

The Dimensions of Aesthetic Preference: a Quantitative Analysis

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The current state of landscape research does not clearly direct environmental managers toward the appropriate choice of terminology to characterize and assess the aesthetic quality of particular landscape types. This study examined the ability of physical, artistic, and psychological descriptor dimensions to predict aesthetic preferences for rural river, forest, and agricultural landscape scenes. Multidimensional scaling analyses were used to identify the salient dimensions subjects used to express their aesthetic preferences for scenes within each type; these dimensions were interpreted quantitatively through correlations with sets of descriptor rating scales. The results generally showed a strong commonality in the dimensions of preference across landscape types, but also pointed to the uniqueness within landscapes. Implications are drawn for the development of theory and improvement of applied methods of aesthetic assessment.

Keywords: landscape perception, aesthetic preference, river, forest, agricultural, descriptor schemes, multidimensional scaling.

1. Introduction

To an unprecedented degree, environmental managers are now required to consider the aesthetic consequences of their landscape decisions if they are to be in compliance with an array of federal, state, and local legislation. In the United States, this requirement is perhaps best illustrated in the provisions of the National Environmental Policy Act, which requires federal agencies to "use all practicable means . . . (to) assure for all Americans safe, healthful, productive and aesthetically and culturally pleasing surroundings . . ." (NEPA Section 101b). The Act further requires agencies to "utilize a

systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking ..."(NEPA Section 102a).

While the intent of this and other legislation of the 1960s and 1970s seems clear enough, just how environmental managers are to implement a full consideration of the aesthetic qualities of landscapes is not so clear. Indeed, the body of research stimulated by the legislation may have unintentionally complicated the problem when it is considered in aggregate. Studies designed for different purposes, or conducted by investigators from different disciplines, have produced an enormous array of landscape attributes thought to be related to the aesthetic qualities of landscapes. In a review of 50 studies on visual quality assessment, we found 1194 different terms had been used to refer to attributes hypothesized to be relevant to aesthetic quality. While many of the terms shared a similar meaning, many did not. When categorized by meaning, there were still 114 readily distinguishable attributes common to three or more studies.

Without progress towards establishing a common vocabulary for use in considering aesthetics in environmental management, it seems unlikely that representatives from the natural and social sciences and environmental design arts will be able to communicate with one another, much less create a "systematic, interdisciplinary approach". More likely, to an environmental manager attempting to deal with aesthetic issues as one aspect of resource protection, the current situation may appear as a veritable Tower of Babylon. For example, aesthetic assessments of "waterscapes" (lake, river, and coastal landscapes) have alternatively been described using such terms as "degree of relative relief", "presence of special physical features", and "diversity of vegetation" (Jones, 1987); "unity", "variety", and "vividness" (Litton, 1977); and "mystery", "coherence", and "complexity" (Herzog, 1985). To a manager wishing to assess the aesthetic quality of waterscapes within his or her own jurisdiction, any consensus in the literature for the appropriate choice of terminology would be difficult to establish. Which terms are the best predictors of aesthetic quality? How do these terms relate to one another? Could these terms be used in developing assessment methodologies for another type of landscape, say, forests? Our perplexed manager might well forgo the project altogether rather than risk criticism of sounding arbitrary and capricious due to the general lack of a standardized methodology (Blatt, 1986).

Little has been done within the research community to sort out this confusion. Studies to date have provided little information about the relationships among the various dimensions of aesthetic quality, their relative effectiveness as predictors of aesthetic preference, or their respective utility for different landscape types. Because these issues are important to the development of theory and to the improvement of applied methods of aesthetic assessment, we felt that it was important to begin to address them within a systematic framework. To this end, the following study attempted to provide a quantitative analysis of the dimensions of aesthetic preference by comparing the diverse terminology of previous investigators, and by comparing this terminology across different landscape types. More specifically, the objectives of this research were: (1) to identify the dimensions untrained subjects used to make aesthetic preference judgments, (2) to interpret these dimensions using physical, artistic, and psychological landscape descriptors, (3) to assess the relative effectiveness of descriptors in predicting aesthetic preference within a landscape type, and (4) to assess the relative effectiveness of descriptors across different landscape types. Our study was conducted in the context of three rural midwestern landscape types: river, forest, and agricultural.

1.1. AESTHETIC DIMENSIONS

In their comprehensive review of the literature, Zube *et al.* (1982) identified four "paradigms" of landscape perception research. The "expert" paradigm was concerned with professional assessments of aesthetic quality, the "psychophysical" paradigm characterized studies which relate physical measurements of the landscape to perceptual judgments of aesthetic quality, the "cognitive" paradigm was concerned with subjective environmental properties, and the "experiential" paradigm characterized studies dealing with the phenomenology of landscape experience. Each paradigm represented a somewhat different way of looking at the realm of landscape aesthetics from a conceptual and methodological standpoint.

In our review of the literature, we were not concerned so much with how environmental dimensions were construed or measured, but what they were and how they were described. Despite the multitude of terms discovered in our review, most of them could be classified as belonging to one of three "descriptor types": physical, artistic, and psychological. Each descriptor type may embrace one or more of the methodological paradigms of Zube *et al.* (1982) and vary in how they are measured, but, within each type, all share a common base in how they relate to the landscape.

Physical descriptors refer to the visible, tangible elements of the landscape, or to the properties thereof. Examples of the former include rocks, trees, water, etc.; examples of the latter include the size of rocks, the height of trees, or the percent of water in a scene. All physical descriptors relate to the external dimensions of the environment—what is "out there" versus what is "in the head"—and herein lies a critical distinction between physical and psychological descriptors. A central argument for the use of physical descriptors comes out of the theoretical concern that any earnest study of the psychology of environments must deal with how actual attributes of the environment affect human behavior (e.g. Wohlwill, 1973, 1976; Daniel and Ittelson, 1981). A second argument relates to a more pragmatic concern that researchers should attempt to identify the physical dimensions of landscapes that can be manipulated by managers to increase aesthetic quality (e.g. Brown and Daniel, 1984; Hull *et al.*, 1987).

Physical descriptors have been used in expert assessments and in psychophysical studies of aesthetic preference. In both types of investigations, the particular choice of descriptors has hinged on the scale and type of landscape under investigation.

In an expert inventory of site-scale river landscapes, Leopold and Marchand (1968) inventoried 28 physical, biological, and human use and interest dimensions "contributing to the aesthetic or emotional reaction to a landscape" (p. 709). Particular dimensions included river "width", "depth", "velocity", "biological diversity", and "amount of trash and litter". Pitt (1976) used similar dimensions in a site-scale analysis of river preference, and found that six dimensions out of 20 measured accounted for 74% of the variance in scenic quality scores. The resulting regression equation identified "natural stream debris", "bottom material", "mean height of stream bank vegetation", "distance between stream bank vegetation", "mean height of valley walls", and "mean height of valley walls divided by width of valley" as significant predictors of aesthetic quality.

In a regional-scale expert assessment, Linton (1968) used only two dimensions, "landform" and "land use", to assess landscape quality on a broad level for the whole of Scotland. And, in a regional-scale preference assessment, Dearden (1980) measured 30 physical dimensions to obtain a regression equation that accounted for 81% of the variance in scenic quality judgments for a rural area in British Colombia. Significant variables in the equation included the "presence/absence of greenhouses", "length of

highways", "length of power-line right-of-ways", "length of undeveloped freshwater shorelines", "number of modern residences", and "percent of area occupied by airports". In his study, all dimensions were measured in 1 km² grid cell sample areas.

