From Tooby & Cosmides, The Adapted Mind 1992?

Orians & Heerwagen

VI
ENVIRONMENTAL AESTHETICS

Art and science seldom meet, but when they do, it is usually on the common ground of perception. The idea that science can shed light on how we see, and therefore on how we see art, is so compelling that it has sometimes spawned new artistic movements, such as Impressionism and Pointillism.

But can science shed light on what we *like?* Our aesthetic preferences seem so irreducibly idiosyncratic, so culturally embedded, that the idea that science could illuminate them seems absurd on the face of it.

Yet both art and science challenge us to look at familiar things with new eyes. The chapters in this section take that challenge to heart and look at environmental aesthetics from an evolutionary and ecological perspective. When viewed from this vantage point, the proposition that our aesthetic preferences in some domains are guided by universal organizing principles begins to look reasonable—in fact, inevitable.

Consider habitat selection. Organisms that cannot move of their own accord do not need many mechanisms for habitat selection—dandelion seeds and diatoms go whichever way the winds blow or the currents flow. But any organism capable of guiding its movements through the environment must have mechanisms that cause it to prefer the habitats that are best for supporting its way of life. In biology, there is a rich literature that describes the cues and mechanisms whereby birds and other animals choose the right habitat. Asking the same questions about humans (who evolved, after all, as hunter-gatherers) is simply the next step.

Supplied, as we are, with every necessity by industrial civilization, emotional responses to landscapes seem completely epiphenomenal and, indeed, seem to exemplify the kind of evanescent psychological phenomenon that must be functionless. But to understand human psychological adaptations, one must place them in the context in which they evolved. To appreciate the importance of good habitat selection for the health and safety of a hunter-gatherer, Orians and Heerwagen ask readers to "imagine you are on a camping trip that lasts a lifetime." Having to carry water from a stream and firewood from the trees, one quickly learns to appreciate the advantages of some campsites over others. Dealing with exposure on a daily basis quickly gives one an appreciation for sheltered sites, out of the wind, snow, or rain. For hunter-gatherers, there is no escape from this way of life: no opportunities to pick up food at the grocery store, no telephones, no emergency services, no artificial water supplies, no fuel deliveries, no cages, guns, or animal control officers to protect one from the predatory animals. In these circumstances, one's life depends on the operation of mechanisms that cause one to prefer habitats that provide sufficient food, water, shelter, information, and safety to support human life, and that cause one to avoid those that do not.

In their chapter on environmental aesthetics, Orians and Heerwagen first discuss evidence relevant to the "savanna hypothesis"—the hypothesis that we have evolved preferences for habitats with features characteristic of a high-quality tropical African savanna, the environment in which the human lineage is thought to have initially evolved. Then, in the spirit of David Marr, they develop a task analysis, or computational theory, specifying what kinds of decisions our ancestors would have had to make in the course of habitat selection and what kinds of environmental cues would have been reliably associated with habitat quality during the Pleistocene. They propose that habitat selection proceeds in three stages. Stage 1 is a highly affective and rapidly made decision to either avoid or explore a new habitat, Stage 2 is an information-gathering phase in which one explores the new habitat to learn more about its potential to yield needed resources, and Stage 3 is the decision to either move on or stay in the habitat long enough to carry out necessary activities. Each of these stages should be characterized by different cognitive and affective processes.

Marr argued that an essential part of any computational theory is a specification of "valid constraints on the way the world is structured—constraints that provide sufficient information to allow the processing to succeed" (Marr & Nishihara, 1978, p. 41). This is just as necessary for the problem of habitat selection as it is for the problem of visual perception. To discover the design of the cognitive processes that govern habitat selection, one must figure out which environmental cues would have provided "sufficient information to allow the processing to succeed"—that is, which would have been reliable indicators of habitat quality over time. To this end, Orians and Heerwagen catalog cues that would have been relevant to decisions that cover different time frames. For example, thunderclouds provide information about weather conditions in the short run, the first buds of spring signal a change in habitat quality that will last several months, and desert conditions indicate habitat quality over a number of years. Environmental cues that cover different time frames are relevant to different classes of decision. Those rich in information about habitat quality should captivate our attention and elicit affective reactions that impel us toward the right course of action.

Wayfinding is another example of an adaptive problem that should have shaped our environmental preferences, and the one that Kaplan's chapter focuses on. Kaplan takes the "sapiens" in *Homo sapiens sapiens* seriously, arguing that we should have evolved a thirst for certain kinds of knowledge and an attraction to situations that can provide it. For example, to develop the kind of knowledge base necessary to safely navigate through an environment, he argues that our ancestors should have been "enticed by new information, by the prospect of updating and extending their cognitive maps" while at the same time not "stray[ing] too far from the familiar, lest they be caught in a situation in which they would have been helpless due to a lack of necessary knowledge."

Using photo questionnaires, Stephen and Rachel Kaplan have been able to collect enormous amounts of data on people's aesthetic preferences. They find that people's choices on these questionnaires are strikingly patterned in a way that suggests they are drawn to scenes that promise the possibility of new infor-

mation, safely obtained. The criteria that can be shown to govern these choices are abstract and deeply inferential. For example, spatial arrays that promote "legibility"—the inference that one could find one's way back if one ventured further into the scene depicted—and ones that promote "mystery"—the inference that one could acquire more information by venturing deeper into the scene and changing one's vantage point—are preferred over spatial arrays that do not promote these inferences. These deeply cognitive criteria are not open to introspection, yet they intuitively guide our attraction to new environments—cognition and affect wedded. Kaplan found that he could not understand the environmental preferences that govern wayfinding unless he could create a conceptual framework in which the usually separate studies of cognition and affect could be united. We hope his efforts inspire others to do the same.

Given that many of the criteria that govern our aesthetic preferences are complex and not open to introspection, it is perhaps not surprising that they should appear inexplicable and idiosyncratic to us. Yet a growing body of evidence suggests that this impression is illusory. Although the study of environmental preferences is still in its infancy, it already appears that our aesthetic preferences are governed by a coherent and sophisticated set of organizing principles. Just as theories of how we see have implications for how we see art, theories of what kinds of environments we prefer have implications for architectural design and urban planning, as both Kaplan and Orians and Heerwagen discuss. If these chapters are any indication, the study of environmental preferences may prove to be yet another common ground upon which science and art will meet.

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Evolved Responses to Landscapes

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Evolutionary approaches to aesthetics are based on the postulate that emotional responses, because they are such powerful motivators of human behavior, could not have evolved unless the behavior they evoked contributed positively, on average, to survival and reproductive success. This is why sugar is sweet and sexual activity is fun. Those of our ancestors who found consuming carbohydrates and engaging in intercourse enjoyable left more surviving descendants than those individuals who were not motivated to engage in those behaviors. Thus, an evolutionary biologist studies the actions evoked by emotional states to determine why those emotions had survival value. This is not to say that the behaviors stimulated by those emotions are always useful. Curiosity does, so we are told, sometimes kill cats. Nonetheless we believe that cats lacking curiosity fail to learn enough about their environments to function in them as well as their more curious brethren, even though being curious sometimes has unfortunate consequences.

The study of human responses to landscapes is a profitable arena in which to study the evolution of aesthetic tastes. Because selection of places in which to live is a universal animal activity, there is considerable body of theory and empirical data upon which to build hypotheses specifically oriented toward human behavior (Charnov, 1976; Cody, 1985; Levins, 1968; MacArthur & Pianka, 1966; Orians, 1980; Partridge, 1978; Rosenzweig, 1974, 1981). Also because choice of habitat exerts a powerful influence on survival and reproductive success, the behavioral mechanisms involved have been under strong selection for millennia.

