Cities and the Environment (CATE)

Volume 12 | Issue 1 Article 3

2019

Exploring Preferences for Urban Greening

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Sustainable responses to urban development point to the need for higher density neighborhoods coupled with extensive urban tree canopy and greening. However, little research has been conducted with urban residents to ascertain if these urban forms match their preferred setting. This study sought to understand whether higher levels of greening could moderate preference for lower density residential settings when 212 participants rated images for preference. Each of the independent variables, greening and density, made a difference in preference: greener settings were more preferred than less green settings overall, and perceived density was marginally significant in relation to preference. A factor analysis resulted in the grouping of five neighborhood types distinguished by certain characteristics (e.g., greening, buffer, building form) which, together with the qualitative responses suggested insights for making higher density residential environments more preferred. We did not find a significant interaction between greening and perceived density in relation to preference, suggesting that greening does not moderate the density-preference relation.

Keywords

urban greening, density, visual preference methodology

Acknowledgements

Funding for this study was provided by (DRL1323168) called “Pathways: From the Lab to the Neighborhood: An Interactive Living Exhibit for Advancing STEM Engagement with Urban Systems in Science Museums.

INTRODUCTION

There is tension between the notion of a compact city, recommended by planners, and people's desire to live in spacious, green and quiet areas (Van den Berg et al. 2007; Kabisch et al. 2015). The potential ecological and community sustainability benefits of greater density are notable: reducing urban sprawl, improving transportation efficiencies, encouraging pedestrian and bicycle transportation, preserving existing rural green space, reducing community isolation, and supporting economic and environmental equity (Churchman 1999; Daniels 2001; Neuman 2005; Benedict and McMahon 2006; Cheng 2010; Kytta and Broberg, 2014). However, the promotion of density does not always consider differences in land use patterns, physical design (Neuman 2005), and the personal preferences of urban residents. The goal of this study was to explore whether urban greening helps to ameliorate negative perceptions of density in an imagined ideal residential setting. Landscape photo preference methodology was used to elicit preferences for visual spatial form that included neighborhoods with a range of density and greening.

This study was developed in association with a National Science Foundation-funded "Pathways" project that was a collaborative effort of three universities and a science museum. An interdisciplinary team of museum exhibit designers, landscape architects, and urban ecologists explored climate change impacts on human-ecology relationships in urban environments. The goals of the Pathways project were to develop an interactive experience in association with a museum exhibit exploring issues of urban sustainability, and to contribute to larger planning discussions of green infrastructure and compact development.

LITERATURE REVIEW and RESEARCH QUESTIONS

Increasing urban density

The current interest in planning for compact development and more dense cities arises from the trend of increasingly urbanized worldwide habitation (Wheeler 2013). Toward that end, municipal planning policies may encourage high density, mixed use developments, efficient mass transportation systems and the promotion of walking and bicycling (Duany et al. 2000; Haaland and van den Bosch 2015). Greater urban density has been promoted as more energy efficient due to proximity to work, homes and commerce; more practical for public transport connectivity (van den Berg et al. 2007); reducing suburban sprawl; and supporting community cohesion and satisfaction (Jacobs 1961; Duany et al. 2000; Dovey and Pafka, 2014). More dense living communities can also support healthier, more walkable lifestyles, linking the built environment to health outcomes (Sallis et al. 2009; Nasar, 2015).

While planners may favor density, exactly which groups of the public like a denser environment and which prefer less density is not well understood. Density can be an elusive concept with many definitions, metrics and scales across the disciplines of planning, design and environmental psychology (Churchman 2002; Dovey and Pafka, 2014; Waters 2016). While density can be quantified in terms of the concentration of buildings, neighborhoods and populations in a given unit area, density is experienced via the interrelationships between urban form, human well-being and environmental sustainability (Boyko and Cooper 2011; Pafka 2013; Dovey and Patka 2014), and is fundamentally relative, subjective and context-dependent (Churchman 1999; Lawson 2010). The concept and experience of density may be especially

evocative because it can be associated with negative consequences of overcrowding such as lack of privacy, noise, congestion, territoriality and troublesome neighbors; and because of the historically powerful association in the United States between having a single-family home and a middle-class lifestyle (Churchman 1999; Cheng 2010; Lindsay et al. 2010; Haaland and van den Bosch 2015).

Urban greening

Interestingly, a renewed appreciation for the role of urban greening has grown contemporaneous with the promotion of urban density. Networks of green infrastructure in increasingly urbanized societies have been proposed to improve both quality of life (Kuo and Sullivan 2001; Chiesura 2004; Lohr et al. 2004) and ecosystem health (Alberti and Marzluff 2004; Nowak et al. 2006; Wheeler 2013). Research suggests that urban forms that integrate moderate mixed-use density with ribbons and corridors of multi-purpose green infrastructure may best support healthy communities and climate change resilience (Hamin and Gurran 2008). However, familiar patterns of environmental and spatial injustice are evident at the small scale of urban residential neighborhoods. Neighborhood greening tends to be found in neighborhoods with higher socio-economic factors (Landry and Chakraborty 2009; Danford. et al. 2014; Shanahan et al. 2014) and the availability and prioritization of funds may determine the installation and maintenance of neighborhood greening (Heynen et al. 2006). When neighborhood greening is implemented it may lead to gentrification, resulting in residents no longer being able to afford their greener neighborhoods (Wolch et al. 2014; Haaland and van den Bosch 2015).

