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EFFECTS OF THE PHYSICAL ENVIRONMENT

ON ENVIRONMENTAL PERCEPTION

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ABSTRACT

Previous studies of cognitive mapping have largely failed to approximate the molar physical environment. The use of slides has been suggested as a valid surrogate to investigate the perception of large-scale spaces. In this study, built and natural landmarks were rated on a variety of dimensions in an attempt to uncover the relationship between an individual's familiar physical environment and environmental perception. Experimental results indicated that subjects rate built landmarks more highly than natural landmarks on a usefulness dimension across both urbanization levels and geographical locations. This finding leads to the speculation that landmarks representative of the built environment serve functional purposes while natural markers are more likely to be perceived along aesthetic dimensions. The organismic-developmental theory served as a guide in formulating the experimental hypotheses; this application of the theory failed to account for the obtained results which can be explained at a functional level.

INTRODUCTION

Each of us has developed, to some extent, knowledge of the large-scale environment. A driver going from one place to another must have an internalized map of the environment that prevents him from getting lost. A child walking to school must have an internalized map of the environment that leads him along on his route. Questions arise as to how we develop highly complex spatial concepts and the extent to which they are influenced by factors such as sex, familiarity with the environment, and age.

Tolman's (1948) experiments provided evidence that the learning process may involve more than simply stimulous-response connections for both rats and men. Tolman hypothesized that in the course of learning, something like a field map of the environment gets established in the rat's brain. Two qualitatively different types of maps were offered to account for the rat's varying performance; a strip-map in which different locations are connected by a single path, and a comprehensive map that allows for variations in routes. The strip-map can be conceptualized as operating at a developmentally earlier period than a comprehensive map. Tolman used the term "cognitive map" to represent the internal representations of the environment in both rats and men.

The issues relevant to cognitive mapping have been extensively investigated from an organismic-developmental perspective (Piaget, 1960, Werner 1948, 1957, Hart and Moore 1973). It is relevant here to briefly describe this theoretical perspective. Underlying the organismic-developmental theory is the assumption that the life process can be characterized as involving a constant interaction between the organism (subject) and the environment (object). This position has been alternatively labelled transactionalism (Dewey and Bentley, 1949), and constructivism (Cassirer, 1944). In looking at behavior as a process, the developmental theorists define the organism as a system whose parts bear an instrumental relationship to the function of the whole (Angyal, 1941, Werner, 1948, 1957). This assumption has been formalized in Werner's (1957) orthogenetic principle: "Insofar as development occurs in a process under consideration there is a progression from a relative globality and lack of differentiation to states of increasing differentiation and hierarchic integration."

Piaget (1960) derived a number of general conclusions from his research on spatial representation in children. The representation of spatial concepts was hypotehsized to arise from the coordination and integration of actions. Prior to the development of a cognitive map, the child learns about the environment through acting upon it. Piaget hypothesized that spatial representation was organized in qualitatively different structures as children develop. Three classes of specific spatial relations were offered which form the content of spatial cognition: topological, projective, and euclidean. Topological space, representing the earliest level of spatial cognition, depends on the purely qualitative relations (e.g. proximity, closure) in a particular figure. Both euclidean and projective space are derived from topological space, and develop in a parallel fashion. Laurendeau and Pinard (1970) characterized projective space as the ability to coordinate the different perspectives of an object, while euclidean space is a coordination of objects among themselves in reference to a total framework. Piaget believed that it was only at the level of concrete operations (i.e. approximately eight or nine) that these relationships emerge.

Methodological Issues

A variety of methods have been utilized to externalize the cognitive maps of both adults and children. Having subjects draw sketch maps of both familiar and unfamiliar environments has yielded data that reveals developmental change in cognitive structure. In one such study (Schouela, Steinberg, Leveton, and Wapner, 1980), college freshmen were asked, over a six month period, to make a number of sketch maps of their new environments. The investigators found that with progressive exposure and familiarity with an environment, the students represented the spatial relations that constitute a scene in an increasingly differentiated and integrated manner. There are several problems with sketch maps that limit their generalizability; the ability to draw is confounded with cognitive mapping skills in both adults and children, though the extent to which this ability represents a component of cognitive mapping is unknown.

