PREDICTING AESTHETIC EVALUATIONS OF FOREST ROADS

by

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ABSTRACT

Scenic beauty may be used as a variable in overlay mapping techniques, which combine different variables into a single composite surface to be used for selecting desirable forest road corridors. The use of scenic beauty as a variable in this type of procedure was validated in several experiments, in which observers judged the scenic quality of color slides of forest scenes. The first experiment showed that the scenic quality of an individual scene did not depend on whether the scene was presented to observers as representing a general area or as part of an ordered sequence of views from a road. Further experiments showed that the overall scenic beauty of a short sequence of slides representing a section of road could be predicted by the mean scenic beauty of the individual scenes within the sequence. These results suggest that information about the scenic beauty at locations within a forested area may be used in overlay mapping techniques to select scenic road corridors through the area. Sections of road high in average scenic quality should then be attractive to people actually driving on the completed route.

INTRODUCTION

Traditionally, economic and engineering considerations have been the primary determiners of road location and design. However, due to increasing concern for the environment, systematic attempts have been made recently to include environmental factors in the selection of road and highway corridors, and in the choice of specific alignments within corridors (Weisz, King and Kingery 1975). Although most of these attempts have focused on physical and biological factors, such as water and sediment, soil conservation, and wildlife disturbance, scenic beauty may also be used as one criterion for forest road corridor selection. Work is currently being done at The University of Arizona to develop a method that will explicitly include aesthetics as one input to forest road planning.

A method has been developed (Daniel and Boster 1976) for determining the scenic beauty of forested areas based on public observers' judgments. Color slides of forest landscapes are shown to groups of observers, who rate their scenic quality. The ratings are submitted to a modified Thurstone scaling procedure based on a signal detection model. In this way a numerical scale value, or Scenic

Beauty Estimate (SBE), is calculated for each slide. The SBE is an interval measure of the relative scenic quality of the area or scene represented by the slide. SBE's have been shown to be a reliable and sensitive measure. Different observers judging the same areas give very similar results, and SBE's reliably distinguish between forest areas that exhibit different landscape characteristics. The use of color slides has been validated by comparisons with results obtained from observers actually visiting the forest sites.

The SBE procedure can be used to derive maps of the aesthetic quality in an area (Daniel et al., in press). A sample of slides is taken throughout the area and the location at which each is taken is recorded. Based on the judgments of a number of observers, SBE's are determined for each slide. The SBE's and locations for all the slides are used as input for a computer program, SYMAP (Dudnick 1971), which interpolates between sample points to find SBE values for all points in the area. One output is a shaded map similar to a topographic contour map, except that it represents variations in scenic quality rather than elevation. SYMAP also creates an output matrix containing interpolated values for all the points on the map.

Maps can also be prepared representing other variables relevant to road construction, such as environmental

sensitivity, suitability of terrain, and economic cost. These maps can then be combined into a composite or overlay map. Figure 1 illustrates the process, with a hypothetical surface having 16 point locations. First the relevant variables are represented in separate maps, showing which locations are desirable or suitable for road construction with respect to each variable. Three such variables, labeled A, B, and C, are shown in the maps at the top of Figure 1. A weighting constant is selected for each variable, reflecting its importance in the decision process, and the values on each map are multiplied by the appropriate weighting constant. A single composite map is formed by adding together the weighted values from all the maps for each point in the area. The composite map, then, is a weighted sum of the maps of individual variables, and represents the overall desirability of each point in the area for road construction. This information may be used to select possible corridors for a road connecting two specified points in the area.

A computer-assisted method for selecting and evaluating different road corridors through a composite map is outlined by Weisz, Rasmussen et al. (1976). The procedure is demonstrated in the bottom of Figure 1. The corridor is constructed one point at a time, starting at one of the specified end points. At each point, the computer examines

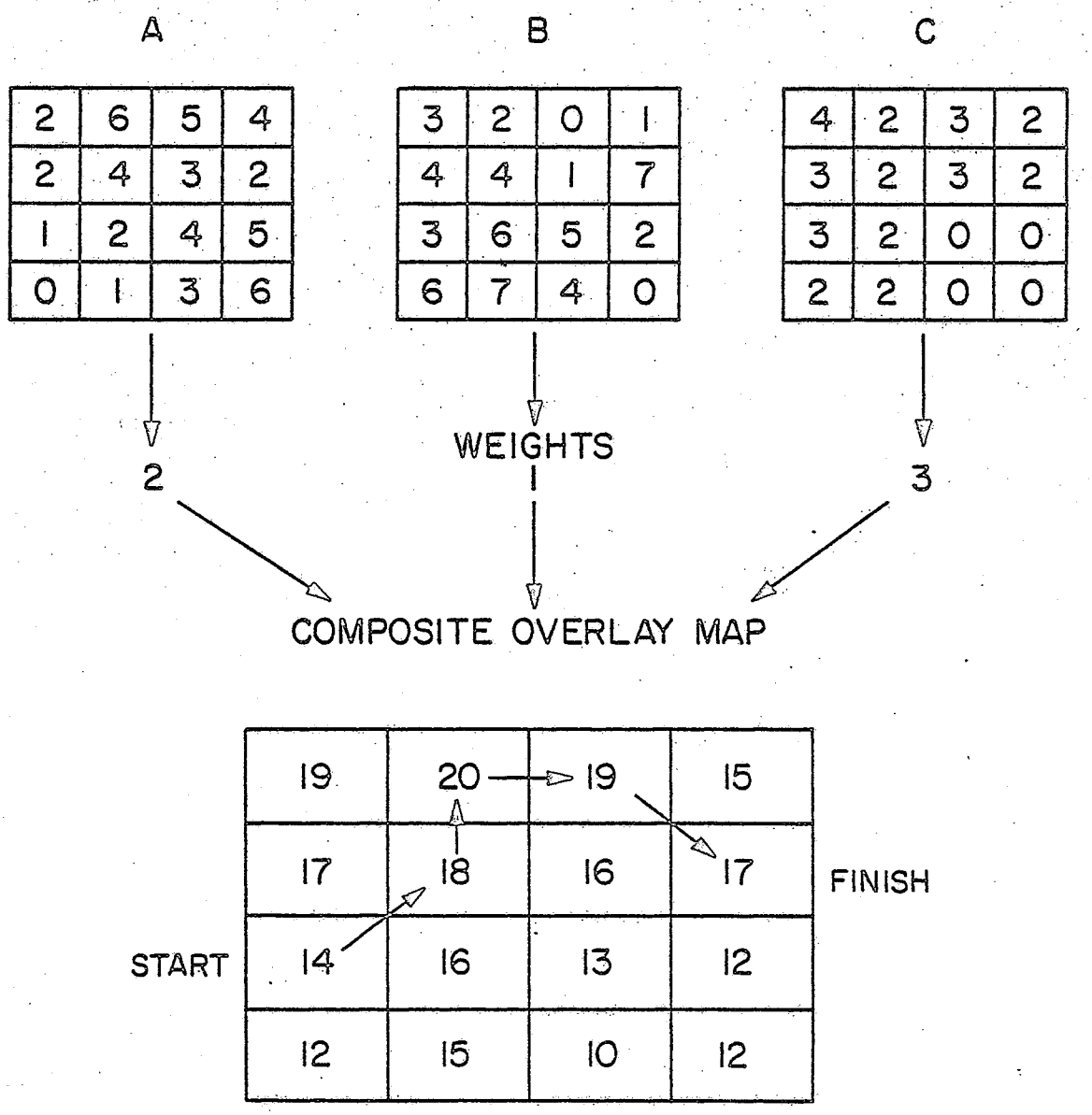

Figure 1. Corridor selection process.

the immediately adjacent points and selects the one that has the highest value. This point is added to the corridor and the procedure continues from there. Some constraint must also be included to keep the corridor moving in the proper general direction. In effect, the computer follows the "path of least resistance" between the two end points.