Healthy street tree canopies in compact neighborhoods can integrate the valuable attributes of green infrastructure and nearby nature into urban settings. Urban tree canopy and greening contribute to various ecosystem, sustainability, and personal benefits, including improving air quality and carbon sequestration (Nowak et al. 2006), decreasing storm water runoff (Benedict and McMahon 2012), providing biodiversity and habitat for avian species (Alberti and Marzluff 2004), contributing to water and energy conservation (Akbari et al. 2001), and providing relief from the stressors of insufficient privacy (Kaplan 2001; Ryan 2002).

Landscape preference approach

In addition to knowing about the benefits of green infrastructure in compact settings at the planning scale, it is important to understand the attitudes of citizens who live their lives within these settings. Landscape preference methodology enables elicitation of public feedback on landscape and design preferences in order to guide planning and decision making about visual impacts (Daniels and Vining 1983). This method has its origin in the work of environmental psychology and has been used to explore the values behind preferences for certain elements and assemblages in the natural and built environments (Gerson et al. 1977; Kaplan and Kaplan 1989; Kaplan et al. 1998; Walker and Ryan 2008). Previous landscape preference research indicates that not all settings are equally preferred: natural environments are generally preferred over built environments (Ulrich 1986; Kaplan et al. 1998); buildings with vegetation tend to be preferred over those without (Kaplan and Kaplan 1989; Jiang et al., 2015); and street canopy may impact the perception of thermal comfort (Klemm et al. 2015). Jiang et al. (2015) explored the relationships between different amounts of tree canopy, as measured in panoramic street level images and plan-view google earth images; and viewer preference. Analysis was done to

quantify the results as a "dose response curve" in order to understand an optimal percent amount of greening. They found that increasing levels of tree canopy had the largest effect on preference in settings with minimal existing greening, while in settings that were already green, additional tree canopy did not make as big a difference.

Literature summary

While greater urban density may provide many benefits by supporting environmental and economic sustainability, promoting exciting community life, and providing access to services and public transportation; there is tension between the idea of the compact city and people's inclinations towards nature, privacy, quiet and space. Tree canopy and other forms of greening can provide environmental and health-related benefits for urban residents. The goal of this study was to contribute insights to the planning and design of urban greening in compact residential settings in order to support user needs and preferences. Data analysis allows insight into what types of people prefer which types of neighborhoods. The following research questions structured this study:

1. What qualities characterize the most and least preferred neighborhoods as measured by photograph ratings?
2. What neighborhood types emerge from photos of neighborhoods that depict various levels of greening and density?
3. Do density and amount of green (i.e., vegetation, trees) in a neighborhood image predict preference? Is there an interaction effect of density and amount of green on preference?
4. What is the relationship between demographic factors (participants' age, gender, community type and housing type) and neighborhood type preference?
5. Using digitally altered photographs, what is the relationship between the amount of greening in a neighborhood image and preference?
6. What themes emerge when participants reflect on their neighborhood preferences?

METHOD

Setting

The origin of the study was associated with the prototyping of the "City Science exhibit", which was located at the EcoTarium Science Museum in Worcester, Massachusetts. This regional museum has approximately 130,000 visitors per year and is located in a city with the second largest population in New England. Data was collected at three study sites: the EcoTarium Museum (45% of the total participants), two public gatherings in the City of Worcester (16% of total participants) and two university classes (39% of total participants).

Participants

A total of 212 people participated in the study; 87 (41%) were male and 123 (58%) female. Unusually, the study included children. The participants' ages in years ranged from 5-11 (8%); 12-17 (19%); 18-25 (39%); and 26 and older (38%). Participants came from the following community types: urban 29%, suburban 54%, and rural 14%. The Worcester participants were self-selected – they chose to attend a family science museum or civic festival and to participate

in the photo survey. The participants in the university setting were students from landscape architecture, planning, and other related fields.

Procedure

A photo poster and 2-page survey instrument were developed to explore levels of preference for greening and density in residential settings. The photo poster, with an overall size of 4 feet by 3 feet, had 24 images. The images depicted residential and mixed-use neighborhoods in Massachusetts and Rhode Island with varying degree of residential density and greening (Appendix A). The poster was placed on an easel and participants were invited to view the images and complete the survey in which they recorded their residential setting preferences for the 24-images; why they rated some photos high and some photos low in preference; and demographic information. Although no personally identifying data was collected, the study was developed in association with the NSF "Pathways" project, for which IRB approval had been secured.