In all organisms, habitat selection presumably involves emotional responses to key features of the environment. These features induce the "positive" and "negative" feelings that lead to rejection, exploration, or settlement. If the strength of these responses is a key proximate factor in decisions about where to settle, as empirical data suggest, then the ability of a habitat to evoke such emotional states should evolve to be positively correlated with expected survival and reproductive success of an organism in different habitats. Good habitats should evoke strong positive responses whereas poor habitats should evoke weaker or negative responses.

However, because a suitable habitat must provide resources for carrying out many different activities over varying time frames, evaluating habitats is a difficult process for organisms. The current state of the environment is important, but probable future states, over the entire time period the site will be occupied, may be equally or more important. For this reason, organisms evolve to use features of habitats that are good predictors of future states. Interestingly, the features used often are not the ones that sity and vertical arrangement of branches as primary settling clues (Cody, 1985; Hildén, 1965; Lack, 1971) rather than attempting to assess food supplies directly. The use of features correlated with, but not actually determining, success is likely to characterize human responses to landscapes as well.

ADAPTIVE RESPONSE TO THE ENVIRONMENT: PLEISTOCENE ORIGINS

The human life cycle is characterized by long generation times and extremely long periods of offspring dependency. The habitats occupied by people during most of our evolutionary history rarely provided reliable resources for long enough times that permanent occupancy of sites was possible. Rather, during the lengthy hunter-gatherer stage of human evolution, frequent moves through the landscape were the rule (Campbell, 1985; Lee & DeVore, 1968, 1976; Lovejoy, 1981; Washburn, 1961).

To understand the importance of habitat selection to our hunting and gathering ancestors, imagine you are on a camping trip that lasts a lifetime. You wake up one morning with an empty stomach and an empty cupboard. It is time to move on. Clouds on the horizon indicate that it has rained for many days in that area, and this is where you will head to look for food. Although the rainy place is many days off, it will be lush and green with berries, vegetables, and fresh water. The animals will come to feed so hunting will be good.

The small band of adults and children gradually begins the long hike across new terrain. By midday the sun is high and hot. In the distance on a ridge crest is a cluster of big trees—they look cool and inviting, but are still several hours off. As the group continues on its hike toward the trees, one of the men spots fresh lion tracks. He stops abruptly, gestures for the group to be quiet as he climbs a rock outcropping for a better view of what's ahead. The lions are only a short distance off, almost hidden from view in the grass. The man watches the lions for hints of their future intentions. Are they hungry? Will they attack? His vast store of animal information tells him not to worry. They have just had a large meal and are resting.

By the time the group reaches the cluster of trees, the sun is low in the sky signaling an end to the unbearable heat of the day. The adults rest momentarily, knowing that soon it will be cooler. They begin setting up camp and preparing the evening meal. The rumble of thunder off in the distance is a welcomed sound. The dry season is coming to an end. Around the campfire that night, the adults break up into small groups. Several women make preparations for the next day's foraging. They discuss the route they would take, recalling where they found the best berries, fruits, and leafy greens last year. On the walk today, one woman remembered seeing Grewia flowers—there may be bushes with ripe berries nearby. Another woman talks about the large nut tree that was so productive last year. The men gather in small clusters to make arrows, all the while talking about the animal tracks they had seen. They plan tomorrow's hunt. It's an unfamiliar terrain, so they need to decide which direction looks most promising. Gradually everyone drifts off to sleep. Shortly before dawn, several of the adults awaken to a loud crashing sound in the bush. The sound recedes, and they fall back asleep. Soon all of the campers awake and begin a new day in a life-style that will last for thousands of generations.

This hypothetical scenario is intended to illustrate what daily life may have been like for our ancestors and the kind of habitat-based decisions they would have had to make. In the remaining sections of this paper, we will consider how our aesthetic reactions to landscapes may have derived, in part, from an evolved psychology that functioned to help hunter-gatherers make better decisions about when to move, where to settle, and what activities to follow in various localities. According to this argument, environmental stimuli as diverse as flowers, sunsets, clouds, thunder, snakes, and lions activate response systems of ancient origin. These systems—including perceptual, cognitive, emotional, and behavioral processes—served important functions in both day-to-day survival and the long-term fitness of early humans.

The needs of our ancestors were the same as our current needs—to find adequate food and water and to protect themselves from the physical environment, predators, and hostile conspecifics. We now seek these amenities in rather different environments than the ones in which we evolved. Nonetheless, the number of generations that we have lived in mechanized, urban environments is small in relation to the number required for substantial evolutionary changes. Therefore, it is reasonable to expect, and to search for, response patterns that evolved under conditions quite different from those we now experience but which, nonetheless, often in unconscious ways, influence our decisions today. Before we develop our argument further, it will be helpful to look at how researchers have approached environmental aesthetics from an evolutionary point of view.

EVOLUTIONARY APPROACHES TO ENVIRONMENTAL AESTHETICS

The notion that aesthetic responses to environments foster behavior that increases the ability of individuals to learn about and function effectively in the environment has been explored by investigators in a number of fields. Data with which to test these ideas are still fragmentary. Nonetheless, it is interesting that investigators from a number of disciplines have been attracted to approaches that are based upon exploring the possible adaptive significance of our patterns of response to landscapes. The research in this area falls into two broad approaches. The first approach focuses on differential response to natural biomes and, in particular, tests hypotheses related to the habitat in which people evolved. The second approach to landscape preferences is based on the notion that we prefer environments in which exploration is easy and which signal the presence of resources necessary for survival. Although these two approaches are highly compatible, the second approach is more general and does not derive its predictions from a specific habitat type.

Tests of environmental preferences have relied almost exclusively on ratings of photographs or slides of landscapes. Studies which have compared photos versus actual trips to a site show that responses do not vary significantly as a function of presentation format. This is an important finding, because photographic techniques make it possible to test a large variety of landscapes that could not be directly experienced.

The Savanna Hypothesis

The basic biological argument underlying the habitat-specific hypothesis is that natural selection should have favored individuals who were motivated to explore and settle in environments likely to afford the necessities of life but to avoid environments tropical Africa, the presumed site of human origins, have high resource-providing potential for large terrestrial, omnivorous primates such as ourselves. In tropical forests, most primary productivity occurs in the canopy, and a terrestrial omnivore largely functions as a scavenger, gathering up bits of food that fall from the more productive canopy. In savannas, however, trees are scattered and much of the productivity is found within two meters of the ground where it is directly accessible to people and to grazing and browsing animals. Biomass and production of meat is also much higher in savannas than in forests (see Orians, 1986). The savannas also afford distant views and low, grassy ground cover favorable to a nomadic life-style. If we assume that the evolution of our species includes the development of psychological mechanisms that aid adaptive response to the environment, then savanna-like habitats should generate positive responses in people, much as the "right" habitat motivates exploration and settling behaviors in other species. This is because the savanna is an environment that provides what we need: nutritious food that is relatively easy to obtain; trees that offer protection from the sun and can be climbed to avoid predators; long, unimpeded views; and frequent changes in elevation that allow us to orient in space. Water is the one resource that is relatively scarce and unpredictably distributed on the African savannas. The scarcity of this critical resource plays a fundamental role in our response to environments, as will be noted later.

If we assume that habitat preferences coevolve with the intrinsic quality of habitats, then certain predictions follow. First, savanna-type environments should be favored over other biomes because of their critical role in the development of modern humans. Second, environmental features that predictably signal distinctions between high- and low-quality savanna habitats should influence preference patterns. One such feature is tree shape.

