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ABSTRACT

Problem, research strategy, and findings: City leaders are under pressure to increase urban residential density to provide affordable housing and meet sustainability objectives. Yet despite the advantages of urban densification, communities throughout North America persistently oppose new developments and housing projects in their neighborhoods. The impact of residential densification on the quality of life for existing residents is ambiguous. In this study we focus on measuring the impact of one key aspect of urban densification: the perceived quality of public space. We use an experimental design to increase pedestrians and stationary users in a pedestrianized green street for randomly selected periods over 3 weeks. We collected surveys with and without our pedestrian treatment and find that adding users to a residential street decreased the perceived quality of the space overall. The changes in perceptions were small yet significant and illustrate the real tradeoffs that planners must consider when increasing urban density in cities, especially in lower density residential communities.

Takeaway for practice: Increasing the number of public users in a residential neighborhood may slightly decrease the perceived quality of the public space. Women's perceptions differ from those of men, and women are more sensitive to the addition of public users. We illustrate how planners may use public life experiments to anticipate how the public might respond to future changes in the public realm.

Keywords: crowding, densification, experiment, public space, upzoning

Single-family zoning, a major fixture of the North American city, has recently come under attack (Wegmann, 2020). Pressures for affordable housing have forced many city leaders to question the political and environmental feasibility of the most common zoning type in North America, frequently referred to as R1 zoning. We are beginning to see signs that planners are opening the door to densification in single-family neighborhoods. Progressive cities and states are picking away at the protections once afforded to low-density enclaves, despite the threat of backlash from residents (Bliss, 2019; Holder & Capps, 2019).

In Minneapolis (MN), the city plan has universally upzoned all single-family and duplex lots to allow for triplexes, eliminating single-family zoning in the city (City of Minneapolis, 2019; Kahlenberg, 2019). Seattle (WA) has passed a similar measure, and Charlotte (NC) and Austin (TX) are studying to do the same (Holder & Capps, 2019). Vancouver (Canada) has allowed basement suites and lane-way homes in most single-family zones for more than a decade, and now there are discussions about eliminating single-family zones entirely (Crook, 2019; St. Denis, 2019). The state legislature of Oregon has gone further, proposing statewide legislation eliminating single-family zones in cities across the state, and California legislators have proposed similar measures with Senate Bill 50 (Bliss, 2019). There seems to be growing momentum behind the idea that planners should seriously consider abolishing R1 zoning in their communities (Manville et al., 2020; Monkkonen & Manville, 2019).

But what would a residential neighborhood feel like if we added more people? These communities are accustomed to quiet streets with little foot traffic. How would the presence of more people change the quality of public space? Theorists in urban design argue that people are attracted to people and that cities benefit from lively

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streetscapes (Gehl, 2010; Whyte, 1980), especially with spaces promoting stationary, lingering, and social activities (Mehta, 2007, 2013; Mehta & Bosson, 2018). These theories are particularly directed at commercial streets and lively squares and plazas, but would the same be true in a residential neighborhood? If a city were considering upzoning in a residential neighborhood, could planners point to "vibrant street life" as an argument in favor of residential densification and upzoning? Can we quantify the changes in the perceived quality of public space when we add more residents?

Questions about the perceptions of public space with the presence of more people have gained renewed attention during the COVID-19 pandemic (Honey-Rosés et al., 2020). Now more than ever, we are sensitive to the presence of people around us. Although our research is framed in the context of residential densification, the pandemic has created an additional reason why planners and researchers might be interested in understanding perceptions of public space under more crowded conditions.

In this study we measure how perceptions of public space change when additional people are added to the public realm. Although our study site is not zoned R1, the street is residential, quiet, calm, and verdant, just like many residential streets across North America. We use an innovative experimental design in which we add pedestrian users to a pedestrianized green street in a randomly selected number of hours. We then surveyed users of the greenway with and without our pedestrian treatment and find that the addition of people reduced the perceived quality of the public space. With more people on the street, the street was found to be more crowded and noisier but not necessarily more interesting or vibrant or a better place to people-watch.

Though there are many benefits to residential densification in cities, we find that adding more pedestrians and public users to quiet residential areas produces measurable decreases in satisfaction overall. It is unclear how people might respond to the same treatment in other types of urban spaces, especially downtown centers or squares, and we do not feel that our results are transferable to vastly different urban environments. Nevertheless, our work illustrates the real tradeoffs that planners must consider when upzoning, especially in lower density residential communities.

We also aim to make a methodological contribution. Experimental research is rare in planning yet may produce original insights. We show that public life experiments are feasible and may be used by planners to anticipate how residents may respond to changes in the public realm.

In the next section we review the two literatures where we aim to make a unique contribution: residential densification and perceptions of public space. We then describe our experimental design to measure changes in perceptions when more people were added to a pedestrianized green street. We find that although the changes in perception are small, the addition of more public users did not improve the perceived quality of the space for most measures. We observe that women appear to be more sensitive to the addition of public users than men. We anticipated that frequent users of the space, such as neighbors, would have different responses to the public life treatment, potentially because they perceived this street as a parochial space, but their changes in perceptions are surprisingly similar to users who had never been to this place before. We conclude by recognizing that our results are far from definitive but also demonstrate a new methodological approach for studying proposed changes in the public realm.