The use of scenic beauty as a variable in overlay mapping techniques for selecting and evaluating forest road corridors may present special problems. Such techniques assume that the best corridor is the one with the highest average or total desirability value. This is appropriate for the economic factor, since the total cost of building a road is simply the sum of the costs of building each segment. The evaluation of the overall scenic quality of a road, however, may not be so simple. Psychologists have long been aware that individual stimuli presented in sequence to an observer may interact in such a way that the same set of stimuli will have different effects when presented in different orders. Procedures such as counterbalancing have been devised to deal with order effects when designing psychological experiments. Investigators in forest and highway aesthetics have also recognized the importance of order in the perception and appreciation of landscapes (Litton 1968; Hornbeck, Forster and Dillingham 1969). Also, even if there are no order effects, it cannot be assumed that

the overall perceptual effect of a group of stimuli is directly related to a simple arithmetic average of the individual components. Helson (1964), for example, has found that a weighted log mean seems more appropriate for describing how observers pool incoming stimuli to arrive at an adaptation level.

Before scenic beauty can be effectively incorporated into overlay mapping techniques for road selection, the exact relationship between scenic beauty maps and the aesthetic perception of roads must be established. The possibility of order effects must be investigated, and a valid procedure must be found for predicting the scenic quality of a road, given only information about the scenic quality of individual points along the road. If the scenic quality of a road is not directly proportional to the mean of individual views along the road, then modifications will have to be made in composite mapping procedures using the scenic beauty variable.

The process of forming a judgment of the overall aesthetic quality of a sequence of visual scenes, as along a road, involves at least two components. The first includes effects on the observer's perception of individual scenes due to the order in which the scenes are viewed. A particular scene may have a different impact depending on the quality of the scenes which precede it. A mediocre

scene may look beautiful if it follows a series of unattractive scenes, for example. The second component is the pooling process by which the observer subjectively combines his perceptions of each separate scene to arrive at an overall evaluation. There are many ways in which this might be done. The first or last scenes in a sequence may have more impact than scenes in the middle, or scenes which are distinctive in some way may be given more weight in the final evaluation. In reality, the two components may not be completely distinguishable, since order effects may enter into the pooling process, as well as influencing the observer's perception of individual scenes.

The evaluation process may also be influenced by the way in which observers interpret the scenes presented to them. Past research has indicated that SBE's of individual slides are not affected by the nature of the slides which precede them. In other words, order effects do not influence SBE's of individual slides. In these studies observers were instructed to respond to each slide independently and were given no information about where or how the slides were taken. If, however, the observers are aware that the slides represent ordered scenes from along a road route, it may be that they will perceive or judge the slides differently than they would otherwise. Order effects may appear when observers view the slides as an

ordered sequence representing a road, rather than as a random series of unrelated scenes.

LITERATURE REVIEW

In this section, literature pertaining to the perception of roads and highways will be reviewed. Special attention will be paid to the problem of assessing the overall impact of ordered sequences of visual scenes.

The importance of considering sequences of views has been recognized by design professionals and applied by them to the aesthetics of highways and roads. Thiel (1970) devised a system of notation for recording sequential experience in architectural settings. The notation records a person's motion and orientation, and the sequence in which he experiences the setting in terms of spaces, enclosure, light, and other design concepts. The sequence notation may be used to analyze and design settings to yield desirable environmental experiences. Appleyard, Lynch and Myer (1964) applied a modified version of Thiel's notation, along with maps, photographs, sketches, and verbal reports, to the study of highway experience in cities. Their work is addressed to highway engineers, the goal being to provide a basis for designing meaningful visual sequences for observers in automobiles. They compare the construction of these sequences to the writing of a musical

composition which must be meaningful when played either forward or backwards, or in segments. They had observers ride on an expressway into Boston and make sketches or give verbal reports about their experience. They noted the frequency with which the observers mentioned or drew particular features, and used these observations to support their analysis of the highway experience. Most of the observers, however, were trained in the design professions, and their responses might not be representative of highway users in general.

Litton and Twiss (1967), in applying concepts from landscape architecture to forest aesthetics, include sequence as one of the visual components of a landscape. They suggest that change and contrast are important to avoid monotony, and propose that trails should be designed to show the complete content of an area in a deliberate way. Litton (1968) applied these ideas to the case study of a forest highway, making use of Thiel's sequence notation idea. He describes sequence as the progressive interplay of the other landscape factors (form, distance, space, light, and observer position). This gives rise to various degrees of contrast, which enhance the visual experience.

Hornbeck et al. (1969) present a model for including aesthetics as an integral component in highway planning and design, giving special emphasis to the combination of

visual impacts into sequences to produce a desired effect. They view the driver and his environment as a system, in which the driver has informational needs which vary with time. The sequence of visual inputs should be related to the driver's cycles of "attentional demand," and should provide a meaningful and aesthetically pleasing experience. They state that two problems need to be solved in order to interrelate visual, behavioral, and engineering criteria in the aesthetic design of highways: "First, it is necessary to identify the degrees of visual impact that are probable from visual factors of the highway. Second, it is necessary to know the relative effectiveness of visual components when in combination as experienced in sequence over various lengths of time" (Hornbeck et al. 1969, p. 35).

Their suggested procedure for evaluating highways includes identifying components in the visual corridor, quantifying the potential visual impact of each, recording these at intervals along the highway, presenting the results in a chart as a sequence in time or distance, and analyzing the sequence to see whether it aids the driver in reaching his destination and provides a meaningful trip. This model was used by Hornbeck and Okerlund (1972) to derive guidelines and criteria for incorporating visual and aesthetic values into decisions about the design of rural highways.

Other authors in the field of highway aesthetics have not considered sequence as an important part of visual experiences from roads. Melhorn and Keller (1973) advocate the use of Leopold's landscape uniqueness ratio for the quantification of aesthetic factors in choosing between alternative locations for highways. The procedure involves categorizing areas on a set of arbitrary factors. A uniqueness index for each area is computed, based on how many other areas share that area's ratings on the various factors. The assumption is made that areas which are unique are aesthetically more valuable. This approach, then, would evaluate highway corridors on the basis of their general characteristics, rather than on what an observer experiences while passing through them.

Mulder (1974) describes his own method for the scenic evaluation of possible road routes. Scenic features are first located, then analyzed according to a number of criteria, resulting in a numerical value for each scene. The route with the highest average points per mile is the one selected as most scenic. The order in which the driver views the scenes is not considered, though the direction of travel, the time interval between scenes, and the time in view for each scene is.

Most of these design studies on aesthetics present criteria on an a priori basis, with little or no empirical

support. Appleyard et al. (1964) are unusual in that they did use observers in part of their study, even though the observers were probably a biased sample. Carr and Schissler (1969) report part of their work, which approaches the question of highway perception on a sounder empirical footing. They used eye movement recorders and memory tests to study what subjects perceive and remember on a city expressway. They found a high degree of consistency between subjects in what they looked at and in what they remembered from the trip, from which they conclude that the form of the highway structures the way in which people scan and select elements to perceive and remember. Elements which stand out from the background or which are in view for long periods of time tend to be remembered more often. It was also found that subjects were more likely to recall those items which they had fixated while on the expressway, and those which were easy to name.

Winkel, Malek and Thiel (1969) had subjects view sets of ten slides, each representing a sequence of views from along a road. Instead of looking at the effects of different sequences of slides, however, Winkel et al. had their subjects rate each sequence on a semantic differential, and related their results to personality differences between individuals.

