Visual Landscapes and Psychological Well-Being

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HUMAN RESPONSES TO VEGETATION AND LANDSCAPES

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ABSTRACT

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The rapidly expanding research record concerning aesthetic, emotional and physiological response to visual landscapes is summarized, with emphasis on aesthetic preferences for views containing trees and other vegetation. The survey is set within a conceptual perspective suggesting that affective responses such as aesthetic preference are central to a landscape observer's thoughts, conscious experience and behavior. Substantial progress has been made in developing models that relate aesthetic responses to specific visual properties of environments. When aesthetic preferences are compared for urban and unspectacular natural views, American and European adult groups evidence a strong tendency to prefer nature. However, liking for urban scenes usually increases when trees and other vegetation are present. Views of nature, compared to most urban scenes lacking natural elements such as trees, appear to have more positive influences on emotional and physiological states. The benefits of visual encounters with vegetation may be greatest for individuals experiencing stress or anxiety. Recent research demonstrates that responses to trees and other vegetation can be linked directly to health, and in turn related to economic benefits of visual quality.

INTRODUCTION

The purpose of this paper is to provide an overview of research findings concerning human responses to natural and urban visual landscapes, with emphasis on affective reactions to urban views, especially those containing trees and other vegetation. Despite the restriction to responses elicited by visual encounters, the relevant empirical literature is now quite large; accordingly, there can be no attempt here to achieve a comprehensive review of all related studies, and the intuitive literature is omitted. Most of the discussion focuses on aesthetic responses, in keeping with the fact that the vast majority of research to date has been concerned with aesthetic preference or pleasantness. The comparatively few studies of emotional and physiological influences of outdoor scenes are also surveyed.

The following section establishes a conceptual context by defining key terms and briefly discussing theoretical notions relating to affects. Then, because research concerning natural landscapes is pertinent to a number of planning and urban forestry issues, aesthetic responsiveness to natural landscapes is addressed in two sections; the first summarizes a preference framework that can be applied to a wide range of environments, while the second focuses specifically on aesthetic reactions to forest scenes. The next sections review findings concerning differences in aesthetic, affective and physiological responses to urban versus natural visual environments. The discussion then shifts to built settings and influences of urban vegetation on aesthetic

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preferences. A concluding section identifies research needs and suggests some directions for the future.

CONCEPTUAL NOTIONS

The term *affect* is used synonymously with *emotion,* although in a strict sense affect is a broader term that encompasses both emotion and feeling in terms of drive states such as thirst and hunger (Izard, 1977). Affect is used here in the narrower sense of emotion. *Aesthetic response* is defined as preference or like–dislike affect in association with pleasurable feelings and neurophysiological activity elicited by visual encounter with an environment (Berlyne, 1971; Ulrich, 1983). Although some investigations have measured preference (like–dislike), and others have used affect-saturated terms or scales such as "scenic quality" or "beautiful–ugly", results from the different measures are highly correlated and appear not to differ significantly (e.g. Zube et al., 1975).

Consistent with the general thrust of recent findings and theory in psychology, affects or emotions are considered to be innate, cross-cultural phenomena, each having characteristic experiential and facial components (e.g. Izard, 1977). Four or five emotions can be elicited at birth, and the onset of others appears to follow a developmental pattern that may be linked with age-related maturational processes (Izard and Buechler, 1980). Numerous studies indicate that the primary or fundamental emotions (e.g. liking, interest, joy, fear) have similar experiential qualities and facial expressions across widely different cultures, including isolated primitive groups having had virtually no contact with Western societies (e.g. Ekman et al., 1972). Whereas affects are universal, two observers who react to a given landscape scene with similar feelings might nonetheless vary considerably in the complexity and nature of their conscious experience. This would occur if the thoughts accompanying their affective responses differed markedly because of variations in factors such as age and experience.

An aesthetic or affective response to an outdoor scene is not an isolated phenomenon that is somehow independent of behaviors and other systems. Rather, the conceptual position here is that an affective reaction is adaptive in terms of the total behavior of the individual, and is closely linked to the preceding affective/cognitive state, to thinking, neurophysiological activity, and behavior (Ulrich, 1983). Regarding behavior, most contemporary emotions frameworks premise that a feeling response motivates adaptive behavior or functioning. For instance, preference (liking) motivates the approach class of behavior; feelings such as dislike and fear motivate avoidance; the emotion of interest motivates attention and processing; etc. Consistent with most emotions theories, it is suggested that an affective reaction is adaptive in the sense that it is appropriate to the situation and leads to functioning or behavior that foster on-going well-being. Some responses motivate actions having obvious adaptive significance, such as acquiring environmental information (exploration) or dealing with a threat. However, many aesthetic and affective reactions are assumed to motivate adaptive functioning that is not necessarily expressed as overt actions. For instance, the passive contemplation of a stand of trees in a city is quite adaptive if it provides a breather from prolonged stress (Ulrich, 1983).