The Pressure to Upzone and Densify

Cities in North America and around the world are under pressure to increase urban residential density for environmental and social gains (Boyko & Cooper, 2011). The compact city has the potential to help address pressing problems associated with affordable housing, energy use, and environmental sustainability (Monkkonen & Manville, 2019; Neuman, 2005). Advocates in favor of increasing urban density argue that compact cities are more sustainable because they tend to be walkable and transit oriented and have smaller environmental footprints (Frank et al., 2006; Rees & Wackernagel, 1996). City leaders have even codified increases in density as an explicit policy goal (Boyko & Cooper, 2011), as exemplified in the EcoDensity Charter passed by the Vancouver city council in 2006 (Rosol, 2013). Furthermore, scholars argue that compact cities are more livable and produce a higher quality of life for residents (Mouratidis, 2018).

Planners aiming to densify their city must often rezone or upzone existing neighborhoods (Gabbe, 2019b). Researchers have studied how upzoning can increase land values and in some instances accelerate gentrification (Freemark, 2020). New developments and rezoning projects can bring additional housing, new amenities, services, or commercial areas that will benefit residents new and old alike. Greater densities and increased pedestrian traffic also provide "eyes on the street" in public space that may increase the sense of safety and community (Jacobs, 1961). Upzoning has also been put forward as part of the solution to the affordable housing crisis (Bliss, 2019).

Yet despite the potential advantages of the compact city, communities throughout North America persistently oppose new developments and housing projects (Monkkonen & Manville, 2019). This opposition is one expression of the "not in my backyard" (NIMBY)

phenomenon aimed at new housing projects or rezoning plans. The pushback from residents and voters remains a persistent and vexing challenge for urban planners. Indeed, organized NIMBY residents mobilized against new housing projects have been compared to cartels, aimed at keeping others out for private gains (Monkkonen & Manville, 2019).

Opponents of new residential developments argue that densification will negatively affect the quality of life of existing residents. They voice concerns about straining public services, increasing traffic, changing neighborhood character, or reducing available parking. Certainly, some of these concerns may be well founded. Increased urban densities may increase traffic, reduce parking availability, or generate more noise and nuisance (Bonnes et al., 1991; O'Toole, 2001).

Planning researchers have studied how to engage with communities resistant to change and NIMBYism. Doberstein and colleagues (2016) use an experimental design in British Columbia (Canada) to test which messaging strategies are most effective at reducing opposition to housing projects and NIMBY attitudes. They find that messages that emphasize the public benefits of housing projects had the most impact on changing perceptions.

Yet debates about how residential densification may affect the quality of life of existing residents are filled with uncertainty and ambiguity. One area of ambiguity concerns how increases in residential density may affect the quality of public space with more users. On the one hand, urban residents may value adding new residents to their neighborhood because they enjoy people-watching or feel enlivened by vibrant and well-used public parks, plazas, or streets (Toderian, 2014). Yet on the other hand, our preferences for lively or calmed areas may depend on context and be less well received in residential areas. In low- to medium-density residential areas, it is particularly unclear how the addition of new users may be received because the residents and homeowners living in these areas have self-selected themselves to live in quiet residential streets and therefore may be more likely to be bothered by noise, the presence of youth, or the absence of calm and privacy (O'Toole, 2001; Talen, 2001). At the same time, these lower density areas may be most in need of upzoning to meet environmental or affordable housing goals (Gabbe, 2019a).

Understanding Perceptions of Public Space

Urban planners, urban sociologists, and environmental psychologists have studied an array of consequences associated with packing more people into cities. In the 1970s and 1980s, much of this literature focused on the negative impacts of crowding, noise, and stress associated with dense city living. In this early work, urban crowding was described as a negative environmental stressor that was predicted to negatively influence social relations and psychological health (Baum et al., 1978; Regoeczi, 2003). Whereas some argued that high-density urban living could lead to negative impacts on health and reduced conviviality, it was difficult to isolate the causal relationship between dense urban living and other confounding factors. Furthermore, environmental and social psychologists found that individual perceptions of crowding are driven by contextual and socio-physical features not necessarily related to actual social density (Bonnes et al., 1991).

Environmental psychologists distinguish density from crowding, in which *density* refers to the number of individuals in an area, whereas *crowding* refers to individuals' subjective feelings about the number of people around them (Gifford, 2014). Increased density will not always increase perceptions of crowding. Crowding is a relative perception of a particular circumstance that may be influenced by emotions, mood, norms, conditions, or social and physical elements. In the last few decades, research on urban crowding has become less common, perhaps in part because the trend of urban decay has reversed, many downtown areas have revitalized, and cities are increasingly becoming a desirable place to live and more successful in attracting highly skilled labor (Glaeser, 2011). The scholarship on perceptions of crowding has been advanced by researchers studying recreation areas who find that crowding is particularly difficult to measure because perceptions may shift over time and the number of people needed to make a place feel crowded gradually increases (Kohlhardt et al., 2018).