Much of the research involving physical landscape descriptors has centered on forest environments. Investigations by Daniel and his colleagues (e.g. Daniel and Boster, 1976; Schroeder and Daniel, 1981; Brown and Daniel, 1984) are typical of this research. The focus has been at the site scale on the assessment of "near view" physical dimensions that relate to timber management. These researchers have assessed the predictive ability of such variables as tree "height" and "density", and amount of "downed wood" and "slash" to account for variations in aesthetic preferences. Typically, regression equations using these variables have accounted for at least 50% of the variance in aesthetic quality judgments.

Very little research of any kind has occurred on agricultural landscapes (Schaumann, 1986). The only empirical studies identified in this review were by Nassauer (1978, 1979), who used physical descriptors to conceptualize the aesthetic quality of agricultural landscapes in the midwest. Nassauer (1978) found that "land use", "water presence", and "topography" together accounted for 67% of the variance in the visual value of agricultural scenes in Iowa. Similar findings were reported for her study of the Illinois landscape (1979). Anderson (1979) used these same variables, along with others, in a statewide expert assessment of aesthetic quality for the State of Iowa.

Artistic descriptors refer to the formal or abstract, compositional dimensions of the landscape. Examples of descriptors include "unity", "variety", and "vividness" (Litton, 1982), variety in "line", "color", "form", and "texture" (USDA Forest Service, 1974), "contrast", "harmony", and "integrity" (USDI Bureau of Land Management, 1980), and others. Artistic descriptors are synthetic abstractions of physical landscape elements, meaning that physical features or properties of the landscape combine to form some arrangement or compositional pattern in the eye of the observer. For example, a landscape with a high degree of unity might result from patterns of vegetation, landform, and land use visually joining together to produce an integrated composition, while a landscape low in contrast might result from the same physical elements having a high degree of similarity or monotony. In this respect, artistic descriptors might be thought of as "higher order" constructs of physical landscape dimensions, constructs which some argue have greater aesthetic relevance than basic physical dimensions, and might be more universally applied across different landscape types (e.g. Litton, 1982; Daniel and Vining, 1983). Others argue that formal, artistic approaches to landscape description discount the importance of detail, motion, ephemeral effects, and the emotional and expressive dimensions of landscapes while emphasizing formal patterns and treating the landscape as if it were a framed picture (Carlson, 1979).

The use of artistic descriptors in aesthetic assessments grew out of formalistic art theory (e.g. Pepper, 1937; Beardsley, 1958) and formal principles of architectural and landscape architectural design (e.g. Hubbard and Kimball, 1929; Laurie, 1975). Most assessment methodologies in this realm are expert-based, qualitative inventories. These are perhaps best illustrated by the Forest Service's (1974) "Visual Management System", and Litton's (1972) descriptive approach to the aesthetic assessment of landscapes. Other expert inventories quantify artistic dimensions of landscapes using numerical ratings (e.g. Jones and Jones, 1975; USDI Bureau of Land Management, 1980).

Expert approaches employing artistic descriptors have been applied at site and regional scales in forest (USDA Forest Service, 1974), wildland (USDI Bureau of Land Management, 1980), river (Litton, 1977), and coastal (Mann, 1975) landscapes. Again,

there has been a dearth of investigation on the aesthetic dimensions of agricultural landscapes, although Schaumann (1986) indicates that artistic descriptors may provide one possible avenue for assessment in this area.

Arthur's (1977) study on the aesthetic quality of forest environments was the only empirical research we found that tested the predictive ability of artistic descriptor dimensions in accounting for people's preferences. Arthur found that "vividness", "detail", "prominence of crown canopy", "surface variation", "contrast", "clouds", and "lighting" accounted for 93% of the variance in aesthetic quality judgments. Other artistic descriptors chosen for analysis in her study included "variety", "enclosure", "focal view", and "observer position".

Psychological descriptors refer to the psychological impacts that a landscape may have on those who observe or experience it. Certain landscapes may be regarded aesthetically because they provide pleasure and interest, afford opportunities for solitude or excitement, give feelings of a oneness with nature, or for other reasons. These dimensions are not visible properties of the landscape or higher order abstractions, but the psychological outcomes of interactions with the physical landscape or its compositional properties. Because of this, studies of the psychological dimensions of environments have been criticized because they do not relate to landscape dimensions which can be perceived or managed (e.g. Wohlwill, 1976; Daniel and Ittelson, 1981). Other researchers maintain these dimensions are the ones that give meaning to the environment, and although they might not map directly to some external reality are worthy of study in their own right (Russell and Ward, 1981). In addition, Kaplan (1975), Gobster (1983), and others assert that some of the physical dimensions used in past studies may have little, if any, actual relevance to people's judgments of aesthetic quality, whereas psychological dimensions may have greater aesthetic relevance.

Psychological descriptors have been used in investigations described by the cognitive and experiential paradigms of Zube *et al.* (1982). Empirical studies employing verbal scaling techniques have been useful in identifying a host of psychological dimensions which may be predictive of people's aesthetic response to landscapes. Research by Russell and his colleagues (Mehrabian and Russell, 1975; Russell, 1978, 1979; Russell and Pratt, 1980; Russell *et al.*, 1981) has been instrumental in identifying the important affective dimensions elicited by physical environments, particularly the dimensions of "pleasure" and "arousal". The Kaplans (Kaplan, 1979, 1987; Kaplan and Kaplan, 1982) have investigated the informational dimensions of environments, and, in a research program that has evolved over some 15 years, have studied the roles that information-based dimensions of "mystery", "complexity", "coherence", and "legibility" play in people's preferences for physical environments. Craik (1971) developed a 200-item "Landscape Adjective Checklist" for identifying psychological and physical descriptors relevant to the description of environments, and many others have used psychological descriptors in semantic differential scale analyses of architectural and landscape stimuli (e.g. Shafer and Richards, 1974; Lowenthal and Riel, 1972).

Phenomenological and empirical studies have been helpful in identifying the psychological dimensions related to the experience of landscapes, dimensions which may also be helpful in predicting aesthetic preferences. One important concept of study in this area has been "sense of place", a feeling of belongingness to and appreciation for environments gained through involvement and knowledge (Tuan, 1975, 1980; Relph, 1976; Langenbach, 1984; Green *et al.*, 1985). S. Kaplan and Talbot (1983) suggest that desires for "peacefulness" and "tranquility", "wholeness", and a sense of "oneness with nature" may be instrumental to the experience of natural and wilderness environments.

And Chenoweth and Gobster (1985) found that people's aesthetic experiences in outdoor environments tended to be described as highly "pleasant" and "memorable".

In contrast to studies of the physical and artistic dimensions of landscapes related to aesthetic quality, studies employing psychological descriptors tend to be less place-oriented. Instead, the focus has been more on the outcomes of people's interactions with landscapes, and on the relationships between various psychological dimensions. An exception to this generalization is the work of the Kaplans and their colleagues, who have studied the role of informational dimensions in a variety of landscape types [see Kaplan (1987) for a review].

1.2. METHODS FOR INVESTIGATING THE AESTHETIC DIMENSIONS OF LANDSCAPES

Divisiveness between investigators operating within opposing methodological paradigms has precluded the study and comparison of alternative modes of landscape description. Research on the physical, artistic, and psychological dimensions of aesthetic preference continues on parallel courses with little crossover, and at times with lively debates over which course is best pursued (see particularly Ward and Russell, 1981; Daniel and Ittelson, 1981; Russell and Ward, 1981; Craik, 1981). But while the reasons behind differing choices of aesthetic descriptors is deep-seated and not easily resolvable, a preliminary comparison between descriptor dimensions can be readily handled with the appropriate research design and selection of the proper means of analysis.