With the rise to prominence of cognitive psychology in the 1960's, affects came to be viewed as products exclusively of thinking. This position is also evident explicitly or implicitly in nearly all the descriptive literature on learned associations and meanings in relation to outdoor scenes. According to this perspective, an observer's feelings are post-cognitive, resulting from a process of cognitive evaluation or appraisal, and from memories and associations which may accompany

appraisal. Given the widespread acceptance of this position, it is disturbing that there is no evidence whatsoever that conscious thought or processing necessarily precede affect, and in fact recent experiments suggest that this perspective may be incorrect. There is growing empirical support for the conceptual view of Zajonc (1980), Izard (1977), Ittelson (1973) and others that many feelings are essentially precognitive and constitute the initial level of response to environment. This initial affective response may then sustain and shape subsequent cognition (Izard, 1977; Sperry, 1982), which in turn can refine the general initial feeling reaction and may generate other emotions (Ulrich, 1983). In this perspective, remembered landscape scenes should in most instances be those that elicit initial feeling responses such as strong liking or dislike. In sum, recent theoretical and empirical developments suggest that affective responses such as preference are central to thought, memory and meaning, and behavior.

AESTHETIC PREFERENCES FOR NATURAL LANDSCAPES

During the last 15 years, a large experimental literature has appeared that focuses on aesthetic responses to natural landscapes and the related issue of scenery quality assessment. A brief survey of this literature appropriately precedes the later sections on urban landscapes, because the conceptual perspectives and research approaches developed for natural scenery have strongly influenced most of the recent studies of urban vegetation aesthetics. Also, as will become evident, some of the findings for natural settings are relevant to the management of urban parks and their evaluation as aesthetic amenities. Finally, in the case of a number of important urban planning issues, such as encroachment on agricultural land and management along the urban–rural interface, the research areas of natural and urban aesthetics are closely intertwined.

One clear trend in the literature on natural landscapes is the development of preference models based on the responses of recreationists and diverse public groups, as opposed to approaches that rely on judgments by individual experts or small groups of professionals. This trend has been accompanied by empirically grounded criticisms of expert-based systems, especially approaches that rest on artistic or aesthetic design principles, such as Litton's (1968) and the Forest Service's Visual Management System (USDA, 1974). These approaches may be seriously deficient in terms of sensitivity, reliability and validity (e.g. Feimer et al., 1981; Daniel and Vining, 1983). Also, professional judgment approaches tend to be incompatible with government policies that increasingly require public input in decisions affecting both natural and urban landscapes. By contrast, studies based on the aesthetic responses of groups of laypersons can constitute an important form of public participation in decision-making, whether the setting is wilderness or urban.

Substantial progress has been made in identifying visual characteristics of natural landscapes that influence aesthetic preference or liking (or correlate ratings such as "scenic quality"), and investigators have consistently demonstrated it is possible to account for most of the variance in individuals' aesthetic judgments. An important factor in this success is the broad agreement in aesthetic preferences for natural settings that usually holds across individuals, groups, and even different Western cultures (e.g. Coughlin and Goldstein, 1970; Shafer and Tooby, 1973; Ulrich, 1973, 1977; Daniel and Boster, 1976; Kwok, 1979; Wellman and Buhyoff, 1980). Also, landscape preferences at the level of adult individuals appear to be stable over moderate periods of time (Hull and Buhyoff, 1984). However, the preferences of young children may vary significantly from those of teenagers and adults (Zube et al., 1983).

The literature on natural landscapes reflects a wide variety of methods and conceptual

perspectives (Zube et al., 1982). One school of approach, which has been termed the "psychological" (Daniel and Vining, 1983), attempts to relate preference and other emotions to psychologically relevant visual properties (e.g. complexity) that are present in widely different landscapes. Often the research is grounded on explicit theoretical statements, as the investigator attempts to explain the psychological basis of affective responses to landscapes. In the following section, the characteristics of high- and low-preference natural scenes are summarized according to a psychological model that has been set out in detail elsewhere (Ulrich, 1977, 1983). Because the environmental properties in the model are present in many, and in some cases all, natural landscapes, an advantage of this approach is its very broad applicability. The model rests on psycho-evolutionary theoretical arguments explaining why these properties should influence like/dislike responses (Ulrich, 1983). Central to the underlying theory is the notion that these environmental properties have adaptive significance in the sense that they effectively elicit like–dislike feelings, which in turn motivate approach–avoidance behaviors appropriate to the observer's on-going well-being. In the case of each property, there is empirical evidence, often from several studies by different researchers, suggesting that the characteristic significantly influences aesthetic preferences for natural scenes.

