TRANSFORMING INNER-CITY LANDSCAPES
Trees, Sense of Safety, and Preference

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ABSTRACT: How would inner-city residents respond to the incorporation of trees and grass in their neighborhoods? Law enforcement officials have argued that, in these settings, trees and other forms of vegetation increase fear. Tree density, tree placement, and levels of grass maintenance were manipulated in photo simulations of neighborhood outdoor space. One hundred residents of Chicago's Robert Taylor Homes living adjacent to the space rated the images with respect to preference and sense of safety. Although tree placement (subspaces created by trees, formality of arrangement) had little effect on sense of safety and no effect on preference, both tree density and grass maintenance had strong effects on preference and sense of safety (η^2s from .49 to .89). Surprisingly, tree density and grass maintenance increased both preference and sense of safety. Results suggest that—contrary to some views—trees and grass maintenance can increase sense of safety in inner-city neighborhoods.

Although there are notable exceptions, the image of urban public housing as the grimmest of urban environments—crowded, ugly, noisy, unsafe, and

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the visible symbol of poverty and deprivation—is too accurate too often. This article examines the potential for providing basic landscaping as one step in making inner-city public housing developments better places for children and families to live.

The very notion of spending precious resources to landscape inner-city neighborhoods might initially sound absurd. There is a common sense conception that landscaping is for the wealthy, a luxury akin to leather couches and imported cotton sheets—nice, but hardly necessary. Indeed, the condition of many urban public housing outdoor spaces today suggests that city planners and public housing managers share this notion—much public housing is recognizable by its conspicuous lack of vegetation (see Figure 1). The intuition seems to be that although landscaping is enjoyable, it serves no functional purpose.

In fact, however, landscaping may serve a number of important functions in the context of inner-city neighborhoods, and the potential benefits of basic landscaping in these neighborhoods may far outweigh the modest costs.

FUNCTIONS OF LANDSCAPING

The role of trees and other vegetation in mitigating many of the negative impacts of intense urban development is well- established. By moderating climate, conserving energy, reducing carbon dioxide, improving air and water quality, and controlling rainwater runoff and flooding, vegetation provides an antidote to many of the physical ills of cities (for review, see Dwyer, McPherson, Schroeder, & Rowntree, 1992).

In addition, in densely populated urban areas, landscaping can provide relief from crowding. The first designers of urban public housing recognized the need for usable outdoor space, and one reason that public housing apartment buildings were designed as high-rises was to increase the outdoor space available to residents. Today, however, the barrenness of many of these spaces renders them barely usable. Limited in mobility by children and lack of transportation (see Gobster & Delgado, 1993), poor families living in such

provided many hours of work on the simulations, and Rebekah Levine Coley and Jennifer Morthland supervised the data collection. We would also like to thank our resident interviewers, Esther Davis and Doris Gayles, as well as the resident management and residents of Robert Taylor Homes. This work was conducted in partial fulfillment of the requirements for a master's degree in landscape architecture at the University of Illinois, Urbana–Champaign; portions of this work were presented at the Environmental Design Research Association Conference, June 1996, Salt Lake City, UT. Requests for reprints should be addressed to Frances E. Kuo, Human-Environment Research Laboratory, 1103 S. Dorner Dr., Urbana, IL 61801, e-mail f-kuo@uiuc.edu.

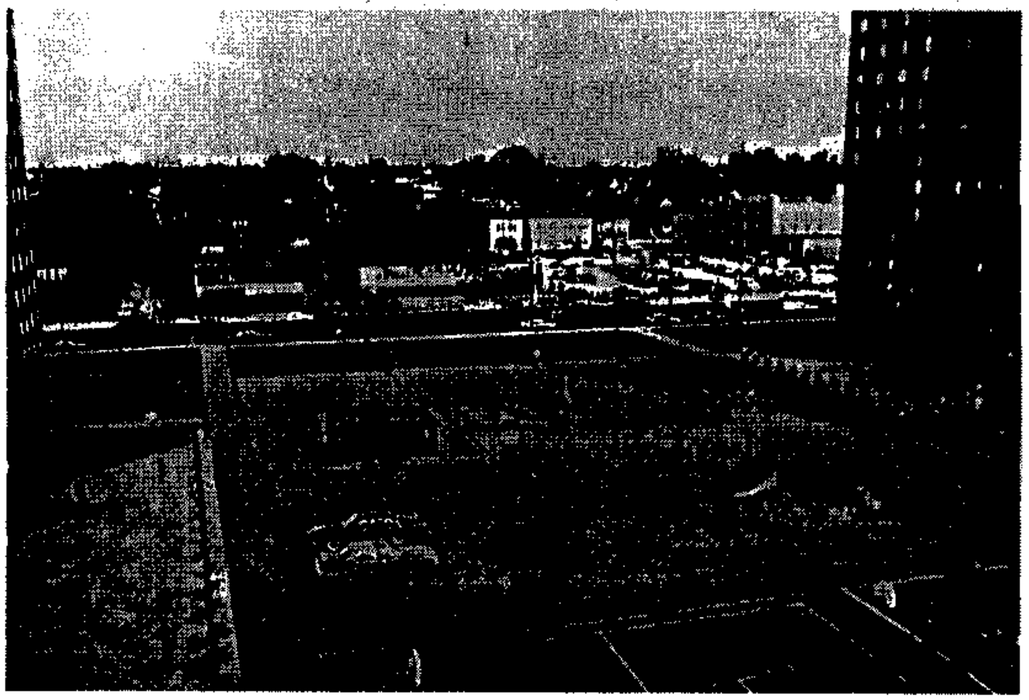

Figure 1: A Courtyard at the Robert Taylor Homes Public Housing Development, Chicago, Illinois

areas may be left with no real alternative to a crowded apartment. To the extent that "green" outdoor spaces could provide an alternative to crowded interior spaces, landscaping may mitigate the negative impacts of crowding on inner-city families.

Another needed function that landscaping can serve in urban public housing is to create more suitable play spaces for children. Children 14 years of age and younger constitute approximately half of urban public housing residents (51% in Chicago public housing; Chicago Housing Authority, 1996). For thousands of children in Chicago alone, everyday outdoor play spaces consist of a courtyard without trees, grass, or flowers (see Figure 1). Although concrete and asphalt are suitable for many games, grass provides a more forgiving surface for many other forms of play, and there is even some evidence that children play more creatively in spaces containing trees and other plant materials (Kirkby, 1989; Moore, 1989; Taylor, Wiley, Kuo, & Sullivan, 1998 [this issue]).

Landscaping may play an important role in the effective functioning of urban individuals and families. There is growing evidence that, in urban and built settings, access to nearby nature and natural views is supportive of

physical and psychological health: access to "nearby nature" and natural views have been shown to speed recovery from surgery (Ulrich, 1984), aid in stress reduction (Ulrich et al., 1991), and improve mental functioning (Cimprich, 1993; Hartig, Mang, & Evans, 1991; Tennessen & Cimprich, 1995). The improved psychological functioning of individuals living near nature appears to yield healthier patterns of social functioning—more positive relations among residents (Kuo & Sullivan, 1995) and less aggression. Mooney and Nicell (1992) reported startling decreases in the incidence of aggressive or violent episodes in Alzheimer's disease patients on the installation of an outdoor garden area, and Kuo and Sullivan (1995) found a lower incidence of domestic violence in public housing families living in buildings with higher levels of vegetation.

Finally, another surprising function that landscaping may serve in inner-city neighborhoods is to decrease levels of graffiti, vandalism, and perhaps even crime. The physical planning theory of Crime Prevention Through Environmental Design (CPTED) advocates that both fear of and opportunity for crime may be reduced by proper design and use of the built environment (Crowe, 1991); to the extent that greening increases use of previously barren spaces, thereby increasing levels of natural surveillance, greening might help deter crime. In an informal study, University of California Extension educators documented the incidence of graffiti in 31 sites in the community of Riverside and found that whereas 90% of nonlandscaped surfaces showed evidence of graffiti or vandalism, 90% of surfaces in landscaped areas were graffiti-free (study by Stamen, Yates, & Cline, cited in Sullivan, 1993). In Philadelphia, it was reported that crime "dropped 90% in one precinct after local police helped community volunteers clean up vacant lots and plant gardens" (Macpherson, 1993, p. 10). Most recent, a study in inner-city Chicago found that levels of physical and social incivilities (e.g., graffiti, vandalism, noise) were systematically lower in neighborhood spaces with trees and grass than in comparable, barren spaces (Brunson, Kuo, & Sullivan, 1997).