To circumvent the problems inherent in pictorial representations, some investigators have utilized subjects' constructions of small-scale "model spaces" as being representative of the large-scale environment. An example of this type of methodology was Piaget's (1960) experimental work on spatial representation. Children, aged 4 to 12, were asked to build a model of their school yard and its vicinity. The main school building models were then rotated 180 degrees, and the children were then asked to make the necessary positional changes in their models. Differences in spatial organization followed a developmental trend.

Kuipers (1977) has argued that the scale of space used to represent spatial organization may critically effect a subject's performance. Ittelson's (1973) speculation is pertinent here; large-scale space is explored, while small-scale space is observed. The influence of scale size on spatial performance has been investigated experimentally (Siegel, Herman, Allen, Kirasic, 1979); children who were exposed to a small-scale model, and were later asked to translate that knowledge into a large-scale model space performed less accurately on the transformed model. Although the construction of small-scale models removes some confounding variables that are associated with sketch maps, this methodology may have been uncovering dimensions associated with fundamental spatial relations, and not those relevant to large-scale spatial experience.

In a series of experiments that utilized large-scale model environments (Herman, 1980, Herman and Siegel, 1978), subjects were exposed to these models, and were then asked to reconstruct the spatial arrangements of objects in a particular setting from memory. In Herman and Siegel's (1978) experiment, children in kindergarten, second, and fifth grade were walked through a 16 x 20 foot model town. Results of this study indicate that even the youngest children were capable of using metric distance relations between buildings and other features of the model layout to improve the accuracy of their cognitive maps. Their performance was at first markedly inferior to the older children's, but with increased familiarity with the setting the younger children's maps reflected an understanding of the environment that was operating at a level approaching euclidean spatial knowledge. This result is difficult to reconcile with Piaget's belief that this form of spatial understanding doesn't become operative until the concrete operations stage.

Theoretical Issues

Hart and Moore (1973) provide a theoretical framework to account for the development of macro-spatial representation based on Piaget's (1956, 1960) research, and on their own work that dealt with adolescents' understanding of urban environments. The child's understanding of the spatial layout of the environment falls into three stages of an increasingly differentiated and integrated system. These stages can be characterized as (1) undifferentiated egocentric reference system: organized around the child's own positions and actions in space, (2) partially coordinated, fixed frame of reference: organized in clusters around various fixed concrete elements, landmarks, or places, (3) operationally coordinated and hierarchically integrated reference systems: organized in terms of some abstract geometric patterns. These stages are assumed to be an extension of the development of fundamental spatial concepts and relationships, and of cognitive development in general.

Siegel and While (1975) define landmarks as unique configurations of perceptual events that identify a specific geographical location (p. 23). They hypothesized that cognitive mapping follows a developmental process in which landmarks are first noticed and remembered. Landmarks are then used as cues that form a foundation for the routes that constitute a primitive understanding of cognitive mapping. Route clusters and landmarks are then integrated in the next level of development into an increasingly objective frame of reference.

When we find ourselves in unfamiliar places it is unlikely that we possess coordinated spatial maps of these new environments. The newcomer must go through many of the same stages of orientation that the child experiences while growing up. In this respect, cognitive mapping begins anew each time we encounter unfamiliar territory. We first anchor our spatial reference systems with concrete markers, landmarks. These markers are then connected by paths, though much like Tolman's rats we get lost fairly easily when these familiar routes aren't available. Built into this initially limited reference system is an understanding of how routes are interconnected. One's sense that the layout of an environment is an integrated whole permits successful navigation on routes that are entirely within the realm of the imagination.

Research Hypotheses

One's experience in a particular environment involves a process of differentiation. When we are exposed to new settings orientation is difficult; directions have little or no meaning when you don't know which cues or landmarks to attend to. Experience facilitates familiarity, and with increased exposure to a setting the newcomer learns his way around. Familiarity with an environmental setting, though, may mean different things to different people. Depending upon where we grew up, or currently live, way-finding in an unfamiliar environment may involve the utilization of landmarks with which we are most familiar. For example, in a town such as Tucson, does the newcomer use the mountains, natural landmarks, or office buildings, built landmarks, to orient himself in space. This may depend upon whether the individual grew up on the east or west coast, in a city or a suburb. Kail (1978) has suggested that the development of an accurate cognitive map is dependent upon the differentiation of landmarks; differences, for example, in perceived importance of landmark usefulnesss may reflect the different ways in which people orient themselves in large-scale spatial settings.