CHARACTERISTICS OF HIGH- AND LOW-PREFERENCE NATURAL LANDSCAPES

In terms of the model, preference or liking for *unspectacular* natural scenes should be comparatively high if:

(1) complexity, or the number of independently perceived elements in the scene, is moderate to high (e.g. Kaplan et al., 1972; Ulrich, 1977);

(2) the complexity is structured to establish a focal point, and other order or patterning is also present (e.g., Küller, 1972; Ulrich, 1977);

(3) there is a moderate to high level of depth that is clearly defined (e.g. Craik, 1970; Wohlwill, 1973; Ulrich, 1973, 1977; Hull and Buhyoff, 1983);

(4) the ground surface has even or uniform length textures that are relatively smooth, and the observer judges that the surface is favorable to movement (e.g. Rabinowitz and Coughlin, 1970; Ulrich, 1973, 1977; Daniel and Boster, 1976);

(5) a deflected or curving sightline is present, conveying a sense that new landscape information lies immediately beyond the observer's visual bounds (e.g. Cullen, 1961; R. Kaplan, 1973; Appleton, 1975; S. Kaplan, 1975; Ulrich, 1977; Herzog, 1984);

(6) judged threat is negligible or absent (Zuckerman and Ulrich, 1982; Ulrich, 1983).

Although the above properties will in concert elicit liking, preference is often especially high when a water feature is present (e.g. Brush and Shafer, 1975; Zube et al., 1975; Penning-Rowsell, 1979). Findings from several studies indicate that high-preference views can frequently be described as park-like or savanna-like in appearance (e.g. Rabinowitz and Coughlin, 1970; Ulrich, 1973; Balling and Falk, 1982). Hence, preferred unspectacular landscapes are comparatively ordered, "civilized" assemblages of natural elements; most are not wild in terms of conveying a sense that human influences are absent. There is little question that urban parks characterized by smooth ground covers, scattered trees, and depth or openness, are visual approximates of a general class of natural landscapes that are highly preferred relative to many, if not most, other natural scenes.

By contrast, the model predicts that low-preference natural scenes are marked by either featureless low complexity, or disordered high complexity with no focal point (e.g. a forest setting cluttered with large

amounts of slash and downed wood). Also, views having sharply restricted depth consistently elicit dislike; a high-depth view may be disliked if the area is flat and featureless. Other characteristics of low-preference scenes include rough ground textures that obstruct movement, and the absence of a deflected vista and water feature. The presence of a judged threat (e.g. the edge of a steep cliff, a dangerous animal) can by itself produce dislike, irrespective of levels of variables such as depth and focality.

Figures 1 and 2 are examples of high- and low-preference views from a study of rural roadside scenes using American and Swedish subjects (Ulrich, 1977). Because none of the 53 scenes in the study contained water or conveyed threat, these properties did not influence the findings. Factor analysis indicated that the subjects assigned highest preferences to a park-like grouping of scenes characterized by high depth, even ground textures, and moderate-to-high complexity consisting largely of scattered trees or small groupings of trees. Only one view in this factor did not have at least a mid-range level of focality. Three scenes containing deflected vistas were also highly preferred. A factor of views having low depth, rough ground textures, and disordered complexity was by far the lowest in preference. Agreement across the American and Swedish groups was impressively high.

AESTHETIC PREFERENCES FOR FORESTS

As noted previously, the above preference model incorporates visual properties that are comparatively general or even universal, giving the approach very wide applicability. Rather

Fig. 1. A park-like, high-preference scene from the cross-cultural roadside study. There is a focal area with deflected vista, depth is moderately high, and the ground texture is even and uniform.

Fig. 2. An example from the low-preference group. The moderately-high complexity cannot readily be grasped because of a lack of focality and other structure; textures are rough and uneven, and depth is restricted.