The density of users in a public space will also affect social interactions and perceptions of safety. For some, a large number of users may increase the perception of safety and encourage others to join in and socialize; for others, the life in cities implies increasing contact with strangers, which some people find overwhelming (Gifford, 2014). Some respond by trying to avoid contact with others (McCauley et al., 1978). How people respond to the presence of others in public can also vary by gender. Although women tend to perceive public spaces as less safe, they may find higher density more appealing and less stressful than men (Mozingo, 1989). A fundamental consideration for the design of public spaces pertains to how perceptions might differ across demographic groups.

Another literature, emerging from environmental psychology, studies how people perceive the quality of public space. This group of scholars has identified key elements associated with positive perceptions of public space, such as noise and sounds (Liu et al., 2013;

Meng & Kang, 2016; Meng et al., 2018), vegetation, brightness, and saliency of social norms (Keizer et al., 2008). Enjoyable natural soundscapes are associated with improved perceptions of a place, whereas road traffic noise tends to have a negative association (Axelsson et al., 2014). Music is preferred over sounds related to human activities and also engages more people in the public space (Meng et al., 2018). Other researchers have used lab experiments to identify the appropriate dose of vegetation on the public space and its relationship with health (Jiang et al., 2014) and biometrics measurements as outcomes of green spaces (Ward Thompson et al., 2012). Laboratory work on perceptions of urban density finds that perceptions are unusually stable to common psychological priming mechanisms such as unpleasant smells or signs of poor hygiene (Hooper, 2018). Although the findings of existing work clearly support the idea that the "quality" of the public space determines the perceptions and experiences of users, experimental evidence establishing a cause-and-effect relationship remains scant.

We are particularly interested in how perceptions might change in a pedestrianized green street or greenway situated in a residential community. It is important to highlight that here we study a pedestrianized green street abundant in vegetation because the design and type of public space studied are likely to influence how perceptions change when new elements are added.

There are a variety of methods and frameworks to study perceptions of public space. In this study we use a field experiment to learn how adding users to a pedestrianized green street may change perceptions. Our respondents were unaware of our intervention during treatment conditions. This approach differs considerably from what has been done in the past. For example, scholars of public space have adopted the Brunswik lens model to study how changing environmental conditions may modify perceptions in an urban environment (Craik & Appleyard, 1980). Alternative approaches may look at users' physiological or psychological responses to changes in the green street conditions. Measures including pulse and heart rate, nervous and endocrine activity, or cognitive outcome levels can help determine how specific environmental conditions affect users (Hansen et al., 2017; Ideno et al., 2017; Song et al., 2014, 2016). These studies suggest that green environments are associated with lower blood/heart rates and emotional regulation (Igarashi et al., 2015; J. Lee et al., 2014; M. Lee et al., 2015; Ochiai et al., 2015; Olafsdottir et al., 2020), as well as with mental restoration (Igarashi et al., 2015; Olafsdottir et al., 2020) and cognitive improvements (Chiang et al., 2017; Jiang et al., 2014; Ochiai et al., 2015; Park et al., 2011). Noise reduction by green infrastructure (Yang et al., 2011) and improved acoustic urban environments (Medvedev et al., 2015) improve visitors' psychological and emotional experiences. Unlike our work, where participants are in situ users of the green street, studies using physiological measures generally involve small sample sizes and intrusive measurement tools, and participants are aware of the research design and tasks they are requested to perform.

Experiments in Planning

The experimental research design we describe here is unique in the planning literature (Honey-Rosés & Stevens, 2019). A search of the *Journal of the American Planning Association* with the keyword "experiment" produces only 13 research articles (July 2019). Of these, only two refer to a formal research experiment (Lindsey & Knaap, 1999; Neuberg, 1986), which is our interest here. The absence of experimental methods is not unique to the *Journal of the American Planning Association*. A review of the methods used by planners in the *Journal of Planning Education and Research* similarly shows that planners rarely experiment (Du Toit et al., 2017). We understand that experimentation is rare in planning because it is difficult. At the same time, researchers from other disciplines have used experiments to study urban questions (Honey-Rosés, 2019; MacDonald et al., 2019). Below we describe an experimental design to study perceptions of public space.

An Experimental Framework to Measure Perceptions of Public Space

Study Area

We study the perceptions of one particular public space in a residential community in Vancouver. Our study took place on a pedestrianized green street that traverses a multiunit residential neighborhood on the southern edge of a university campus. The street is aligned with the central axis of the university and serves as the southern gateway to campus (Figure 1). The street is wide enough to support emergency vehicles but prioritizes nonmotorized transportation (Figure 2). The surrounding landscaping is abundant in vegetation and grass, making it an inviting place for rest, contemplation, and relaxation. The sound of water from a fountain contributes to a peaceful environment.