Research on landscape preferences strongly indicates that savanna-like environments are consistently better liked than other environments (see reviews in Balling & Falk, 1982; Ulrich, 1983, 1986). In the only direct test of preferences for the different biomes, Balling and Falk (1982) hypothesized that humans have an innate preference for savanna-like environments that arises from their long evolutionary history on the savannas of East Africa. They argued that an "innate predisposition" for the savanna should be more likely to be revealed in children than in adults because adults are likely to have had experience living in biomes other than savannas. Their study included six age groups (8, 11, 15, 18, 35, and 70 or over). Subjects rated how much they would like to "live in" or "visit" five natural biomes shown in slide format. The biomes included tropical forest, deciduous forest, coniferous forest, East African savanna, and desert. None of the photos used in the study included water or animals. Balling and Falk found that the 8-year-old children would rather live in as well as visit the savanna than the other habitats and that they rated the savanna higher on both factors than did all of the other age groups. From age 15 on, the savanna, deciduous forest, and coniferous forest were liked equally well, and all three biomes were preferred over the rain forest or desert. Interestingly, the desert was the least liked environment for all age groups; and two slides of the savanna during the dry season also received lower ratings than the greener savanna settings.

Because none of the respondents in the Balling and Falk study had ever been in tropical savannas, the authors postulate a developmental pattern, with innately programmed responses that later are modified by experience in particular settings (in this case, the deciduous woods of the eastern U.S.). The fact that forests

did not become preferred over tropical ones suggests that, although experience is important in determining aesthetic responses to environments, it does not override completely the presumably innate responses that express themselves strongly among children.

Studies we are conducting at the University of Washington also lend support to the savanna hypothesis. We have been testing people's responses to tree shapes and have found that tree shapes characteristic of high-quality savanna are preferred over those found in lower-quality savanna. To control for other features of plant architecture and general habitat, we are using photos of one species only, *Acacia tortilis*. This tree varies considerably in its shape in different areas of the savanna. In high-quality habitat, this acacia has the quintessential savanna look—a spreading, multilayered canopy and a trunk that branches close to the ground. In wetter savannas, the species has a canopy that is taller than it is broad with a high trunk, while in very dry savanna *A. tortilis* is dense and shrubby looking.

We are currently completing a cross-cultural study of aesthetic responses to trees with subjects from Seattle, Argentina, and Australia. We used a photo questionnaire similar to that used by other researchers (see Kaplan & Kaplan, 1982). Subjects were asked to rate the attractiveness of each of the trees shown in photographs. Photos used in the study were taken in Kenya by G. and E. Orians. We used black and white rather than color photography because this procedure diminishes variability in the lushness of the setting and the color of the sky, both of which are known to influence response to landscapes. A standardized photographic procedure was used to eliminate as much background variability as possible. Each photo focused on one tree, and all pictures were taken under similar daylight and weather conditions. Photos with clouds, mountains, or water were deleted from the pool of trees selected for the study. Trees selected for inclusion in the questionnaire varied in canopy density, canopy shape, trunk height, and branching pattern. Because trees tend to vary simultaneously on a number of these features, the questionnaire was designed so that each page had trees that were similar for one of the primary characteristics. For instance, one page consisted of six trees that all had high trunks. However, the canopy patterns varied among them. Some of the trees had broad, layered canopies, and the others had narrower or denser canopies. Because many of the trees appear on more than one page, we can determine if trees are rated consistently, or whether their ratings change as a result of the other trees with which they are being compared. Although our data analysis is not yet complete, we have found that the three subject groups from the U.S., Argentina, and Australia show very similar patterns of response. The trees rated as most attractive by all three groups are those in which canopies are moderately dense and trunks bifurcate near the ground. Trees with high trunks and skimpy or very dense canopies are judged as least attractive by all three groups.

The characteristic features of the tropical savanna are exploited in a variety of other ways, including landscape painting. For instance, Humphrey Repton, the nineteenth-century pioneer of British landscape gardening, regularly included scattered clumps of trees in his designs to break up straight edges dividing pastures from woods (Repton, 1907). He also regularly used animals in his famous "before and after" drawings for his potential clients, as found in his "Redbooks." In addition, he appreciated the importance of the shapes of savanna trees. For example, on page 105 of his treatise, he notes: "Those pleasing combinations of trees which we admire in forest scenery will often be found to consist of forked trees, or at least of trees placed so near each other that the branches intermix, and by a natural effort of vegetation the stems of the trees themselves are forced from that perpendicular direction which is always observable in trees planted at regular distances from each other."

Although there is evidence that savanna-like environments are positively experienced by many people, this does not mean that all cultures consider this spatial form as an ideal or preferred type. Preference is also influenced by experience. The geomorphological characteristics of many landscapes differ dramatically from those of the savanna. Personal interaction with these places over a lifetime creates a wealth of knowledge and meanings that provide the basis for emotional attachment to places (see Relph, 1976; Tuan, 1974). What we are suggesting in this paper is that people have a generalized bias toward savanna-like environments. If this bias does, indeed, exist, then people should react positively to savannas even in the absence of direct experience. Further, we predict that positive responses to other types of biomes, such as desert, steppe, and closed forest, require direct experience. In the absence of experience, these environments should be given lower aesthetic ratings than savannas.

General Evolutionary Hypotheses

Studies of adaptive responses to landscapes have looked at the spatial features and particular contents of the environment that influence preference patterns. Psychological approaches, many of which are summarized by Ulrich (1983, 1986), have found that people prefer environments that have water, large trees, a focal point, changes in elevation, semi-open space, even ground cover, distant views to the horizon, and moderate degrees of complexity. Although these features are certainly characteristic of the savanna, they are also present in other environments. Interestingly, there are no studies on the relationship between preferences and the presence of animals in the landscape. Most researchers deliberately leave animals out of photographs because they are suspected to enhance preference scores—this is true for exotic animals such as zebras or giraffes, as well as more common animals such as cows (Schauman, personal communication, 1990).

Other researchers using an evolutionary approach have looked at the features of landscapes that influence exploration and information gathering. The general argument is that safe movement through the environment requires a great deal of skill and knowledge. Landscapes that aid and encourage exploration, wayfinding, and information processing should be more favored than landscapes that impede these needs. Using slides and photo questionnaires of everyday environments, Steven and Rachel Kaplan (S. Kaplan, 1987; S. and R. Kaplan, 1982; see also S. Kaplan, this volume) have found that preferred landscapes tend to be easier to "read" than other landscapes, but not so easy that they are boring. Desirable landscapes contain moderate degrees of complexity, a sense of coherence, and a semi-open spatial configuration. These features signal ease of movement as well as the potential for gaining more information about the environment. Preferred landscapes often contain a quality the Kaplans have called "mystery"—the hint of interesting features that could be discovered if the observer were to explore the environment. Environments high in mystery contain roads or paths that bend around hills, meandering streams, or partially blocked views, all of which emotionally entice the viewer to enter the environment because there is more to be learned. The Kaplans, as well as other researchers, have consistently found that natural environments are preferred over built environments and that built environments with trees and other vegetation are more positively regarded than similar built spaces lacking vegetation (Kaplan & Kaplan, 1982; Ulrich, 1983; Wohlwill, 1983). Furthermore, Ulrich has found that people in stressful situations who view slides of nature scenes as compared to scenes of buildings show lower distress responses on a number of affective and physiological measures (Ulrich, 1979, 1986; Ulrich, Simons, Losito, Fiorito, Miles and Zelson, in press). Ulrich's work suggests that our responses to landscapes and nature can have profound effects on human well-being.

