors to rather than residents of Vancouver's West End neighborhood, our study does not speak to regular exposure to these three design interventions. Although other urban psychology studies using an experience sampling method do show relationships between environment and affect (e.g. MacKerron and Mourato 2013, Fujiwara et al. 2017, Shoval et al. 2018), our study has the benefit of consistency in

what brings participants to the sites, giving us stronger experimental control.

Third, our study cannot speak to the effect of sociological variables such as homophobia at the rainbow crosswalk. Although individual attitudes toward the LGBTQ+ community may have affected participants' reactions to the rainbow intersection, because we did not collect this data, we are unable to tease apart this effect from the visual effect of the colorful paint. Future directions may include incorporating more qualitative approaches to examine this question as well as to complement our quantitative findings.

Finally, it is important to be clear that our measures describe affective responses 'in the moment,' and, though it seems logical to suppose that place-based affective responses captured by methods such as those we describe will, in the longer term, accrue mental health and wellness benefits to citizens who enjoy frequent contact with such places, our intention in this brief study was not to establish the verity of such connections.

Conclusion

Considering the current rate of urbanization, it is increasingly important to understand how the urban

environment shapes our mental, physical and social well-being. Our study presents a novel environmental-psychological methodology for collecting empirical affective and cognitive data on how individuals respond to urban design, and highlights the potential of urban design interventions to both increase subjective well-being and to help mitigate social isolation among city residents. Specifically, greenery and community-driven interventions that promote place attachment – both relatively simple, low-cost projects that municipal administrators can help communities undertake – show great potential to improve both individual and community well-being. We hope this study will serve as a model for others that follow, and that it will play a part in helping cities to create intentional design changes within their various neighborhoods toward the improvement of the health and well-being of their inhabitants.

Notes

1. Arousal was the only variable that did not reflect valence, and as such behaved much differently than the other items.
2. The exception to this pattern is the higher rating of arousal, the only variable without valence, at the standard intersection after arriving from the rainbow intersection (on the standard route) than after arriving from the community garden (on the reverse route). In this case, participants on the standard route would have calibrated their arousal based on the high arousal level they had already reported at the rainbow intersection.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Notes on contributors

Hanna R. Negami is a doctoral candidate in cognitive neuroscience in the Department of Psychology at the University of Waterloo. Her research is broadly guided by the question of how the esthetics of our immediate environment shapes our cognition and behavior. Her work focuses on the effects of awe in built environments; and she also explores, from a cognitive perspective, how people perceive and interact with public and private spaces.

Robin Mazumder is a Vanier Scholar and doctoral candidate in cognitive neuroscience in the Department of Psychology at the University of Waterloo, where he is studying the psychological impacts of urban design. He is particularly interested in how the built environment of the city influences emotion and proxemics. Prior to beginning his doctorate, Robin worked in community mental health as an occupational therapist. This frontline clinical experience working in urban centers inspires his research interests.

Mitchell Reardon is an urbanist with Happy City, IBI Group and Metropolitan Collective, as well as board member for the Vancouver Public Space Network. Mitchell's interdisciplinary work centers on health and well-being, innovations in urban processes and technology, and tactical urbanism. He pursues these subjects through real-world experimentation, small-scale improvements to the built form and smart city policy development.

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References

- Baumeister, R.F. and Tice, D.M., 1990. Anxiety and social exclusion. *Journal of social and clinical psychology*, 9 (2), 165–195. doi:10.1521/jscp.1990.9.2.165
- Bowler, D.E., et al., 2010. A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC public health*, 10 (1), 456. doi:10.1186/1471-2458-10-456
- Cacioppo, J.T., et al., 2006. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analysis. *Psychology and aging*, 21 (1), 140–151. doi:10.1037/0882-7974.21.1.140
- Da Silva, L., et al., 2004. Civic responsibility among Australian adolescents: testing two competing models. *Journal of community psychology*, 32 (3), 229–255. doi:10.1002/(ISSN)1520-6629
- Fujiwara, D., Lawton, R.N., and MacKerron, G., 2017. Experience sampling in and around airports. Momentary subjective wellbeing, airports, and aviation noise in England. *Transportation research part D*, 56, 43–54. doi:10.1016/j.trd.2017.07.015
- Fuller, R.A., et al., 2007. Psychological benefits of green-space increase with biodiversity. *Biology letters*, 3, 390–394. doi:10.1098/rsbl.2007.0149
- Gjerde, M., 2011. Visual evaluation of urban streetscapes: how do public preferences reconcile with those held by