The greenway is rectangular (155 m long and 20 m wide). The street has three public benches that can comfortably fit three people each, and there is informal seating on a fountain ledge that may seat eight more. Residents have direct access to the street through a private patio gate or via a main entrance located at the center of the street. To the north, one enters the university campus. To the south, this street connects to a site

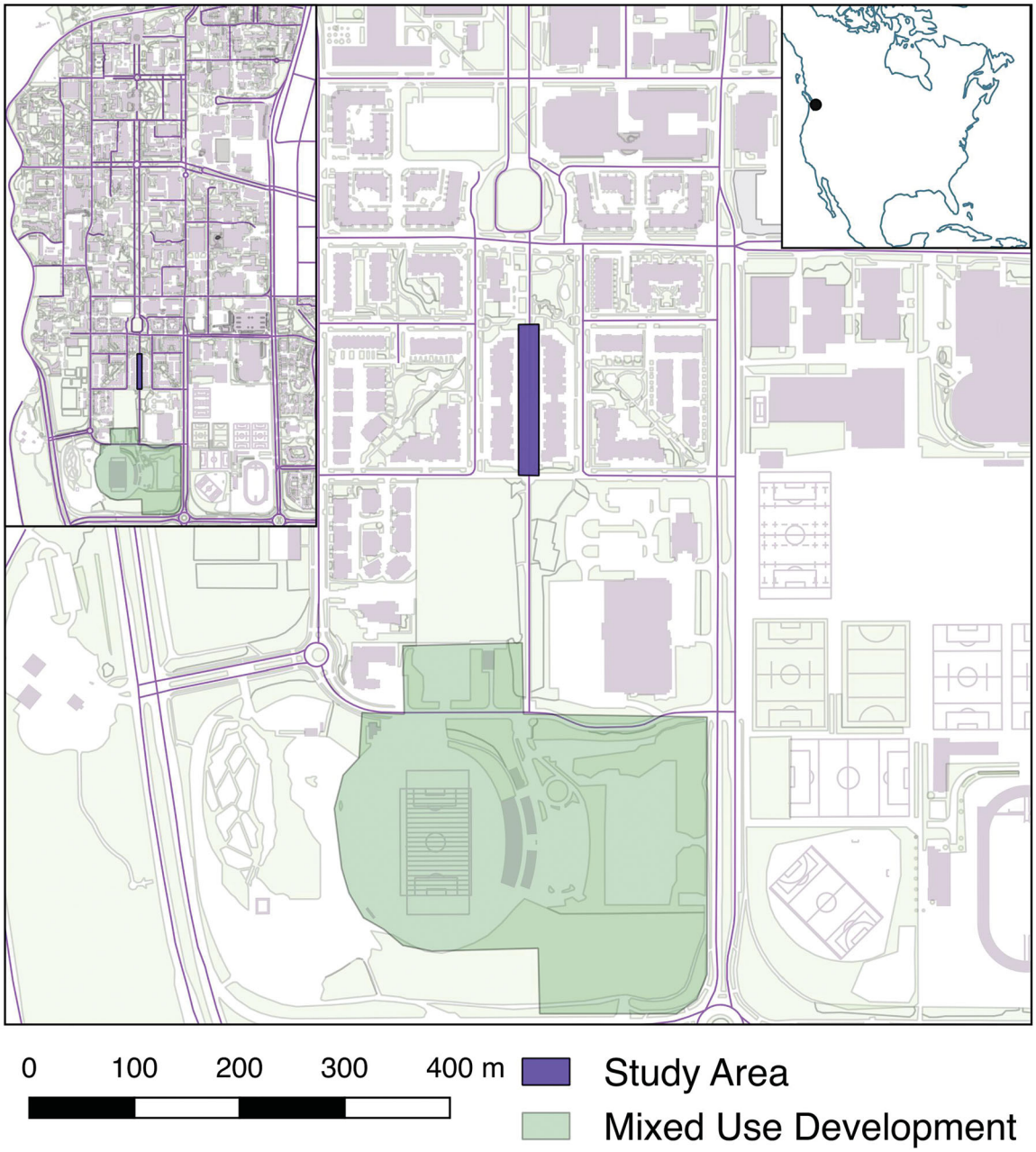

Figure 1. Study area. The residential street is aligned with the central axis of the university. The development of new residential and academic buildings to the south of campus is expected to increase pedestrian traffic moving through this pedestrian corridor.

that is planned for development and expected to be a new mixed-use development. Beyond the undeveloped site, there is a mixed-use neighborhood with a secondary school, university housing, and market housing. In the site planned for development, the current plan is to develop 1.5 million square feet of housing, of which up to two-thirds will be rental housing (Korenberg, 2019). Current residents have expressed concern about this new development and the negative impacts generated by introducing additional residents nearby. The study area will be sandwiched between two important university developments, and the corridor is likely to be the primary pedestrian route to buildings and services in the south (and north), leading to increased pedestrian traffic. Existing residents have also expressed opposition to the building height and residential densities being proposed by the university (Korenberg, 2019). The tension between the university planning staff and existing residents who oppose new development is illustrative of the types of conflicts in cities around North America, making this a useful context in which to

Figure 2. The studied pedestrianized green street in Vancouver (British Columbia, Canada).

study how a simulated increase in urban density may change the perceptions of public space.