A first step in such a study would be to assess the relative effectiveness of physical, artistic, and psychological dimensions in predicting aesthetic preference for the *same set of landscape scenes*. This design would also allow study of the relationships between different descriptor dimensions. While this has rarely been done within the context of a single study, there are some notable exceptions. Arthur (1977) studied the predictive effectiveness and relationships between "physical", "design", and "timber cruise" descriptor dimensions for a set of forest landscape scenes. She found that each set of dimensions could account for at least 75% of the variance in aesthetic preference judgments, and also reported a number of significant correlations between dimensions from different descriptor types. Ward and Russell (1981) studied the relationships between the perceived similarity of a wide variety of physical environments and ratings of various "affective" and "perceptual-cognitive" dimensions. Similarly, Oostendorp and Berlyne (1978) investigated people's preferences for architectural facades using a variety of "collative-affective" and "stylistic-technical" dimensions. Both groups of investigators found strong relationships between different types of dimensions, and found that many of the descriptor dimensions could adequately explain the variance in people's judgments.

A second step in such an analysis would be to compare the predictive power and relationships between descriptor types *across different landscape settings*. This would provide useful information on how descriptor dimensions relate to aesthetic preference judgments as a function of landscape type. While our literature review did not identify any single studies which addressed this question, several researchers have studied the role certain dimensions play in accounting for preferences for different landscape types. Again, the work of the Kaplans mentioned above is notable, as is recent work by Herzog on the role that selected psychological and artistic dimensions play in preferences for waterscapes (1985), field and forest landscapes (1986), and mountain and desert areas (1987).

A final step for addressing the dimensions of aesthetic preference is to design the

study so that the descriptor dimensions used can be assessed relative to the *dimensions that people actually use to form aesthetic preferences* for landscapes. While the semantic differential has received wide use in the study of psychological meaning, some researchers have questioned the adequacy of verbal techniques to reveal people's judgments about the meaning of or preference for environments. In order to employ the semantic differential, the researcher must supply subjects with verbal response scales; this forces subjects to respond to the environment in terms of the investigator's choosing. These investigator defined descriptors might not be those the subjects would use naturally, and some think their use could alter the ways in which the environment is perceived or cognized (Ward and Russell, 1981). An alternative approach that sidesteps these perceived shortcomings relies on simple preference judgments to uncover the dimensional structure of a person's judgment process.

Multidimensional scaling (MDS), some have argued (e.g. Carroll and Wish, 1974) provides a method for uncovering the dimensions of stimuli which may be more relevant to the subject's conceptualization of stimulus meaning than verbal scaling approaches. The technique transforms a subject's ratings of similarity or preference into a spatial map, where stimulus points are organized according to the underlying criteria that the subject used to discriminate between the stimuli. The dimensions which underlie the configuration of points are not explicitly known to the investigator, but can be interpreted by correlating MDS stimulus coordinates with independently-measured stimulus properties, such as physical, artistic, and psychological descriptor dimensions. This combination of methods has been applied in research on a variety of physical environments (e.g. Oostendorp and Berlyne, 1978; Nasar, 1980; Ward and Russell, 1981; Pearce and Waters, 1983).

2. Methods

2.1. RESEARCH DESIGN

The data needed to address the above considerations were collected in two experiments. For experiment 1, a group of subjects made aesthetic preference judgments of paired landscape scenes within three separate stimulus sets: river, forest, and agricultural. Multidimensional scaling was used to identify the number of dimensions underlying aesthetic preference judgments for each set of scenes. For experiment 2, a second group of subjects rated the same scenes from each landscape type on a variety of physical, artistic, and psychological rating scales. These ratings were correlated with the MDS dimensions found in experiment 1 to quantitatively interpret the dimensions subjects used to make aesthetic preference judgments. The same ratings were also intercorrelated to identify patterns of common meaning among descriptor dimensions. Finally, the data from both experiments were used to make comparisons within and across landscape types.

2.2. SELECTION OF SCENES

From an original sample of 2500 color slides of rural Wisconsin river, forest, and agricultural scenes, 18 scenes of each type were selected to represent the range of conditions found throughout the state. The subsample was limited to this size for two reasons. First, due to the redundancy of the pairwise comparison method of obtaining aesthetic preference judgments in experiment one, 18 scenes was the maximum number

that observers could reasonably judge within an hour-long rating session. With all possible combinations, 18 slides amounted to 153 separate judgments. Alternative MDS models which do not require paired comparison judgments are available (e.g. the Coombs Unfolding Model), but are known to produce degenerate solutions (see generally Schiffman *et al.*, 1981; in landscape research see Purcell, 1987). Second, the time spent and accuracy of judgments also precluded using more than 18 slides in the rating of scenes on individual descriptor dimensions in experiment 2. Approximately 30 ratings were needed for each scene in this portion of the study.

The scenes that were chosen varied along major physical dimensions such as degree of development, extent of view, and topography, and on dimensions specific to each landscape type such as river width, age of tree vegetation, and size of agricultural fields. Together, these dimensions were thought to represent the major physical properties which defined the range of rural Wisconsin landscape types. Their choice was based on previous use in the landscape research literature, and most were also included as dimensions for rating by subjects in experiment 2 so that their effects could be assessed.

At the same time, other scene parameters were controlled to assure consistency across the stimulus sets. All scenes were photographed during summer, leaf-on conditions to control seasonality effects (Buhyoff and Wellman, 1980). A 50 mm "normal" lens and 35 mm Kodak 64 ASA color side film were used in all cases. All scenes were taken from eye-level, or nearly so, and caution was used to avoid scenes where foreground vegetation framed the view. These common simulation precautions are discussed by Nassauer (1983).

2.3. SELECTION OF DESCRIPTOR DIMENSIONS

The investigators reviewed 50 major empirical and non-empirical studies in the landscape research literature to select descriptors for analysis. Descriptors were selected on the basis of their frequency of use in the studies reviewed, and on those which did not receive wide use but were felt to be important in representing the range of physical, artistic, and psychological descriptors.

Thirteen physical descriptors were chosen, including "land use variety", "land use complexity", "uniqueness of physical features", "degree of alteration", "steepness of topography", and "distance of view". While these physical descriptors were common to all landscape types, "river sinuosity", "calmness of water", "tree density", "tree age", "intensity of agricultural development", and "size of agricultural fields" were selected to assess specific dimensions of river, forest, or agricultural scenes.

Eleven descriptors were used to represent the artistic dimensions of scenes, including "prominence of focal point", "unity", "variety in color", "variety in line", "variety in form", "variety in texture", "overall variety", "balance", "contrast", "enclosure", and "vividness".

Ten psychological descriptors were chosen for study, including "mystery", "harmony", "pleasingness", "peacefulness", "closeness to nature", "sense of place", "legibility", "awe" and "arousal". "Scenic quality" was added to the list of psychological descriptors so that an assessment could be made as to how well the scaling of aesthetic preference judgments correlated with a similar, rated dimension of the aesthetic quality of scenes.

Each descriptor was transformed into a seven-point unipolar or bipolar rating scale, with anchor labels reflecting the meaning of the descriptor. These are shown in Table 1.