The two independent variables, density and greening, were varied in the photo images of the residential neighborhoods. The dependent variable was preference for residential settings.

Constructs and Measures

Density: The first independent variable, density, concerns the perceived density of the neighborhoods in the photo images. Density was operationally defined by asking thirteen professors from landscape architecture and planning to rate each of the images for perceived residential density within the geographic context of the study area. The density value of each photo was calculated as the mean score of the thirteen density ratings, on a scale of 1 (not at all) to 5 (very much). An objective quantification of density of the image areas, such as number of housing units per acre, was not used as that would have been inconsistent with the scale of the images to which participants were responding, and discordant with the notion of perceived density.

A variety of building styles and setbacks were represented in the photos. The neighborhood image with the lowest density was a single-family home surrounded by lawn, and the image with the highest density was a large, four-story housing complex. It should be noted that the neighborhoods represented in the photos reflected the range of neighborhood densities and types of the Worcester area, and so did not include extremely dense urban neighborhoods or rural neighborhoods.

Greening: The second independent variable, greening, refers to the amount of tree canopy and vegetation in each image. Some photos were manipulated to incorporate more greening and some were borrowed from a previous project (Cheng et al. 2017). Greening was quantified using Adobe Photoshop to calculate the percent of greening, relative to the total image area, including all trees, shrubs, and lawn area.

Preference for residential settings: The dependent variable, preference for residential settings, was operationalized by responses to the 24-photo poster survey (Appendix A). The

arrangement of the images was consistent for all study participants. The images were chosen with the intent to reflect typical residential types in the study area to relate to the life experiences of the local participants. Photos that were identical, other than digitally added greening, were not placed adjacent to each other on the poster in order to reduce immediate visual comparisons. Survey participants indicated preference for each image in response to the prompt: "Please circle the choice that describes how much you would like to live in a neighborhood such as those shown in the pictures" on a 1-5 scale: (1) not at all, 2) a little, 3) somewhat, 4) quite a bit, 5) very much).

Analytic strategy

To explore research question one – *what qualities characterize the neighborhood images rated most and least preferred overall?* – descriptive statistics (e.g., mean and standard deviations) were used to analyze how study participants rated the photos for preference. For research question two - *what neighborhood types emerge from the preference patterns of the various photos?* - a factor analysis was conducted to determine whether neighborhood types emerged, and to what extent these types might be associated with preference. Research question three asked - *do the amounts of neighborhood density and greening (i.e., vegetation, trees) in a neighborhood image predict preference and is there an interaction effect of density and amount of green on preference?* Correlations were used to explore the relationships between the photo density score and preference ratings; as well as the photo greening score and preference ratings. In order to explore potential interaction effects, we conducted a multiple linear regression analysis that added percent greening x density as an interaction term. T-tests and one-way ANOVA were used for research question four – *what is the relationships between demographic characteristics (gender, age, residential setting, home style, survey setting) and participants' neighborhood type preferences?* To explore research question five – *what is the relationship between the amount of greening and preference?* - the preference ratings of seven pairs of images, an original image and the same image with digitally added greening, were evaluated with paired t-tests. For the sixth research question - *what themes emerge when participants reflect on their neighborhood preferences?* - content analysis was conducted on the responses to the open-ended questions to explore emergent themes and associations when participants reflected on their photo preferences.

RESULTS

Frequency and descriptive statistics were used to explore the first research question: what qualities characterized the images that were rated most and least preferred overall? The three photos with the highest overall means (Figure 1) included two versions of the sole single-family house in the survey, with and without additional greening (P13 and P5) and a photo of a neighborhood built in the New Urbanism style (P15).


P13 mean: 3.41; S.D.:1.21

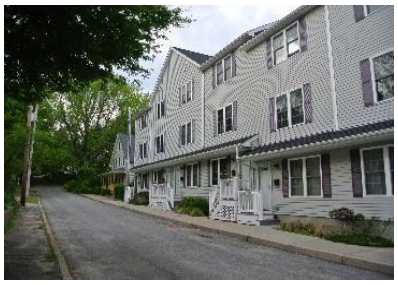

P15 mean: 3.22; S.D.:1.17


P5 mean 3.09; S.D.:1.36

Figure 1: The three most preferred scenes

A review of the three photos with the lowest overall means (Figure 2) share characteristics of a narrow buffer between the street and housing; and minimal greening. Two of the least preferred images were newer apartment buildings while the lowest rated image was a traditional triple-decker apartment building common to Worcester and other cities in the northeastern United States.