Intervention

We introduced additional pedestrians and public users to the pedestrianized green street during a random set of hours for 3 weeks in the month of August 2018. We restricted data collection to weekdays between 10 a.m. and 4 p.m. and randomized eligible hours ($n = 90$) into treatment or control periods. We block randomized by day and time to produce balanced treatment and control observation periods (see Technical Appendices 1 and 2). We collected surveys for 90 h, of which 45 were randomly selected treatment hours and 45 were random selected control hours. During treatment hours, we relied on 10 paid confederates and a rotating team of 21 volunteer confederates to act as pedestrians and public users. Each treatment hour included 10 paid confederates plus 1 to 6 volunteers for a total of 11 to16 additional public users. We developed a pedestrian protocol for confederates that described their role and expectations. The confederates rotated between three roles: pedestrians, quiet staying activity, and social staying activity. Confederates were divided into three groups (pedestrians, quiet staying, and social staying) and played each role for 20 min. Pedestrians were instructed to walk up and down the pedestrian street in a group or by themselves. We asked them to engage in normal behavior and not bring attention to themselves. Those playing the role of social staying activity could chat, share stories, or engage in casual conversation without being loud or conspicuous. Those playing the role of quiet staying activity engaged in quiet activities such as reading, studying, enjoying nature, or using electronics. Our intervention combined multiple forms of public users, which is more likely to reflect the real complexities of urban life. At this stage, we are not interested in isolating the effects of specific users (pedestrians versus staying activity) but rather on the combined effect of their presence.

All confederates were from the university community; most were undergraduate students. The age and demographic composition of the confederates were representative of the university community. The confederates were predominately female (61%), White (45%),

Table 1. Agree/disagree statements in treatment and control conditions on a scale of 1 to 7 ($N = 506$).

Statement	Variable	Control	Treatment
Today, I feel welcome in this space.	Welcome	6.42	6.21
Today, this is a vibrant public space.	Vibrant	5.32	5.49
Today, I feel crowded here.	Crowded	1.79	2.15
Today, this public space is ideal for people watching.	Watching	4.26	4.52
Today, this public space is dull (not interesting).	Dull	2.38	2.43
Today, it is too noisy for my taste.	Noisy	1.81	2.04
I would like to spend more time here.	More time	5.88	5.74
Overall, this is a high-quality public space.	High quality	6.15	6.10

and Asian (42%). Each confederate received clear guidelines to not raise suspicion that they were part of an experimental study. They were asked to check in with a coordinating confederate and not speak with the research assistants collecting the survey data to avoid raising suspicion that the pedestrians were part of the research.

Data Collection and Analysis

We used an intercept survey to measure perceptions and attitudes of users in the public space during treatment and control hours. Three university researchers collected surveys that asked respondents agree/disagree statements about the greenway scored on a scale from 1 to 7. We developed our own agree/disagree statements that aimed to be clear and unambiguous (Table 1). Because we did not use validated agree/disagree statements, we piloted the survey prior to data collection. The data collection routine was exactly the same for treatment and control periods. Respondents could only complete one survey. Our research design was approved by the Behavioural Research Ethics Board of the University of British Columbia (H18-01446). We analyzed our data using an ordered logit regression model that accounts for the ordinal data and allows us to determine whether the differences observed between the treatment and control subjects may be attributed to the intervention or due to chance (see Technical Appendix 4). We developed a pre-analysis plan that outlined our hypothesis and analytical approach that was deposited in the registry managed by Evidence in Governance and Politics (Study ID 20180810AA) before data collection.

Hypotheses

We hypothesized that adding users to the pedestrianized green street would change perceptions and that these changes would differ by subgroup. Specifically, we hypothesized that our intervention would make the space feel more welcoming, more vibrant, more interesting, more noisy, more crowded, and a more attractive place to watch others. We were uncertain how the intervention would influence perceptions about the overall quality of the public space or whether they would want to spend more time in this space. We are interested in both the direction of the change (positive or negative) and the size of the effects.

We hypothesized differential effects by gender and frequency of use. In particular, we hypothesized that university students and members of the university community would be more likely to appreciate the addition of public life, whereas more frequent users and current residents would view the introduced changes negatively.

Limitations

Our field experiment has several limitations. First, our results might differ at different sites or times of day. Our results are specific to changes in perceptions during working hours on weekdays. We cannot extrapolate our results to perceptions at night. Furthermore, as with any experimental design, there may be questions about how our results might be valid in other sites or contexts (external validity). We cannot extrapolate our results to a busy city square or downtown streets, yet we believe our site is comparable with other residential streets, especially greenways and pedestrianized streets. It would be valuable to conduct a public life experiment in streets with even lower densities in the suburbs. Similarly, it would be valuable to learn how perceptions might change in more lively spaces, squares, or downtown areas. It is difficult to predict whether our results are transferable to these other spaces, beyond the residential street.

Second, our experiment narrowly measures short-term changes in perceptions rather than a long-term change in utility. In addition, our study is not able to account for the tradeoffs associated with upzoning. The debate surrounding changes in urban density must balance different costs and benefits, and our work

Table 2. Changes in perception associated with the addition of public users to a residential street by gender and frequency of visit.