An article by Lynch and Rivkin (1959) suggests the importance of order and context effects in an anecdotal way. They recorded verbal impressions as people walked around a block and through an alley in Boston. The subjects reacted negatively to the alley and welcomed the spatial release at its end. In particular, a parking lot which had been a source of irritation when viewed from the street was a pleasant relief after walking through the closed-in alley. The subjects' reactions to the place were radically different, depending on the immediately preceding experiences. A similar study was done by Lowenthal (1972) in which subjects took walks in a city and then filled out a semantic differential questionnaire about the areas they saw. All subjects were instructed to take the walk in the same direction, because "reversed paths yield quite different responses" (Lowenthal 1972, p. 4). Lowenthal, unfortunately, does not discuss the nature of the differences.

The references considered so far indicate an awareness of the importance of considering sequences of visual scenes, but no specific quantitative research on the effect of placing scenes in a particular sequence to produce a total effect. Adaptation level theory (Helson 1964) may have something to contribute to this question. According to Helson, organisms pool incoming stimuli to produce an adaptation level. Stimuli close in value to the prevailing

level will not be noticed, or will be responded to indifferently. Stimuli different from the adaptation level will be noticeable, and will also cause the level to shift in their direction. A person viewing a visual sequence and making aesthetic judgments would have a continually shifting adaptation level and would be expected to react strongly only to scenes which don't fall close to the prevailing level. Helson's theory is quantitative, and he supports the theory with examples of research from many different areas, including affective responses and aesthetics. Adaptation level theory has been used to account for effects of context and order of presentation of stimuli, but the research deals with responses to single stimuli rather than to entire sequences.

Bock and Jones (1968) discuss research which has established scales on which preferences for compound objects (e.g., pairs of birthday gifts) may be predicted by the sum of the preferences for the component objects. They report that predictions based on this additivity assumption seem valid for paired comparison data. For rating scale data, such as is used in the SBE method, there is evidence that the scale value of a compound object is not the sum of the scale values of the composite stimuli, although the relationship does appear to be linear. The authors report experiments of their own in which they predicted paired comparison

preferences for menus consisting of different combinations of foods from rating scale preference data about the component foods included in the menus. Each menu contained three foods: a meat, a starch, and a vegetable. Using a multiple regression model, it was found that when data about individual food items only were included in the regression analysis, the coefficient of determination was .82. When rating scale data for preferences for pairs of food items were included in the regression analysis, the coefficient of determination became .96, indicating that there were pairwise interactions between food items which affected overall preferences for meals.

This literature review shows that order effects and pooling of stimulus information have been recognized in the areas of aesthetics and preference, and that some research has been done to determine the nature of the processes involved. The present study investigates these same processes in the practical context of forest road corridor selection.

The experiments reported below address two main empirical questions. The first experiment investigates whether aesthetic evaluations of forest scenes are influenced by the observers' knowledge that the scenes represent a road route. The second and third experiments test the assumption that the overall scenic quality of a section of road may be expressed as the mean of the scenic quality at

points along the way. Following the discussion of these empirical findings is a description of how scenic beauty maps may be used to select attractive road routes, using a procedure of the sort described by Weisz et al. (1976).

EMPIRICAL STUDIES

Data Base

The slides of forest scenes used in the following studies were taken in the Woods Canyon watershed, Coconino National Forest, in northern Arizona. The observers who evaluated the slides were volunteers from introductory psychology classes at The University of Arizona.

Many of the scenic beauty values reported here were obtained in the course of previous research at The University of Arizona. Specific features of this data base are described below.

The Woods Canyon Point Sample

A stratified random sample of 250 locations in the Woods Canyon watershed was chosen. At each point on the ground four slides were taken in different randomly determined directions, resulting in a total of 1000 slides. These slides were viewed by ten groups of observers who rated the slides' scenic quality. Each group rated 125 of the slides, including a set of 25 slides that were common to all groups. This common set was included to provide a basis for comparision and combination of the results of all

the groups. The correlations between the SBE's of these common slides across the many different groups of observers provides one test of the reliability of the point sample data. The intergroup reliability correlations are quite high, ranging from .793 to .928, with a mean of .862. (The complete matrix of reliability correlations will be found in Appendix A.) Since the common slides were randomly interspersed among the other slides in each different presentation, these high correlations also offer evidence that slide SBE's are relatively unaffected by the context of other slides in which they are presented.

The Woods Canyon Road Sample

Points were chosen at approximately one-tenth mile intervals along a number of existing roads and jeep trails in Woods Canyon, and four slides were taken in different directions at each point. The directions were chosen to prevent the road itself from appearing in the slides. The ground location for each point was noted. In this way a total of 956 slides were taken at 239 points. These slides were shown to 12 groups of observers. The slides seen by each group were divided into sets of five, each set representing a short section of road. The slides within each set were arranged in the order in which the corresponding views would be seen by a person driving along that section

of road. A set of five slides ordered in this way will be called a sequence. Each group of observers viewed many such sequences arranged to represent an actual route through Woods Canyon. A stratified random sample of 100 slides from the Woods Canyon point sample served as a common basis for comparison among groups. These slides were divided arbitrarily into 20 sequences of five slides each, and were shown as a block in the middle of each presentation. After viewing each five-slide sequence, observers rated the scenic quality of the entire section of road represented by the sequence. SBE's calculated from these ratings will be called sequence SBE's, since they estimate the scenic beauty of an ordered sequence of views representing a road. As before, the intergroup correlations of the common sequences provide a test of the reliability of the data. These correlations range from .668 to .938, with a mean correlation of .840. Some of the correlations are lower than those for the Woods Canyon point sample, but overall they are still high enough to indicate good reliability.

New SBE values for many of the slides in the Woods Canyon road sample were obtained in the experiments reported below. Comparisons between the pre-existing data base and the new SBE values were made to investigate the process by which observers make evaluations of whole slide sequences.

Experiment I

The first experiment investigated the effects of the observers' knowledge about the relationship among the slides they are judging. In presentations to separate groups, the same slides were described as an ordered sequence of views from along a road or as a random selection of views from several different areas. A comparison between scenic beauty judgments of the same slides made by these different observer groups should indicate whether order effects occur when observers interpret the slides as an ordered sequence of views from a road.

Method

Eighty-five slides representing a route through Woods Canyon were shown to three groups of observers. The slides were presented in the order in which they occurred along the route, but were not grouped into five-slide sequences. One group (N = 26) was informed that each slide represented an area and that they were to rate the scenic quality of the area represented by each slide, using a ten-point scale. The second group (N = 27) was told that the slides had been taken along a road, and that they were being shown in the order in which they had been taken. Observers in this group were instructed to rate the scenic quality of the view from the road at each point at which a slide was taken. The third group (N = 26) was also told that the

slides represented a road, but they were instructed to give a rating after each slide to indicate the quality of the entire road seen up to that point, i.e., a progressive update of their evaluation of the road.

After viewing the slides each group was also asked to give an overall rating of the entire set of slides using a six-point scale. Further, they were asked to describe any distinctive slides which they remembered, and to give scenic beauty ratings of those distinctive slides, using the six-point scale. (The exact instructions given to observers are contained in Appendix B.)