CONCEPTUAL FRAMEWORK

In this paper, we extend previous approaches to landscape aesthetics by considering several stages in people's experience of environments and novel situations. We also develop some ways of thinking about responses to environments that affect behavior on time frames ranging from very short to long-term. Our purpose is to provide a richer context than is currently available for thinking about aesthetic responses from an adaptive perspective. Most previous research has tended to focus on behavioral outcomes and, in particular, on preferences associated with different environmental settings. This paper will focus on the ways in which the context influences what we attend to, how we evaluate the situation, and how these evaluations influence variability in behavioral outcomes. In this sense, it is a "computational" framework whose purpose is to guide research into the psychological mechanisms that promote adaptive functioning in different environmental contexts (see Cosmides and Tooby, 1987, Marr, 1982). By adaptive functioning we mean what Staddon (1987) has described as programs that "enable the animal to do the right thing at the right time and place, where 'right' means 'such as to improve fitness'" (p. 103). Fitness, as Staddon notes, is difficult to measure directly; our psychological mechanisms can measure only proxies for fitness such as access to water, food, and protected places. To understand the relationship between aesthetic responses and evolution, however, we must first consider human interactions with landscapes.

Landscapes provide resources such as food, water, and safe resting and sleeping places. They are also potential sources of danger. Danger may be posed by the physical environment in the form of bad weather, physical barriers to passage, earthquakes, landslides, fires, or avalanches. Biological sources of danger include predators, parasites, toxic foods, and unfriendly conspecifics. These dangers can, of course, be reduced by not venturing out into the environment, but this is achieved at the price of forfeiting access to resources and information that improve survival and reproductive success. Organisms are expected to evolve behavioral responses that provide, on average, the best ratio of benefits to risks. Good ratios can be achieved by avoidance of environments high in potential risks relative to their resource-providing potential and concentrating exploration in those environments promising better resources that can be exploited with lower risks. The benefits and risks vary among species and within species according to current conditions and needs. Thus, there is no reason to expect an invariable ranking of risks and benefits among environments by the individuals of a particular species or for a given individual throughout its lifetime. The existence of such variability makes the task of finding general patterns more difficult but does not constitute a reason for abandoning an effort to discover them. The conceptual frametion approach that includes a consideration of the ways in which settling individuals deal with both spatial and temporal scales of assessment provides a powerful conceptual framework for thinking about a diverse array of human responses to environments.

Spatial Frame of Reference

Two complementary frames of reference are useful in approaching evolved responses to landscapes, one spatial and the other temporal. The spatial frame of reference concerns the stages of exploration of an unfamiliar landscape, or "habitat," as it is usually referred to in biological literature. Stage 1, which accompanies an initial encounter with a landscape, is the decision to either explore the landscape further or avoid it and move on to other areas. Responses at this stage are known to be highly affective, to occur almost instantly, and are believed to influence subsequent actions (Ulrich, 1983). These rapid responses can be influenced by both the innate constitution of the individual and by previous experience. The speed with which these judgments are made should not mislead us to underestimate their importance. If the initial response is negative, no further exploration of the environment is likely.

If the response in the first stage is positive, the individual may enter Stage 2, that of information gathering. In this stage the individual explores the environment to learn more about its potential to provide resources. Unlike the responses in Stage 1, cognition figures prominently in Stage 2, and the act of exploration may last many days. The individual may draw upon memories and associations between other environments and the resources they provided. Evolved responses are likely to be important at this stage to encourage exploration and to increase the likelihood that attention is given to the most relevant aspects of the habitat.

Stage 3 concerns the decision to stay in the environment to carry out a certain set of activities there. Such a decision may relate to a specific activity that is intended to last for only a short time, or it may be a permanent decision affecting all of the behavior of the individual for the rest of its life. Because organisms require many resources in their lives, often more than one habitat must be utilized to fulfill all needs. Thus, the proximity of habitats providing different components of the suite of essential resources may influence settling decisions. Research efforts must take this possibility into account.

Temporal Frame of Reference

The second frame of reference concerns the time frames of decisions. Some environmental cues pertain to conditions that are transitory. Changes in weather, perception of prey, predators, or enemies, and arrival of a prospective mate are examples of such cues. These changes in the environment demand immediate attention and evaluation and a quick response. Time for thought is minimal if the opportunity is to be seized or danger avoided.

Other environmental cues signal changes that occur more slowly and affect benefits and risks over longer time spans. Examples of these cues include seasonal changes in the vegetative and reproductive cycles of plants, and activities of animals associated with reproduction. Understanding of and response to these seasonal changes is vital for successful functioning in the environment, but rarely are immediate responses

At the other extreme are cues that signal relatively permanent features of the environment. Prime among these cues are geomorphological features such as topographic relief and the presence of lakes, rivers, and streams. The general features of the vegetation of an area are also relatively permanent, although they clearly change more rapidly than cliffs erode or lakes fill with sediments.

In this paper we use these two complementary frameworks to explore a variety of environmental features known to evoke strong emotional responses in people. Throughout, our point of reference is to suggest how responses to these features enhance the ability of individuals to function in environments. We believe these frameworks can be used not only to explain known phenomena, but also to generate many new and fruitful hypotheses concerning the psychological mechanisms governing environmental aesthetics in humans.

STAGES OF HABITAT SELECTION

Responses at different stages of habitat exploration are distinguished in terms of (a) the basic kinds of decisions required; (b) the extent to which the decisions can be made automatically and rapidly or require more extensive evaluation; and (c) the features of the environment that exert the strongest influences on responses and decision making.

Stage 1

The decision made on an initial encounter with an environment is whether or not to explore the environment further or to avoid it and move on to other areas. Responses at this stage are known to be highly affective and to occur almost instantly (Ulrich, 1983; Zajonc, 1980). These rapid responses can occur with little or no conscious inference, but, nonetheless, a great deal of unconscious processing could be occurring, especially if the environments share features with others that have been previously experienced (see Kaplan, this volume). There are several compelling reasons for believing that evolutionarily molded behavioral responses should often be rapid and unconscious (Orians, 1980). Time is often important, and automatic responses leave the brain free to attend to those aspects of behavior that do require attention.

Theoretical and empirical work on preferences suggests that these rapid responses are typically made to rather general features of the environment (Baron, 1981; Zajonc, 1980). With respect to landscapes, important general features, termed "preferenda" by Zajonc (1980), include such factors as spatial configurations, gross depth cues, and certain classes of content, such as water or trees (Ulrich, 1983). Spatial configurations, such as the degree of openness of an environment (e.g., desert versus closed forest) are certainly perceived quickly. They also provide useful, and generally accurate, information regarding the ability of the space to meet human needs. An open environment, devoid of protective cover, is relatively undesirable for human occupation. So is a completely closed canopy forest within which movement and visual access are very difficult. Clearly both those types of environments are inhabited by people, but more extensive experience and learning are needed to cope with them than for dealing with environments of intermediate cover. Gross depth cues allow rapid assessment of distances, which may be of value in determining the time required to cross open spaces judgments of the ease of movement afforded by environments. Water and trees provide useful and reasonably accurate information about the availability of basic resources and safe sites in unfamiliar environments.

Stage 2

If responses to the first stage of habitat selection are positive, the individual may enter Stage 2, that of information gathering. In this stage the individual may peruse the environment carefully and explore it to learn more about its potential to provide resources and afford safety. Features of the environment important to this stage can be divided into those that entice exploration and those that aid the ability to orient in space so that one can return safely to the point where exploration began. Exploration, according to Berlyne (1971) is whetted by such attributes as complexity, surprisingness, novelty, and incongruity. Other abstract features, such as "mystery" (Kaplan, 1987; Kaplan & Kaplan, 1982), patterns (Platt, 1961), and repeated or "rhyming" patterns (Humphrey, 1980) can entice exploration by providing inducements to gather information in an environment that is complex enough to be promising but not so complex as to be "unreadable." The horizon may also provoke exploration by stimulating imagination and the desire to know "what's over the hill" (Appleton, 1990). Way finding and long distance movements in the environment are aided by changes in elevation, or lookouts, from which the environment can be seen as a whole, allowing movements to be planned in advance. Other features include landmarks for orienting, pathways or other indicators of connections between places, and borders or edges that can be followed for some distance.