P12 mean: 2.17; S.D.:1.19


P19 mean: 2.16; S.D.:0.98

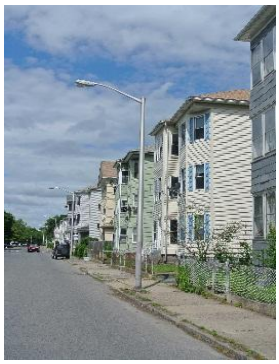

P23 mean: 1.83; S.D.:0.99

Figure 2: The three least preferred scenes

After exploring overall preference ratings, we examined the second question - what *neighborhood types emerge from photos of neighborhoods that depict various levels of greening and density?* Using the preference ratings for the 24 images, a principal-axis factor analysis with Varimax rotation was conducted, resulting in both data reduction and the aggregation of photo groups from the pattern of image preferences into five neighborhood types which differed in their spatial form and amount of greening (Table 1). When Cronbach's alpha was calculated to assess the reliability of the preference ratings the scores were relatively high for all types, suggesting that there was internal consistency in the factor analysis groupings. A total of six photos did not group into any neighborhood type: one was in a type of its own; another had too low a loading to fall into any neighborhood type; and four photos had dual loadings.

Table 1: Neighborhood types derived from factor analysis, percent green and mean density

Neighbor-hood Types	Pref-erence Mean	Cron-bachs Alpha	Photos	Example of neighborhood type	Photo Mean	Load-ing	Percent Green	Mean density rating
Single Family Homes Eigenvalue: 1.060	3.25	.82	P 5		3.09	.96	60.35	1.58
			P13		3.41	.69		
Downtown Apartment Blocks Eigenvalue: 1.858	2.78	.74	P20		3.06	.78	54.97	4.00
			P 2		2.48	.74		
Multi-Family Units Eigenvalue: 7.925	2.55	.81	P24		2.22	.62	43.59	3.17
			P 7		2.44	.62		
			P17		2.70	.59		

Table 1: continued

Neighbor-hood Types	Pref-erence Mean	Cron-bachs Alpha	Photos	Example of neighborhood type	Photo Mean	Load-ing	% Green	Mean density rating
Duplex/ Triple Deckers Eigenvalue: 2.615	2.43	.79	P21		2.46	.78	19.76	3.12
			P10		2.25	.64		
			P 3		2.71	.56		
Multi-units in large complex Eigenvalue: 1.443	2.37	.81	P12		2.17	.69	27.73	3.77
			P11		2.59	.65		
			P 1		2.36	.60		

The factor analysis helped us learn more about density and greening. In order to quantify greening we calculated the composite percentage greening in the five neighborhood types (Table 1). We found that the neighborhood type preference ratings and percent green were significantly correlated, $r=.47$, $p<.05$, suggesting that neighborhood images with more greening were more preferred. Furthermore, the composite density ratings were significantly correlated

with neighborhood type preference, r=-.43, p<.05, indicating that there was a negative relationship between perceived density and preference. These findings suggested that while, in general, higher preference for neighborhood types was associated with higher levels of greening and lower density, there were variations in these trends, which might provide insights into planning neighborhood form.

The neighborhood type with the highest overall preference was the Single-Family Home, composed of two photos of the same single-family home with lawn and trees, one of which had additional trees digitally added. This neighborhood type had the highest percent green, as well as lowest rating for density; as compared to the other neighborhood types.

The second most preferred neighborhood type and the second highest in percent greening was the Downtown Apartment Blocks which had mature tree canopies and vegetation. Interestingly, in spite of the overall negative correlation between perceived density and preference in the study as a whole, the Downtown Apartment Block neighborhood type rated the highest for perceived density and second most highly preferred. These results suggest that there may not be a linear negative relationship between density and preference but rather that other characteristics may be present, in this case, mature greening or the perceived benefits of downtown living, which may impact preference.

The third most preferred neighborhood type, Multi-Family Units, had the third-highest amount of greening and the second-highest density rating. This neighborhood type was composed of three images of large, multi-unit buildings, with extensive lawn and greening in the foreground. Two of the images were a paired set with trees digitally added to one of the images.

The fourth most preferred neighborhood type was the Duplex/Triple Decker homes, which depicted detached housing units with some greening, and a sidewalk between the street and the homes. This neighborhood type had the lowest amount of greening and a mid-scale density rating.

The fifth type, which yielded the lowest mean preference score as compared to the other types, had Multi-Housing Units in Large Complexes in close proximity to the street with minimal vegetated areas between the street and buildings. This neighborhood type had the second to the lowest percent greening and rated second to the highest in density. For these study participants the three images with the large housing complexes all grouped into the least preferred neighborhood type. These results may suggest a negative impact of size of housing complexes for preferred living environments.

Predicting neighborhood preference:

In order to better understand participants' preferences for neighborhood form, we sought to disentangle the independent variables of greening and perceived density in predicting preference. Research question three asked - *do the amounts of neighborhood density and greening (i.e., vegetation, trees) in a neighborhood image predict preference and is there an interaction effect of density and amount of green on preference?* We first conducted a multiple linear regression analysis to assess if percent greening and amount of density predicted preferences for the 24 images. The results of the regression analysis showed that the two

predictors explained 34.4% of the variance (R^2 =.34, F (2,21) =5.496, p< .05). It was found that amount of greening predicted preference (β=.40, p<.035, t=2.25), while density as predictor of preference was marginally statistically significant (β=.36, p=.058, t=-2.00). We next conducted a multiple linear regression analysis that added percent greening x density as an interaction term, which yielded no significant (>0.05) results, meaning that in this study greening did not moderate the relationship between perceived density and preference. However, each of the individual independent variables, especially percent greening, had an effect that deserved further exploration.