different research aims are evident in several studies that have focused more narrowly on forest landscapes. These investigations tend to have a strongly practical orientation in the sense there is often an attempt to relate aesthetic preference to environmental properties that are directly relevant to forest management practices (e.g. tree diameter). Most of the work reflects the psycho-physical or physicalist approach, where a multiple regression equation is identified that produces a good fit between preference ratings and particular properties of forest scenes that can be objectively measured (e.g. cubic feet/acre of slash). Some of these techniques, such as those of Daniel and his colleagues (Daniel and Boster, 1976; Daniel and Schroeder, 1979), have achieved impressively high levels of sensitivity and reliability, and have considerable utility for resource managers. Multiple R^2 values in the 0.50–0.95 range have been reported by several investigators, indicating that the forest properties measured can account for most of the variance in aesthetic preferences. Like the generic model described in the previous section, these studies typically rely on data obtained from public groups, rather than on the judgments of an individual expert or small group of professionals. However, a shortcoming of the physicalist approach is that usually there are no theoretical statements whatsoever to explain why the environmental variables influence aesthetic responses. Also, a given predictive model can be applied only to a specific type of forest landscape (e.g. ponderosa pine). In practice, this requires developing a new equation, and sometimes identifying new physical variables,

for each forest type. Recently, physicalist methods have been adapted successfully for the modeling of preference responses to urban forests and street trees. As this vein of research develops, the strengths and limitations noted here for natural landscapes will probably also be evident for urban applications.

Findings from the physicalist school, as well as from studies using other methods, have revealed a great deal about aesthetic responses to forests. Large trees have positive influences on liking, whereas small trees have a mild negative effect (Gallager, 1977; Brush, 1978; Daniel and Schroeder, 1979; Herzog, 1984). Large amounts of downed wood or slash, or a high-density shrub understory, have powerful negative effects on preference (e.g. Daniel and Boster, 1976; Arthur, 1977; Brush, 1978; Patey and Evans, 1979). By contrast, low understory shrub density, and lush, grassy or herbaceous ground covers, tend to have strong positive effects on liking. Nearly all studies have found that depth or openness in a tree stand increases preference (e.g. Brush, 1976, 1978; Daniel and Boster, 1976). Selective cutting is aesthetically preferred over clear-cutting (e.g. Rutherford and Shafer, 1969; Echelberger, 1979). The presence of dead trees detracts from liking (Daniel and Schroeder, 1979). Studies by Buhyoff and his colleagues have shown that tree damage from insects, such as the southern pine beetle, diminishes preference among observers who are informed about the damage or who are knowledgeable about forestry, but may not always lower liking judgments by uninformed individuals (Buhyoff et al., 1979, 1982). Taken together, findings in this area support an important general conclusion: aesthetic preferences tend to be significantly higher for managed forest stands than for non-manipulated settings. Hence, certain management practices that increase timber yields may also enhance scenic beauty (Brush, 1978). An implication for urban planning is that the highly manipulated stands characteristic of fringe parks and recreation areas are often more effective as aesthetic amenities than unmanaged, comparatively "wild" forest settings.

It is worth noting that the findings surveyed here are quite consistent with the predictions of the generic landscape preference model. The broader framework forecasts high liking for scenes having, among other properties, depth, even-length ground textures, and moderate-to-high complexity that is structured and easily grasped. Likewise, the forest aesthetics literature clearly indicates that observers prefer park-like settings (Patey and Evans, 1979), characterized by openness, uniform ground covers, and the ordered complexity associated with large-diameter trees and only small amounts of slash and downed wood. Small, closely spaced trees, large amounts of slash or downed wood, and/or a dense understory produce conditions of restricted depth, rough ground textures, and unstructured high complexity that the generic model predicts should elicit low preference or dislike.

AESTHETIC RESPONSES TO URBAN VERSUS NATURAL SCENES

More than a score of studies have been unanimous in showing that there is a strong tendency for North American and European adult groups to prefer natural landscape scenes over urban views, especially when the latter lack vegetation or water features. Even unspectacular or mediocre natural views consistently elicit higher aesthetic preference than do all except a very small percentage of urban scenes (e.g. Kaplan et al., 1972; Zube et al., 1975; Wohlwill, 1976; Palmer, 1978; Bernaldez and Parra, 1979). Apart from eliciting quite different patterns of aesthetic preference, there is abundant evidence that natural versus man-made properties are central in influencing perception and categorization of outdoor environments. Several stu-

dies employing multivariate procedures such as multi-dimensional scaling have shown that visual landscapes are representable in a consensual space of clearly interpretable dimensionality, and that natural versus built groupings of scenes appear as prominent dimensions whenever diverse samples of views are used (e.g. Kaplan et al., 1972; Ullrich and Ullrich, 1976; Ward, 1977). Individuals appear to respond in fundamentally different ways to natural and man-made material, irrespective of levels of other visual properties such as complexity and depth. The findings from dimensional and factor analysis studies also indicate that the domain of natural visual landscapes extends considerably beyond wilderness to encompass many obviously man-made settings such as cultivated fields, golf courses, and wooded parks. In general, American groups tend to categorize views as "natural" if the landscape content is predominantly vegetation and/or water, and if man-made features such as buildings and cars are absent or inconspicuous.