TABLE 1. Scale anchors used in the study

Physical Descriptors:

Low variety of land uses/high variety of land uses
 Low land use complexity/high land use complexity
 No unique physical features/highly unique physical features
 Low degree of human alteration/high degree of human alteration
 Flat terrain/steep terrain
 Blocked view/distant view
 Straight river/winding river
 Calm water/rough water
 Narrow river/wide river
 Sparse trees/dense trees
 Young trees/old trees
 Low intensity agricultural development/high intensity agricultural development
 Small fields/large fields

Artistic Descriptors:

Weak focal point/strong focal point
 Low unity/high unity
 Low variety in color/high variety in color
 Low variety in line/high variety in line
 Low variety in form/high variety in form
 Low variety in texture/high variety in texture
 Low overall variety/high overall variety
 No balance/highly balanced
 Low contrast/high contrast
 Low enclosure/high enclosure
 Low vividness/high vividness

Psychological Descriptors:

No sense of mystery/high sense of mystery
 No feeling of harmony/high feeling of harmony
 Unpleasant/pleasant
 Unpeaceful/peaceful
 Removed from nature/close to nature
 Low sense of place/high sense of place
 Illegible/highly legible
 Not awe inspiring/highly awe inspiring
 Relaxed/stimulated
 Low scenic quality/high scenic quality

2.4. SELECTION OF OBSERVERS

Seventy-four college undergraduates participated in the study. Subjects from two populations on the University of Wisconsin- Madison campus were recruited for the experiments. For experiment 1, 30 undergraduates in non-design majors participated in the rating of slide pairs on aesthetic preference. For experiment 2, 44 undergraduates enrolled in an introductory landscape architecture course rated individual scenes on physical, artistic, and psychological descriptor scales.

Previous research (e.g. Daniel and Boster, 1976) found college students' aesthetic preferences to be representative of the general population. To reduce the possibility that other biases might enter into study results, precautions were taken in the final selection of subjects. None of the subjects chosen had received any substantive exposure to design

principles, a factor that previous research found might influence preference ratings (Buhyoff *et al.*, 1978). Subject groups were balanced with respect to gender and the type of environment in which they grew up, other factors which might bias ratings (Macia, 1979; Dearden, 1984). Subjects were however, quite homogeneous in other respects. They were mostly white, ranged from 18–36 years of age, and 82% were from the upper midwestern United States. Lifespan and cross-cultural research have pointed to differences in aesthetic preferences (Zube *et al.*, 1983; Zube and Pitt, 1981), which may in turn limit the generalizability of college students' perceptions to other age and cultural groups.

2.5. PROCEDURE

2.5.1. *Experiment 1*

Aesthetic preference judgments were collected in hour-long sessions on three consecutive days, with each session devoted to one of the landscape types. The 153 slide pairs (representing all possible combinations of the 18 scenes for a given landscape type) were shown to observers in random order, and were rated on a seven-point scale labelled "difference in amount of scenic beauty". Scale anchors were "very similar" and "very different". Subjects were given 15 seconds to examine and rate each slide pair.

2.5.2. *Experiment 2*

Descriptor dimension ratings were also collected during hour-long sessions over a three day period, with each session devoted to a single landscape type. A session involved the rating of nine color slides of a landscape type on all of the descriptor dimensions. Each set of 18 river, forest, and agricultural scenes were randomly partitioned in half for presentation to observers. The rating group was also partitioned ($n = 22, 22$) so that each slide would have an adequate amount of observations to help insure reliable ratings on the descriptor dimensions. This partitioning was done because the possibility of response fatigue prohibited showing an entire set of scenes to the subject group within a single session.

The slides were shown to observers in random order, and were rated on seven-point scales for each of the descriptor dimensions. The survey instrument consisted of three pages of scales for each scene, each page containing the entire set of physical, artistic, or psychological ratings scales. The page order of the three scale types was counterbalanced across subjects to randomize order effects. Prior to actual rating, the investigators provided subjects with brief, nominal definitions of each descriptor. Approximately five minutes were allotted observers to rate each scene on all of the scales.

3. Results

3.1. EXPERIMENT 1

3.1.1. *Reliability*

Analysis of variance (ANOVA) was used to assess the interrater reliability of aesthetic preference ratings. ANOVA showed significant main effects for "slide pairs" for all three data sets (all P s < 0.0001). The corresponding interrater reliability coefficients (Winer, 1971, p. 283) were $r = 0.91$ for river scenes, $r = 0.96$ for forest scenes, and $r = 0.96$ for agricultural scenes. These findings indicated a high agreement among subjects' ratings.

3.1.2. Dimensionality

Subjects' ratings for a given landscape type were combined to form a single matrix of mean scores. The resulting matrix was analyzed using the ALSCAL package of MDS programs (Young and Lewycky, 1979). The model selected for analysis was the simple or "classic" Euclidean model, and data was treated at the ordinal level of measurement. The MDS algorithm transforms ordinal scale proximities into a graphic map of interval scale distances showing the spatial relationships between objects in the number of dimensions specified by the investigator. MDS analyses were conducted in one through five dimensions. The values of two goodness-of-fit statistics, Kruskal's (1964) stress formula one and the squared correlation coefficient, were plotted against the number of dimensions to assist in interpreting the correct dimensionality. As an aid to interpretation, the solutions were rotated to simple structure (varimax) to help align stimulus points along the dimensional axes. A hierarchical cluster analysis (Baker, 1972) was also applied to the data to help interpret the stimulus patterns.

On the basis of these procedures and on the interpretability of the configurations, the investigators decided that a three dimensional solution was the most appropriate way to represent the data for all three landscape types. The three-dimensional solution for river landscape scenes showed the best goodness-of-fit of all landscape types. Stress was 0.09 and r^2 was 0.94, both statistics showing that the estimated data closely fitted the three-dimensional MDS model. Goodness-of-fit for the two other data sets was also quite acceptable, with the MDS solution for forest scenes showing stress and r^2 values of 0.18 and 0.85, respectively, and the solution for agricultural scenes showing stress and r^2 values of 0.15 and 0.89, respectively.

3.1.3. Interpretation

River scenes. Examination of the MDS configurations allowed the investigators to form some initial hypotheses about the dimensions subjects used to discriminate between scenes. For river scenes, dimension one showed a strong natural-developed orientation, with scenes showing undeveloped shorelines and pristine, fast-moving water opposed by human-altered scenes with calm or stagnant water. Dimension two related to river width (narrow/wide), while dimension three separated scenes on the basis of view availability (blocked views/distant views).

Forest scenes. The first dimension of the forest landscape set was also related to naturalness, with scenes at one end of the axis showing naturally-appearing woodlands and scenes on the opposite end showing considerable human activity. Dimension two reflected viewing distance (near views/distant views), while the third dimension showed dead vegetation and undirected views at one end and lush vegetation with focused views at the other.

Agricultural scenes. Dimension one showed a plain-scenic orientation. Flat, dry-looking scenes with unkempt vegetation and modern farm and residential buildings characterized plain views, while rolling, pastoral scenes with lush vegetation and traditional farmsteads characterized scenic views. Dimension two related to topographic variation (flat/hilly), while dimension three reflected an order/disorder orientation.

Comparison across landscape types. When comparing interpretations across stimulus sets, it appeared that naturalness and the spatial structure of scenes were important

dimensions related to aesthetic preference for all landscape types. At the same time, this qualitative interpretation of the data seemed to show that aesthetic preferences were cued by physical dimensions unique to each landscape type. This was reflected in water movement for river scenes, the aliveness of vegetation in forest scenes, and the order or tidiness of land use in agricultural scenes.

3.2. EXPERIMENT 2

In experiment 2, various correlational procedures were used to examine the relationships between the MDS solutions in the first experiment, and the ratings on physical, artistic, and psychological descriptor dimensions. These analyses included simple, multiple, and canonical correlation. In addition, principle components factor analysis was used to examine the interrelationships among descriptor dimensions.

3.2.1. *Reliability*

Analysis of variance was used to assess the inter-rater reliability of each of the physical, artistic, and psychological descriptor dimensions. As a whole, reliability was quite good. The lowest reliability was for "arousal" ratings for agricultural landscape scenes, where $r=0.64$. The highest reliability was $r=0.99$ for "calmness of water" for river landscape scenes. Average reliability, over all scales and over all landscape types, was $r=0.92$.