Demographic differences

The study participants spanned a range of ages and backgrounds, prompting the fourth research question - *What is the relationship between demographic factors (participants' age, gender, community type and housing type) and neighborhood type preference?* A one-way between subjects' ANOVA test was conducted to assess the relationship of gender on neighborhood type preference, and did not yield a statistically significant result at the .05 significance level.

When the same test was used to explore the relationship of age on neighborhood type preference, there were some statistically significant results. The young adults in the 18-25-year age group preferred the Downtown Apartment Blocks neighborhood type (mean: 3.61) significantly more than did young children in the 5-11-year age group (mean: 2.31) [F (4,206) =5.11, p<.001]. These results suggest that young adults prefer the types of neighborhoods depicted in the Downtown Apartment Blocks neighborhood type more than the younger participants. The Single-Family Home neighborhood type was significantly more preferred by the adult and middle-age participants ages 26-65 (mean: 3.68) than by the young adults [mean: 2.92; F (4, 206) = 5.13, p<.001]. These results suggest that the Single-Family Home neighborhood type was more the ideal for adult participants, many perhaps with families and children; than younger adults who might be more interested in the amenities of downtown living.

In terms of the two study sites, Worcester and Amherst, an independent t-test was conducted to compare the neighborhood type preference ratings for the study participants. However, no statistically significant differences were found between the study populations from the two locations, perhaps because both populations had a mix of people from rural, suburban and urban settings; which supports the decision to combine the data for the two groups in further analysis.

A one-way between subjects ANOVA was conducted to compare the relationship between participants' community type where they currently lived (city, suburb and rural residents) and their neighborhood preference (Table 2). Both the Multi-Family Units and the Duplex-Triple Decker neighborhood types were rated significantly higher by urban and suburban residents as compared to rural residents. These results suggest that that rural dwellers were less favorably inclined towards the Multi-Family Units and Duplex-Triple Deckers neighborhood types, as compared to participants from urban and suburban settings.

Table 2: Relationship between residential environment and housing type; and neighborhood type preference using one-way between subjects ANOVA

	Mean Preference			**F**	**d.f.**	**p value**
Residential environment:	*City* N=65	*Suburb* N=110	*Rural* N=29			
Multi-family Units	2.71	2.61	1.95	11.19	2,201	<.000
Duplex-Triple Deckers	2.68	2.47	1.86	11.33	2,201	<.001
Housing type:	*House* N=139	*Apartment* N=41	*Condo* N=11			
Multi-family Units	2.44	2.85	2.76	2.25	2,188	<.00

A one-way between subjects ANOVA was then conducted to compare the association of participants' current housing type (house, apartment and condo) and neighborhood preference. A statistically significant relationship between housing and preference for the Multi-Family Units neighborhood type was found. Participants who identified as apartment dwellers rated this neighborhood type significantly more highly than those who identified as living in single-family houses.

Neighborhood greening and preference

The fifth research question explored the relationship between the amount of greening in a neighborhood image and preference. In order to isolate the greening variable, the study used seven pairs of neighborhood images, with one of each pair having digitized greening added. Two-tailed paired t-tests were conducted with the preference ratings of each of the photo pairs (Table 3). The results of the paired photo comparisons indicate that the addition of trees consistently improved the overall preference ratings for the settings, even those with perceived higher density.

Table 3: Paired photos with additional greening

Original photo	**Digitally manipulated photo with more greening/trees**	**T**	**df**	**p value**
 P1 mean: 2.36	 P11 mean: 2.59	3.80	210	<.001
 P21 mean: 2.46	 P3 mean: 2.75	3.76	208	<.001

Table 3: continued

Original photo	Digitally manipulated photo with more greening/trees	T	df	p value
 P5 mean: 3.09	 P13 mean: 3.41	4.82	206	<.001
 P23 mean: 1.83	 P6 mean: 2.87	11.83	207	<.001
 P24 mean: 2.22	 P7 mean: 2.44	2.97	208	<.003
 P19 mean: 2.16	 P8 mean: 2.49	4.85	207	<.01
 P12 mean: 2.17	 P22 mean: 2.55	4.98	29	<.01

Themes in neighborhood preference comments

Finally, the study used short answer questions to explore research question six - *what themes emerge when participants reflected on their neighborhood preference ratings using photographs?* While this type of semi-qualitative data cannot support causal hypotheses, it can suggest clues as to how meaning is made and used (Yin 1999; O'Cathain and Thomas 2004; Dovey and Pakfa 2014; Marshall and Rossman 2016). Content analysis was conducted on responses to the open-ended questions and yielded emergent themes of greening, privacy, crowding, safety, housing characteristics, pavement, intangibles and capacity to provide amenities that were important to the participants. These themes are further explored in the discussion section below.