It is assumed in this study that landmarks are the cornerstone of the cognitive map. Following this assumption, differences in the perception of both built and natural landmarks will be experimentally investigated. Subjects will be sampled from a variety of environments that differ both in terms of urbanization level (rural, suburban, urban), and geographical location (East coast, Midwest, Southwest and West coast). The subjects will view both the built and natural landmarks, and will then rate them on a variety of scales.

In an attempt to uncover dimensions that were relevant to the perception of the built environment, Appleyard (1969) found that a landmark's usefulness in facilitating spatial orientation, and its physical form were two of the components that were most important in determining whether a landmark was included in an individual's cognitive map. Using this investigation as a guide, both usefulness and physical form ratings will be utilized to uncover subjective differences in the perception of the built and natural environment. Subjects will rate both the usefulness of each landmark, and the distinctiveness, complexity, and uniqueness of each landmark's physical form.

It is expected that those subjects from predominantly urban/suburban environments will find the built landmarks most useful for spatial orientation, while subjects from more rural environments will rate the natural landmarks as being high is usefulness. Differences across geographical locations are expected to be minimal on this scale with any significant effects found within these regions. On the physical form ratings the direction of subject preferences both across and within geographical locations cannot be predicted. This aspect of the experiment is exploratory, and results from this study will provide future directions for how these components influence environmental perception.

It is expected that subjects from the East coast will be most familiar with the built landmarks that were selected from settings representing this section of the country. In contrast, the Western group of subjects are expected to be more familiar with the natural landmarks that were selected from Western settings. Familiarity is a potentially confounding variable as it might prove to be highly correlated with usefulness. To answer this question subjects will rate their familiarity with each type of landmark that is presented.

Lowenthal's (1972) study of environmental perception indicated that our transactions with the environment could be characterized along aesthetic as well as descriptive dimensions. The meaning that an environmental setting holds for us may simply be another measure of familiarity, or it may be a more aesthetically determined mode of experience. To answer this question subjects will rate the symbolic value of each landmark. A high correlation between the symbolism and familiarity scales indicates the similarity between these two dimensions; alternatively, symbolic value may prove to mean more than simply familiarity with an environmental setting.

Six rating scales have been selected for experimental investigation. By examining the interrelationships across the rating scales, and in relationship to a variety of different physical environments it will be possible to develop some ideas about both the perception of the environment, and the landmarks that are included in the cognitive map.

Landmarks will be represented through the use of black and white slides. There has been some concern as to whether these two-dimensional surrogates are valid in approximating the molar physical environment. A number of studies have utilized slides to study environmental perception (Ulrich, 1981, Ward and Russell, 1981). Daniel and Ittelson (1981) have pointed out that this methodology does serve to differentiate between different categories of environments, and results can be generalized to the actual environmental settings.

METHODS

Subjects

Approximately 300 students were recruited from the University's general psychology course to participate in this experiment. The sample was broken down into three geographical locations based on demographic information that the subjects provided. These locations were: (1) East- representing the Northeast states, (2) Midwest - representing the central portion of the United States, (3) Coast - representing the Southwest and California. Subjects were included in the analyzed sample who had spent, on the average, less than 5 months in their present setting. Based on this criterion system we felt reasonably assured that the location indicated as the one in which the subject grew up could be characterized as his/her familiar physical environment.

Subjects rated the urbanization level (rural, suburban, urban) of their familiar environments on a five point scale (e.g. 1-rural, 5-urban). 60 subjects were assigned to the three geographical sections in groups of 20. Based on indicated urbanization levels, each section was represented as follows: East - rural (4), suburban (13), urban (3); Midwest - rural (2), suburban (8), urban (10); Coast - rural (2), suburban (8), urban (10). The sample also consisted of 20 males, and 40 females.