In sum, landscaping may serve a number of important functions in urban public housing in addition to mitigating the desolated, harsh appearance of barren outdoor spaces. Landscaping has the potential to mitigate the environmental ills and crowding of these densely populated areas, provide humane play spaces for inner-city children, support public health, and perhaps even address levels of violence and crime in the inner city. Moreover, a cost-benefit analysis of urban trees suggests that the benefits associated with trees outweigh the costs within several years of planting; furthermore, the cost-benefit ratio was most favorable in urban public housing (McPherson, 1995).

BUT WOULD LANDSCAPING BE WELCOME?

Research and analysis suggest that landscaping would be both functional and cost-effective in the context of urban public housing. To successfully implement landscaping in urban public housing, however, the issue of residents' responses to landscaping must be addressed. As with any intervention effort in a community, there is little point in implementing a change that members of the community would not welcome—the long-term survival prospects of new trees and grass in intensely trafficked areas are substantially better if residents are committed to the change than if residents resent, or are simply neutral to, the introduction of landscaping.

Similarly, there is little point in introducing landscaping in urban public housing if residents would not feel safe in, and thus would not use, the newly planted outdoor spaces. Sense of safety has emerged as an important issue in landscape research involving inner-city residents (e.g., Kaplan & Talbot, 1988) and urban public housing residents in particular (e.g., Rohe & Burby, 1988). In Chicago public housing, where this study was conducted, African Americans comprise 97% of family housing residents (Chicago Housing Authority, 1996); in previous research involving low-income African Americans, safety concerns were identified as the most frequent barrier to the use of public spaces such as urban parks (Taylor, 1992; Washburne & Wall, 1980). Before introducing new landscaping efforts in urban public housing, then, two questions must be addressed: What do residents like and dislike? What makes residents feel safe or unsafe?

The following section reviews the literature bearing on these questions. Three basic issues in landscaping are examined: the presence and density of trees, the placement of trees, and levels of grass maintenance.

THE PRESENCE AND DENSITY OF TREES

How would urban public housing residents respond to the planting of trees in currently treeless outdoor spaces? A review of the literature suggests that residents' responses may depend on the number of trees planted, and that trees might, or might not, have a negative impact on sense of safety.

With respect to preference, it is clear that the presence of natural elements increases preference for a variety of urban settings and populations (e.g., Kaplan & Kaplan, 1989; Thayer & Atwood, 1978; Ulrich, 1986). What is less clear is whether higher densities of trees are necessary or optimal for preference. That is, preference might be a roughly linear function of tree density, in which the higher the density, the greater the preference; alternatively, preference might plateau or decline at higher densities. These are important questions for urban foresters, because the principal costs associated

with urban forests—establishing and caring for trees—are directly related to the number planted (Dwyer et al., 1992).

The findings with respect to preference for high densities are mixed. Although some studies have found that preference increases with tree density only up to a point (Hull & Harvey, 1989; Smardon, 1988), others suggest that preference increases with density, and that the highest preferences are for the most densely planted settings (Schroeder & Anderson, 1984; Schroeder & Orland, 1994). Similarly, Kaplan and Talbot's (1988) sample of inner-city Detroit residents generally showed less preference for outdoor urban settings with dense vegetation, but the same participants responded positively to scenes showing high densities of trees when trees were widely spaced and when the scenes showed greater visibility and openness.

The findings are similarly mixed with respect to sense of safety. An evaluation of urban recreation sites showed that perceived safety seemed to decrease in densely wooded areas, but that picnic areas near forested settings were rated high on both density and sense of safety (Schroeder & Anderson, 1984). It appears that in some contexts at least, high density is compatible with high sense of safety. Moreover, the effects of vegetation density may depend on the type of vegetation. Although dense understory is associated with decreased feelings of safety (e.g., Nasar & Fisher, 1993), trees in urban public housing are typically limbed up such that they minimally interfere with surveillance and provide little concealment for potential predators. Pruning practices might make high densities of trees compatible with sense of safety.

In sum, although there is abundant reason to believe that urban public housing residents would respond more positively to treed spaces than to treeless outdoor spaces, it is not clear how residents might respond to high densities of trees. High densities of planting are sometimes associated with high levels of preference and sense of safety and sometimes not. The particular responses to a high density of trees appear to depend on the spacing and arrangement of the trees and on the context. In this study, we examined residents' reactions to different densities of trees, planted in a variety of arrangements, in the specific context of an urban public housing outdoor space.

THE PLACEMENT OF TREES

The placement or arrangement of trees involves a number of key decisions; for example, trees may be arranged in more or less open configurations, using any of a variety of different geometries. A review of the literature suggested that inner-city residents' responses to trees might be affected by both the

degree of spatial definition created by the trees and the formality of the arrangement.

Spatial definition is one of the fundamental principles taught in landscape design (Arnold, 1993; Booth & Hiss, 1991), and indeed, it is clear that some populations do prefer landscapes with greater levels of spatial definition (Herbert, 1981; Kaplan, 1985). However, there are some systematic differences in preferences for natural settings for different income groups and different ethnic groups (e.g., Getz, Alexander, & Kielbaso, 1982); hence, what is preferred by one group is not always preferred by others. Moreover, in one study involving inner-city Detroit residents, Black residents mentioned disliking scenes that felt closed-in more frequently than did Whites (Kaplan & Talbot, 1988). Thus, there is some suggestion that inner-city residents might prefer more open spaces; at the same time, it is not at all clear whether limbed-up trees contribute to a "closed-in" feeling, regardless of the spaces created in their placement.

If limbed-up trees contribute to a closed-in feeling, then perhaps the spaces created by trees could affect people's sense of safety. A recent study of crime in urban parks (Michael & Hull, 1994) argues that safety depends on the ability to detect a perpetrator and to observe one's surroundings. More specifically, a study in urban parks showed that users feared being in areas where vegetation restricted their view of what or who was around; the further they could see in the scene, the higher they rated its security (Schroeder & Anderson, 1984). Similarly, Kaplan and Talbot (1988) found that although inner-city residents valued having trees and nature nearby, they also expressed concerns about safety and visibility within the area. All these findings suggest that to the extent that using trees to create subspaces blocks views, subspaces might decrease sense of safety. Again, however, it is not clear whether limbed-up trees substantially block views. In this study, we examined urban public housing residents' reactions to spatial subdivision versus more open configurations.

The placement of trees can create different levels of spatial definition. In addition, the placement of trees in a space can create a variety of basic organizing geometries in that space; for example, trees can be planted in straight lines, at angles, in soft curved lines, or in clusters (Booth & Hiss, 1991). There is evidence to suggest that some urban public housing residents might prefer more formal, structured geometries. In a number of studies, urban African Americans have been found to place a high value on a sense of order in natural settings (e.g., for reviews, see Kaplan & Kaplan, 1989; Schroeder, 1989); in Kaplan and Talbot's (1988) study, disorderliness in a scene was the most frequently mentioned point of concern among the African

American participants. Perhaps planting trees in strict rows, rather than in less structured clusters, would help make outdoor spaces seem more orderly, and therefore, more highly preferred.

There is some reason to think that more orderly arrangements might have positive effects not only on residents' preferences but on residents' sense of safety as well. In Talbot and Kaplan (1984), inner-city residents' verbal responses to disliked urban nature scenes focused on lack of order and safety concerns. In this study, we examined urban public housing residents' reactions to trees placed in more and less formal arrangements.

GRASS MAINTENANCE

Grass maintenance is often inadequate in high-rise urban public housing environments, where the high numbers of residents sharing a common outdoor space makes the grass look far from well maintained. There are reasons to suggest that grass maintenance may play a surprisingly large role in determining public housing residents' like, or dislike, of an outdoor space. Among low- and moderate-income families, satisfaction with management of the home, development, and grounds are predictors of general housing satisfaction (Francescato, Weidemann, Anderson, & Chenoweth, 1979). Similarly, site maintenance is one of the strongest predictors of residential satisfaction among those who live in urban public housing (Anthony, Weidemann, & Chin, 1990). Moreover, African Americans seem to prefer manicured natural outdoor settings more than do Whites (Kaplan & Talbot, 1988).