DISCUSSION

Sustainable patterns of urban development point to the need for higher density neighborhoods complemented by urban tree canopy and greening. This study sought to understand whether higher levels of greening could offset preference for lower density in residential settings. Each of the independent variables made a difference in preference: greener settings were more preferred than less green settings overall, and perceived density was marginally significant in relation to preference. However, we did not find a significant interaction between greening and perceived density in relation to preference, suggesting that greening does not moderate the relation between perceived density and preference.

This study advances knowledge by supporting previous findings (Jiang, et al., 2015) that in general, greener settings were more preferred than less green settings. In the clearest study result, in which the photo images were consistent, except for the addition of a digitized tree, the greened versions of the neighborhoods were consistently more favorably rated. While this academic result is not new, the application of this concept is not yet fully realized as many residential neighborhoods are bereft of greening, especially in under-resourced communities.

Furthermore, the study suggests that there is a relationship between greening and perceived neighborhood density which may point to ways to ease the tension between the two. The factor analysis resulted in the grouping of five neighborhood types, distinguished by certain characteristics (e.g., greening, buffer, building form) which, together with the qualitative responses suggested insights for making higher density residential environments more preferred.

Greening and preference

The seven pairs of original and digitally-greened photos provided the clearest view of this inclination towards greening, with participants consistently preferring the digitally greened images over the original images. By using this paired-photo technique, a methodological challenge in photo preference research was addressed: the potential for image variation due to camera angle, time of day, weather and subject. Using the paired comparison, the association between greening and image preference could be seen more clearly because the other elements of the image remained constant. The added digitized greening, consisting of one or two small to mid-size deciduous trees between the housing and street, at times partially obscured the view of the housing, or provided a vegetative element in an otherwise hardscape setting. The greening was intentionally done at a minimum scale in order to approximate a feasible neighborhood

greening intervention. These results lend support to the notion found in research by Jiang et al. (2015) that even modest neighborhood greening efforts can contribute to more highly preferred residential settings.

Density and preference

Untangling the association of density and preference was less straightforward. While the Single-Family neighborhood type with the highest green and lowest density had the highest preference, there was not a simple linear relationship between amounts of density, greening and preference. For example, the neighborhood types with the lowest mean preference, the Multi-Family Units in a Large Complex, did not have the lowest mean percent green or the highest density score. Likewise, the Downtown Apartment Block type rated highest in density, was second in percent greening and second in overall mean preference. This suggests that while more greening and lower density may be preferred, their lack does not necessarily mean that a neighborhood will be non-preferred. Rather, it may be that the dynamic relationship between housing type, density and a strategic use of greening, can help buffer the perceived consequences of denser living environments. This supports promoting urban neighborhood greening in compact residential environments in conjunction with thoughtful design of residential spatial form.

Some of the results suggest that perceived density is influenced by previous life experiences (Churchman 1999). First, urban residents rated all the images higher than the participants who reside in suburban and rural settings. Second, apartment dwellers rated the higher density settings more favorably than the non-apartment dwellers, perhaps due to familiarity with higher density residential neighborhoods. Third, urban and suburban participants rated two of the denser neighborhood types: the Multi-Family Units (moderate density, greening, setback from street) and the Duplex-Triple Decker Units in a large complex (detached housing units, with some greening, and sidewalk between the street and the homes); more highly than rural residents. Fourth, there was a statistically significant difference in preference for the Multi-Family Units type by participants who live in houses and apartments; suggesting that apartment dwellers viewed this neighborhood type more favorably than house dwellers did.

The participants' short-answer responses may provide clues to the attitudes underlying these results. When participants were asked to identify why some settings were rated higher for preference, participants wrote of positive associations with the denser settings because they evoked memories of similar settings, because they supported sustainability, and because they liked the closer proximity to other people and urban amenities such as entertainment and mass transit.

In addition to the role of previous life experience in neighborhood preferences, participant age, and associated with life-stage linked affordances may have played a part. The images in the Downtown Apartment Block neighborhood type were more highly preferred by participants in the 18-25-year-old age group than any other, while the single-family homes type appealed less to this age group than to both younger and older participants. It seems reasonable that this young adult age group would find potential characteristics of downtown living attractive; such as the potential for a lively, engaging public life and access to employment and public transportation. The short answers support this idea, with comments less favorable towards

the less dense environments, because they are boring or uneventful; and more favorable towards the downtown street as being more interesting and livelier. On the other hand, many participants from the age groups other than the young adult group preferred the Single-Family Home neighborhood type and wrote positive comments that the setting could provide a place for children to play, trees to climb, and lawn. Aversion towards the denser neighborhood settings was expressed in the short-answers with comments about potentially dangerous traffic; as well as concerns for overall safety and limited outdoor space.