	Regression models: Ordered logit						
		Gender		Frequency of visits			
Outcome variables	All (1)	Female (2)	Male (3)	Often (4)	Occasionally (5)	Rarely (6)	Never (7)
Noisy	0.404* (0.202)	0.314 (0.323)	0.833** (0.310)	0.611* (0.299)	−0.143 (0.615)	0.142 (0.798)	0.813 (0.654)
Crowded	0.607*** (0.184)	0.721* (0.315)	0.455 (0.267)	0.895** (0.321)	−0.300 (0.585)	1.175 (1.046)	1.127* (0.652)
Dull	0.091 (0.185)	0.336 (0.280)	−0.234 (0.302)	0.151 (0.292)	−2.465** (0.789)	0.336 (0.778)	1.118* (0.540)
Watching	0.302 (0.183)	0.256 (0.293)	0.491 (0.288)	0.133 (0.287)	0.364 (0.609)	1.155 (0.863)	0.277 (0.428)
Vibrant	0.184 (0.186)	−0.201 (0.301)	0.436 (0.271)	−0.001 (0.276)	−0.220 (0.612)	−0.347 (1.188)	0.994* (0.494)
More time in public space	−0.251 (0.183)	−0.243 (0.267)	−0.018 (0.274)	−0.088 (0.287)	−0.066 (0.537)	−1.940* (1.016)	−0.106 (0.584)
High quality	−0.360 (0.197)	−0.579* (0.294)	−0.092 (0.319)	−0.111 (0.308)	0.349 (0.677)	−1.123 (1.055)	−1.807* (0.766)
Welcome	−0.346 (0.201)	−0.638* (0.301)	−0.072 (0.309)	−0.386 (0.329)	−0.264 (0.622)	−0.908 (0.955)	−0.327 (0.597)
Block variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	506	244	262	224	104	61	114

Notes: Standard errors in parentheses. The coefficients show how perceptions changed on each dimension as a result of the pedestrian treatment by comparing respondents in the treatment condition with respondents in the control condition. We find that the addition of street users makes the space feel noisier and more crowded. In the other dimensions, the change in perceptions varies by gender and by how frequently a visitor walked through the site. We include a block variable that indicates the day and time of the respondent's visit (i.e., Monday 10 a.m.; Thursday 3 p.m.). This allows us control for shared characteristics of individuals visiting the residential street the same day and time. For example, visitors at noon may share the characteristics because they go for a walk during their lunchtime, whereas visitors in the morning (e.g., 10 a.m.) may share the characteristic of having a more flexible work schedule. Controlling for these shared characteristics make our results more precise. *$p < .05$; **$p < .01$; ***$p < .001$.

narrowly focuses on only one aspect of dense urban living without accounting for many of the other benefits. Furthermore, we are only able to measure short-term changes, whereas in the long run, users' perceptions and expectations about public space are likely to adapt and change over time (Kohlhardt et al., 2018).

Third, a public life experiment that adds people to public space might be sensitive to the gender, race, or ethnicity of the confederates. Research has shown that race can be a key determinant of urban perceptions and behavior (Goddard et al., 2015). In an innovative urban experiment, researchers demonstrate that drivers have a systemic bias against Black pedestrians waiting to cross at a crosswalk, even when meticulously controlling for pedestrian height, build, gender, and clothes (Goddard et al., 2015). Therefore, race could influence perceptions, especially in highly racialized contexts. In our case, the composition of our confederate team was similar to the gender, race, and ethnic composition that one might expect and not unusual in any way.

Another critique pertains to the reliability of the responses from residents or frequent users of our study site. It has been suggested that current residents or frequent users of the site might answer the survey based on their experience of the site and not on what was happening at the moment when the survey was administered. The survey prompted respondents to consider the current conditions and underscored this by starting each statement with "Today, … " (Table 1). It is impossible for us to determine how many, if any, of the survey respondents based their answers on some preconceived notion of what the space was like. But in the case that frequent users responded based on past experience, rather than the experimental condition, they would essentially be ignoring the treatment conditions and responding based on their preconceived notions, or control conditions. This would underestimate the treatment effects among this subgroup and amplify the difference between frequent and first-time visitors. Yet in our results, the differences between frequent and first-time visitors are smaller that what we expected, not greater. Therefore, although we cannot rule out a downward bias on our results from the frequent visitors (Table 2, column 4), we suspect that this bias is small.

Adding Street Users Reduces the Overall Quality of the Greenway

We find that the overall quality of the greenway decreased slightly as a result of the additional public users introduced by our experiment. Our results are based on 506 survey responses, of which 254 surveys were collected in the treatment condition (with additional people) and 252 were collected under typical conditions (without additional people). The randomization by hour produced comparable treatment and