These concepts can all be accommodated in a framework that asserts that the extent of exploration of an unfamiliar environment is related to how long it takes to learn the essential features of the area (Kaplan, this volume) and whether or not the accumulated information indicates that the environment is actually rich in resources.

Although exploration is a positive emotional and cognitive experience, it brings with it potential hazards. Danger, as well as adventure, may lurk behind the bend in the road or in the cluster of trees. An exploring organism must, therefore, be constantly ready to respond to sudden stimuli and unexpected danger. This is accomplished through a reflexive orienting response to such stimuli as sudden or intense changes in sound or light levels (Bernstein, 1979; O'Gorman, 1979; Kahnemann, 1973; Sokolov, 1963). The orienting response inhibits ongoing activity, produces intense processing of stimuli, and prepares the body for future responses. Automatic fear or caution responses also occur with respect to certain classes of content, such as snakes and spiders (Öhman, 1986; Tuan, 1979; E. O. Wilson, 1984).

Some degree of risk assessment is likely in Stage 2, especially in unfamiliar environments and for movement in familiar environments under hazardous conditions (e.g., darkness, stormy weather) or when a potential new threat appears. Assessment is aided by the presence of particular environmental features such as overhangs or other formations conducive to concealment, places that afford high visual access into the space, multiple concealments that allow evaluation from different angles and distances, changes in elevation that provide expansive views of the space from above, and multiple escape routes. A newly encountered environment that contains these features should appear to us as more pleasing and desirable than a comparable environment in which they are absent. This response is not necessarily based on a conscious eval-

uation of these features. In fact, it is highly likely that people are not aware of or able to articulate the relationship between the presence or absence of these features in an environment and the overall impression the space provides to them. From an evolutionary perspective, an automatic risk-assessment response is highly adaptive. The focus of conscious evaluation should be directed toward the potentially dangerous event or stimulus. If we are to perform this function effectively, our mind cannot be distracted by simultaneously having to monitor and evaluate our own movements in the environment.

Blanchard and Blanchard (1988) suggest that many potentially threatening situations (including unknown places) do not involve discrete, easily discriminated sources of danger. Under these circumstances, elaborate risk-assessment and risk-avoidance behaviors are seen in many animals, such as clinging to edges or walls, refraining from unnecessary movement, leaning forward and then rapidly withdrawing ("stretched attention"), and suppression of other normal activities. If the potential dangers appear to diminish, the animal begins slowly to explore the space, and then eventually to engage in normal activities. Although we do not expect all newly encountered environments to be threatening, it is nonetheless highly advantageous for a newcomer to be receptive to environmental features that allow for investigating resources and potential dangers safely.

Stage 3

The final stage of habitat selection concerns the decision to stay in the environment to carry out a certain set of activities there. Evaluation of spatial configurations of patches in the environment may be especially important at this stage. A suitable habitat must contain a mixture of patches that provides opportunities for all of the activities required during the time interval that the habitat is to be occupied. Some of these activities, such as foraging, are extensive in nature, whereas others, such as sleeping or escape, are local. Good foraging areas may have poor escape sites and vice versa. Distances between the patches may be so great that much time and energy is lost in transit between sites. Trade-off problems of this type normally accompany habitat selection decisions by people. Once a site is selected, much effort may be devoted to improving those components most deficient (e.g., by digging a well, building a shelter).

The ways in which people handle complex trade-off decisions have been the subject of many studies (Beach, 1990; Halloway, 1979; Janis & Mann, 1977; Simon, 1957). It is beyond the scope of this paper to review and analyze these studies. For our purposes it suffices to note that the human mind clearly has evolved to be able to make such complex decisions, just as it has evolved to enable us to respond quickly to sudden changes in the environment.

TIME FRAMES OF DECISIONS

Stimuli from the environment signal features of highly variable duration. Responses to those stimuli, no matter how fast or slow they are made, also affect subsequent behavior for very different time periods. We now consider these important variations in some detail.

Environmental Cues Requiring Immediate Response

Many environmental signals emanate from events that are transitory. These transitory environmental cues—light, weather, fire, large mammals—occur regularly in most environments regardless of their overall quality from the perspective of human life. What they have in common is the requirement that adaptive responses to them must take place quickly. Hence, they must be able to override the events to which we have been paying attention. From an evolutionary perspective, therefore, the strong emotional reactions people display to these events are expected. Although appropriate responses must be exercised quickly, the response itself may also be transitory. In addition, responses to a given signal may be positive or negative, depending on the situation of the observer. The same signal may trigger quite variable responses among different individuals or by a single individual at different times or under different circumstances.

Prominent among such transitory signals are those involving weather patterns. Clouds are important signals about probable weather patterns during the next few hours. Thunder or lightening signal events impending within a few minutes. Sudden changes in the speed and direction of the wind indicate passages of frontal systems or approaching storms. It is highly likely to be adaptive for an individual to alter its behavior in response to perceiving such signals. Seeking cover, changing clothing, rounding up the kids, or protecting objects may be advisable, and to be effective these actions may need to be initiated quickly.

There is ample evidence from studies of the orienting response that people automaticallv attend to sudden change in signal intensity, such as sudden changes in noise levels oı brightness of light (Bernstein, 1968, 1969; Sokolov, 1963). Although little attention has been paid to why we respond so strongly to these changes, from an evolutionary-ecological point of view it is clear that sudden changes in the characteristics of a stimulus are likely to be associated with potential hazards or opportunities. Bernstein (1968) suggests that sudden increases in stimulus intensity are more meaningful than changes involving a decrease in intensity. Intensity increases may represent "heightened sensation to a class of stimuli indicating 'something is approaching the organism'" (p. 128). Such sensitivity, as Bernstein notes, is highly advantageous for effective functioning in the environment.

The power of such signals to elicit attention and increase emotional arousal is well known. Even intense conversations rarely continue unabated through an outburst of thunder. Cloud patterns are among the most powerful evokers of strong emotions, both positive and negative. The development of the role of clouds in landscape painting is informative on this point. At the time of Claude Lorrain (1600–1682), when landscapes first became the subjects of attention in themselves rather than being backgrounds for the human activities that were the primary concern of the painter, skies were always bland and nonthreatening. Later, in landscapes of Constable and Turner, detailed attention is paid to clouds, and they are used to influence emotional responses to the paintings, both positive and negative. Indeed, Constable was a careful student of clouds, and his paintings reveal a detailed knowledge of the patterns of change in weather associated with different cloud patterns (Thornes, 1984).

The color of the sky and the lengthening of shadows do not necessarily reflect changes in weather patterns, but they do signal very powerfully that a change from day to night or vice versa is imminent. To diurnal animals with poor nocturnal vision like ourselves, evidence that night is approaching nearly always calls for changes in behavior that will prepare us for impending darkness. It is therefore not surprising that the color patterns in skies accompanying sunrises and sunsets should summon emotional reactions and that strong patterns of shadow should attract our attention. The flat light of midday signals that many daylight hours remain and that changes in behavior on that account are not called for. Shadows also allow better perception of depth and, hence, details of the environment. This doubtless enhances the value of attending to shadows. The dramatic effect of shadows and slanted rays of light associated with sunrise or sunset are often used by photographers to enhance the appeal of their work.

Although weather and time of day have been virtually ignored in landscape research, studies in architecture strongly suggest that building occupants are well aware of the value of windows for information on time and weather (Collins, 1975; Heerwagen, 1986; 1989; Heerwagen & Orians, 1986). Furthermore, studies of windowless intensive care units attribute poor recovery in these environments, as compared with windowed intensive care rooms, to disorientation from loss of daylight and information regarding time of day, weather, and seasonal change (Keep, 1977; Keep, James, & Inman, 1980; L. M. Wilson, 1972).