Grass maintenance may have positive effects on not only residents' preference but also on residents' sense of safety. Maintenance problems such as litter and graffiti decrease perceived security in urban parks (Schroeder & Anderson, 1984), and a study examining ethnic factors in the use of urban outdoor spaces suggests that for many African Americans, well- maintained settings evoke a greater sense of safety than do poorly maintained settings (Washburne & Wall, 1980). In this study, we assessed the importance of grass maintenance in determining residents' reactions to different landscape options.

How would urban public housing residents respond to the addition of basic landscaping in their outdoor common spaces? To answer this question, computer simulation techniques were used to create a set of landscape scenes representing various tree planting and grass maintenance options in a Chicago public housing development. One hundred residents rated these simulations in terms of preference and sense of safety and answered a series of questions concerning the public space outside their apartment.

METHOD

SITE AND NEEDS ASSESSMENT

The site for this study was an outdoor space at Robert Taylor Homes in Chicago, Illinois. The Robert Taylor Homes is a high-rise, urban public housing development comprising 28, 16-story buildings. Although the official records show 14,000 residents, estimates indicate that more than 20,000 people actually live there. Courtyards of about 2 acres serve as the primary outdoor spaces for about 1,500 people each. Like many urban public housing outdoor spaces, the courtyard we selected has few trees, considerable paving, and a small area for planting.

We conducted three separate focus groups—with residents, Chicago Housing Authority administrators, and Chicago Housing Authority police—to solicit ideas regarding the addition of trees to the courtyard and landscape maintenance. A scale model (1 inch = 20 feet) of the site with moveable trees and grass patches was used to promote discussion.

The focus groups revealed some striking differences between residents', administrators', and police officers' responses to potential tree planting. Whereas residents were enthusiastic about having trees planted and about improving the landscape maintenance, administrators were concerned with the expenses associated with expanded planting areas. Whereas administrators and police officers were concerned about safety, arguing that trees would serve as hiding places for criminals and make residents feel less safe being outdoors, residents felt strongly that trees would not decrease their sense of safety.

SIMULATING THE POSSIBILITIES

Computer-based photo simulation was used to create realistic images of a variety of landscape treatments for the courtyard. Photo simulations have two main advantages as a means of assessing reactions to possible futures. First, people's responses to two-dimensional representations of a setting are surprisingly similar to what they are in the actual setting (Kaplan & Kaplan, 1989). Second, pictures can be systematically manipulated to show different levels of independent variables while holding other variables constant. In this study, different possible landscaping treatments were simulated while holding other variables that could affect preference—such as tree height, time of day, vantage point, and architecture— constant.

Each landscape treatment we tested was shown from four vantage points: showing a number of vantage points is necessary because it decreases any positive or negative bias that might be associated with a single vantage point

(e.g., a particularly flattering view of the trees in a particular location). We took 35 mm slides of the site, which were then developed, scanned, and digitized as computer images. Shots were taken from each of the three buildings surrounding the courtyard from three different heights: ground level, third floor, and eighth floor. Four of these pictures, each from a different vantage point, were selected as base images; taken together, the viewsheds from these four vantage points cover the entire courtyard (see Figure 2).

THE POSSIBILITIES

Three possible densities of tree planting were tested: a zero density, a medium density, and a high density. To determine the high density, we focused on the unpaved areas in the courtyard and, using a plan view, drew as many trees as could be planted in these spaces. Trees were spaced at a constant distance of 25 feet between trunks (the minimum distance suggested by the Chicago Bureau of Forestry). This procedure yielded a density of 22 trees per acre. The medium density was set at approximately half the high density, or 12 trees per acre. To depict the zero density, any of the very few existing trees visible in the base images were electronically deleted. To depict the higher tree densities, photos of existing mature trees, taken in different areas of the Robert Taylor Homes, were electronically pasted onto the zero density images.

Two possible levels of spatial subdivision were tested: trees planted to form either a single, wide open space and trees planted to create two smaller subspaces. In the resident focus group, some residents argued for keeping the courtyard space open, whereas others suggested that trees be planted by the basketball courts, bisecting the courtyard. Because it seemed possible that the effect of subdividing the space might depend on the density of the planting, we tested these two configurations for both medium- and high-tree densities.

Two possible arrangements were tested: a more formal arrangement with trees in a strict, linear geometry (rows) and a less formal arrangement with trees in clusters. Again, because it seemed possible that the difference between trees planted in rows versus planted in clusters might be clearer at higher planting densities, we tested the effect of arrangement at both medium- and high-tree densities.

Two possible levels of grass maintenance were tested: a relatively unmaintained condition and a well-maintained condition. The unmaintained condition simply showed the existing condition of the grounds, with more than half of the grass yellowed and the remainder bare soil. The maintained condition depicted healthy grass with the bare patches covered. Because there might be

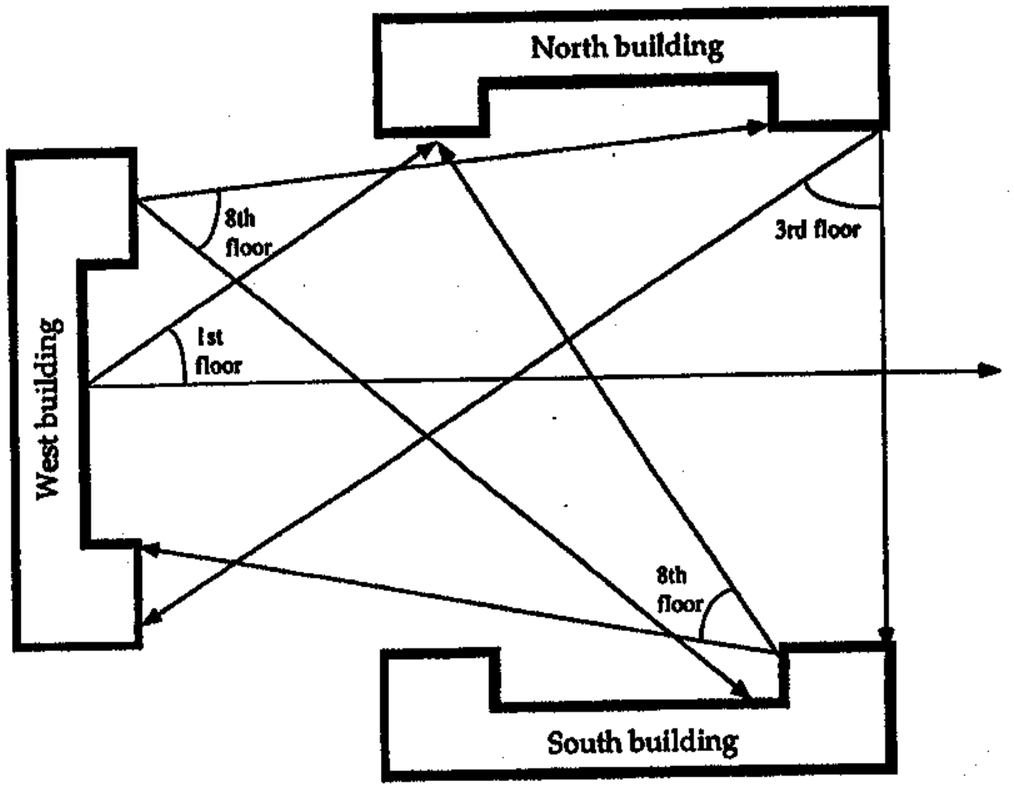

Figure 2: Plan View of the Viewsheds From the Four Selected Vantage Points

a tradeoff between density of trees and grass maintenance, where grass maintenance becomes increasingly important as the number of trees decreases, we tested the two levels of grass maintenance at all three tree densities.