The most frequently cited themes in the short answer data concerned greening, privacy, crowding, safety, housing characteristics, pavement, intangibles and capacity to provide amenities that were important to the participants. The most frequently mentioned theme overall was centered on greening: both in the value of having greening and the negative association with its absence. Within the greening theme, trees were the most frequently mentioned element, followed by green space, yards, nature and grass. The high frequency of trees as compared to other greening elements, follows previous research highlighting trees as a highly valued green element (Kaplan 1983).

Density concerns were also evident in the short-answers, including thoughts about privacy, dwellings, neighbors; and proximity of the housing to the street. The comments that clustered in this theme align with previous research, that the perception and experience of density are related to both the interrelationships between the buildings and people (Pafka 2013; Dovey and Pafka 2014); as well as social elements such as concerns for privacy, territoriality, and social hierarchy (Cheng 2010). However, the comments about privacy were nuanced. Similar to previous research (Lawson 2010) the participants' concerns were not necessarily about a desire for personal isolation but rather a desire to have some sense of control over boundaries in interpersonal contacts and in daily spatial experience.

The housing theme was expressed in comments about housing type (e.g. single family versus attached), apparent age, style and aesthetics. Pavement appeared as both a positive attribute, for example accessible sidewalks and enough room to park; as well as a negative attribute, such as pavement that was excessive or poorly maintained. Some responses about the neighborhoods were grouped in the theme of intangibles, with descriptors ranging from exciting, peaceful, quiet, welcoming and family-friendly; to depressing, noisy, bleak and boring. Some participants assessed the settings by whether they would support affordances that were important to them, such as a sense of community, having a yard in which children could play, or a tree to provide cooling shade. Interestingly, the affordance theme often overlapped with the greening theme, for example, a preference for green space to socialize with friends. It may be useful to consider the land use characteristics that support both affordances and greening as a guide for making urban residential neighborhoods more preferred.

Limitations and future directions

The aim of this study was to explore the relationships between the independent variables of greening and perceived density, and the dependent variable of preference for residential settings. To further interpret the results several potential limitations should be considered.

The study began in concert with the prototyping of an urban ecology exhibit at a regional science museum and was modestly scaled to work in that setting and with a population that spanned all ages. While we overheard some discussions between parents and children who noticed the similarities between the photos, the open administration of the survey and the conversations between participants were part of the "Pathways" project design to introduce participants to concepts of urban planning. The study population grew to include participants from the Worcester downtown area and university students which broadened its demographics while retaining the original simple survey instrument. In order to reduce the potential for conformance bias in future studies, the survey protocol could include a greater number of photos that are randomly presented.

The study goal was to provide holistic images of greening and residential density to ordinary people of all ages and assess their visual preferences. Further study that distinguishes among the different forms of greening (tree canopy, shrubs and turf grass) and preference could further refine this study's findings and could be a promising avenue for future study.

The selection of photos in photo preference methodology is important and complex. Efforts were made to isolate the potentially confounding variables of greening by digitizing the photos for percent green; and density by having design professionals render a perceived density score for each photo. However, design professionals may have background and knowledge that result in perceptions of residential density that differ from those of the non-expert survey participants.

Extraneous factors were best controlled in the portion of the study with the seven pairs of original and greened residential settings, in which the original images served as a control treatment. Since the only feature that had changed in the pairs was the addition of digitized greening, the differences in the preference means between the original and greened photos can be attributed to the treatment of greening.

The study design included a potential confounding factor of housing characteristics which may have compromised the inferences that can be drawn about the relationships between the constructs of greening and density; and preference. In order to capture typical neighborhood types in the study area, the neighborhood images had different styles and age of housing, which may have influenced the preference ratings. For example, the second most preferred photo was from a neighborhood built in the New Urbanism style, with a modest vegetated buffer, low fence, front porch and characteristic architectural detailing. In this case and others, the preference ratings did not reveal to what extent participants' photo preferences were associated with housing style. The short answer portion of the survey did provide insight into the personal values underlying the ratings, and architectural style was a theme among the reasons that an image was more or less preferred. For future studies, photos of dwellings that have similar value as measured by assessed value, monthly rent, or median neighborhood income could be selected in order to control for differences in settings.

The study participants were not a randomized population sample, they were people who chose to visit a regional science museum, to stop by a table at a public event, or to take a university class. As such, the findings of this study are most applicable in the context of the

study participants and may be less generalized to the general population or to other regions of the United States or the world. However, previous landscape preference studies support the current findings, that people strongly prefer more greened living environments (Kaplan & Kaplan, 1989), and help to broaden the applicability of our study results.