On the basis of the well-documented pattern of differential responsiveness to natural and urban landscapes, Wohlwill (1983) has argued that nature is a "natural" psychological category, and that individuals very readily discriminate nature from man-made environments because of particular stimulus characteristics such as curvilinear contours and continuous gradations of shape and color. Other authors have suggested that unlearned factors deriving from our evolutionary heritage may be partly responsible for different reactions to natural and urban material (e.g. Stainbrook, 1968; Driver and Greene, 1977; Ulrich, 1983). Interestingly, Wohlwill has reported that German school children respond readily and spontaneously to natural versus man-made distinctions in scenes, and that this pattern of differentiation may be well-developed in 6-year-olds, the youngest group he studied (Wohlwill, 1983). Although findings to date unequivocally suggest that adult observers have quite different aesthetic preferences for, and readily discriminate between, natural and urban scenes, these conclusions should nonetheless be treated with some caution because data are lacking for some minority groups in Western countries, and for most non-Western cultures.

In view of the finding that observers prefer natural scenes over urban views, it is not surprising that some investigations have found that the presence of man-made features in natural settings can have strong negative effects on liking (e.g. Clamp, 1976; Evans and Wood, 1980). Certain man-made features, such as utility poles and power lines, appear to reduce attractiveness to a greater extent than other types of built elements (Brush and Palmer, 1979). The negative visual impacts of built elements may be especially pronounced along the interface of wildland and urban environments (Magill et al., 1979). Also, human intrusiveness in the form of visible air pollution and reduced visual range appears to lower scenic beauty ratings for some vistas, such as the Grand Canyon, but may not lower liking for many other natural landscapes (Latimer et al., 1981). One of the few studies to address acoustic impacts on aesthetic judgments found that urban sounds (e.g. traffic, overhead jets) heard in natural settings can have strong negative effects on observers' evaluations (Anderson et al., 1983).

However, research by Wohlwill shows that there is no simple general relationship between aesthetic responses and the presence of built features in natural settings (Wohlwill, 1979; Wohlwill and Harris, 1980). His findings support the conclusion that liking is less influenced by the number or extent of man-made features than by the degree of 'fittingness" or compatibility between the elements and their surroundings. Fittingness refers to the perceived harmony or integration between a feature and its natural background. Low fittingness, or obtrusiveness, is produced by properties such as large element size, low

congruity of shape, and high color contrast (Wohlwill and Harris, 1980). Sorte's (1971) work in Scandinavia suggests that fittingness is low when observers evaluate a feature as temporary rather than permanent. Examples of common temporary features include cars and billboards. Research by Zube and his colleagues raises the possibility that children under 12 years are less sensitive than adults to compatibility between natural and man-made elements. However, despite this age difference, their findings still suggest that there is a significant positive relationship between land-use compatibility and the aesthetic preferences of children (Zube et al., 1983). More research is needed on the fittingness issue because of its relevance for pressing urban design and planning issues such as the selection of building forms, and the choice of types of development, that are harmonious with natural surroundings, including urban forests.

PSYCHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF URBAN VERSUS NATURAL SCENES

There is growing evidence that differential responsiveness to natural and urban views extends far beyond aesthetic preference to include other affects and appears to be expressed as well in neurophysiological activity and overt behavior. In a study performed in Sweden, subjects were exposed to lengthy color-slide presentations of either (1) nature dominated by trees and other vegetation, (2) nature with water, or (3) Scandinavian urban settings without vegetation or water (Ulrich, 1981). The slide samples were equivalent in terms of information rate. Results from self-ratings of feelings made immediately before and after the presentations indicated that exposure to the two categories of natural scenes, especially water, had more positive influences on subjects' emotional states – although the effects were not globally or comprehensively beneficial relative to the urban settings. A salient difference was that the natural scenes sustained attention and interest much more effectively than the urban views. Further, recordings of brain electrical activity revealed that alpha-wave amplitudes were significantly higher while subjects viewed trees and other vegetation as opposed to urban scenes, and tended to be higher during the water rather than the urban presentations. The alpha results are noteworthy because they indicate that the natural and urban scenes had different effects on cortical activity, and constitute strong evidence that the individuals felt more wakefully relaxed while viewing the vegetation and water settings.