Studies of preferences for types and intensity of lighting also support the notion that shadows and variability in light levels are more emotionally pleasant and more preferred than uniformly lighted spaces (Aldworth, 1971; Flynn, Spencer, Martyniuk, & Hendrick, 1973). In fact, the more contrasting the space, the more highly pleasing it is.

Fire is another transitory environmental cue that commands our attention. Abundant archaeological evidence indicates that our ancestors used fire to provide warmth, heat, and light as well as a central focus for home base, and as a means of cooking food that would otherwise be inedible or less nutritious (Campbell, 1985). In addition, fire has been used as protection against predators, an aid in toolmaking, to influence movements of large animals, and to deflect and manage successional stages of vegetation. According to Konner (1982), the control of fire and its use as the focal point of evening social life resulted in a "quantum advance in human communication: a lengthy, nightly discussion, perhaps, of the day's events, of plans for the next day, of important occurrences in the lives of individuals and in the cultural past, and of long-term possibilities for the residence and activity of the band" (p. 50). Such conversations, as Konner notes, are more likely at night when the urgencies of the day are past and the desire is for social comfort, light, and warmth.

Although fire has many benefits, it is also a dangerous event to which immediate responses are often needed. The strong emotions evoked by fire, both positive and negative, have long been recognized. They play, for example, a key role in parts of Freudian psychology. The appeal of Smokey the Bear rests in part upon the fear that fire generates among people. Fear of fires is one of the strongest barriers to implementing the new policies of the National Park Service and the U.S. Forest Service to let fires burn naturally.

Large mammals are another source of transitory information; they are both a potential source of food and a source of danger. Although they may be present in an environment on a long-term basis, they are constantly on the move. The opportunities they provide depend upon their location at the moment, and these details, accordingly, demand immediate attention. It is not surprising, then, that we should enjoy watching large mammals and that we should find their behavior intrinsically interesting.

The power of large mammals to evoke positive emotional responses is well known. The nineteenth-century British landscape architect Humphrey Repton regularly graced the redesigned landscapes of his "Redbooks" with large ungulates as part of his strategy to acquire the business of potential clients even though the animals' presence was unrelated to any of his proposed modifications to the estates. Pastoral landscapes have long had a strong appeal to people from many cultures, and preservation of such landscapes regularly ranks high on conservation agendas. Furthermore, nature programs devote extensive time and money to portraits of large mammals, from whales and caribou to elephants and gorillas. Large mammals are also used in advertisements to add appeal to products as diverse as insurance and beer. Yet little scientific attention has been paid to the ways in which the presence of large mammals enriches environmental experience. Certainly, one of the more exciting aspects of a safari (or its surrogate in a trip to the zoo) is the sudden discovery of an animal. The visual search for "hidden" animals and other objects and the pleasure experienced in their discovery are clearly adaptive responses to our early ancestors' hunting and gathering life-style. As with sunsets, however, large hidden animals may trigger concern and fear as well as pleasure. A lion, unexpectedly encountered at a short distance, elicits fear in even the most experienced hunter. The same animal seen from a safe distance is the source of awe and delight.

Environmental Cues Associated with Seasonal Changes

Survival and reproductive success depend upon appropriate responses to seasonal changes in the environment. All natural environments, including tropical rain forests, experience important seasonal changes that affect the location and availability of resources. All traditional human cultures are rich in rituals that respond to seasonal changes and prescribe and proscribe behaviors appropriate or inappropriate to particular times of the year. The annual cycle is a powerful organizing theme for literary works. The power of Aldo Leopold's "A Sand County Almanac" results from both the ideas and concepts it espouses and the framework of changing seasons in which it is cast.

Responses to seasonal changes in the environment differ from those to the transitory events discussed earlier in four important ways. First, these responses may affect behavior for several months, as, for example, during a shift from a winter to a spring encampment. Second, the timing of the appropriate behavioral responses is highly predictable because the key environmental variables are driven by seasonal changes in day length, temperature, and rainfall whose timing varies little or not at all from year to year. Third, appropriate responses to these variables often involve anticipation of forthcoming changes and preparation for them before they are encountered. We may change to the spring encampment without having visited it that year or having any direct knowledge of conditions there. Fourth, there is usually much time in which to contemplate and plan for responses to seasonal cues.

Unfortunately, there is little research on seasonal responses to the environment. In fact, most research on environmental preferences deliberately eliminates differences in seasonal cues so that responses are made to landscapes photographed under the same conditions, usually at peak growing season.

Among the most important signals of seasonal changes are vegetative transformations of plants. The greening and browning of grass, germination and sprouting of seeds, leafing of woody plants, and autumnal coloration of deciduous trees and shrubs all provide powerful signals of changes in environmental conditions and resource availability. From an evolutionary perspective, however, we would expect the signals to be emotionally asymmetrical. That is, cues associated with productivity and harvest (greenness, budding trees, fruiting bushes) should be more positively received than cues associated with the dormant season (bare-limbed trees, brown grass). It may be difficult for many of us, with the year-round supplies of a wide array of fruits and vegetables in our supermarkets, to understand the importance of the first salad greens of the season to people throughout most of human history.

Reproductive responses of plants (e.g., flowering) also signal important changes in resource availability. For an organism that rarely eats flowers, it is perhaps surprising that we place such a high value on them and spend so much effort and money to have flowers in and around our dwellings and in city parks. The evolutionary biologist, however, sees flowers as signals of improving resources and as providing cues about good foraging sites some time in the future. In species-rich plant communities, flowers also provide the best way to determine the locations of plants that offer different resources. When not in bloom, all plants are green. (Indeed, many taxonomic distinctions can only be made by inspection of flowers.) Thus, paying attention to flowers should result in improved functioning in natural environments.

The strength of human emotional responses to flowers has been recognized and used in the developing field of therapeutic horticulture. The National Council for Therapy and Rehabilitation through Horticulture, founded in 1973, promotes and encourages the use of horticulture activities for therapy and rehabilitation. The success of these efforts is impressive (McDonald, 1976). The habit of bringing flowers to people in hospitals is not merely a friendly gesture. The presence of flowers in a hospital room may improve the mental state and rate of recovery of patients (Watson & Burlingame, 1960). Research on people's perceptions of their neighborhoods also shows the enormous appeal of flowers (Vernez-Moudon & Heerwagen, 1990). In the neighborhood study, residents accompanied the researchers on a predetermined route in three Seattle neighborhoods that varied considerably in their characteristics, especially in the type of houses. The study subjects were told to talk about what they liked and disliked about the places that were seen along the walk route. In each neighborhood, there were extensive comments on the landscapes—particularly the vegetation and flowers, which were very appealing to the subjects.

The appeal of flowers is also apparent in the enormous efforts expended on breeding plants to increase the sizes and numbers of floral parts and brilliance of coloration. Competition to excel in these efforts is widespread among both professionals and amateurs. Although the strength of our responses to flowers has long been appreciated, as far as we are aware, conceptual theories about these responses are totally lacking. An evolutionary approach to habitat selection offers a potentially powerful approach in this area of study.

Environmental Cues Influencing Long-Term Behavior

Whereas many environments are used for only short periods of time and for specific purposes, people also settle in one place for long time periods. Typically people invest heavily in construction and habitat modifications when they intend to occupy an area for a long time. This increases the costs associated with subsequent movement. For these reasons, we expect long-term settlement decisions to be influenced primarily by features of the environment that reflect its long-term safety and resource-provisioning potential. Short-term signals from the environment should be ignored unless they provide indications of longer-term consequences. For example, a current flood may indicate a high probability of future flooding.

Many features of landscapes are permanent, at least from the perspective of a human lifetime, and others change slowly enough that current conditions are reliable predictors of the relatively long-term future. Mountains, hills, valleys, rivers, and lakes do eventually erode away or fill up, but the rate at which they do so is very slow compared with the time frames relevant to our decisions about places in which to live. Vegetation changes occur more rapidly, but successional sequences from disturbance to climax may take up to several centuries. Habitat quality changes during such sequences, but rates of change are such that a good habitat today is likely to remain so for some time into the future, barring unforeseen catastrophic accidents.