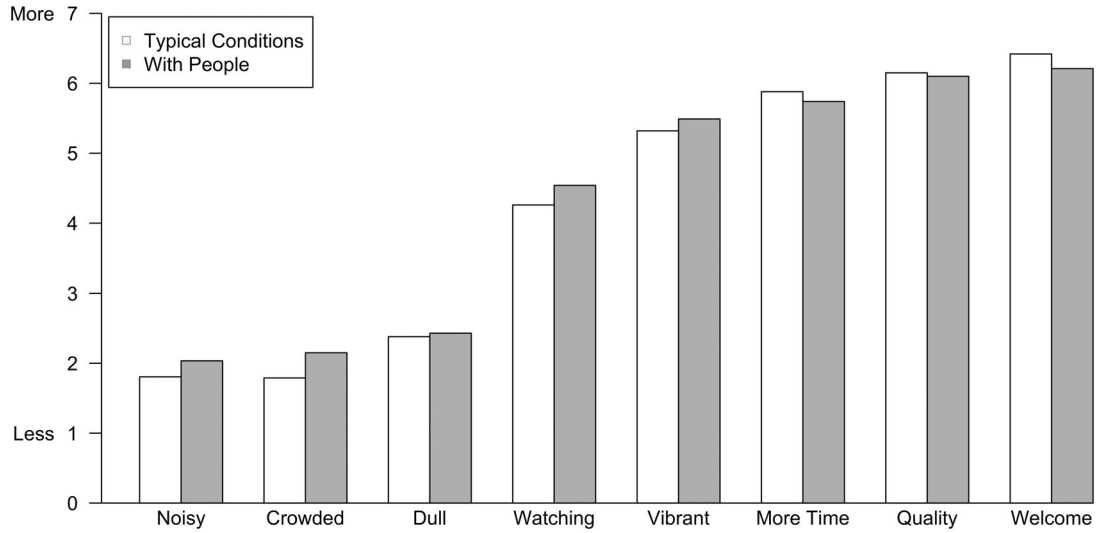

Figure 3. A comparison of mean Likert scores of surveyed public users during typical conditions (without additional public users) and during the experimental treatment (with people).

control groups that were similar in age, gender, university affiliation, and residency (Technical Appendix 3).

Increasing pedestrian and stationary activity in the pedestrianized green street led respondents to perceive the place to be more crowded, noisier, less welcoming, and of slightly lower quality overall (Figure 3). We observed the largest effect on perceptions related to crowding (*Today, I feel crowded here*) and noise (*Today, it is too noisy for my taste*). The results related to crowding and noise are statistically significant and consistent with our hypothesis.

We had hypothesized that that the presence of more public users would make the space feel more vibrant and less dull (more interesting) and a better place to watch people. Yet the effects we observe across these dimensions when including both genders are not statistically significant, suggesting either that our treatment did not change these perceptions or that the treatment effect is too small to be captured with our sample size.

It is important to clarify that during the experimental treatment conditions, residents did not find the space to be *too noisy* or *too crowded*. Rather, we find that our treatment shifted perceptions slightly to make the space feel a bit noisier and a bit more crowded. Similarly, our pedestrian treatment did not lead respondents to feel that the place was a low-quality public space or make them not want to spend more time there. These places remained enjoyable across all dimensions measured even with more public users. We merely find that these places are perceived to be of slightly lower quality when additional users were added.

Gender Differences: Women Are More Sensitive to the Addition of Public Users and Feel Less Welcome

Women and men agreed that the addition of public users made the street feel more crowded and noisier and a better place to watch people and that the overall quality of the space decreased. On most dimensions we found consistency between the two genders, because the sign of the coefficient was the same for both women and men (Table 2, columns 2 and 3). However, with a careful look, we also see important differences.

We find statistically significant results for women in the answer to the statements "Overall, this is a high-quality public space" and "Today, I feel welcome in this space," in which women felt *less* welcome and had more negative views of the space when more public users were present. The reduced feeling of being welcomed in the space is notable and concerning. For men we also find negative coefficients for welcome and high quality, but the size of the coefficient is very small. Therefore, the reduced quality in public space in aggregate terms seems to be driven mostly by women scoring the place lower during treatment conditions.

Looking across the other dimensions, if we compare the size of the coefficients between women and men, we see that women consistently have stronger negative views about the pedestrian treatment. In five of the eight variables, women have larger coefficients than men, suggesting that women are more sensitive than men to the addition of public users in public space. These findings suggest that there are real gender differences in the perceptions of public space.

Different Perceptions Based on Familiarity With the Site

We hypothesized that those individuals most familiar with the greenway would respond negatively to the addition of public users, especially compared with first-time visitors. Neighbors are more likely to perceive this space as theirs, or as an extension of their home, and be more sensitive to any changes. One might think that neighbors consider this space to be what Lyn Lofland (1998) describes as the "parochial realm," which is "characterized by a sense of commonality among acquaintances or neighbors who are involved in an interpersonal networks that are located within communities" (p. 10). As a residential street, we could envision important differences in changes to perceptions between neighbors and others, but to our surprise, though we find some differences, these were smaller than expected (Table 2, columns 4–7).

Frequent users of the greenway noticed that the site was more crowded and noisier but did not report significant results on any other dimension (Table 2, column 4). In fact, first-time visitors (Table 2, column 7) were more sensitive to the additional public life than frequent users. So although we observe some differences that depend on how familiar an individual is with the site, we do not see that the frequent users overwhelmingly reject the additional public life. The reaction of frequent users (Table 2, column 4) is surprisingly similar to that of all users in aggregate (Table 2, column 1). We anticipated that frequent users would be particularly affected by our treatment because they know what the street looks like under normal conditions. At the other extreme, first-time visitors have no prior knowledge of the site or any reference point upon which to evaluate the quality of the street and are only exposed to either treatment or control conditions. Those with an intermediate level of familiarity with the site may have a reference point, but it is weaker than that of the other two groups. The addition of public users had little effect among occasional and rare visitors.