Apparatus

Twenty-two black and white slides were selected for presentation that represented 12 natural and 10 built landmarks. The natural slides depicted landmarks such as mountains, waterfalls, and trees, while the built slides depicted a variety of buildings, signs, and monuments (see Appendix A for a complete listing of the landmarks). Four randomized presentation orders were set up to control against possible sequence effects.

The slides were presented with a Kodak Carousel projector in two rounds. During the first viewing, subjects were shown the slides at the rate of one per two seconds in an effort to orient them to the presented stimuli. The second round involved the subjects rating each of the slides across six dimensions. During this presentation, slides were presented at the rate of one per 10 seconds. Four randomly selected orders were presented to control against possible trial effects.

The experiment was conducted in a room with an adjustable lighting level that made it possible for the slides to be clearly visible, while subjects rated the slides without visual impediments.

Procedure

Approximately 30 subjects were tested during each session. The experimenter explained the general nature of the study, and then proceeded to present the slides. Subjects were asked to number their scoring sheets during the initial presentation.

After the first presentation, the experimenter explained the way in which each of the six dimensions were to be scored. Each dimension represented a 5 point scale (i.e. 1-lowest, 5-highest). The subjects were first instructed to indicate the distinctive quality of each slide; it was explained that distinctiveness represented the quality of the landmark's physical form. The Empire State building was offered as a landmark that could be characterized as being very high in distinctiveness. The second dimension, usefulness, involved the subjects imagining that they were lost in an unfamiliar environment. They were then to indicate how useful each landmark was in facilitating spatial orientation. As an example, subjects were asked to consider how useful a skyscraper might be in determining which direction "uptown" was in an urban environment. The third dimension, uniqueness, had the subjects indicate where on a continuum from very unique (5) to very common (1) the landmark fell. The Washington monument was offered as an example of a landmark that was very unique, as opposed to any one office building in a city where all of the buildings might appear very similar. The fourth dimension was labelled as the simplicity-complexity scale (1-simple, complex-5); here subjects were to indicate whether they perceived the landmark as representing a simple or complex physical form. The University library was characterized as a complex physical form due to the variety of its different sections, while the rounded basketball arena was characterized as a relatively simple form. On the fifth dimension, symbolism, subjects were to indicate the degree of personal meaningfulness each slide held for them, and on the sixth dimension, familiarity, they indicated how familiar they were with each type of landmark that was presented.

After rating the slides subjects were asked to indicate where they had been born, grew up, the number of months that they had lived in Tucson, and to rate the area they had grown up in on the urbanization scale.

RESULTS

The data was analyzed in two ways: (1) to assess the degree of interrelatedness across the rating criteria, and (2) to reveal the effects of the physical environment in the perception of built and natural landmarks.

Interrelation Among Rating Scales

Correlation coefficients were calculated for each combination of mean rating scores. A high correlation between distinctiveness and uniqueness ($r = .65$), as well as the strong similarity that characterized the relationship between these two scales and the other ratings lead to the collapsing of the former scales into one construct (distinctiveness-uniqueness). The results of the correlational analysis are presented in Table 1.

A step-wise regression was performed using the usefulness scale as the criterion measure with slide type and the four remaining scales as predictor vectors. Three of the vectors enter significantly into the prediction equation: slide type ($r^2 = .09$, $p < .001$), symbolism (incremental $r^2 = .15$, $p < .001$) and distinctiveness-uniqueness (incremental $r^2 = .19$, $p < .001$).

The correlation between familiarity and usefulness ($r = .13$, $p < .001$) indicates that the degree of familiarity subjects have with landmark types may possibly be confounding usefulness ratings. A

Table 1. Correlations Across Rating Dimensions

Variables	1	2	3	4	5
1. Familiarity	1.0	.37*	-.03	.13*	.04
2. Symbolism		1.0	.28*	.36*	.47*
3. Complexity			1.0	.25*	.47*
4. Use				1.0	.59*
5. Distinct-Unique					1.0

* $p < .001$
cases = 1320

partial correlation was performed controlling for the effect of symbolism on familiarity with the modified correlation significantly reducing the correlation between familiarity and usefulness (r = -.055). It is possible that subjects interpreted the familiarity scale in terms of the personal meaning each landmark held for them, and not as an objective approximation of the degree of exposure they have had with each setting. This speculation is strengthened by the finding that symbolism continues to be significantly associated with usefulness after familiarity has statistically controlled ($r = .35$, $p < .001$). There were no significant interactions for physical environment by familiarity indicated by subsequent F-tests.