Figure 3 shows the 10 treatments we examined. The four base images, with trees removed, served as the *0 trees/acre, unmaintained grass* condition (Treatment A). Nine additional simulations depicting various levels of the independent variables were then created for each base image by electronically adding trees and grass. The use of these 10 treatments allows clean tests of each of the four independent variables and three of the most plausible interactions between them.[1]

The final simulations were displayed in a format differing somewhat from the randomized serial format commonly used in studies of landscape preference. In most landscape preference studies, the to-be-rated images depict a set of different places, and each image has no particular relationship to other images in the set; hence, images are presented serially in random order. In this study, all of the to-be-rated images depicted the same place, and different pairs of images showed the effects of a particular transformation; hence, it

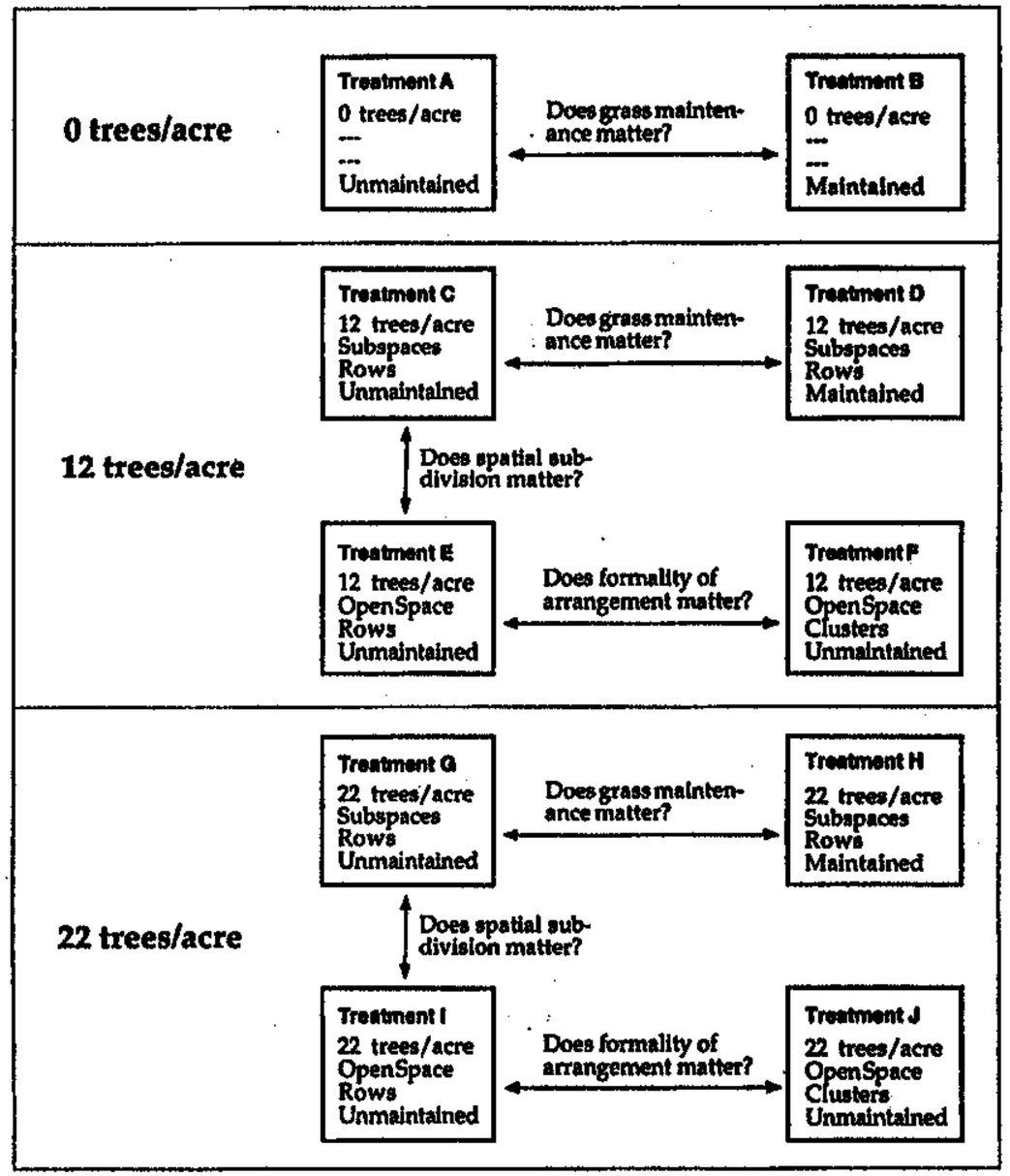

Figure 3: Nonfull Factorial Design for Visual Simulations

NOTE: Each box represents one possible landscape treatment. An arrow between two boxes represents a direct comparison within one independent variable. Comparisons were made within and between three tree densities. Treatments A, C, and G show the same base image (with unmaintained grass) at three different tree densities. To test the effect of grass maintenance, they were altered to show well-maintained grass, yielding Treatments B, D, and H. Treatments C and G show trees planted in rows, with one row bisecting the courtyard, creating two subspaces. To test the effect of spatial subdivision, Treatments C and G were altered to create a large open space, yielding Treatments E and I. To test the effect of formality of arrangement, Treatments E and I were altered to show trees arranged in clusters, yielding Treatments F and J. Each of the 10 treatments was tested at each of four vantage points.

seemed appropriate to allow participants to more directly compare items before and after the transformation. Indeed, pretesting revealed that when images were displayed in the randomized serial format, participants became suspicious that some sort of trick was being played on them and spent the bulk of the viewing time attempting to determine whether a particular image had been shown before.

Consequently, simulations were presented in a format that facilitated comparisons between similar treatments, within a single vantage point. Simulations were displayed on four 18 ×18 inch laminated boards. Each board comprised 10 3 × 5 inch color images, depicting the 10 treatments from one of the four vantage points. The spatial arrangement of images was the same on each board, with the 0 trees/acre, unmaintained grass condition at the top left. Photo simulations of similar treatments were placed adjacent to one another to facilitate comparison.

WRITTEN ITEMS

In addition to having participants rate the different landscape treatments, we asked a number of more general questions about residents' outdoor preferences and fears. One set of questions assessed residents' preferences and sense of safety for the courtyard in its existing condition, as well as their actual use of the space. A second set probed how residents' sense of safety might change if trees were planted. A third set probed how residents' liking for the courtyard might change if trees were planted and which views they would prefer to keep unobstructed. A fourth set of questions addressed participants' anticipated use of the space if trees were planted. A fifth set probed participants' willingness to help plant trees and take care of newly planted trees. The questionnaire concluded with standard demographic questions. All questions were pretested and refined for appropriateness of language through discussions with residents before data collection.

GETTING RESPONSES TO THE POSSIBILITIES

Two hundred and fifty residents of the courtyard were approached door-to-door, and 100—a 40% response rate—agreed to be interviewed. In the final sample, each of the three buildings was equally represented, with 33, 33, and 34 participants from the north, south, and west buildings, respectively. The different floors are also represented in roughly equal proportion, with at least 2 participants from 43 of the 48 building floors. Perhaps because men

are often unofficial residents of public housing, they were less willing than women to participate, yielding a gender distribution of 77 women and 23 men.

Two female residents of the Robert Taylor Homes with extensive training in data collection conducted face-to-face, structured interviews during a period of 1 month. The interviewers presented themselves as working with the University of Illinois and framed the survey as a tool to facilitate communication between residents and the Chicago Housing Authority. Participants were assured that their responses were confidential and that they could withdraw without penalty at any point. Once a resident agreed to participate, the interview was conducted in the resident's apartment.

Interviews took an average of 25 minutes to complete. First, participants' response to the courtyard in its existing condition were probed. Residents were asked about their liking, sense of safety, and use of the courtyard.

Second, participants' responses to the various landscape treatments were obtained. Participants were explicitly told that there was no guarantee that any of the possibilities depicted would be adopted, and that there was no guarantee that the Housing Authority would institute greening programs, increased levels of security, or any other improvements to the courtyard, but that information gathered in the study could provide the authority with a sense of what residents like and do not like and what would make residents feel safe or unsafe.

Participants were shown the photo simulation boards in a standard order. The interviewers explained that the scenes had been simulated on a computer, that sometimes the differences between pictures were small, and that it was acceptable to give the same rating to pictures that looked the same. To elicit preference ratings, participants were asked for each image, How much do you like it? After the 40 preference ratings were obtained (4 boards × 10 pictures/board), sense of safety ratings were elicited (10 ratings, yielding a total of 50 ratings). The first picture board shown was shown a second time, and for each of the images participants were asked, How safe would you feel? All ratings were made on a 5-point, Likert-type scale (0 = *not at all*, 1 = *a little*, 2 = *a medium amount*, 3 = *quite or quite a lot*, 4 = *very or very much*).

After rating the photo simulations, residents were asked a series of verbal questions about how they might respond to the courtyard if trees were planted. Residents were asked how their (a) preference for the courtyard, (b) sense of safety in the courtyard, and (c) use of the courtyard might change if trees were planted. The interview concluded with demographic questions.