- experts? *Urban design international*, 16 (3), 153–161. doi:10.1057/udi.2011.10
- Halpenney, E.A., 2010. Pro-environmental behaviours and park visitors: the effect of place attachment. *Journal of environmental psychology*, 30, 409–421. doi:10.1016/j.jenvp.2010.04.006
- Hartig, T., Mang, M., and Evans, G., 1991. Restorative effects of natural environment experiences. *Environment and behavior*, 23 (3), 3–26. doi:10.1177/0013916591231001
- Helliwell, J. and Wang, S., 2011. Trust and wellbeing. *Journal of Wellbeing*, 1 (1), 42–78.
- Hillier, B., 1996. *Space is the machine: A configurational theory of architecture*. Cambridge: Cambridge University Press.
- Holt-Lunstad, J., et al., 2015. Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspectives on psychological science*, 10 (2), 227–237. doi:10.1177/1745691614568352
- Horiuchi, M., et al., 2013. Influence of forest walking on blood pressure, profile of mood states and stress markers from the viewpoint of aging. *Journal of aging and gerontology*, 1, 9–17.
- House, J.S., Landis, K.R., and Umberson, D., 1988. Social relationships and health. *Science*, 241 (4865), 540–545. doi:10.1126/science.3399889
- Jackson, L.E., 2003. The relationship of urban design to human health and condition. *Landscape and urban planning*, 64 (4), 191–200. doi:10.1016/S0169-2046(02)00230-X
- Jiang, B., et al., 2016. A dose-response curve describing the relationship between urban tree cover density and self-reported stress recovery. *Environment and behavior*, 48 (4), 607–629. doi:10.1177/0013916514552321
- Kaplan, R. and Kaplan, S., 1989. *The experience of nature: A psychological perspective*. New York: Cambridge University Press.
- Kaplan, S., 1995. The urban forest as a source of psychological well-being. In: G.A. Bradley, ed. *Urban forest landscapes: integrating multidisciplinary perspectives*. Seattle: University Washington Press, 100–108.
- Krasny, M.E. and Tidball, K.G., 2017. Community gardens as contexts for science, stewardship, and civic action learning. In: J. Blum, ed. *Urban horticulture: ecology, landscape, and agriculture*. Oakville, ON: Apple Academic Press, 267–290.
- MacKerron, G. and Mourato, S., 2013. Happiness is greater in natural environments. *Global environmental change*, 23, 992–1000. doi:10.1016/j.gloenvcha.2013.03.010
- Mehrabian, A. and Russell, J.A., 1974. *An approach to environmental psychology*. Cambridge, MA: MIT Press.
- Nasar, J.L., 1994. Urban design aesthetics: the evaluative qualities of building exteriors. *Environment and behavior*, 26 (3), 377–401. doi:10.1177/001391659402600305
- Nisbet, E.K. and Zelenski, J.M., 2011. Underestimating nearby nature: affective forecasting errors obscure the happy path to sustainability. *Psychological science*, 29 (9), 1101–1106. doi:10.1177/0956797611418527
- Park, B.J., et al., 2010. The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. *Environmental health and preventive medicine*, 15 (1), 18–26. doi:10.1007/s12199-009-0086-9
- Shoval, N., Schvimer, Y., and Tamir, M., 2018. Tracking technologies and urban analysis: adding the emotional dimension. *Cities (London, England)*, 72, 34–42. doi:10.1016/j.cities.2017.08.005
- Stamps, A.E., 2004. Mystery, complexity, legibility and coherence: a meta-analysis. *Journal of environmental psychology*, 24, 1–16.
- Statistics Canada, 2017a. *Population size and growth in Canada: key results from the 2016 Census* [online]. Available from: <http://www.statcan.gc.ca/daily-quotidien/170208/dq170208a-eng.htm> Accessed 15 August 2017
- Statistics Canada, 2017b. *Census profile, 2016 Census: Vancouver [Census metropolitan area], British Columbia and Canada [Country]* [online]. Available from: <http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E> Accessed 15 March 2018
- Stefaniak, A., Bilewicz, M., and Lewicka, M., 2017. The merits of teaching local history: increased place attachment enhances civic engagement and social trust. *Journal of environmental psychology*, 51, 217–225. doi:10.1016/j.jenvp.2017.03.014
- Tavakol, M. and Dennick, R., 2011. Making sense of Cronbach's alpha. *International journal of medical education*, 2, 53–55. doi:10.5116/ijme.4dfb.8dfd
- Uchino, B.N., 2006. Social support and health: a review of physiological processes potentially underlying links to disease outcomes. *Journal of behavioral medicine*, 29 (4), 377–387. doi:10.1007/s10865-006-9056-5
- Ulrich, R.S., et al., 1991. Stress recovery during exposure to natural and urban environments. *Journal of environmental psychology*, 11, 201–230. doi:10.1016/S0272-4944(05)80184-7
- Vancouver Foundation, 2012. *Connections and engagement: A survey of metro Vancouver* [online]. Available from: <https://www.vancouverfoundation.ca/sites/default/files/documents/VanFdn-SurveyResults-Report.pdf> [Accessed 15 August 2017]
- Von Wirth, T., et al., 2016. Exploring the influence of perceived urban change on residents' place attachment. *Journal of environmental psychology*, 46, 67–82. doi:10.1016/j.jenvp.2016.03.001
- Wakefield, S.E.L., et al., 2001. Environmental risk and (re) action: air quality, health, and civic involvement in an urban industrial neighbourhood. *Health & place*, 7, 163–177. doi:10.1016/S1353-8292(01)00006-5
- Zelenski, J.M., Dopko, R.L., and Capaldi, C.A., 2015. Cooperation is in our nature: nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of environmental psychology*, 42, 24–31. doi:10.1016/j.jenvp.2015.01.005
- Zelenski, J.M. and Nisbet, E.K., 2014. Happiness and feeling connected: the distinct role of nature relatedness. *Environment and behavior*, 46 (1), 3–23. doi:10.1177/0013916512451901
- Zhang, J.W., et al., 2013. An occasion for unselfing: beautiful nature leads to prosociality. *Journal of environmental psychology*, 37, 61–72. doi:10.1016/j.jenvp.2013.11.008