Other research has addressed the "nature restoration hypothesis" – the notion that natural views tend to be therapeutic compared to urban scenes in terms of reducing stress or anxiety (Ulrich, 1979). The intuitively based idea that stressed urbanites benefit emotionally from contacts with nature has traditionally been advanced as an argument in support of city parks and urban forestry projects (e.g. Olmsted, 1865; Driver et al., 1978). In a test of this hypothesis, mildly stressed subjects were shown color slides of either everyday nature scenes dominated by trees and other vegetation, or unblighted American city views lacking vegetation (Ulrich, 1979). The individuals rated their feelings immediately before and after the slide presentations using a standard affect questionnaire. Consistent with the restoration hypothesis, exposure to the vegetation views significantly reduced feelings of fear, and positive affects such as affection and elation were increased. By contrast, the urban presentations actually aggravated anxiety on some dimensions, particularly in terms of increased feelings of sadness. These findings applied to both sexes, and to subjects with either rural or urban backgrounds.

Based on these findings and those from the study performed in Sweden, it has been sug-

gested that people may benefit most from visual encounters with nature when they are uncomfortably stressed or anxious (Ulrich, 1981, 1983). If an observer is experiencing stress, views of most natural in contrast to urban settings should elicit positive feelings, hold interest, and may block or reduce stressful thoughts. These influences should foster recuperation.

To further evaluate this nature restoration hypothesis, a recent study examined post-surgical recovery data for patients in a suburban Pennsylvania hospital to determine whether assignment to a room with a window view of a natural setting might have therapeutic influences (Ulrich, 1984). Surgical patients were exceptionally suited as a study group because they usually experience considerable stress or anxiety, and hospital confinement limits their outdoor contacts almost entirely to views through windows. Recovery data were compared for pairs of patients with the same operation who were closely matched for variables such as age, sex, weight, tobacco use and previous hospitalization. The patients were assigned to rooms that were identical except for window view; one member of each pair overlooked a small stand of deciduous trees (mixed hardwoods), while the other had a view of a brown brick building wall. In comparison with the wall-view patients, individuals with tree views had significantly shorter post-operative hospital stays, had far fewer negative evaluative comments in nurses' notes (e.g. "needs much encouragement"), and tended to have lower scores for minor post-surgical complications. Also, the wall-view patients were given many more doses of potent narcotic analgesics, whereas the tree group more frequently received weak pain-killers such as aspirin and acetaminophen. These findings strongly suggest that the view of trees had comparatively therapeutic influences on the patients.

Compared to other investigations concerned with aesthetic and social benefits of trees and nature in urban areas, the hospital study is unusual because the data are tangible and can be linked directly to dollar costs in the health-care system. Accordingly, the findings can be reconciled with economic methods to provide quantitative (dollar) values for natural aesthetics. In 1985, spending for short-term general hospital care in the United States will exceed $100 *billion* (American Hospital Association, 1984). This huge figure does not include costs for federal and long-term institutions. Expenditures for hospital care are so large that even a slight reduction in the United States in in-patient days (e.g. a 1% decline) could produce yearly savings of several hundred million dollars. The tree-view patients in the study spent 8.5% fewer post-operative days in the hospital, and required fewer costly injections of potent analgesics than the built-view patients. To the extent the findings might hold for many other categories of patients known to experience anxiety, the results raise the possibility that large savings in health costs might be realized if hospitals are designed to provide patients with attractive, stress-reducing views of nature.

Finally, research on motorists' trip behavior shows that preferences for natural versus urban scenes can influence route selection, and this, in turn, has additional implications for the economic assessment of natural scenery (Ulrich, 1973). A group of Michigan shoppers were studied who could choose between driving a slow, wooded parkway or a fast but unattractive expressway to a large shopping center. Although the expressway was several minutes faster, shoppers used the parkway for slightly more than half their trips. The major reason given for driving the slower road was to view its natural scenery. This is noteworthy because in economic analysis widely used by highway planners, dollar benefits are projected on the basis of anticipated time-savings for users, and benefits totaling millions of dollars annually are often claimed for a high-speed road that may reduce travel time. Applying

the same cost–benefit reasoning, it follows that the natural scenery along the parkway must be worth a great deal of money, because motorists consciously gave up large amounts of time in order to experience the wooded roadsides (Ulrich, 1983).

VEGETATION IN URBAN LANDSCAPES

A large body of anecdotal, historical and survey research evidence indicates that most city dwellers attach considerable importance to urban forests and parks, and that views of trees, grass and open space provided by such settings are judged to be very important environmental amenities (for surveys see Driver et al., 1978; R. Kaplan, 1983). It appears that many, if not most, urbanites may derive greater benefit from viewing the natural scenery and passively enjoying other natural amenities of parks than from active recreation experiences (Ulrich and Addoms, 1981; Hayward and Weitzer, 1984). Large, manicured spaces that are cleared of trees to create playing fields preclude the comparatively natural visual encounters that rate highly as benefits. For park planners, this implies that attention should be given to providing diverse settings that have both attractive scenery and cleared fields for sports and other active recreation (Ulrich and Addoms, 1981).