Environmental Characteristics and Rating Scales

The second set of analyses examined the relationships between sex, section of country, urbanization level, presentation order, and the environmental rating scales. Preliminary analyses revealed no significant effects associated with either order of presentation or sex of subject; this data was subsequently collapsed over the remaining variables. Results of the 3 (section of country) x 3 (urbanization level) ANOVA, with slide type and the five scales as within subjects factors are presented in Table 2.

There is a significant type x rating interaction, $F(4,204) = 15.90$, $p < .001$, across all the rating scales (see Figure 1). Subsequent tests for simple effects indicate that the slide type difference on the usefulness rating, $F(1,51) = 34.02$, $p < .001$), is the only effect

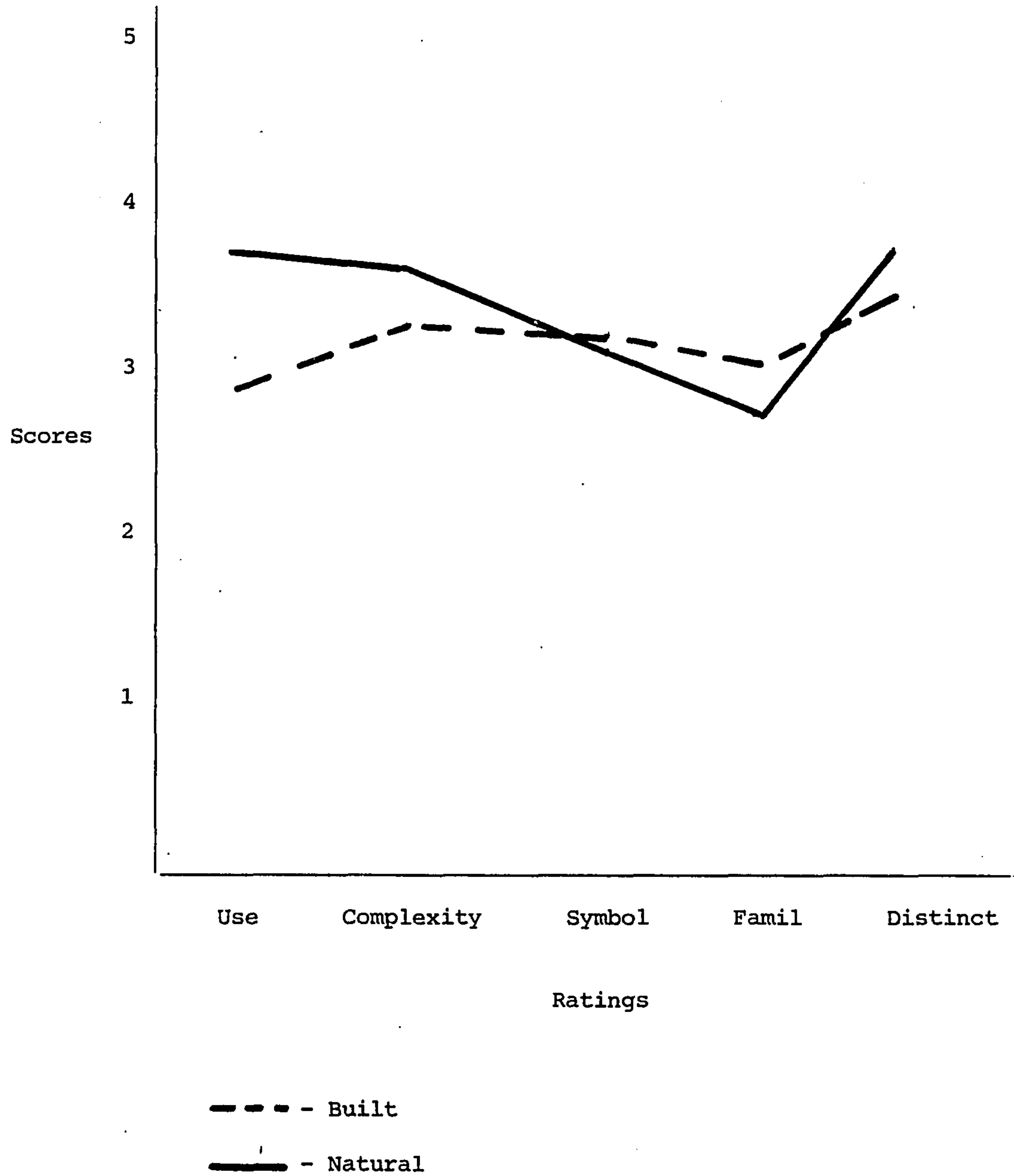
Table 2. Analysis of Variance Breakdown

Source	Sum of Squares	Degree of Freedom	Mean Square	F	Prob.
Section of Country	4.16	2	2.08	2.27	NS
Urbanization Level	.67	2	.34	.37	NS
Section x UL	9.16	4	2.29	2.50	*
Error	46.70	51	.92		
Slide Type	1.53	1	1.53	1.88	NS
Type x Section	.45	2	.22	.27	NS
Type x UL	1.64	2	.82	1.01	NS
Type x Sect x UL	.30	4	.08	.09	NS
Error	41.60	51	.82		
Ratings	21.42	4	5.35	11.23	***
Ratings x Section	6.74	8	.84	1.77	NS
Ratings x UL	3.18	8	.40	.83	NS
Ratings x Sect x UL	5.99	16	.37	.78	NS
Error	97.30	204	.48		
Type x Ratings	12.38	4	3.10	15.90	***
Type x Ratings x Sect	5.08	8	.63	3.26	**
Type x Ratings x UL	1.33	8	.17	.85	NS
Type x Ratings x UL x Sect	1.62	16	.10	.52	NS
Error	39.70	204	.19		

N = 60

* $p < .10$
** $p < .01$
*** $p < .001$

Figure 1. Breakdown of Mean Scores by Rating Scales



which reached significance on the individual scales when the alpha level was adjusted for experimentwise comparisons. Subjects gave high ratings to built landmarks on this scale across all environmental settings ($\bar{x}$ built = 3.68, $\bar{x}$ natural = 2.89). The complete breakdown of scores by physical environment is presented in Table 3.