3.2.2. *Relationships between single descriptor scales and MDS spaces*

Simple and multiple correlation analyses were used to relate single scale descriptor dimensions to the stimulus coordinates of the MDS solutions. These results are reported in Table 2. Examination of the simple correlations revealed that nearly all of the descriptor dimensions correlated at the 0.5 alpha level with at least one of the MDS dimensions in each landscape type. This was not unexpected, for the descriptors were originally chosen on the basis of their previous use in the literature. Perhaps more interesting were the patterns of correlation across the three dimensions of the MDS space in each landscape type. These patterns of correlation helped to further identify the underlying meaning of aesthetic preference dimensions.

River scenes. Nearly all scales correlated highest with the first dimension for river landscape scenes. Exceptions to this included the scales, "river width", and "distance of view". These scales suggested that the second dimension was related to the spatial quality of the landscape.

Forest scenes. The results of the single correlations with the MDS forest data showed the greatest pattern of distribution across different MDS dimensions. All of the psychological scales correlated highest with the first dimension of the MDS space. "Distance of view" and "enclosure" correlated highest with dimension two, suggesting a spatial dimension similar to that for river landscape scenes. Many of the artistic descriptor scales also correlated significantly with dimension two, but the magnitudes of most were moderate. Finally, the scales "age of trees" and "strength of focal point" showed significant, moderately high correlations with dimension three.

Agricultural scenes. Like the data set for rivers, nearly all scales for agricultural scenes correlated highest with the first dimension of the MDS space. An interesting difference

TABLE 2a. Single and multiple correlations of descriptor-scale ratings with dimensions of MDS spaces for river landscapes

	Pearson's <i>r</i>			Multiple Correlation
	Dimension 1	Dimension 2	Dimension 3	
Mnemonic	1	2	3	<i>R</i>
<i>Physical</i>				
LUV	0.64***	−0.34	0.03	0.70*
CPLX	−0.64***	0.32	−0.19	0.72*
UNIQ	−0.81*****	0.19	−0.11	0.82*****
ALTO	0.80*****	−0.11	0.08	0.81***
TOPO	−0.73*****	0.03	0.10	0.73*
DIST	0.41*	−0.46*	−0.36	0.70*
SINU	−0.40*	0.07	−0.05	0.41
CALM	−0.71***	−0.11	0.26	0.77***
WIDTH	0.42*	−0.66***	0.10	0.76***
<i>Artistic</i>				
FOCAL	−0.73*****	0.06	−0.14	0.74**
UNITY	−0.89*****	0.14	0.04	0.89*****
COLOR	−0.57**	−0.16	−0.16	0.63
LINE	−0.61***	0.31	−0.14	0.68*
FORM	−0.69*****	0.27	−0.06	0.72*
TEXT	−0.80*****	0.36	−0.03	0.85*****
VARY	−0.69*****	0.20	−0.11	0.72*
BAL	−0.88*****	0.15	−0.01	0.88*****
CONT	−0.66*****	−0.01	−0.12	0.67*
ENCLOSE	−0.61***	0.47*	0.10	0.76**
VIVID	−0.90*****	0.08	−0.10	0.91*****
<i>Psychological</i>				
MYST	−0.87*****	0.40*	0.07	0.94*****
HARM	−0.84*****	0.04	0.01	0.84*****
PLEASE	−0.85*****	−0.15	0.04	0.88*****
PEACE	−0.55**	−0.16	0.10	0.57
NAT	−0.86*****	0.22	0.03	0.87*****
PLACE	−0.96*****	0.05	0.04	0.96*****
LEGIB	−0.88*****	−0.04	0.12	0.89*****
AWE	−0.96*****	0.05	−0.03	0.96*****
AROUSE	−0.75*****	−0.09	−0.04	0.77***
SCENIC	−0.96*****	−0.02	0.01	0.96*****

* 0.01 < *P* < 0.05, ** 0.005 < *P* < 0.01, *** 0.001 < *P* < 0.005, **** 0.0005 < *P* < 0.001, ***** *P* < 0.0005.

between the agricultural scenes and the river and forest scenes was that the scales "distance of view" and "enclosure" were essentially uncorrelated with any of the dimensions. What seemed to be important scales for describing secondary dimensions for forest and river landscapes did not show up for agricultural scenes in this analysis.

Comparisons across landscape types. When compared across landscape types, the single correlations showed a consistent pattern of similarity. The fact that nearly all of the scales correlated with the first dimension of the MDS spaces suggested that dimension one might be a general dimension of aesthetic preference. The psychological descriptor dimensions consistently correlated highest with dimension one, but both physical and

TABLE 2b. Single and multiple correlations of descriptor-scale ratings with MDS dimensions for forest landscapes

Mnemonic	Pearson's <i>r</i>			Multiple Correlation
	Dimension 1	Dimension 2	Dimension 3	
<i>Physical</i>				
LUV	-0.06	-0.16	-0.50*	0.56
CPLX	0.12	0.34	-0.24	0.40
UNIQ	0.48*	0.38	-0.51*	0.70*
ALTO	-0.59***	-0.33	-0.27	0.77***
TOPO	0.35	-0.11	-0.35	0.49
DIST	0.31	-0.75*****	0.03	0.85*****
DENS	0.39	0.21	-0.46*	0.57
TAGE	0.19	0.13	-0.64***	0.65*
<i>Artistic</i>				
FOCAL	0.21	0.44*	-0.70****	0.79***
UNITY	0.42*	0.37	-0.40	0.61
COLOR	-0.00	0.57**	0.25	0.65*
LINE	0.27	0.48*	-0.25	0.55
FORM	0.17	0.37	-0.29	0.46
TEXT	0.23	0.58**	-0.28	0.63
VARY	0.27	0.54**	-0.26	0.60
BAL	0.66***	0.44*	-0.26	0.76***
CONT	-0.00	0.58**	-0.15	0.56
ENCLOSE	-0.05	0.69***	-0.36	0.77***
VIVID	0.56**	0.54**	-0.45*	0.80***
<i>Psychological</i>				
MYST	0.67***	0.52*	-0.16	0.80***
HARM	0.81*****	0.39	-0.26	0.87*****
PLEASE	0.84*****	0.36	-0.39	0.91*****
PEACE	0.84*****	0.32	-0.33	0.89*****
NAT	0.74*****	0.26	0.04	0.79****
PLACE	0.73*****	0.45*	-0.35	0.84****
LEGIB	0.53*	0.37	-0.18	0.61
AWE	0.79*****	0.30	-0.25	0.82****
AROUSE	0.47	0.28	-0.19	0.60
SCENIC	0.84*****	0.35	-0.38	0.89*****

* 0.01 < *P* < 0.05, ** 0.005 < *P* < 0.01, *** 0.001 < *P* < 0.005, **** 0.0005 < *P* < 0.001, ***** *P* < 0.0005.

artistic descriptors often approached the same magnitude of correlation. The multiple correlation coefficients also indicated that while psychological descriptors correlated highest, nearly all descriptors were good predictors of aesthetic preference regardless of landscape type.

Secondly, certain scales for river and forest landscape scenes suggested that dimension two was related to the spatial properties of scenes. This commonality was not found for the set of agricultural scenes; in fact, those descriptor dimensions which defined spatial structure in river and forest scenes did not correlate significantly with any of the dimensions in the agricultural set of scenes.

Finally, it appeared that those physical descriptor scales that were specific to a particular landscape type were important in defining properties of aesthetic preference.