Strong associations exist between vegetation patterns and availability of resources in those environments. This relationship has been exploited by Orians (1980, 1986) in his development of the "savanna theory" of environmental aesthetics, as discussed earlier. Evidence of aesthetic responses attuned to the savanna environment can be found in our manipulations of landscapes for aesthetic purposes (parks and gardens; see, e.g., Orians, 1986) and in the design of landscape paintings (Appleton, 1975).

Geological features of landscapes also exert powerful influences on human emotions. Indeed, America's national parks are centered around monumental land forms—mountains, canyons, cliffs, waterfalls, geysers, rivers, and caves. This preoccupation has been criticized by some observers who believe that parks should be established to preserve representative examples of the earth's life zones (Curry-Lindahl, 1974; Runte, 1979). Others have defended the park systems on the grounds that spectacular scenery stimulates use and that representative ecosystems, whatever their scientific value, will not serve the functions that our current types of parks do (Vale, 1988). Whatever one's perspective, it is clear that conservation and preservation values are subservient in our national parks to our preoccupation with the monumental. This is strong testimony to the powerful effect on human behavior of geological features that provide expansive views, which are important for learning about the environment and provide opportunities to view potential hazardous elements from a position of safety.

In addition to the geomorphological and vegetative features that signal the long-term quality of environments, people, as well as other organisms, also rely upon evidence of the presence of conspecifics for further information about an environment. Such information may be either positive or negative. On the positive side, signs of human occupancy suggest that other people have evaluated and selected this habitat and have survived in it. This is prima facie evidence of its suitability. Such signals as bridges and paths, suggesting safe ways of moving through the environment, also provide evidence of a suitable place. And, indeed, paths and bridges are frequently used in photography and landscape paintings to evoke positive feelings. On the negative side, the presence of other people may be associated with crowding or depleted resources. Reactions are, therefore, likely to depend on the apparent density and impacts of prior residents on the site. Simulation research by Chambers (1974) supports this prediction.

FROM SIGNAL TO SYMBOL: THE APPLICATION OF EVOLUTIONARY THEORY TO SPECIFIC ENVIRONMENTAL AESTHETIC RESPONSES

In our evolutionary past, the environmental features and events discussed in this paper warned us of hazards and threats, as well as opportunities and resources that supported life and provided comfort. If attention to these stimuli and events is a cross-cultural universal, as seems likely, many of these ecological signals should have been transformed, over time, into cultural events and artifacts that are used to manipulate aesthetic experiences. In the section that follows, we discuss specific research areas that deal with applications of evolutionary-ecological theory to environmental aesthetics.

Prospect-Refuge Theory

In its simplest terms, prospect-range theory predicts that people should prefer places and environments that allow opportunities to see without being seen (Appleton, 1975). Furthermore, under conditions of perceived hazard, the desire for refuge should be heightened. Specific predictions that result from prospect-refuge theory are that (a) people should prefer edges more than the middle of a space because edges provide the best visual access to an area; (b) spaces that provide something over the head (a roof, tree canopy, trellis, etc.) should be preferred over spaces that provide only a back or side surface; (c) spaces protected at the back or side should be preferred over those without any vertical surface (e.g., those exposed to the view of others on all sides); (d) if one wants to be seen, then sitting in the middle of a space without intervening surfaces would be preferred because this area provides the greatest exposure; (e) an environment will be judged as more pleasant if it contains a balance between prospect and refuge opportunities, with screening elements to achieve privacy and variability in desired levels of intimacy in a space (see Thiel, Harrison, & Alden, 1986); and (f) preferred spaces should contain multiple view opportunities from most locations and multiple ways of moving through the space; these features encourage environmental surveillance and escape.

Urban Spaces

Interestingly, popular small-scale urban spaces contain these features (Whyte, 1980). However, most of the research in this area has been descriptive rather than theoretical. Spaces are often chosen for analysis on the basis of their availability, rather than on variability in their spatial features or other parameters that are expected to influence preference patterns. Further, the absence of theory to guide research in the designed environment has lead to the accumulation of specific data that cannot be generalized in a way that is useful to the design of new spaces or the renovation of existing ones. The evolutionary-ecological approach we propose in this paper provides a framework for investigating these environments. However, much research needs to be done before it is possible to determine the relative contribution of different features to preference patterns. We don't know, for instance, whether a small grove of trees is a better investment than a fountain, or how to manipulate the balance between prospect and refuge opportunities to achieve different psychological experiences. These questions are amenable to study, however. Techniques such as Archea's (1984) visual-exposure/visual-access model or Benedikt's (1979) isovist process can be used to study the ways in which specific architectural or natural features influence visibility and usage patterns (Heerwagen, 1989). Analysis of the order in which people occupy particular locations will provide information on which subspaces or seating areas are most popular and how the presence of other people influences the responses of newcomers.

Architectural Application

In an intriguing psychological profile of Frank Lloyd Wright's houses, Hildebrand (1991) uses prospect-refuge theory to explain the consistent appeal of Wright's architecture. According to Hildebrand, Wright's houses have a basic motif that mixes the drama of discovery with a strong sense of hominess. Unexpected views and refuge opportunities abound, from the front gate through the backyard of a Wright house. An internal, contained fireplace with a lowered ceiling and glass doors or windows opposite gives a strong sense of refuge, balanced by the opportunity to see out and survey the surrounding environment. There are internal views of varying size and penetration throughout the houses, and terraces with deep overhangs that afford prospect opportunities from the vantage of safety. In one of Wright's most famous houses, "Falling Waters," the psychological impact of refuge is enhanced by the hazard symbolism of a gorge and waterfalls that literally surround the house.

Wright's consistent use of changes in ceiling elevation and the placement of major living spaces directly under the roof both open up the space visually and create the comfortable sensation of living under a tree canopy. The sense of refuge and protection that one feels under a spreading tree canopy is certainly consistent with an evolutionary approach to aesthetics. Trees were likely to have been used by early humans to escape from sudden hazards, such as dangerous animals, and as protection from sun and rain. In areas lacking topographic relief, a tree also provided a readily accessible viewing platform for surveying the surrounding environment. Although we may lose the tree-climbing desire as adults, trees play a significant role in children's play behaviors (Hart, 1980).

Despite the intuitive appeal of trees, very little research has dealt with human responses to trees. An evolutionary-ecological approach to aesthetics suggests that the incorporation of trees and tree forms, actual or symbolic, into the built environment should have a strong positive impact on people. In support of this prediction, Rachel Kaplan found that people whose view from an apartment window included large trees were more satisfied with both their physical and social environment than people whose views were dominated by built features or grassy expanses (R. Kaplan, 1983). Further, a study of hospital recovery indicates that patients whose windows looked out upon a small grove of deciduous trees had a more positive post-surgical recovery, including a shorter hospital stay, than a matched control group of patients whose windows looked out upon a building (Ulrich, 1984).

Further research should investigate such factors as tree shapes, the placement of trees to enhance mystery and refuge in an environment, and the symbolic use of tree shapes in the built environment. For instance, tree canopies appear symbolically in many aspects of design, including sloped ceilings, trellises, awnings, porches, and building overhangs, particularly those with pillars. We predict that the presence of these "symbolic trees' is associated with positive response to built environments.

Despite the intuitive appeal of prospect-refuge theory, research on refuge preferences has produced some mixed results (Woodcock, 1982). This is partially due to the

fact that it is difficult to assess refuges in photographs (the preferred medium for landscape studies). A cluster of bushes or a thick stand of trees is certainly a refuge once one is inside, but they may be hazardous to approach, and they also block potential views in a photograph. The use of behavioral analysis to assess responses to a refuge may yield quite different results, in part, because one may have to experience a refuge to appreciate its value.