RESULTS

THE STATUS QUO: RESIDENTS' EXPERIENCE OF A COURTYARD IN ITS EXISTING CONDITION

How are public housing high-rise open spaces currently experienced by residents? Residents' experience of the courtyard examined in this study was not at all positive. On a 5-point, Likert-type scale (0 = *not at all* and 4 = *very much*), mean preference ratings for various aspects of the courtyard were considerably less than 1, *a little*. On average, participants rated their preference for the condition of the grass, 0.2; for the way the courtyard looks now, 0.3; and for the view from (their) apartment, 0.6. Not only did participants dislike the appearance of the courtyard, they also felt unsafe there. Mean ratings for how safe participants feel outside during the day and at night were 1.6 and 1.3, respectively, with 0 = *not at all safe* and 4 = *very safe*. Residents were quite worried about their own safety ($M = 3.1$) and their children's safety ($M = 3.2$).

It is clear that residents' responses to the current condition of this outdoor space could hardly be worse. How would residents respond to the addition of basic landscaping? To assess the impact of specific landscaping choices (presence and density of trees, placement of trees, and grass maintenance), residents' preference and sense of safety ratings in response to photo simulations were subjected to repeated measures analyses of variance. For preference, ratings of a particular treatment from the four different vantage points were collapsed into a single mean rating for that treatment.

EFFECTS OF THE PRESENCE AND DENSITY OF TREES

How would the addition of trees affect residents' responses to their courtyard? Figure 4 shows simulations of the courtyard without and with trees, from the vantage point of the third floor of the northernmost building. Residents' preference and sense of safety in response to both the presence and the density of trees were examined.

The presence of trees had strong, positive effects on residents' preference ratings for the courtyard. Residents gave images with trees higher mean ratings than they did images without trees for each of the four vantage points. In fact, participants liked even the least liked tree condition ($M = 1.4$) as much or more than the best liked treeless condition ($M = 1.3$).[2] Moreover, residents gave emphatic positive responses to verbal interview items about trees: 84% of participants said they would like it *very much* if trees were planted, 86% said that views would improve if trees were planted, and 96% considered it *quite important* or *very important* that the space look more natural.

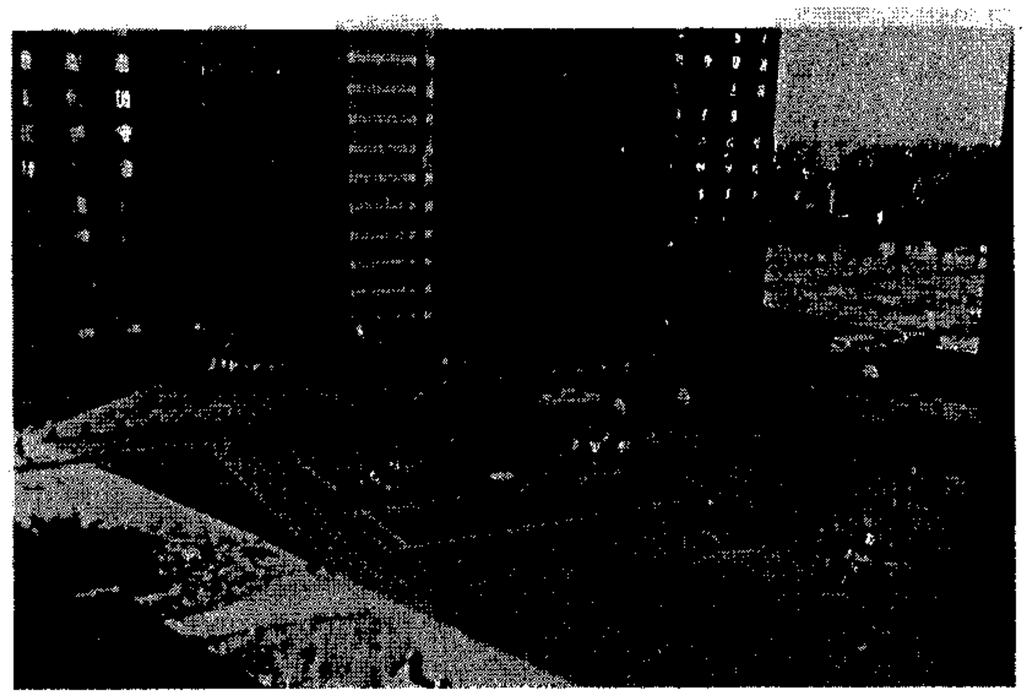

Figure 4: Views Depicting the Courtyard Without Trees (Treatment A) and With Trees (Treatment G)

NOTE: Participants rated 3.5" by 5" color pictures, which showed considerable more detail than the smaller, black and white images shown here.

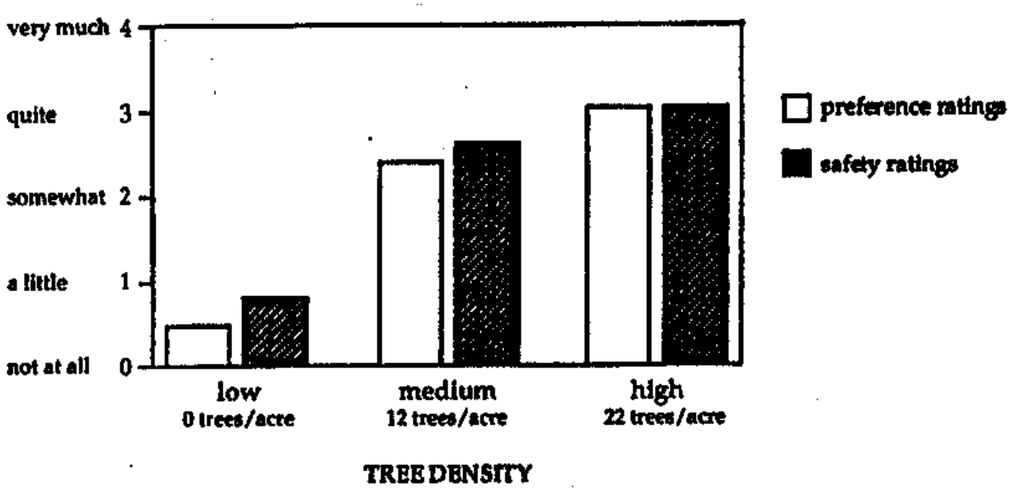

Figure 5: Mean Preference and Safety Ratings for the Three Tree Densities

The presence of trees had strong, positive effects on residents' sense of safety for the courtyard, as well. Mean safety ratings were consistently higher in response to images with trees than to treeless images, and strikingly, even the least safe treed image ($M = 2.3$) was judged more safe than the safest treeless image ($M = 1.3$). Again, residents' responses to verbal interview items upheld the simulation-based findings. Out of 100 participants, 25 said they would feel *safer* if trees were planted, 70 said they would feel *just as safe*, and only 5 said they would feel *less safe*.

Residents' strongly positive response to treed images of the courtyard was underscored by two additional findings. Approximately one out of three participants reported that they would use the outdoor space more if trees were planted, and when asked if they would be willing to help plant trees and care for newly planted trees, more than half of participants said yes. Together, these findings strongly suggest that urban public housing residents would very much welcome the addition of trees to nearby outdoor spaces. A logical next question, then, would be how many trees?

How many trees would be optimal for residents' experience of outdoor spaces? Residents' preference and sense of safety ratings for three different tree densities suggest that, within the range of densities tested here, the more trees the better. Residents' ratings showed monotonically increasing effects of tree density (see Figure 5). With respect to preference, the medium-density condition was rated significantly higher in preference than the low ($M = 2.4$ vs. 0.5), $F(1, 97) = 1{,}764.3$, $p < .0001$, and the high density was rated higher

still ($M = 3.0$ vs. 2.4), $F(1, 96) = 151.4$, $p < .0001$. The positive effect of tree density on preference was consistent across the four vantage points.

Sense of safety ratings also showed a positive effect of tree density. Participants rated sense of safety significantly higher for the medium-density condition than for the low ($M = 2.6$ vs. 0.8), $F(1, 96) = 35.1$, $p < .0001$, and rated the high density significantly safer than the medium ($M = 3.0$ vs. 2.6), $F(1, 98) = 333.2$, $p < .0001$. Residents' ratings suggest that within the range of densities tested here, the greater the density of trees the safer they would feel.