The type x rating interaction was modified by a type x rating x section interaction, $\underline{F}(8,204) = 3.26$, $\underline{p} < .002$. Subsequent tests for simple effects, however, revealed no significant values within this interaction.

Table 3. Breakdown of Mean Scores by Section

	Usefulness		Complexity		Symbol		Familiarity	
	Built	Natural	Built	Natural	Built	Natural	Built	Natural
East	3.52	2.75	3.27	3.37	3.23	3.07	3.17	2.99
Midwest	3.80	2.99	3.71	3.25	2.82	3.30	2.56	3.02
Coast	3.72	2.92	3.48	3.15	3.03	3.09	2.54	2.81
	X_B-3.68	X_N-2.89	X_B-3.49	X_N-3.26	X_B-3.03	X_N-3.15	X_B-2.75	X_N-2.94
	X_{BN}-3.27		X_{BN}-3.38		X_{BN}-3.09		X_{BN}-2.85	

	Distinct-Unique		Overall by Section		
	Built	Natural	Built	Natural	Combined
East	3.72	3.52	3.38	3.14	3.26
Midwest	3.82	3.58	3.34	3.23	3.29
Coast	3.59	3.41	3.27	3.08	3.17
	X_B-3.71	X_N-3.50		Overall	X-3.24

N = 60

DISCUSSION

Contrary to the expectation that environmental setting would influence landmark use, it was found that all subjects perceive built landmarks as significantly more useful in facilitating spatial orientation than their natural counterparts regardless of the individual's familiar physical environment. Although these findings fail to confirm theoretical expectations derived from the organismic-developmental perspective, they can be explained at a functional level. It was assumed that individuals who grow up in rural settings have extensive contact with natural environments, and would subsequently find natural landmarks more useful than built markers in facilitating spatial orientation. This hypothesis fails to account for the existence of man-made structures within natural environments, and the wide range of environmental experiences potentially available to people from every section of this country. Although it is now possible to encounter built environments devoid of natural elements, the opposite is not true of natural environments. For example, even those individuals from the most rural environment in this country would have experience in utilizing road signs.