Results

An SBE was calculated for each slide, based on the ratings given by each group of observers. In Figure 2 the SBE's for each slide are plotted in the order in which the slides were shown to the observers, resulting in "scenic profiles" of the road on which the slides were taken. Each scenic profile represents the way in which the corresponding group perceived the scenic quality at points along the route from start to finish. An examination of the scenic profiles for the area instruction group and the road instruction group (top two panels of Figure 2) shows that these two groups were very similar in their judgments of the scenic quality of the views along the route. Slides rated high by one group were also rated high by the other group

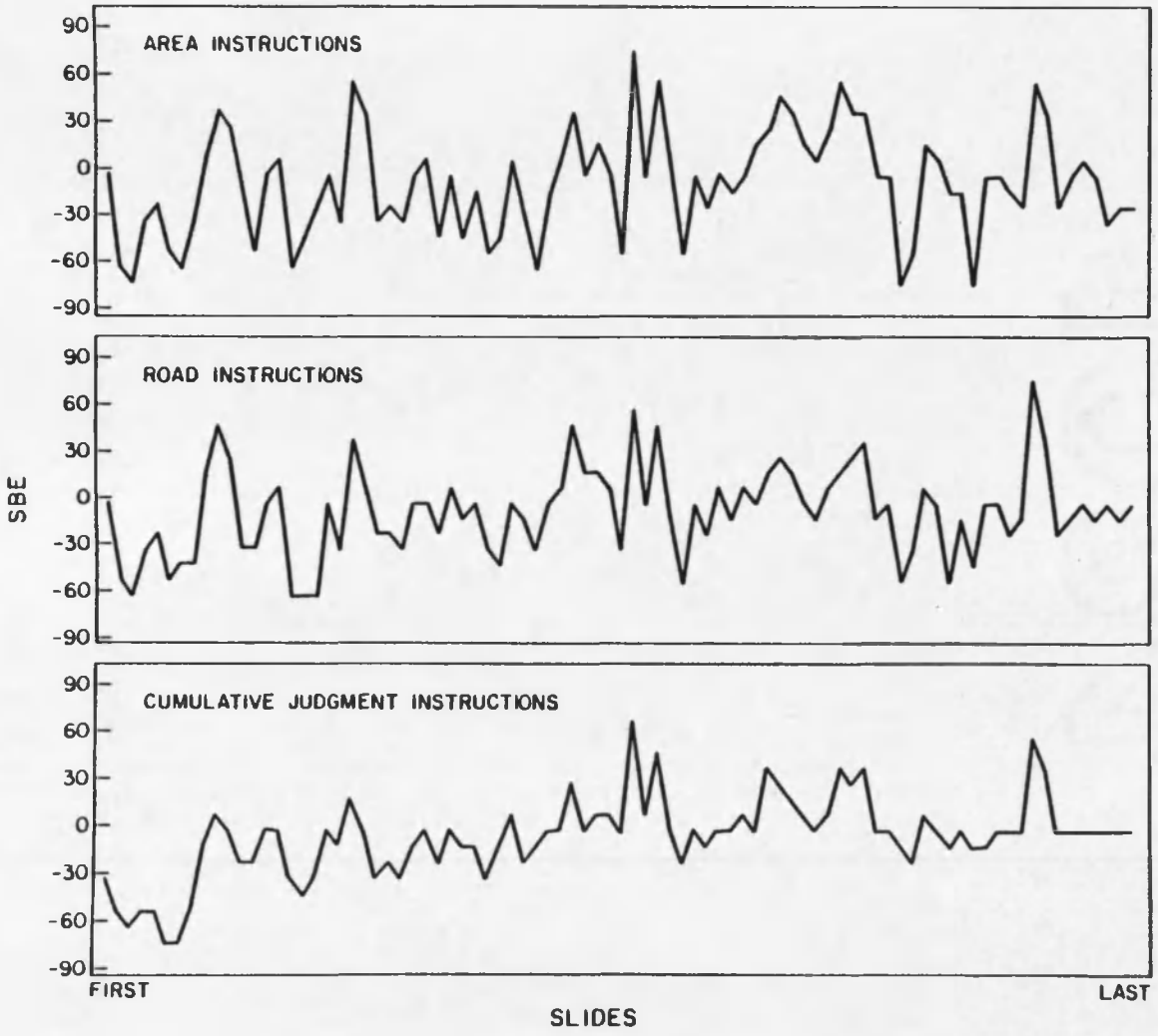

Figure 2. SBE's for slides in Experiment I.

and similarly for slides rated low in scenic quality. The correlation between SBE's from these two groups is .906, confirming that the perception of the relative scenic quality of the slides is not affected by whether the slides are presented as views along a road, or as scenes from random areas.

While the profile obtained from the third, cumulative judgment group is similar to the first two groups, it does show a noticeable tendency to flatten out, especially toward the end. As more slides were seen, the judgments made by these observers were less influenced by each new slide. This would be expected of observers performing a cumulative judgment task. The SBE's from the cumulative judgment group have a correlation of .822 with SBE's from the area instruction group and a correlation of .848 with SBE's from the road instruction group. These correlations are surprisingly high, considering the difference between the cumulative judgment task and the individual slide judgment task given to the other groups.

The results of the SBE analysis described above are supported by an analysis of the raw ratings from which the SBE's were calculated. (Due to memory limitations of the computer program used for the ANOVA some observers were randomly deleted to yield equal N's of 19 in each group.) Profiles of mean ratings of slides derived from each group

of observers are presented in Figure 3. As with the SBE profiles, these graphs show that all three groups were similar in their perception of the relative scenic quality of the slides. A main effect of slides on ratings ($F = 17.45$, $df = 84,4536$) confirms that observers did respond reliably to differences in the slides. Furthermore, the different groups distinguished between slides in the same way, as indicated by the lack of an interaction between instructions and slides ($F = 1.08$, $df = 168,4536$). If the different instructions had changed the relative differences in the ratings of the slides, the interaction would have been significant. As can be seen in Figure 3, there was a main effect of groups on ratings ($F = 3.68$, $df = 2,54$), with the road instruction group giving generally higher ratings than the other groups. This difference between the groups would not affect the SBE analysis, which is sensitive only to relative differences between the slides.

Observers' ratings of the overall scenic quality of the entire set of slides, and their descriptions and ratings of the distinctive slides which they recalled were also examined. Observers usually recalled slides which were either outstandingly high or low in scenic quality, but there was a tendency to recall slides high in scenic quality more often than slides low in scenic quality. A more detailed description of these data is given in Appendix C.