If planning for higher densities is going to succeed in being implemented, people will need to choose it – even if they have the means to choose lower densities. The study results suggest several strategies for potentially making higher density residential neighborhoods more preferred:

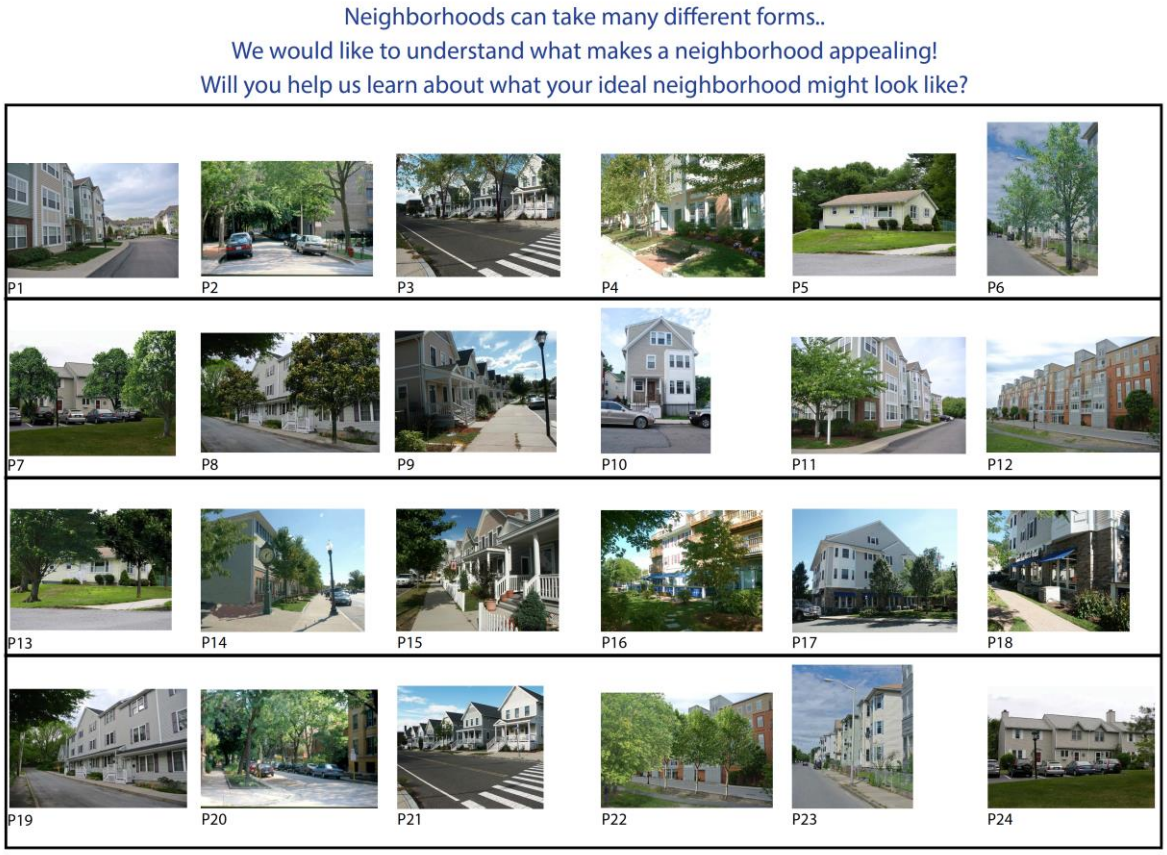
- The presence of neighborhood greening was highly preferred, it was seen as providing nearby nature, beauty, a buffer from crowding and cooling shade. Thus, higher density neighborhoods should intentionally incorporate greening to create more livable neighborhoods.
- Housing that abuts the street consistently received lower preference ratings from all respondent groups. Creating even a minimal vegetated setback from the street can help buffer between public and residential spaces, support privacy needs and provide multiple ecological benefits to urban communities.
- The scale of the housing also seemed to matter. Multi-units in larger complexes were less preferred, thus planners should consider design and planning solutions to minimize the perceived scale and height of buildings. Strategies could include setbacks with lower building height near streets or lower story buildings at higher actual density.

CONCLUSION

It is clear that people care about how they live in proximity to neighbors and nature. Previous life experience, life stage and anticipated environmental affordances all seem to play a part in preference for residential neighborhood types. While the inclination towards greening is well documented in research, many urban residential neighborhoods, including those in the study city of Worcester, have minimal to non-existent greening.

A robust body of research suggests that urban greening supports green infrastructure goals and that contact with nature contributes positively to personal well-being. However, efforts to garner support for urban greening are not always successful and urban greening is inequitably distributed along the urban socio-economic gradient. This points to the importance of street trees and residential greening to provide localized, incidental access to nature. In recognition of historic and ongoing economic inequities among urban communities, this study supports the value of the public provision of vegetation, for example municipal and community tree planting, especially for underserved neighborhoods. If we listen to the call of urban planner Anne Whiston Spirn (2017) to take on the goal of designing cities as life sustaining and life enhancing habitats, incorporating a robust and equitable network of greening at the neighborhood scale is a start.

APPENDIX A: Photo preference poster for urban greening survey



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