TABLE 2c. Single and multiple correlations of descriptor-scale ratings with MDS dimensions for agricultural landscapes

Mnemonic	Pearson's <i>r</i>			Multiple Correlation <i>R</i>
	Dimension 1	Dimension 2	Dimension 3	
<i>Physical</i>				
LUV	−0.54**	−0.43*	0.21	0.68*
CPLX	−0.73*****	−0.27	0.37	0.84*****
UNIQ	−0.84*****	−0.24	−0.16	0.85*****
ALTO	0.74****	−0.16	0.34	0.86*****
TOPO	−0.75*****	−0.18	−0.01	0.75**
DIST	−0.23	−0.21	−0.12	0.30
INTENS	0.41*	−0.22	−0.05	0.52
SIZE	0.36	−0.14	−0.14	0.44
<i>Artistic</i>				
FOCAL	−0.67****	−0.29	0.04	0.69*
UNITY	−0.64***	−0.15	−0.27	0.69*
COLOR	−0.29	−0.12	0.28	0.42
LINE	−0.57**	−0.42*	0.21	0.70*
FORM	−0.72*****	−0.29	0.27	0.81****
TEXT	−0.64***	−0.36	0.18	0.71*
VARY	−0.73*****	−0.32	0.23	0.80***
BAL	−0.57**	−0.15	−0.25	0.61
CONT	−0.60***	−0.37	0.03	0.65*
ENCLOSE	−0.25	0.16	0.07	0.33
VIVID	−0.76*****	−0.26	−0.07	0.77***
<i>Psychological</i>				
MYST	−0.80*****	−0.08	−0.14	0.82****
HARM	−0.91*****	−0.22	−0.10	0.91*****
PLEASE	−0.93	−0.24	−0.03	0.93*****
PEACE	−0.89*****	−0.26	−0.20	0.91*****
NAT	−0.91*****	−0.05	−0.24	0.94*****
PLACE	−0.93*****	−0.33	−0.02	0.94*****
LEGIB	−0.65***	−0.47*	−0.08	0.74**
AWE	−0.96*****	−0.24	−0.16	0.97*****
AROUSE	−0.36	−0.00	−0.01	0.36
SCENIC	−0.95*****	−0.30	−0.09	0.96*****

* 0.01 < *P* < 0.05, ** 0.005 < *P* < 0.01, *** 0.001 < *P* < 0.005, **** 0.0005 < *P* < 0.001, ***** *P* < 0.0005.

“River width” helped to define the spatial dimension of the river MDS space, while “density of trees” and “age of trees” helped define dimension three of the forest MDS space. In contrast, the specific descriptor dimensions “size of agricultural fields” and “intensity of agricultural development” did not correlate highly with any of the MDS dimensions for the agricultural scenes.

Comparisons across descriptor types. The multiple correlations in Table 2 indicated how well each scale correlated with aesthetic preference ratings over all dimensions. The highest multiple correlation, averaged across all landscape types, was “scenic quality”, with *R* = 0.94 (*P* < 0.0001). This finding was a good indication that the MDS stimulus spaces actually did represent aesthetic preference judgments. The multiple correlation of

TABLE 3b. Canonical correlations of physical, artistic, and psychological descriptor sets with MDS spaces for forest scenes

Descriptor set	Canonical variate	Eigenvalue	Canonical correlation (R_c)	χ^2	d.f.	Tail probability	Redundancy	
							R_{d1-2}	R_{d2-1}
Physical	1	0.892	0.94	53.54	24	0.001	0.28	0.12
	2	0.808	0.90	29.05	14	0.010	0.29	0.18
	3	0.628	0.79	10.87	6	0.092	0.21	0.11
	Total redundancy:						0.78	0.41
Artistic	1	0.947	0.97	66.45	33	0.001	0.35	0.10
	2	0.906	0.95	38.53	20	0.008	0.32	0.30
	3	0.816	0.90	16.09	9	0.065	0.22	0.04
	Total redundancy:						0.89	0.44
Psychological	1	0.956	0.98	55.86	30	0.003	0.38	0.51
	2	0.813	0.90	24.61	18	0.136	0.10	0.08
	3	0.542	0.74	7.80	8	0.453	0.15	0.06
	Total redundancy:						0.63	0.65

TABLE 3c. Canonical correlations of physical, artistic, and psychological descriptor sets with MDS spaces for agricultural scenes

Descriptor set	Canonical variate	Eigenvalue	Canonical correlation (R_c)	χ^2	d.f.	Tail probability	Redundancy	
							R_{d1-2}	R_{d2-1}
Physical	1	0.943	0.97	49.40	24	0.002	0.32	0.33
	2	0.723	0.85	17.95	14	0.209	0.24	0.10
	3	0.293	0.54	3.82	6	0.701	0.10	0.04
	Total redundancy:						0.66	0.47
Artistic	1	0.922	0.96	39.96	33	0.189	0.33	0.35
	2	0.614	0.78	15.70	20	0.735	0.19	0.01
	3	0.503	0.71	6.65	9	0.674	0.16	0.08
	Total redundancy:						0.68	0.44
Psychological	1	0.978	0.99	52.87	30	0.006	0.34	0.72
	2	0.691	0.83	14.77	18	0.678	0.22	0.02
	3	0.261	0.51	3.02	8	0.933	0.09	0.01
	Total redundancy:						0.65	0.75

River scenes. For each of the canonical analyses, the first variate was significant beyond the 0.01 alpha level. All corresponding canonical correlation coefficients were above $R_c = 0.97$. None of the data sets had significant second or third canonical variates. Total redundancies ranged between $\bar{R}_{d2-1} = 0.52$ for the redundancy between the physical descriptor set and the MDS space, and $\bar{R}_{d1-2} = 0.76$ for the redundancy between the MDS

space and the psychological descriptor space. The $\bar{R}_{d1-2}$ statistic is perhaps the more relevant for this analysis, because it indicates the proportion of variance in the MDS space accounted for by a descriptor set. Using the $\bar{R}_{d1-2}$ statistic, the physical variable set accounted for 73% of the variance, the artistic variable set accounted for 65% of the variance, and the psychological set accounted for 65% of the variance in the MDS space.

Forest scenes. Each analysis had at least one canonical variate found significant at the 0.05 alpha level, and analyses using the physical and artistic data sets had two significant variates. The first significant variates were all above $R_c = 0.94$, while significant second-order variates ranged from $R_c = 0.89$ to $R_c = 0.95$. Total redundancies ranged from $\bar{R}_{d2-1} = 0.41$ to $\bar{R}_{d1-2} = 0.89$. For $\bar{R}_{d1-2}$, the physical variable set accounted for 78% of the variance, the artistic variable set accounted for 89% of the variance, and the psychological variable set accounted for 63% of the variance in the MDS space.

Agricultural scenes. All analyses except the artistic data set had at least one canonical variate found significant beyond the 0.05 alpha level. All corresponding canonical correlation coefficients were above $R_c = 0.96$. The physical data canonical analysis had a second significant variate, whose canonical correlation was $R_c = 0.91$ ($P < 0.05$). Total redundancies ranged from $\bar{R}_{d2-1} = 0.44$ to $\bar{R}_{d1-2} = 0.75$. For $\bar{R}_{d1-2}$, the physical variable set accounted for 66% of the variance, the artistic variable set accounted for 68% of the variance, and the psychological set accounted for 65% of the variance in the MDS space.

Comparison across landscape types. The physical descriptor set did a slightly better job than the other sets in accounting for variance in judgments of river landscapes, and the artistic descriptor set did a better job for forest landscape scenes. Overall, the analyses showed that all three descriptor sets predicted a considerable amount (over 60%) of the variance in MDS spaces for all three landscape types. Except for the minor differences just noted, there did not seem to be any set of descriptors that was clearly superior to another. Instead, all three descriptor sets appeared to be useful ways to describe aesthetic preference judgments for the sample of scenes used.