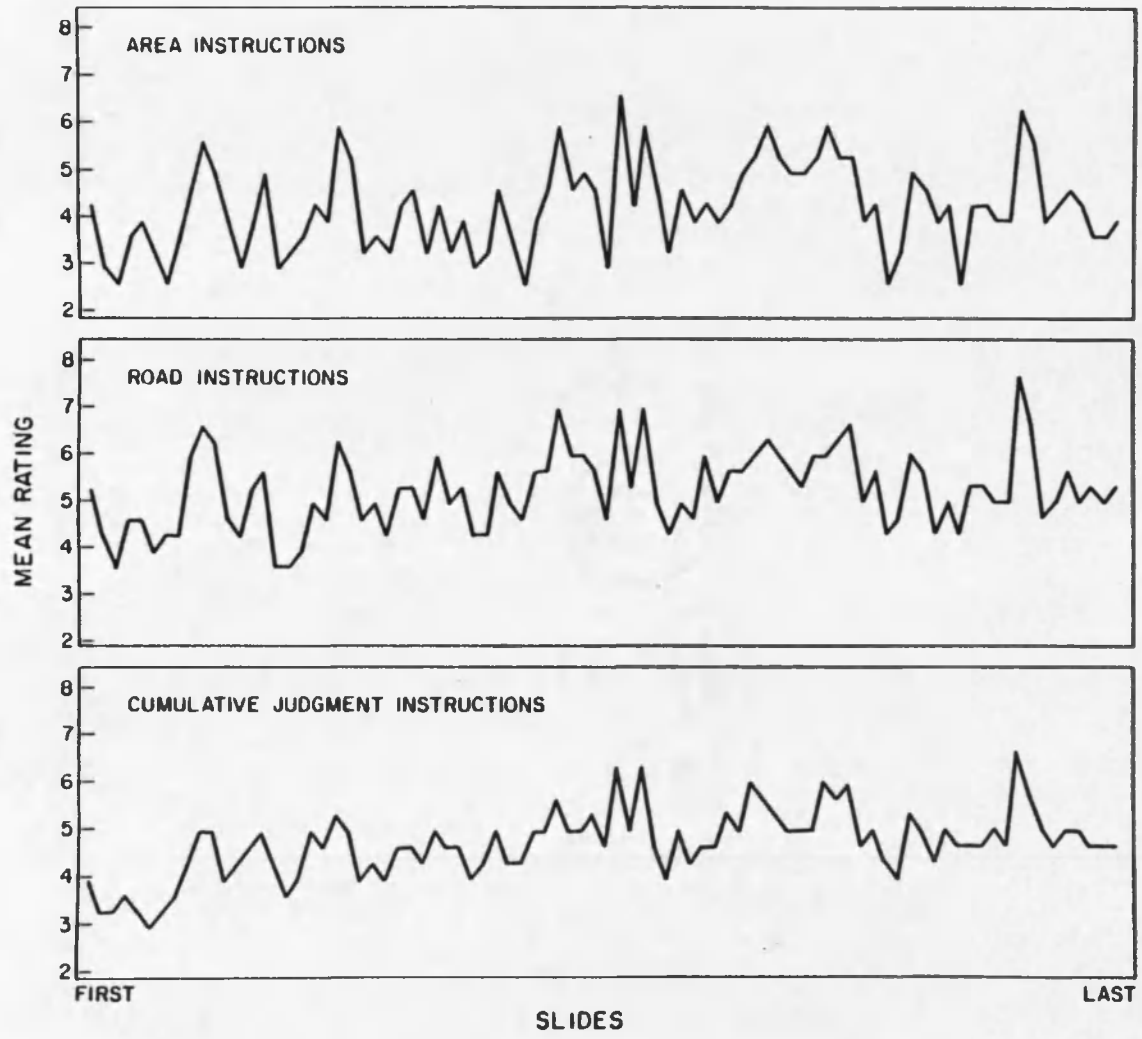

Figure 3. Mean ratings for slides in Experiment I.

Experiment II

The second experiment and subsequent analyses address the question of how the scenic quality of a sequence of views representing a road might be predicted using information about the scenic quality of the separate views within that sequence. The simplest procedure would be to use the mean SBE of slides within a sequence to predict the scenic quality of that sequence. If, however, the mean SBE is not a good predictor, more complex ways of combining individual SBE's may be investigated. Weighted means based on adaptation level theory (Helson 1964), for example, may be more effective predictors of the overall quality of a sequence of views.

The general procedure for evaluating the effectiveness of a predictor, such as the mean SBE, was to present a set of slides in two ways. One group of observers is shown the slides grouped into sequences of five, each sequence representing a different section of a road. These observers rate the overall scenic quality of the section of road represented by each sequence. Another group of observers is told that each slide represents an area, and is given no information about the locations of the areas. These observers rate the scenic quality of each individual slide. Thus each separate slide receives an SBE from one group of observers and each sequence of five slides seen as

a whole receives a sequence SBE from the other group. The five SBE's for the slides within each sequence may be averaged (or otherwise combined) to yield a prediction of the overall scenic quality of that sequence. Finally, these mean SBE's are correlated with the corresponding sequence SBE's over the entire set of sequences, to determine how well the mean SBE can predict the overall scenic quality of a sequence.

Method

A set of 260 slides that had previously been shown as part of the Woods Canyon road sample was divided into 52 sequences of five slides each. These sequences were shown to a group of 22 new observers, who rated the overall scenic quality of each sequence. These same slides were then divided at random into two sets of 120 slides each and one set of 20 slides. Two additional groups of observers (N = 25 and 33) each viewed one of the sets of 120 slides. The set of 20 slides was shown to both groups, randomly interspersed among the other slides, to serve as a basis for comparison and combination of the results. Observers in these two groups rated the scenic quality of each individual slide.

Results

The comparability of the two groups rating individual slides was assessed by correlating the SBE's of the 20 common slides between the two groups. The correlation coefficient was .815, indicating a good correspondence between the groups. The means of the SBE's of slides within each of the 52 sequences were then calculated from the ratings made by the two individual judgment groups. These means were compared with the SBE's for the corresponding sequences judged as a whole by the sequence judgment group. Figure 4 illustrates the comparison in a scatterplot of mean SBE's against sequence SBE's. The correlation between sequence SBE's and mean SBE's was .376, indicating that the mean SBE was not a good predictor of the overall scenic quality of a sequence of slides.

The results of the above comparison are, however, not supported by additional comparisons between sequence SBE's and mean SBE's, which were made using the data from Experiment I and the Woods Canyon road and point samples. For example, the SBE's calculated from ratings made by the area instruction group of Experiment I were used to predict sequence SBE's for that set of slides. These predictions were compared to the actual sequence SBE's for these slides obtained from the Woods Canyon road sample. Figure 5 shows a scatterplot of mean SBE's against sequence SBE's

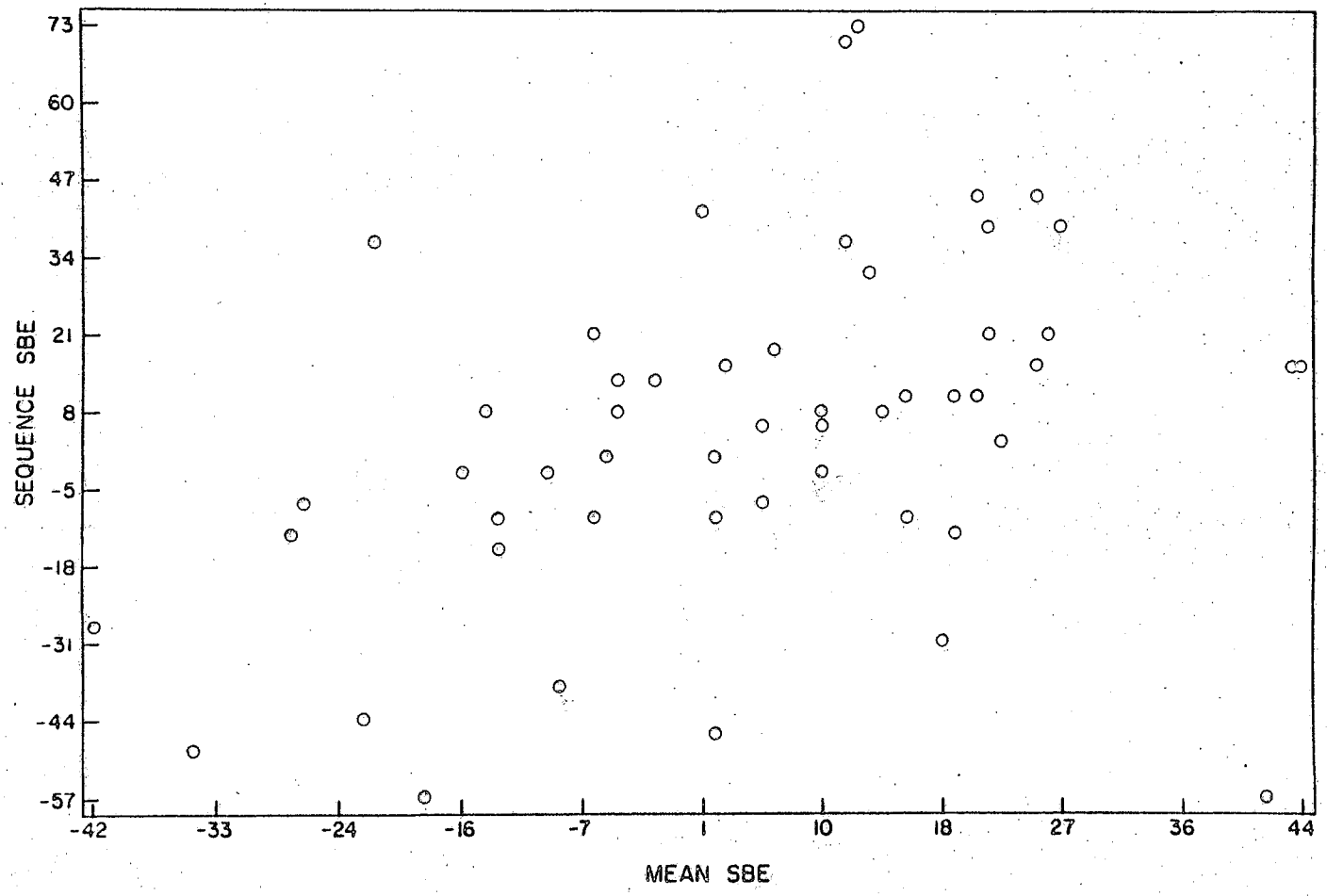

Figure 4. Scatterplot of mean SBE's and sequence SBE's for Experiment II.