The effects of tree density on preference and sense of safety were not only statistically significant but impressive in magnitude. Ratings for different landscape treatments ranged widely; the mean preference rating for the high-density condition was more than six standard deviations away from the mean preference ratings for the low-density condition, and the mean safety ratings for the high- and low-density conditions were more than two standard deviations apart. Adding 22 trees per acre was sufficient to move residents' preference ratings from one side of the preference scale to the other, from *not at all* to *quite a lot*.[3]

In sum, residents responded extremely positively to the presence of trees, both in terms of preference and sense of safety. Of the three tree densities tested, residents responded most positively to the highest density (22 trees per acre).

EFFECTS OF THE PLACEMENT OF TREES

In addition to examining residents' responses to different densities of trees, we also examined residents' responses to different configurations of trees. Two issues with respect to the configuration, or placement, of trees were explored. First, we examined residents' responses to the degree of spatial subdivision created by the placement of trees. Figure 6 shows the courtyard with trees planted to (a) leave a large, central open space and (b) divide the space into two smaller spaces. Second, we examined residents' responses to the use of relatively formal versus more "natural" arrangements. Figure 7 shows the courtyard with trees planted in (a) a linear, strict geometry and (b) informal clusters. Neither spatial definition nor formality of arrangement had consistently substantial effects on residents' preference or sense of safety ratings.

Spatial definition had no effect on residents' preferences overall and only an inconsistent negative effect on residents' sense of safety. There was no significant difference in preference ratings for open space versus subspace configurations overall.[4] The negative effect of spatial definition on residents' sense of safety, $F(1, 96) = 6.0$, $p < .05$, was inconsistent over different

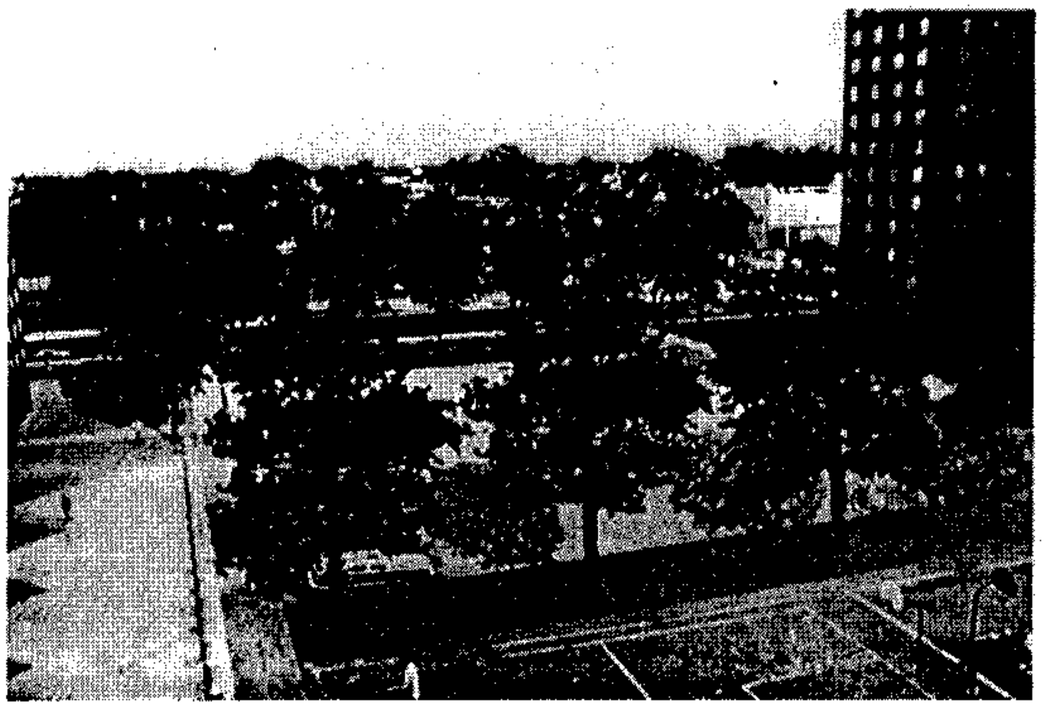

Figure 6: Views With Trees Creating a Single Open Space (Treatment E, left) Versus Two Smaller Subspaces (Treatment C)

Figure 7: Pictures Showing Trees Planted in Rows (Treatment E, left) and Trees Planted in Clusters (Treatment F)

densities. Although spatial definition had a substantial impact at the intermediate density of trees, it had only a trivial impact at the high density of trees: At the intermediate density, the open configuration received a mean sense of safety rating almost half a scale point higher (+0.4) than did the subdivided configuration; at the high-tree density, the open configuration received a mean sense of safety rating nearly equal (+0.1) that of the subdivided configuration.

A number of findings suggested that the negative effects of spatial definition on sense of safety might be attributable to shorter view distances. Residents' responses to verbal interview questions about view distances suggested that the shorter the view distance the less safe they feel. Three quarters of participants indicated they would be concerned if, when inside looking onto the courtyard, trees blocked their view to their children, and nearly half of participants indicated that if trees blocked their view from the courtyard to the building, they would feel less safe.

Formality of arrangement had little or no effect on residents. There was no significant overall effect of tree arrangement on preference,[5] and formality had no significant effect on sense of safety.

In sum, whereas the presence and density of trees had clear, consistent, and substantial effects on residents' preference and sense of safety, tree placement had essentially no effect on preference and an inconsistent effect on sense of safety.

EFFECTS OF GRASS MAINTENANCE

One element of a basic landscaping program is the provision and maintenance of grass. What impact would the level of grass maintenance have on urban public housing residents' responses to their outdoor common spaces? Figure 8 shows images depicting the courtyard with the grass in its existing condition (left) and in a well-maintained condition (right).

Results show that overall, the effect of grass maintenance on residents' responses is quite positive. Participants' ratings for the existing condition of the grass averaged barely above zero ($M = 0.2$), indicating they do not like it at all, and images showing well-maintained grass were preferred over those showing grass in its existing condition, $F(1, 97) = 82.8$, $p = .0001$. When asked how important it was that the courtyard look "better kept," participants responded nearly unanimously *very much* ($M = 4.0$). Grass maintenance also had positive effects on residents' sense of safety ratings; images showing well-maintained grass were given significantly higher ratings than images showing grass in its existing condition, $F(1, 97) = 81.3$, $p = .0001$.

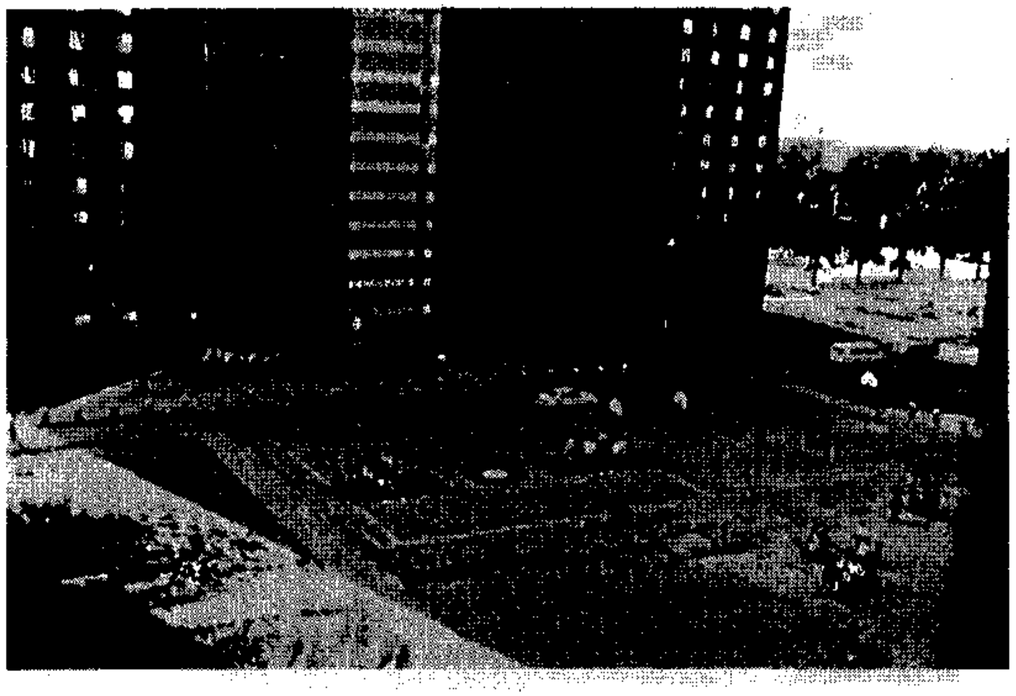

Figure 8: Images of the Courtyard Showing the Existing Condition of the Grass (Treatment A, left) and Well-Maintained Grass (Treatment B)

NOTE: Participants looked at color images in which the differences between conditions were more evident than in the black and white images shown here.