3.2.3. Relationships among descriptors

The results up to this point have described relationships between the descriptor dimensions and the MDS spaces. These results provided a quantitative means for interpreting the dimensions of the MDS spaces, but the descriptor dimensions themselves also provided useful information on the interrelationships between descriptor concepts.

Principle component factor analysis was used to identify interrelated groups of descriptor dimensions. To aid interpretation, the solutions were rotated using the varimax procedure. These results are shown in Table 4. High factor loadings (above 0.6) of descriptor dimensions on a given factor indicated a high degree of interrelatedness among those dimensions.

River scenes. Four factors were extracted in the analysis, accounting for 90.2% of the variance in the original set of variables. Factor 1 showed that many of the artistic descriptor dimensions were interrelated, with nine of the 11 dimensions loading at or above 0.82. The physical descriptor dimensions "complexity", "uniqueness", "topography", and "calmness of water" were also part of this grouping, as were the

TABLE 4a. Factor analysis of descriptor scales, river landscape scenes

Mnemonic	Factor 1	Factor 2	Factor 3	Factor 4	Comm.
LUV	0.08	-0.69*	-0.66	0.11	0.93
CPLX	0.89*	0.06	0.19	0.13	0.87
UNIQ	0.90*	0.32	0.16	0.06	0.94
ALTO	-0.15	-0.86*	-0.33	0.03	0.87
TOPO	0.58*	0.40	0.16	0.31	0.62
DIST	-0.03	-0.19	-0.91*	0.05	0.87
SINU	0.31	0.35	-0.05	0.65*	0.64
CALM	0.79*	0.26	0.18	-0.33	0.83
WIDTH	-0.10	-0.26	-0.77*	-0.37	0.81
FOCAL	0.86*	0.25	0.21	-0.07	0.85
UNITY	0.40	0.82*	0.26	-0.00	0.90
COLOR	0.87*	0.17	-0.20	0.18	0.86
LINE	0.79*	0.17	0.09	0.52	0.93
FORM	0.88*	0.17	0.19	0.29	0.93
TEXT	0.79*	0.36	0.30	0.32	0.95
VARY	0.91*	0.19	0.04	0.34	0.99
BAL	0.34	0.86*	0.23	0.01	0.91
CONT	0.96*	0.14	-0.04	0.02	0.93
ENCLOSE	0.30	0.21	0.89*	-0.13	0.94
VIVID	0.83*	0.48	0.22	0.00	0.97
MYST	0.47	0.56	0.66*	0.01	0.97
HARM	0.20	0.93*	0.17	0.17	0.97
PLEASE	0.31	0.88*	0.02	0.17	0.90
PEACE	-0.17	0.85*	0.16	0.39	0.92
NAT	0.23	0.88*	0.38	0.09	0.97
PLACE	0.49	0.82*	0.22	0.08	0.96
LEGIB	0.54	0.77*	0.01	0.15	0.90
AWE	0.69*	0.68	0.15	-0.07	0.96
AROUSE	0.85*	0.29	0.08	-0.36	0.94
SCENIC	0.61	0.77*	0.08	0.07	0.99
Variance accounted for (%):	61.2	16.3	7.8	4.8	Total 90.1

* Indicates highest factor loading for a variable.

psychological dimensions of "awe" and "arousal". Together, these variables defined a factor related to the compositional properties of landscape scenes. Factor 2 showed that all of the psychological descriptor dimensions except arousal were interrelated, and could be labelled an affective-informational factor. The physical dimensions "land use variety" and "degree of alteration", and the artistic dimensions "unity" and "balance" were also part of this grouping. Factor 3 represented a construct related to the spatial structure of landscape scenes, grouping together the physical dimensions "distance", "river width", and "land use variety" with the artistic dimension of "enclosure" and the "psychological dimension of "mystery". Factor 4 included only one variable, the physical dimension "river sinuosity".

Forest scenes. The analysis uncovered five factors, accounting for 88% of the variance in the original set of variables. Factor 1 grouped together all of the psychological variables except "arousal", and also included the physical variable "degree of alteration" and the artistic variables "unity" and "balance". This factor appeared to represent an affective-

TABLE 4b. Factor analysis of descriptor scales, forest landscape scenes

Mnemonic	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Comm.
LUV	-0.44	0.52	-0.33	0.55*	0.06	0.89
CPLX	0.07	0.94*	-0.01	0.15	0.09	0.92
UNIQ	0.51	0.58*	-0.15	0.53	-0.03	0.91
ALTO	-0.88*	0.04	0.02	0.34	0.09	0.91
TOPO	0.24	0.59*	-0.50	0.19	0.19	0.73
DIST	0.05	-0.26	-0.92*	0.01	0.03	0.93
DENS	0.43	0.03	0.30	0.25	0.74*	0.89
TAGE	0.25	0.28	0.03	0.63*	0.35	0.66
FOCAL	0.22	0.37	0.20	0.79*	0.02	0.86
UNITY	0.63*	-0.40	0.35	0.46	-0.10	0.90
COLOR	0.07	0.75*	0.31	-0.30	-0.24	0.81
LINE	0.16	0.91*	0.11	0.10	0.16	0.91
FORM	0.22	0.87*	-0.09	0.21	-0.09	0.87
TEXT	0.27	0.90*	0.12	0.17	-0.04	0.94
VARY	0.24	0.94*	0.06	0.12	0.07	0.96
BAL	0.89*	0.04	0.11	0.18	-0.19	0.87
CONT	0.08	0.75*	0.29	0.21	0.13	0.72
ENCLOSE	0.15	0.13	0.86*	0.16	0.27	0.88
VIVID	0.70*	0.46	0.25	0.26	0.29	0.92
MYST	0.84*	0.22	0.18	-0.03	0.34	0.91
HARM	0.92*	0.23	-0.03	0.17	0.15	0.95
PLEASE	0.89*	0.25	-0.06	0.26	0.22	0.96
PEACE	0.91*	0.11	-0.07	0.25	0.04	0.91
NAT	0.93*	0.03	-0.09	-0.23	0.14	0.94
PLACE	0.86*	0.26	0.06	0.23	0.22	0.90
LEGIB	0.83*	0.16	0.15	0.11	0.18	0.78
AWE	0.85*	0.41	-0.22	0.08	0.13	0.97
AROUSE	0.45	-0.04	-0.53	-0.02	0.55*	0.79
SCENIC	0.85*	0.35	-0.15	0.26	0.12	0.96
Variance accounted for (%)	47.5	19.7	10.1	6.9	3.9	Total 88.1

* Indicates highest factor loading for a variable.

informational property of the scenes. Factor 2 defined a compositional property of scenes, showing high loadings on most of the artistic dimensions, and the physical dimensions "complexity" and "uniqueness" of land uses, and "steepness of topography". The variables "distance", and "enclosure", and "arousal" loaded highest on factor 3, connoting a spatial factor. Factor 4 appeared related to the prominence or distinctiveness of vegetation, grouping the physical dimensions "tree age" and "land use variety" together with the artistic dimension "focal point". Factor 5 was defined by only one variable, "tree density".