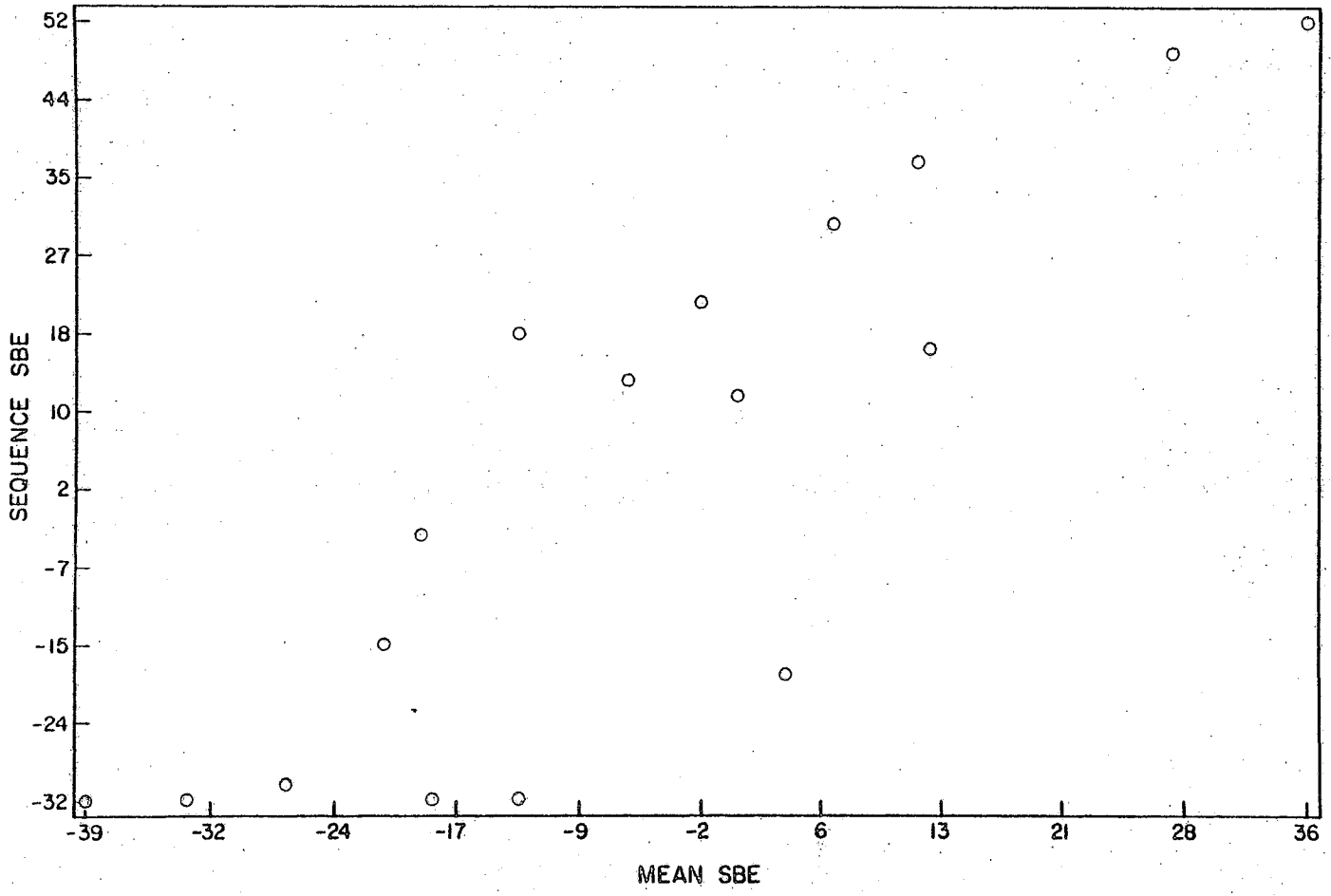

Figure 5. Scatterplot of mean SBE's and sequence SBE's for slides shown in Experiment I.

for this comparison. For these 17 sequences, the correlation between sequence SBE's and mean SBE's was .861, demonstrating that in this case the mean was a very good predictor of the overall quality of the sequence. Also, the set of 20 common sequences shown to all groups in the Woods Canyon road sample provides another opportunity to test the effectiveness of the mean SBE as a predictor of the sequence SBE. Each sequence of this common set had sequence SBE's from all of the 12 groups in the road study, so the 12 SBE's for each sequence were first averaged across groups. Then the SBE's for each individual slide, which were obtained from the Woods Canyon point sample, were used to predict the sequence SBE's obtained from the road sample. This comparison is illustrated by the scatterplot in Figure 6. For these 20 sequences, the correlation between mean SBE's and sequence SBE's was .881, again showing that the mean is a very good predictor of the sequence SBE.

There is an obvious discrepancy between the very poor relationship between mean SBE's and sequence SBE's obtained in Experiment II and the very good relationship found with the other two sets of slides. To investigate the nature of this discrepancy, several partial replications of Experiment II were undertaken.