It should be noted that the effects of grass maintenance were moderated by both tree density and vantage point. There were significant interactions between grass maintenance and tree density for both preference and safety, $F(2, 198) = 32.3$, $p = .0001$, and $F(2, 194) = 16.0$, $p = .0001$, respectively, and between grass maintenance and vantage point for preference, $F(3, 297) = 55.3$, $p = .0001$. Grass maintenance had larger effects on ratings when there were fewer trees and when viewed from the two eighth-floor vantage points. It is not surprising that the condition of the grass is more evident when trees are not blocking the view and when the view looks down onto the grass rather than across at the trees.

RELATIVE CONTRIBUTIONS OF TREE PLANTING, TREE PLACEMENT, AND GRASS MAINTENANCE

To summarize thus far, tree planting and grass maintenance had clear, positive effects on preference and sense of safety; tree placement had no effect on preference and an inconsistent effect on sense of safety. What are the relative contributions of these landscaping variables on residents' responses? Tables 1 and 2 show residents' mean preference and sense of safety ratings in response to each of the 10 treatments (collapsing over different vantage points). Comparing the mean differences and η^2s for the various manipulations gives a sense for their relative contributions to preference and sense of safety.

Looking down the columns in Table 1 gives a sense for the effect size associated with tree density. Means differ substantially between the 0 density and 22 density rows. Indeed, the η^2s for the density of trees (calculated for images showing three densities over two levels of grass maintenance, with tree placement held constant) indicate that the density of trees explains 89% of the variance in preference ratings and 69% of the total variance in sense of safety ratings. Looking across rows in Table 1 gives a sense for the effect size associated with grass maintenance. The effect size of grass maintenance is not as large as the effect size of tree density but still quite substantial; η^2s (calculated for images showing two levels of grass maintenance over three levels of tree density, with tree placement held constant) indicate that the level of grass maintenance explains almost half of the variance (46% and 46%) in both preference and sense of safety ratings. Not surprisingly, the combined effects of trees and grass maintenance produce the largest increases in both preference and sense of safety: Adding grass maintenance and a high-density of trees to the unmaintained, treeless condition yields a +3.0 scale point difference in preference and a +2.8 scale point difference in safety.

TABLE 1
Residents' Mean Preference and Sense of Safety Ratings in Response to Different Levels of Tree Density and Grass Maintenance (standard deviations in parentheses)

	Preference Ratings		*Sense of Safety Ratings*	
	Unmaintained Grass	*Maintained Grass*	*Unmaintained Grass*	*Maintained Grass*
0 trees per acre	0.2 (0.4)	0.7 (0.6)	0.4 (0.8)	1.3 (1.1)
12 trees per acre	2.3 (0.6)	2.6 (0.6)	2.3 (0.8)	2.9 (0.9)
22 trees per acre	3.1 (0.7)	3.2 (0.8)	2.9 (1.0)	3.2 (1.1)

TABLE 2
Residents' Mean Preference and Sense of Safety Ratings in Response to Three Different Tree Placements at Two Different Densities

	Preference Ratings			*Sense of Safety Ratings*		
	Subspace Formal	*Open Space Formal*	*Open Space Informal*	*Subspace Formal*	*Open Space Formal*	*Open Space Informal*
12 trees per acre	2.3 (0.6)	2.4 (0.7)	2.3 (0.7)	2.3 (0.8)	2.7 (1.0)	2.6 (1.1)
22 trees per acre	3.1 (0.7)	2.9 (0.8)	2.9 (0.8)	2.9 (1.0)	3.0 (1.1)	3.0 (1.1)

NOTE: Standard deviations are given in parentheses. Columns 1 and 2 show the effect of spatial subdivision, holding formality of arrangement constant; columns 2 and 3 show the effect of formality of arrangement, holding spatial subdivision constant.

Looking across the rows in Table 2 gives a sense for the effect size associated with tree placement. By contrast with the effects of tree density and grass maintenance (ranging from 89% to 46%), the effect sizes associated with tree placement are quite small (ranging from 7% to 0.3%). The effect of spatial subdivision (calculated for images showing two levels of subdivision over two levels of tree density, with grass maintenance held constant) is small for sense of safety, explaining 7% of the variance, and essentially nonexistent for preference, explaining 0.3% of the variance. Formality of arrangement explains 2% of the variance in preference and 1% of the variance in sense of

safety (effect sizes were calculated for images showing two levels of formality over two levels of tree density, with grass maintenance held constant).

DISCUSSION

Currently, little work has examined responses to urban nature in inner-city populations and contexts. The findings here extend our understanding of the relationship between urban nature, preference, and sense of safety in the inner city and have implications for the planning and design of inner-city neighborhoods.

PREFERENCE FOR URBAN NATURE IN THE INNER CITY

In this study, residents from 2 of the 10 poorest neighborhoods in America (Iherijika, 1995) showed a positive and dramatic response to trees and well-maintained grass. The direction of their response is unsurprising but worth noting nonetheless. Although positive responses to urban nature have been documented in a wide variety of urban settings and populations, this study shows that the preference for urban nature extends across socioeconomic strata to include the poorest of America's poor. This study reinforces previous findings suggesting that basic landscaping is not an amenity appreciated only by the wealthy or relatively well off; indeed; it broadens the base of evidence that there is a universal human preference for urban nature.

The magnitude of residents' response to trees and grass maintenance was striking. To a middle-class reader surrounded on a daily basis by reasonably pleasant settings, the addition of trees and grass maintenance to this barren courtyard may seem only a modest improvement. The findings here suggest that to an urban public housing resident living at "the Hole" and surrounded by relatively bleak settings, the transformation of this familiar outdoor space is profound. The surprising strength of these residents' response to such simple landscaping changes suggests that although there may well be a universal preference for urban nature, the extent of a population's appreciation for landscaping is likely magnified or attenuated by expectation and the content of daily experience.

Residents' most positive responses were to the highest density of trees tested. Although this might seem surprising in light of studies in which the highest densities were not the most preferred (e.g., Kaplan & Talbot, 1988), other studies have found preference increasing with density (Schroeder & Anderson, 1984; Schroeder & Orland, 1994), and it is important to note that

the range of densities tested here was considerably lower than might be typical of parks or heavily forested areas (see Schroeder & Green, 1985). The contribution of this study is to show that within the urban residential context, the most preferred planting density may be the maximum recommended density.

Whereas the presence and density of trees were important in residents' responses, the placement of trees had little effect. Although the widely accepted landscape design principle of creating spatial definition (e.g., Booth & Hiss, 1991) would seem to imply that subdivided spaces are universally preferred, inner-city residents showed no more preference for a subdivided space than for a more open configuration. This study suggests that landscape design principles developed in the context of largely middle- or upper-income European American neighborhoods are not universal.

SENSE OF SAFETY AND URBAN NATURE IN THE INNER CITY

Although sense of safety is as important a component of the human response to urban landscapes as preference, far less is known about the factors contributing to sense of safety. The findings from this study extend the understanding of the complex effects of view distance, site maintenance, and tree density on sense of safety.

In this study, residents generally reported that blocked views would make them feel less safe, echoing previous findings suggesting that view distance is a factor in sense of safety (e.g., Fisher & Nasar, 1992; Michael & Hull, 1994). Furthermore, there was some indication that even trees that are limbed and spaced at 25 foot intervals could have measurable effects on view distance and sense of safety: At the 12 trees per acre density, those arrangements where trees bisected the courtyard received lower sense of safety ratings than did arrangements retaining a central open space. At the same time, however, the effect of blocked views (spatial subdivision) on safety was both inconsistent and small (spatial subdivision had only a trivial effect at the 22 trees per acre density and accounted for only 7% of the variance in sense of safety ratings overall). Thus, in this study, blocked views were only one factor in sense of safety and a small factor at that.