A small but growing experimental literature has examined aesthetic preferences for urban scenes with and without vegetation. At a general level, a consistent finding has been that the presence of vegetation, especially trees, has positive effects on preference. An early investigation by Lynch and Rivkin (1959) found that a sample of pedestrians in downtown Boston universally responded in a very positive, pleasurable manner to vegetation, particularly to views of the Public Gardens. Thayer and Atwood (1978) compared pleasantness ratings for slide-pairs of urban scenes that were similar except for the presence or absence of vegetation, and reported that the presence of plants usually increased ratings significantly. The sole exception was a strip-development where plants presumably occupied only a small portion of the view compared to broad expanses of highway and clutter associated with signs, facades and utility wires. Another investigation revealed that residents of a high-density housing complex rated urban settings far higher in liking when they contained prominent amounts of foreground and middleground vegetation, and when buildings were at middleground or greater distances (Ulrich and Addoms, 1981). The same residents accorded lowest preference to commercial areas that lacked vegetation and were highly complex because of signs, wires and mixed facades. Likewise, a factor analysis study of preferences for a diverse sample of urban slides identified an Urban Nature factor of views, characterized by many trees and much other vegetation, that scored far higher than other types of built scenes (Herzog et al., 1982). Importantly, this pattern of findings favoring vegetation appears to hold across widely different groups in America. A study of an exceptionally diverse sample of 250 residents of inner-city areas of Detroit (70% black subjects; 30% white) concluded there was broad agreement in terms of strongly positive feelings for trees in cities (Getz et al., 1982). This investigation also found that low-income inner-city residents judged a woodland scene to be much higher in beauty than a downtown commercial view lacking trees.

The importance of views containing vegetation has further emerged in studies of neighborhood preferences and satisfactions. On the basis of several studies of moderate- and high-density housing complexes in Britain and America, Cooper-Marcus (1982) concluded that residents tended to judge the attractiveness of their neighborhoods largely by what they saw from their windows – and that the vast majority of residents preferred views that included vegetation, as opposed to, for in-

stance, buildings or parking lots devoid of greenery. However, not all views of vegetation in residential areas are necessarily preferred. Other research suggests that residents respond with moderately low preference to neighborhood scenes consisting of empty grass-covered expanses lacking trees and shrubs (R. Kaplan, 1983). As with commercial and other built landscapes, residential scenes tend to be especially favored when they contain prominent trees (e.g. Brush and Palmer, 1979; Nasar, 1983). In this regard, findings from the aforementioned study of inner-city Detroit residents showed that the attractiveness of urban trees was considered their most important benefit, and that residential streets received the highest importance ratings as locations for tree plantings (Getz et al., 1982). Additional insights concerning the preference effects of trees come from a recent application of physicalist regression modeling to residential street scenes (Buhyoff et al., 1984). Among the most important physical variables in terms of positive relationships with preference were total area of a view depicting vegetation, basal area per tree stem and amount of tree crown enclosure. Results suggested that street scenes with many small-diameter trees may be less preferred than views having fewer, large-diameter trees. A noteworthy finding was that the relationship between preference and extent of trees and other vegetation may be non-monotonic. That is, liking for residential streets increases with greater amounts of vegetation up to a point, and then might flatten out or possibly decline. This has some parallels with Payne's (1973) finding that the market value of residential property rises as the number of trees in yards increases, but that the relationship becomes non-monotonic when the number of trees is quite large. These results imply that a pitfall for urban foresters and planners to avoid is a simplistic policy of "the more the better" with respect to vegetation in city settings. It seems likely that the planting of very large amounts of vegetation on a street achieves a less satisfactory aesthetic outcome than more moderate levels of trees and other plants that are characterized by visual structure and understory openness.

Yet another positive effect of urban vegetation aesthetics has been identified by an investigation of cognitive maps (Evans et al., 1982). Among the physical characteristics of buildings found to significantly enhance their recall was the extent of landscaping or greenery immediately surrounding the structure. The authors speculated that buildings surrounded by trees and other vegetation are more remembered partly because the greenery increases attractiveness and may make the structures more noticeable. This interpretation is consistent with the position taken in the earlier conceptual section that remembered landscape scenes tend to be those that elicit either high liking or strong dislike.

There is limited evidence that at least some of the benefits urbanites derive from outdoor vegetation aesthetics may also be realized from views of large-scale *indoor* plantings. This suggestion is supported, for instance, by findings from a post-occupancy evaluation of the Dragvoll campus of the University of Trondheim, Norway (Cold et al., 1985). Due largely to the area's cool, damp climate (Trondheim's latitude is 63.5°), the campus has been constructed around a multi-story, glass-enclosed, semi-climatized street which contains extensive displays of greenery, including trees. The evaluation concluded that the vegetation views in the enclosed street are an especially liked and positive aspect of the campus; faculty and students report that the vegetation contributes to a feeling of well-being when they experience the setting.