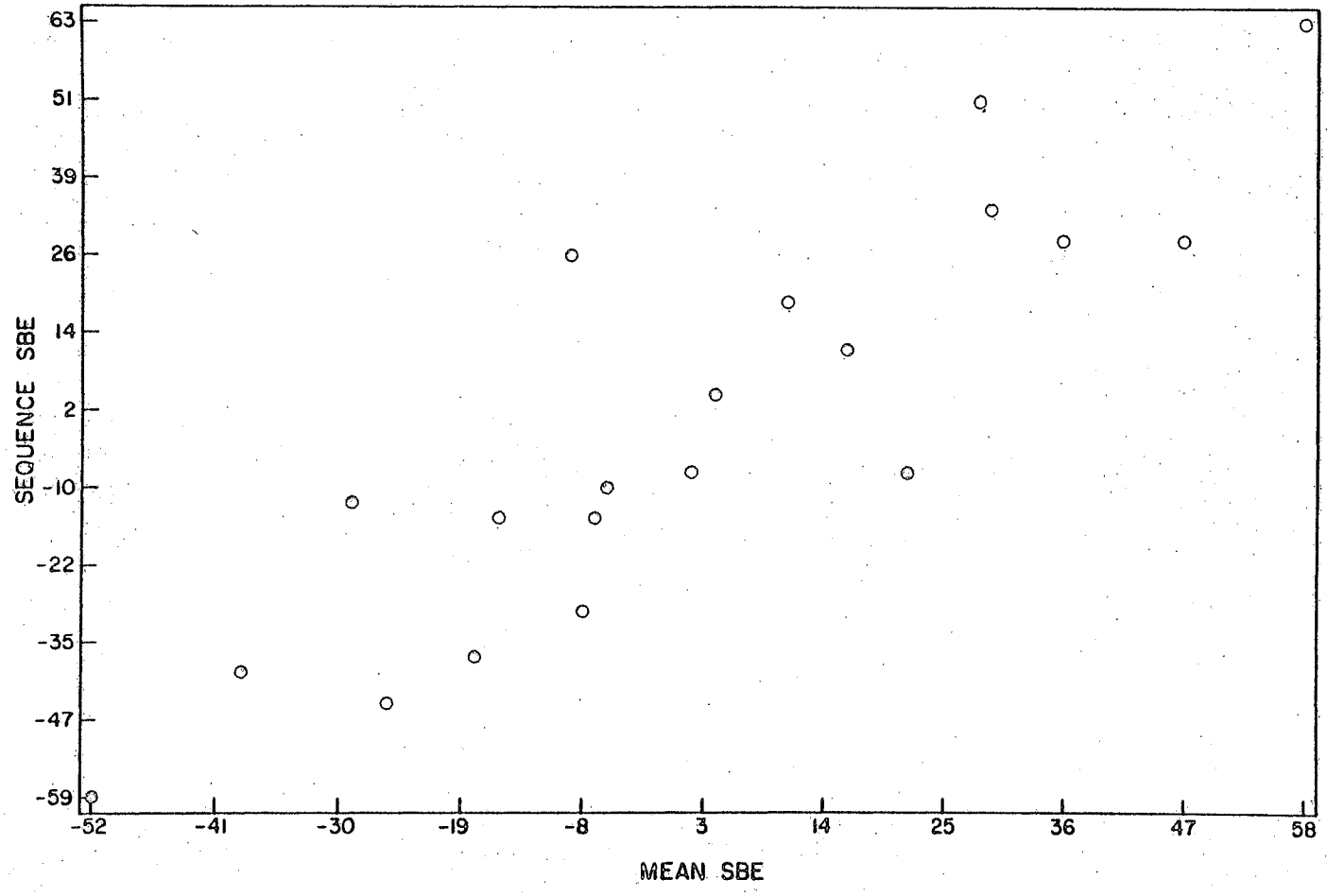

Figure 6. Scatterplot of mean SBE's and sequence SBE's for the Woods Canyon road sample common sequences.

Replications and Further Analyses

The entire set of 52 sequences (260 slides) was shown to another group of 18 observers and new sequence SBE's were obtained. In addition, since it was thought that observers might have become tired and bored during the second half of the sequence presentation, the second half of the sequences only was shown to another group of 20 observers. As a further test of the reliability of the individual slide SBE's, the slides of the first half of the sequence presentation were arranged in random order and shown to a new group of 24 observers, who rated them as individual slides. Means of individual slide SBE's were calculated for each sequence in these replications, and the sequence SBE's and mean SBE's were correlated between all groups of the original experiment and the replications. The results are presented in Table 1. Correlations between sequence SBE's and mean SBE's range from .316 to .588. Correlations between replications of the sequence SBE's range from .432 to .758. The correlation between the original mean SBE's and the replicated ones is .644. All of these correlations are considerably lower than would be expected from the usually high reliability demonstrated by the Woods Canyon point and road sample intergroup correlations (average r's = .862 and .840, respectively).

Table 1. Correlations between sequence SBE's and mean SBE's for Experiment II and subsequent replications.

	Mean SBE	Mean SBE (Replication of first half)	Sequence SBE (Complete replication)	Sequence SBE (Replication of last half)
Sequence SBE	.376	.316	.701	.432
Mean SBE		.644	.489	.401
Mean SBE (Replication of first half)			.588	---
Sequence SBE (Complete replication)				.758

A possible explanation of these difficulties is found by making some comparisons with the results of the Woods Canyon road sample. The slides presented to observers in Experiment II had previously been used as experimental slides for two of the groups in the Woods Canyon road sample. The observers in group 1 of the road sample saw one-half of the slides which were used in Experiment II, and the observers in group 2 saw the other half. In both groups the slides were arranged in different sequences than in Experiment II. In addition to these experimental sequences each group also saw the set of 20 sequences common to all the Woods Canyon road sample groups. Table 2 shows the correlations between sequence SBE's and mean SBE's for the experimental sequences and for the common sequences in groups 1 and 2 of the Woods Canyon road sample. The correlations for the experimental sequences are quite low, as they were in Experiment II, but the correlations for the common sequences in the same groups are as high as the inter-group baseline correlations for the road sample data. This strongly suggests that some characteristic of the experimental slides caused the correlations in Experiment II to be low, rather than a problem with the procedure or a generally occurring sequence effect.

The set of sequences used in Experiment II and in groups 1 and 2 of the Woods Canyon road sample was taken

Table 2. Correlations between sequence SBE's and mean SBE's for groups 1 and 2 of the Woods Canyon road sample.

	Experimental Sequences	Common Sequences
Group 1	.624	.767
Group 2	.432	.849

on a single stretch of road in the eastern end of the Woods Canyon watershed. The common sequences, on the other hand, were selected from over the entire area. Perhaps the slides used in Experiment II were too homogeneous in scenic quality for the observers to make reliable distinctions between them. Such a restriction in the range of the quality of the slides would lead to generally lower correlations, as was the case in Experiment II. A direct comparison of the variability of the common slides with the variability of the experimental slides in groups 1 and 2 of the road study supports this conjecture. Table 3 shows the standard deviations of SBE's for the slides in question. Clearly, the experimental slides, which were used in Experiment II, have less variability than the common slides. (An F-ratio formed from the variances of the two sets of slides is

Table 3. Standard deviations of sequence SBE's for groups 1 and 2 of the Woods Canyon road sample.

	Experimental Sequences	Common Sequences
Group 1	23.66	36.53
Group 2	21.18	35.72

statistically significant: $F = 2.60$, $df = 39, 51$.) The generally low correlations observed in Experiment II, then, may be a result of the unusually uniform scenic quality of the slides which were used.

Experiment III

The results described so far support the hypothesis that the mean SBE is a good predictor of the overall scenic quality of a sequence of slides, if the slides are sufficiently heterogeneous in scenic quality. In each of the comparisons described above, the sequence SBE's were derived from judgments made during a single presentation to one group of observers. The third experiment was designed to provide a final test of the mean SBE as a predictor of the sequence SBE, with the sequence SBE's obtained from several presentations to different observer groups.

Method

A stratified random sample of sequences was selected from the Woods Canyon road sample. Two sequences were taken from each of ten groups, for a total of 20 sequences. To avoid the problems of uniformity encountered in Experiment II the sequences were selected from across the entire Woods Canyon area. The slides from these sequences were arranged in random order and shown to a group of 20 observers, who were instructed to rate the scenic quality of each individual slide.

Results

SBE's of the individual slides were calculated, and the means of individual slide SBE's for the sequences were correlated with the corresponding sequence SBE's from the Woods Canyon road sample (Figure 7). The correlation coefficient was .739. Although this correlation is rather low, it is considerably higher than any of the correlations between sequence SBE's and mean SBE's in Experiment II, and is within the range of intergroup correlations for the Woods Canyon road sample. Thus, even when sequence SBE's are obtained from many different observer groups, the mean SBE is a reasonably good predictor of the scenic quality of the sequence. Differences between the various observer groups rating slide sequences introduce an additional source of uncontrolled variability, so it is not surprising that the