Agricultural scenes. The analysis defined four factors accounting for 86.2% of the variance in the original variable set. Factor 1 appeared to be an affective-informational factor, grouping together most of the psychological dimensions, the physical dimensions "uniqueness of land uses", "degree of alteration", and "steepness of topography", and the artistic dimensions "focal point" and "unity". Factor 2 related to the compositional

TABLE 4c. Factor analysis of descriptor scales, agricultural landscape scenes

Mnemonic	Factor 1	Factor 2	Factor 3	Factor 4	Comm.
LUV	0.44	0.70*	0.43	-0.10	0.88
CPLX	0.37	0.88*	-0.20	-0.01	0.95
UNIQ	0.70*	0.51	-0.28	0.15	0.85
ALTO	-0.73*	0.01	0.61	0.01	0.90
TOPO	0.69*	0.32	-0.28	0.03	0.66
DIST	0.36	0.07	0.83*	-0.03	0.81
INTENS	-0.19	-0.22	0.83*	0.16	0.81
SIZE	-0.12	-0.24	0.87*	0.31	0.93
FOCAL	0.63*	0.33	-0.03	0.21	0.55
UNITY	0.70*	0.07	0.22	0.59	0.89
COLOR	0.01	0.58	0.18	0.70*	0.86
LINE	0.38	0.77*	0.14	0.27	0.83
FORM	0.44	0.81*	-0.30	0.14	0.97
TEXT	0.32	0.86*	-0.09	0.26	0.91
VARY	0.43	0.84*	-0.08	0.31	0.99
BAL	0.62	0.09	0.25	0.68*	0.91
CONT	0.41	0.58	-0.11	0.63*	0.92
ENCLOSE	0.15	-0.04	-0.89*	0.17	0.85
VIVID	0.60	0.41	-0.15	0.62*	0.94
MYST	0.75*	0.24	-0.52	0.15	0.91
HARM	0.86*	0.37	0.01	0.20	0.93
PLEASE	0.82*	0.45	-0.08	0.24	0.93
PEACE	0.90*	0.33	0.04	0.19	0.96
NAT	0.84*	0.30	-0.28	-0.02	0.87
PLACE	0.79*	0.53	-0.07	0.23	0.96
LEGIB	0.64*	0.29	0.11	0.47	0.72
AWE	0.87*	0.37	-0.21	0.17	0.97
AROUSE	0.21	-0.05	-0.54*	-0.05	0.33
SCENIC	0.85*	0.45	-0.11	0.20	0.99
Variance accounted for (%)	57.5	16.2	7.6	4.9	Total 86.2

* Indicates highest factor loading for a variable.

properties of scenes, showing high loadings on most of the artistic dimensions and the physical dimensions "land use variety", and "land use complexity". Factor 3 related to a spacial dimension, with the physical dimensions "distance", "intensity of agricultural use", and "size of agricultural fields", the artistic dimension "enclosure", and the psychological dimension "arousal" loading highest on this factor. Factor 4 appeared to be a secondary factor of composition, grouping together "variety in color", "balance", "contrast", and "vividness". This factor was not well defined, for these variables also loaded highly on factors one and two.

Comparison across landscape types. There was a high degree of consistency among the factor analyses for the three landscape types. Interrelated variables defined affective-informational, compositional, and spatial factors for all landscape types. In addition, less important factors seemed to relate specifically to a given landscape type. This included a factor of "river sinuosity" for river scenes, and factors related to the prominence and density of tree vegetation for forest scenes.

Interrelationships among descriptors. The factor analyses showed that most of the psychological descriptor dimensions were highly interrelated, as were many of the artistic descriptor dimensions. This was not the case with the physical descriptors, however. Some physical dimensions such as "degree of alteration" were consistently grouped in an affective-informational factor along with psychological dimensions, while others like "distance", "river width", and "size of agricultural fields" helped to define spatial factors. In other cases, physical descriptors did not group with any of the factors.

Of all the descriptor types, physical descriptors seemed to be useful in measuring multiple properties of landscape scenes. Affective-informational, compositional, spatial, and specific physical properties were all represented by certain physical descriptors. This was not the case with artistic and psychological descriptors, which usually loaded highly on one or two factors. This finding showed that while there was a high coherence in the meaning of many of the psychological and artistic dimensions, it would be a mistake to think of physical descriptors as tapping a singular property of aesthetic preference.

4. Discussion

A principle finding of this research was that the dimensions people use to make judgments about aesthetic preference can be interpreted in a variety of ways. Aesthetic preference can be explained in terms of physical dimensions as well as through psychological and artistic ones. Correlating independently measured scales with MDS stimulus dimensions helped offer a richer interpretation of people's aesthetic preferences than could a simple interpretation by the investigators. These findings agree with the research of Oostendorp and Berlyne (1978) and Ward and Russell (1981), who found MDS solutions interpretable by multiple sets of properties.

A second major finding was that the physical, artistic, and psychological variables seemed to relate to one another to a great extent, but did so within a definable structure. By using multidimensional scaling as a base to define the structure of aesthetic judgments, a primary dimension of aesthetic preference was found which related to affective and cognitive (psychological) as well as artistic and physical variables. Secondary dimensions did not carry the same affective connotations, but related more to the spatial properties of the landscape. These may be taken as spatial properties common across landscapes, but are more realistically defined by the spatial qualities unique within a landscape type. With regard to this secondary dimension, it appeared that spatial quality was a more important identifier of aesthetic preference for river and forest landscapes than it was for agricultural landscapes.

Principal component factor analyses of descriptor dimensions also showed the conceptual interrelatedness among descriptor dimensions. To a large extent, artistic and psychological dimensions defined separate constructs relating to compositional and affective-informational meanings. This was not the case with the physical descriptor dimensions. They were far less cohesive as a set, and seemed important in helping define multiple properties of scenes.

These findings should be of interest to those concerned with theory and application in landscape research. Aesthetic theories based solely on formal-artistic, bioevolutionary, or other singular-sets of properties (i.e. physical-ecological, psychological-affective, etc.) may not do justice to the richness of human aesthetic response to landscapes. To build an aesthetic theory of landscapes, investigators need to broaden their understanding of the multidimensional nature of aesthetic preference.

This study also has a number of implications for environmental managers who need to incorporate aesthetic quality considerations into the environmental decision-making process. First, findings show for the sample of scenes under analysis that aesthetic preference can be predicted using a diverse array of physical, artistic, or psychological dimensions. In developing a descriptive inventory or empirical model of aesthetic quality, managers need not be overly concerned with reliance upon one descriptor type over another. What is more important is to choose descriptors which capture the range of aesthetic dimensions which define a particular landscape type. For the landscape types looked at in this study, this included a primary aesthetic dimension which could be defined in physical terms using a descriptor such as "degree of alteration", in artistic terms using a descriptor such as "vividness", or in psychological terms using a descriptor such as "harmony". These descriptors, and others which correlated highly with the first dimension of aesthetic preference judgments, seem to capture the primary affective or evaluative nature of landscapes. By nature they appear to be "universal" dimensions, that is, predictive of aesthetic preference across landscape types.

Along with choosing primary aesthetic dimensions, it is also important to select descriptors which define aesthetic qualities unique to particular landscape types. In this study, MDS analyses for river and forest landscape types revealed spatial dimensions that were important to aesthetic preference judgments. Again, it is possible to describe these unique landscape qualities using physical, artistic, or psychological descriptor types, as long as they accurately reflect the underlying aesthetic dimensions.

This second consideration also implies that managers looking for a "generic" assessment method would do well to re-evaluate the merits of their quest. This study and others that have examined the properties of aesthetic preference across different landscape types (e.g. Herzog, 1985, 1986, 1987) show that assessment techniques might be improved by incorporating dimensions reflecting the unique qualities of the landscape type under investigation. Further multidimensional scalings of aesthetic preference could help managers more specifically define the properties of particular landscape types to fine tune their assessment techniques.

Finally, the results of this study help to show there is no panacea for managers who might wish to rule out one set of descriptors over another because of their lack of predictability or low reliability. A manager's ultimate choice may have to rest on those descriptors with which they feel most comfortable in assessing and in communicating their results with other groups involved.

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