Despite the clear beginning that has been made in investigating aesthetic responses to urban vegetation, a shortcoming is the limited relevance of much of the research to contemporary forms of auto-dependent sprawl urbanization. Arguably, the empirical literature to date is quite pertinent to many residential

settings in North America and Europe, but applies only to commercial landscapes with large pedestrian precincts, as in Danish and Swedish cities. The reality is that American urbanization since World War II has been dominated by low-density forms, where dependence on the auto is extreme. Except in some parts of older cities, such as New York and Philadelphia, auto travel is overwhelmingly preeminent in comparison to pedestrian movement. In fast-growing cities such as Houston, Phoenix and Los Angeles, pedestrian movement accounts for 5% or even less of total outdoor movement (Ulrich, 1976). It should be emphasized that auto travel has drastic effects on landscape perception (Appleyard et al., 1964). For instance, as speed increases, the motorist's point of visual concentration moves much farther away, and peripheral vision diminishes sharply to a comparatively narrow sector centered on the roadbed (Pushkarev, 1961). Also, high speeds simply preclude perception of foreground detail. To a motorist moving at 40 m.p.h., for example, roadside features closer than about 40 feet appear blurred and incoherent, and roadside elements between 40 and about 80 feet from the car suffer loss of detail (Ulrich, 1976). These effects of auto movement have been largely ignored in research on urban landscape aesthetics. Nearly all studies have measured responses to static landscape presentations such as slides or photos, and, although these simulations are probably valid for window-view contexts or the experience of pedestrians (e.g. Shuttleworth, 1980), they probably do not correspond to the visual perspective of motorists. If subjects are asked to rate a slide depicting, for instance, a four-lane highway with a cluster of low shrubs on one roadside, the results might well suggest that the vegetation increases preference. However, the same vegetation would be essentially invisible to actual users of the road. Hence, there is a need for studies of urban vegetation aesthetics that use subjects who are drivers or passengers in cars, and that employ measures such as eye-movement recordings in combination with verbal reports. Previous findings concerning the effects of auto travel on perception imply that if vegetation is to have a major aesthetic impact in auto-dependent areas, it must be large-sized – such as trees – in order to be easily visible to drivers and passengers at middle distances (Ulrich, 1976). In some cases, smaller vegetation, including flowering plants, might be quite effective as aesthetic displays if concentrated at particular points where motorists must stop for several seconds (e.g. traffic islands adjacent to stoplights).

RESEARCH NEEDS AND FUTURE DIRECTIONS

As is evident from the preceding discussion, much has been learned in recent years about human responses to vegetation and landscapes. Despite the progress in this area, however, a number of important questions remain unresolved. In the case of research on both natural and urban landscapes, very little work has compared preferences for different tree species, and studies of liking responses to smaller types of vegetation, such as shrubs and herbaceous flowering plants, are virtually non-existent. Another topic that has received essentially no attention is emotional responsiveness to scenes with prominent ephemeral phenomena such as sunsets and cloud formations. This issue has been so neglected that even responses to common temporary conditions associated with seasonal changes (e.g. the absence of foliage on deciduous street trees and yard shrubs) have not been empirically investigated. As the previous section pointed out, research on urban landscapes has largely ignored the effects of auto travel on visual perception. Other research needs include a greater number of cross-cultural studies, and investigations of habituation to scenes following repeated exposures over

moderate time-periods. Concerning the latter issue, a conspicuous need from the standpoint of urban design is to identify visual properties, including vegetation, that not only elicit liking, but also are effective in sustaining the interest and attention of individuals who frequently experience an environment.

An especially important direction for future research concerns the tangible valuation of the aesthetic and psychological benefits of attractive visual landscapes. The implementation of aesthetic considerations in planning contexts has long been handicapped by the lack of empirical studies documenting social and economic values of visual quality. The hospital window-view study described earlier illustrates that visual landscape quality can be related directly to health, and in turn linked to substantial economic benefits. Much more work is needed that establishes relationships between visual landscape characteristics, aesthetic and emotional responses, and measures of human health and economic productivity. Progress in the assessment of health and economic benefits will clearly require a greater number of investigations that measure physiological responses and various behaviors, rather than studies that rely exclusively on verbal measures (e.g. preference ratings and semantic scales). To the extent that future research achieves more tangible valuations of landscape quality, considerations such as vegetation aesthetics or urban forestry will probably be assigned higher priority in public allocation decisions.

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