In fact, the largest factors in sense of safety in this study were levels of vegetation: Levels of grass maintenance had a surprisingly large effect on sense of safety, accounting for 46% of the variance in ratings, and density of trees had an even larger effect, accounting for 69% of the variance. If grass maintenance has no effect on view distance, why does grass maintenance increase sense of safety? Moreover, if trees decrease view distance, why were the highest sense of safety ratings given to images with the highest levels of

tree density (shortest view distances) and the lowest sense of safety ratings given to images without trees—images with the greatest view distances?

The mystery deepens when these findings are compared with previous, related findings. With respect to grass maintenance, although previous work has indicated that well-maintained landscapes are rated higher in sense of safety (e.g., Schroeder & Anderson, 1984), one central difference between this and previous work makes the replication here surprising. In previous work, participants have been unfamiliar with many of the particular landscapes being rated—in the absence of any direct knowledge, the level of site maintenance might reasonably serve as a cue for predicting levels of policing, safety, and danger in a place. In this study, participants were quite aware of the actual levels of policing, safety, and danger in their courtyard, and no changes in amount of security were either promised or implied. Why would residents report a higher sense of safety for images showing maintained grass, when view distances and security measures were unchanged?

The mystery deepens further still when we examine the findings with respect to tree density. Although in some cases high tree densities are compatible with high sense of safety (Schroeder & Anderson, 1984), the general pattern is for densely wooded areas to evoke less sense of safety than other areas (e.g., Kaplan & Talbot, 1988; Schroeder & Anderson, 1984); this is the first study to find a positive relationship between tree density and sense of safety. Why would participants in this study report a higher sense of safety for images showing more trees when view distances could only be decreased and security measures were unchanged, particularly when this pattern of findings has not been obtained in other contexts? Are the findings here an anomaly?

A more recent study conducted within the same public housing development suggests that the puzzling findings from the current study are no anomaly. Kuo, Sullivan, Coley, and Brunson (1997) examined a different sample of residents, in a different set of buildings, and found that residents living in buildings with more nearby trees and grass gave higher ratings to the item "I feel safe living here" than did residents living in relatively barren buildings. Thus, the positive relationship between trees, grass, and sense of safety appears to hold in the context of inner-city neighborhoods, whether the vegetation is real or depicted, and in both between- and within-subjects designs.

A closer look at the inner-city context reveals a potential solution to the mystery. Wilson and Kelling's (1982) "broken windows" thesis suggests that visible signs of decay in an urban area (e.g., accumulated trash, broken windows) can precipitate further resident withdrawal and neglect and mark the area as vulnerable to vandalism and crime, creating a downward spiral of

deterioration. Perhaps in the context of barren, inner-city no man's lands, the presence of trees and well-maintained grass sends a positive signal, indicating to residents and possible offenders that this is a "nice" place, a civilized, cared-for place with civilized standards of behavior. If so, trees may affect sense of safety in two opposing ways—both *decreasing* sense of safety through decreasing view distances and *increasing* sense of safety through increasing the civilized, cared-for character of a space. Thus, in urban settings with a strong "no man's land" character (e.g., inner-city outdoor spaces, abandoned city lots), the positive impacts of trees on sense of safety may far outweigh the negative; in contrast, in the more affluent urban settings typical of much previous research, the negative impacts of high tree densities might be expected to outweigh the positive.

IMPLICATIONS FOR THE GREENING OF INNER-CITY NEIGHBORHOODS

Previous research and analysis suggest that landscaping has the potential to transform inner-city neighborhoods—the potential to mitigate the negative environmental impacts of urban development, provide relief from crowding, provide more humane play spaces for children, increase the physical and psychological health of inner-city families, and perhaps even decrease levels of vandalism and destruction. The purpose of this study was to determine whether residents' reactions to landscaping would make introducing landscaping viable. Contrary to predictions made by law enforcement officials and some housing managers, residents' responses indicate that basic landscaping would be very welcome. The barren common space in this study evoked neither liking nor a sense of safety; in contrast, participants responded quite positively to images depicting the space with well-maintained grass and a high density of trees, and the effects of greening on both preference and sense of safety ratings were dramatic.

The findings indicated not only that landscaping would be welcome but also that as far as residents were concerned, the greener the space the better; the more trees and grass depicted in the courtyard, the more residents liked it and the safer they said they would feel in it (within the range of tree densities allowed by the Chicago Bureau of Forestry). At the same time, there were multiple indications in this study that residents feel safer when views are not blocked. Together, these findings suggest that the most promising tree planting configurations are dense (up to the maximum recommended density) yet maximize view distances. Furthermore, although trees and grass maintenance were sufficient to substantially increase residents' preference and sense of safety, it is unclear how residents might respond to the addition of shrubs.

We found residents very willing to participate in the greening process itself; striking numbers of participants indicated they would be willing to help plant and take care of trees in their courtyard. As planting and maintenance are the chief costs in greening programs, involving residents in those activities might have a major impact on the already low costs of greening.

The importance of resident involvement in greening was underscored in a resident focus group and in our interviewers' informal conversations with residents. A recurrent topic of concern among participants was how to ensure that any trees planted would survive; when asked how this could be done, the reply was straightforward, "you've got to involve everybody." Participants clearly felt that residents were key to the survival of any plantings, and that gaining resident commitment to the protection of the plantings would require that residents be involved in the decision to plant. Furthermore, participants' comments made it clear that one of the biggest challenges in planting design in this context is to address the various and occasionally conflicting needs of the different groups living in urban public housing—children, teenagers, single mothers, adult men, elderly persons. Although there may be general principles for landscape design in these settings—some of which were explored in this study—there may be no shortcuts. Resident involvement in not only planting and maintenance but also in decision making and design may be key in the long-term success of greening programs.

Tree planting and grass maintenance may be a cost-effective, viable step in addressing many of the ills plaguing inner-city neighborhoods. We offer three general recommendations for the greening of these neighborhoods: (a) the greener the better, (b) maintain view distances for sense of safety, and (c) involve residents in all phases of greening efforts. Greening might help make inner-city neighborhoods more supportive places for children and families; resident involvement might make inner-city neighborhoods more supportive places for greening.

NOTES

1. A full factorial design testing all possible interactions between the four independent variables for the two dependent variables would require participants to give preference and sense of safety ratings for 72 images (18 possibilities at each of four vantage points). Pilot testing suggested that this was far too many images for one person to rate without feeling tired and/or distracted.

2. Possible effects of both interviewer and the participant's building were examined. There were no main effects of interviewer on either preference or safety ratings nor were there significant interactions between interviewer and any of the independent variables examined. There were also no significant differences in ratings from participants living in different buildings.

3. In landscape preference research, it is relatively rare to see a full scale point difference between two means (Kaplan & Kaplan, 1989), yet in this study, the difference between the 0 tree condition and the 22 tree/acre condition is more than 2 full scale points. This raises the question of whether the image display method used here, which facilitates comparison between similar images, exaggerates the magnitudes of differences. A number of considerations suggest that this image display method does not exaggerate the magnitudes of differences. First, the instructions explicitly made it acceptable to rate similar images similarly—participants had no special reason to exaggerate perceived differences or to use more of the scale than participants in other studies. Second, large differences remain large when expressed in standard deviations, which normalizes for *S*s using the entire scale. Third, although a large mean difference was obtained, very small systematic mean differences (one tenth of a scale point) were obtained as well, and in another study with the same stimuli and same display method, a smaller mean difference was obtained for the 0 and 22 tree per acre densities; thus, it appears that this image display method yields small differences where small differences exist. In our view, the most plausible interpretation of the magnitude of the tree density effect in this study is that for residents living next to this barren courtyard, the addition of a substantial number of trees to the courtyard would truly make a huge difference in their response to it. Although the serial display method would have been inappropriate to use given the design of the present study, future research should explore the advantages and disadvantages of the two display methods, as well as the conditions under which each is most appropriate. The considerations listed above suggest that any discrepancies in effect sizes yielded by the two methods might well be attributed to an underrepresentation of effect sizes by the serial method, as opposed to an exaggeration of effect sizes by the parallel method.

4. Although finer-grained comparisons revealed statistically significant effects of spatial subdivision, these effects were neither consistent over different tree densities (subspaces received lower ratings at intermediate density and higher ratings at the high density), consequential in size (means differed by –0.1 and +0.2, respectively), nor consistent over different vantage points.

5. Although finer-grained analyses revealed a statistically significant effect of formality at the intermediate tree density, $F(1, 98) = 19.6$, $p = .0001$, again, the effect was neither consistent over different densities, consequential in size (mean differences were 0.1 and 0.0), nor consistent over different vantage points.

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