Built landmarks differ from natural markers along more than the built-natural dimension. One important difference is that built environments are designed to be distinctive; this dimension correlated highly with usefulness ratings. For example, in an urban setting such as New York City, even visitors who were unfamiliar with the City will notice certain buildings, and probably utilize them in way-finding. A similar prediction cannot be made for natural settings; an urban dweller who has had a limited amount of experience in natural environments would not have similar distinctive cues available that allow him to distinguish one mountain peak from another, and subsequently would not include these landmarks in his cognitive map.

Rating differences along the built-natural dimension can possibly be more accurately explained as produced by varying levels of form distinctiveness; the built landmarks were perceived as being relatively high on this dimension in contrast to the natural landmarks. An interesting question is whether built-natural differences would continue to emerge after matching built and natural landmarks on levels of distinctiveness. What should be pointed out, however, is that differences along the distinctiveness dimension were relatively small in comparison to usefulness rating differences on the built-natural dimension. These results point to the continued salience of the built-natural dimension after matching for levels of distinctiveness. Supporting this speculation are findings by Kaplan et al. (1972), and Ulrich (1981) which demonstrate that differences in the perception of natural-urban scenes continue to be significant after levels of complexity have been both experimentally and statistically controlled.

Although familiarity differences across geographical sections failed to reach statistical significance, there was a trend for the Eastern group to characterize built landmarks as more familiar, and for the Midwest and Coast groups to rate the natural landmarks as more familiar. This is a potential confounding variable that could have been eliminated by matching for levels of familiarity across these settings. Results from the experiment indicate, however, that familiarity is weakly correlated with usefulness after its covariation with symbolism has been statistically controlled. The familiarity dimension was interpreted more in terms of the meanings that the landmarks held for the subjects, and not as an approximation of the degree of contact they have had with them.

There has been some speculation by environmental psychologists (e.g. Levi, 1981) that the built environment is defined in terms of its functional value, while the natural environment is construed more in terms of its symbolic-emotive qualities. To some extent this hypothesis has been supported in the present experiment. Built landmarks were rated as more useful than natural landmarks across all geographical and urbanization settings. Additionally, the natural landmarks were rated more highly than the built landmarks in two of the three geographic sections, and overall on the symbolism dimension.

In future experiments more precise means of defining the relationships between aesthetic and functional qualities of the environment must be advanced. Possibly, usefulness and symbolism are interpreted differently dependent upon the environmental context. That is, the underlying semantics of a "useful" or "meaningful" built marker may imply different connotations in contrast to a natural landmark. For example, a skyscraper may help an individual to determine which direction "uptown" is in a city, and it may symbolize a high level of technology in this setting, while a mountain peak could symbolize the tranquilizing affects of nature, yet not have any specific functional value. The mountain peak, in contrast to the skyscraper, is useful in that it provides an escape from the built environment, but does not serve as a potential marker in an individual's cognitive map. Symbolic value and function seem more closely related in relationship to built landmarks, while natural landmarks may serve aesthetic ends without any clear utility. If we all lived in the wilderness the opposite effects might be demonstrated for these distinct environments.

APPENDIX A

DESCRIPTION OF SLIDES

Natural	Built
1. Snow covered mountain peak	13. Pan-Am building
2. River winding around a mountain	14. Flat-iron building
3. Waterfall	15. Seagram building
4. Sand dunes	16. Street signs
5. Zion National Park rock formation	17. Times Square sign
6. Tree along California coast	18. Grant's tomb
7. Large tree	19. N.Y. Times building
8. Rocks along a coastline	20. Washington Square Park
9. Devil's Tower	21. Plaza Hotel
10. Saguaro cactus	22. Copper Union building
11. Sunset over Manhattan	
12. Mountain range	

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