Photography and Paintings

Prospect, refuge, and other features of preferred landscapes can also be studied in other media, including paintings and photographs. Photography and landscape painting, for instance, share many common features. The views they provide are artificially bounded and two dimensional. In addition, the observer can never enter the environment even though the presentation may be designed to foster contemplation about entering it. Every person views a photograph or painting for the first time. If we assume that the artist wishes the viewer to pause on the first encounter and to want to view the scene more than once, then photos and paintings of environments should have features that evoke instantaneous positive responses. Appleton's (1975) analysis of landscape paintings shows that this is very much the case. Common photographic devices such as framing pictures (creating the impression that the observer is in a refuge), use of shadows (indicating a time of day when changes in behavior are likely to be required), and inclusion of cloud formations (signaling potential changes in weather) serve to emphasize those cues that should have evolved as immediate attention-getters. The environments portrayed need not be ones that evoke desires to engage in extensive exploration. They may be designed to evoke fear or sensations of the sublime, but above all, they must command our immediate attention.

For those photos and paintings designed to appeal to the exploratory phase of the habitat selection process (Stage 2), effective devices include evidence that exploration can take place in relative safety and evidence that abundant resources are likely to be found if exploration does ensue (e.g., presence of water, large mammals, or indicators of prior human occupation). However, to motivate the desire to view the art many times requires devices that evoke the feeling that there is always more to be learned. This component of environmental aesthetics is the heart of what the Kaplans call "mystery," creating expectations that cannot be fulfilled by repeated viewing but which may make us continually curious about what we might find if we were able to actually enter and explore the environment (see S. Kaplan, 1987 for a review).

The Role of Mystery in Environmental Aesthetics

As defined by S. Kaplan (1987), "mystery" is a characteristic of landscapes that draws the viewer into the scene, making him/her want to find out more. The winding road that goes out of sight behind a bank of trees or a small hill has proven to be an excellent predictor of landscape preferences. The desire to know what's around the hill or over the horizon is likely to have evolutionary roots. The sense of mystery would facilitate learning about the landscape, a highly adaptive behavior for our hunting and foraging ancestors who probably moved long distances on a regular basis.

Despite its positive role in environmental aesthetics, mystery has a dark side. That which is out of sight may be dangerous (see Herzog, 1988). This suggests that environments high in mystery should product a feeling of apprehension as well as of interest

In dangerous settings, apprehension may come to the forefront, generating feelings of anxiety and stress. This is exactly what Newman (1972) found in his studies of New York housing developments. Housing residents avoided places where they did not have high visual access of the entire space. Further, crime rates and vandalism are likely to be much higher in places where visual surveillance is inadequate due to blocked views, winding paths, or changes in light availability. The little study there has been on this topic suggests that it is a fruitful area for further research on the relationship between the physical environment and crime, including vandalism (Wise, 1983) and violent crimes, particularly rapes (Stoks, 1983).

Unfortunately, the need for visual access frequently leads to extreme environments that totally lack visual appeal. Research is needed on ways of incorporating the positive aspects of mystery with the need for adequate visual surveillance of spaces. Solutions such as increasing the angle at which the path turns, using trees instead of dense shrubbery, using shrubbery with thorns to discourage hiding, and providing numerous lookout points should be studied from both a safety and aesthetic perspective. Furthermore, in environments where low levels of mystery are desirable for safety reasons, other means of increasing aesthetic responses should be encouraged, such as the use of flowers, water features, and color. At the present time, we know little about the relative value of these various aesthetic features in an environment. Questions of relative merit of design alternatives are becoming increasingly important in urban settings where spaces are limited, potential dangers are high, and funds for aesthetic features are often limited.

Age-Related Changes in Environmental Aesthetics

If our aesthetic responses are based, in part, on behavioral ecology, as we suggest in this paper, then we would expect to find fundamental age-related differences in the way humans respond to the environment. The basic perceptual and cognitive mechanisms underlying environmental response change with age as do physical abilities. An evolutionary approach begins by asking what influences survival and reproductive success most strongly at different ages. In the most general terms, both survival and success depend on how well an organism negotiates the balance between the hazards and opportunities it faces on a regular basis.

Although there is virtually no research on age-related stages of environmental aesthetics, the ecological perspective presented here predicts that age-related environmental transitions should include (a) changes in the characteristics of preferred environments; (b) changes in the kind of information that is most useful in terms of adaptive functioning; (c) differences in how environmental information is obtained and used; and (d) differences in the effects of the environment on psychological functioning. These predictions are based on the notion that humans are adapted organisms at each stage in their life: Development does not simply lead up to a final well-adapted "adult" form.

As a child's normal range of movement in the environment expands from infancy through adolescence, so, too, do the kinds of hazards and opportunities it encounters. Successful ventures into the environment depend upon paying attention to stimuli and events that are the most "useful" to a child for its age. The usefulness of information relates to changes over time, relative to the physical, cognitive, and social abil-

For instance, we would not expect a 3-year-old child to pay much attention to sunsets or other time cues such as lengthening shadows. This is because very young children seldom venture far from home on their own. Thus knowing what time it is, in terms of its "usefulness" in motivating needed changes in behavior, is simply not relevant to a very young child. On the other hand, it is important for a 3-year-old to be able to separate edible from inedible or toxic objects. Thus, a concern with properties and attributes of objects that separate them into good-bad, edible-inedible, ripe-not ripe would be highly adaptive. Furthermore, because young children cannot be expected to know, in advance, the consequences of eating the wrong thing, it is advantageous for them to be in close contact with an adult who does know what the expected outcomes are. The young child uses the older person's knowledge as a way of learning the appropriate response. It is not surprising then that young children are fascinated with small objects and enjoy collecting and playing with them.

Future studies need to address such basic questions as what kind of environments or environmental stimuli do people prefer at different ages? What do they reject as uninteresting? At what point in life do children begin to attend to distant stimuli such as views and sunsets? How do responses to refuge and prospect dimensions of the environment change over time? Why do adults so readily experience feelings of nostalgia and longing for the landscapes of childhood? How—and why—does environmental experience transform from the hands-on, concrete experience of childhood to the more abstract, often spiritual, quality of adult responses to the environment?

CONCLUDING REMARKS

We have attempted to illustrate the richness of concepts and hypotheses that can be generated from an evolutionary perspective on environmental aesthetics. Although many hypotheses have already been developed to varying degrees, we have just begun to scratch the surface of the possibilities inherent in this approach. Testing of these ideas has just begun, but already support for some hypotheses has been generated. Some preliminary results have demonstrated the need to modify and expand earlier predictions. This mutually stimulating interaction between theory and empirical testing can be continued profitably for a long time. Until recently, study of responses to environments has been a strongly empirical venture. The scarcity of theoretical concepts to guide research has narrowed the scope of investigations and generated a body of data that is difficult to interpret. Empirical generalizations are useful, but they lack the explanatory and predictive power of causal hypotheses.

We do not suggest that an evolutionary-adaptive approach to environmental aesthetics is the only way to proceed. However, such an approach can enrich studies from a variety of perspectives and in a wide range of topics. Indeed, we have suggested applications of this approach to the ontogeny of the aesthetic sense, to design of buildings and public spaces, and to analyses of works of art. Unless one denies that our emotional responses evolved in part to enable us to function more effectively in our environments, it is difficult to see how this approach cannot be useful. Nonetheless, the task before us is not easy. Good evolutionary theories are difficult to formulate and test. Many apparently promising ideas will be discarded on the intellectual trash heap that accompanies the progress we all seek. However, this is the pattern of all scientific research, and the discarded ideas may well have played a key role along the path to

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