Visitors who came to the place for the first time found it more crowded, less interesting, more vibrant, and of lower quality overall when additional users were added. This subgroup is the only one in which the experiment had a positive and statistically significant effect on vibrant, as hypothesized. In short, although there may be some differences by familiarity, we did not see local residents and neighbors with a strong aversive reaction to the increase in public users on their residential street. The change in perception of neighbors (frequent users) was very similar to those who had never been there before, leading us to believe that the notions of parochial space do not explain our results.

We tested various estimation models and find that our results are robust to modeling specifications and the clustering of standard errors. Our results are consistent across regression specifications, with conventional or clustered standard errors, or with or without including controls such as gender, age group, University of British Columbia affiliation, and frequency of visits (see Technical Appendices 5 and 6).

The Pedestrianized Green Street Is Perceived as a Place of Refuge

We hypothesized that the addition of street life would make the place more enjoyable. Indeed, many planners and urban designers have argued for more active street life (Gehl, 2010; Jacobs, 1961; Mehta, 2007; Toderian, 2014). Although our study took place in a pedestrianized green street in a residential neighborhood and not in a public square or commercial street, it was plausible that the addition of public life could improve the overall quality of this space, and yet we saw very little measurable improvements in user perceptions of the space. We suspect we did not see these results in part because of the lush and verdant aesthetic of this greenway. The calm and verdant a ambience may have led people to perceive the space as a place of refuge, a place to enjoy nature or be alone, rather than a place designed for active street life.

It is possible that we might see more positive results or improved perceptions of public space in places with a more urban feel and design. Of course, many residential streets in North America are quiet, verdant, and shaded by tree cover; therefore, our results are most relevant to residential streets rather than to a dense urban environment.

Neighborhood green spaces that offer residents a quiet place of refuge may become more valued spaces in the post-COVID city (Honey-Rosés et al., 2020). The COVID-19 pandemic has made us more sensitive to the number of people that surround us, especially as a result of the physical distancing measures. Our research presents pre-COVID-19 measures in a pedestrianized greenway; after the pandemic, these perceptions might change. Our experimental method might be replicated to quantify the extent to which the pandemic has changed our perceptions with and without people in public. More sophisticated experiments would be needed to understand the mechanisms driving the changes in perceptions, with how many people, and in what types of spaces. What are the differences by gender, race, and demographic groups? Are there critical thresholds? How can tactical design mitigate perceptions of crowding? And how will these changing perceptions evolve? We hope that future experiments such

as the one we present here may help provide reliable measures of changing perceptions in the post-COVID city.

Conclusion

A major theme in the planning literature has been that the compact city is an inevitable part of our sustainable future. City leaders are under pressure to increase urban residential density to meet a variety of environmental and social goals, including the provision of affordable housing. But there are real costs to increasing density, and planners should understand the tradeoffs involved. In these debates about increasing urban density, it is unclear how the new street life might change the quality of public spaces, especially in lower density residential neighborhoods. This question is especially relevant for planners who are considering upzoning residential neighborhoods.

We provide experimental evidence that adding pedestrians and stationary users to a pedestrianized green street will change the perceived quality of this space. In particular, we find that more users may reduce the perceived quality of a residential street by making it feel more crowded and noisy but not necessarily more welcoming or interesting or a higher quality public space overall. The addition of people in a greenway, even relatively few people, can make small but significant changes in perceptions. The measured changes were not necessarily those we hypothesized. We anticipated that the addition of public users would make the place feel more vibrant and more interesting and a better place to watch others. Instead, we find significant results on variables related to noise and crowding, and women responded most negatively to the addition of public users. It appears that women are more sensitive to the addition of street life than men, even during daylight hours and in an ostensibly safe environment.

When interpreting the results, it is important to distinguish the direction of the change from the overall assessment. It would be inaccurate to say that the addition of public users made survey respondents feel that the space was crowded, noisy, or unwelcoming. Scores in both treatment and control conditions were consistently positive. We find small changes in perceptions, yet the general sentiment remains consistent. The residential street we studied remained an enjoyable place even with more public users. Our study site has the "carrying capacity" to add more users without making the place undesirable. The lens of carrying capacity lends itself to a more optimistic interpretation for planners interested in upzoning: Even with the addition of 11 to 16 more people in this residential street, people *still* found the place to be of high quality, welcoming, and an enjoyable place to be. For planners in our context, this suggests that residential users could be added to the neighborhood without major swings in perceptions and without creating an undesirable place. Advocates in favor of upzoning and residential densification might be more satisfied with this interpretation and may be interested in using experiments to estimate the carrying capacity of public spaces.

Our results are far from definitive. Results could vary depending on the particular site or the composition of the new residents added. Planners may also consider other experiments in public space to understand how tactical changes in the public realm might be received. Flexible interventions might be easily tested, such as outdoor play elements, music, or flexible seating. Experiments may help us to learn about how the public may receive future changes to their neighborhood. Being able to quantify the positive or negative changes in satisfaction may help inform debates about the benefits or costs of one key aspect of increasing urban densities.

Residential densification will be essential to build more equitable, affordable, and sustainable cities. If residential densification is in our future, we must understand the impacts of residential densification and find ways to incorporate new residents in a way that builds stronger, healthier, and more inclusive cities.

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SUPPLEMENTAL MATERIAL

Supplemental data for this article can be found on the publisher's website.

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