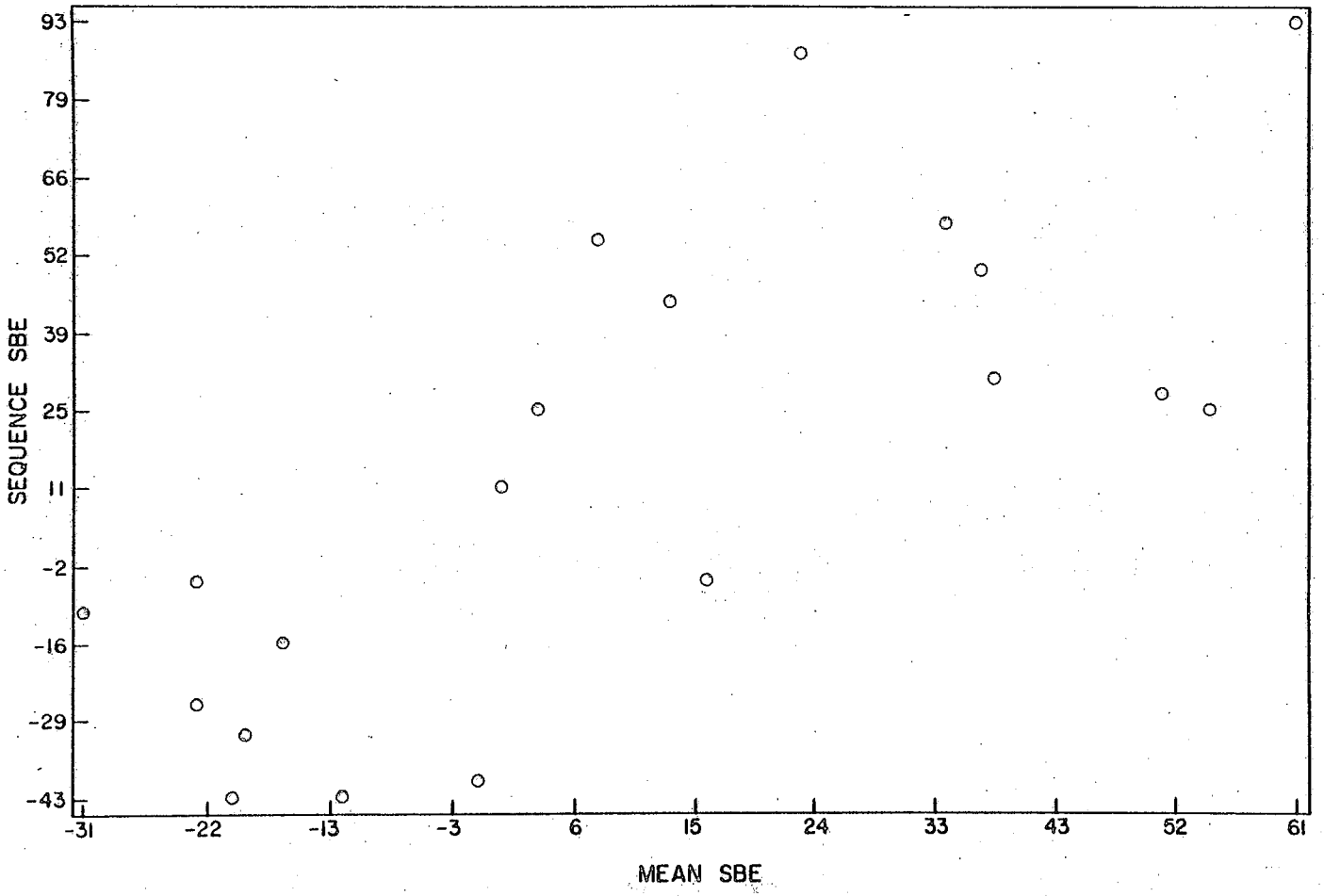

Figure 7. Scatterplot of mean SBE's and sequence SBE's for Experiment III.

relationship is not as strong in this experiment as in some of the preceding comparisons.

The general results of all the comparisons discussed above are summarized in Figure 8, which shows the correlations between sequence SBE's and mean SBE's for all the data sets. In general, the mean SBE is a good predictor of the scenic quality of a five-slide sequence representing a section of road. This is especially true when the sequence SBE's are obtained from ratings made by a single group of observers. Only when a set of sequences unusually uniform in scenic quality was used, did the mean SBE fail as a predictor of the sequence SBE.

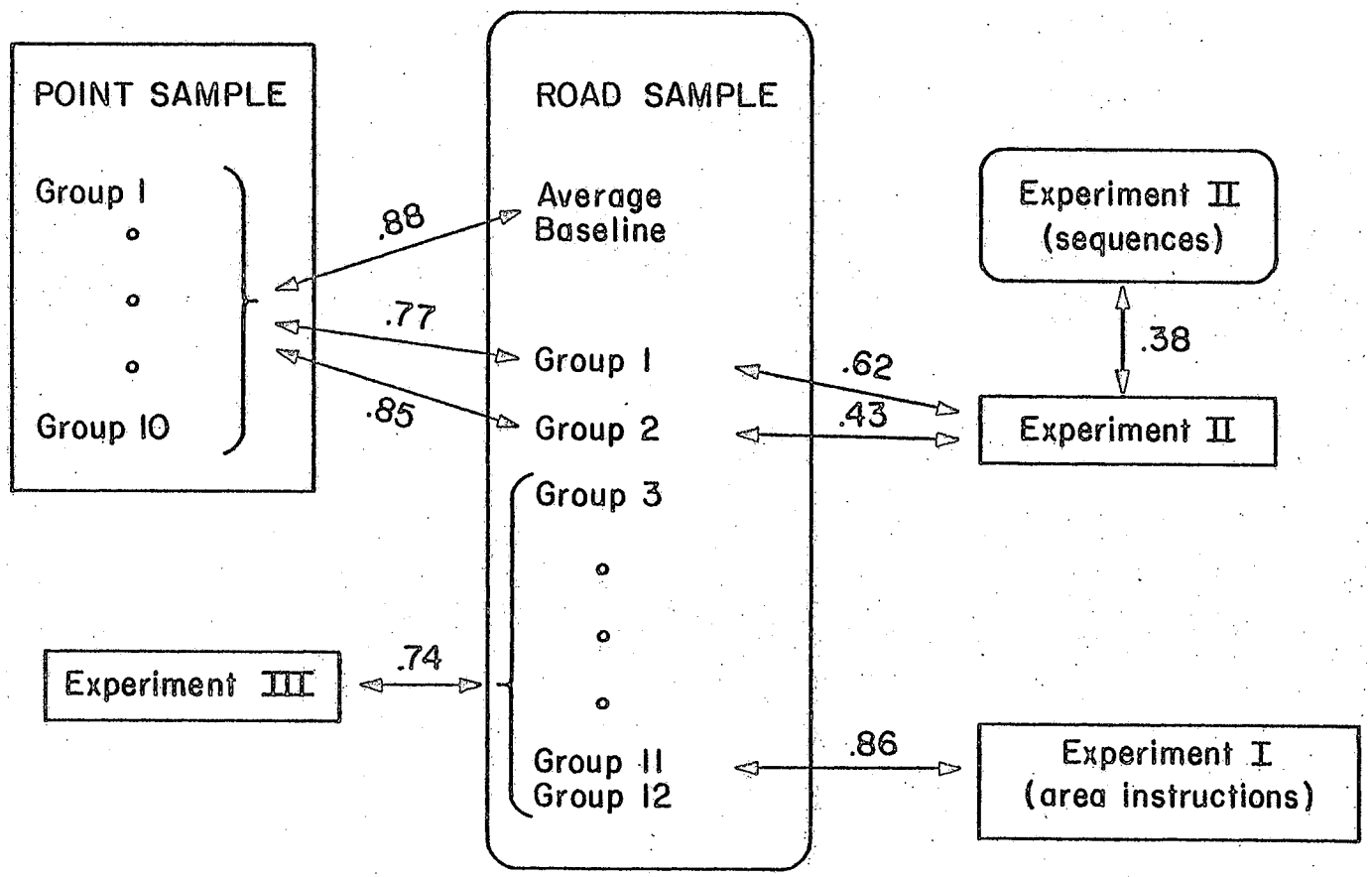

Figure 8. Correlations between sequence SBE's and mean SBE's.

DISCUSSION

The use of scenic beauty data in overlay mapping techniques for road corridor selection requires that two conditions be met. First, because scenic beauty maps represent the scenic quality of independently viewed areas, it must be shown that the mapped values are directly related to the scenic quality of the same areas as observed in sequence by a person moving along a road. The results of Experiment I indicate that there are no systematic differences between SBE's for a set of slides shown as a representation of a road route and SBE's for the same slides shown as representing a random assortment of different areas. In other words, order effects are not introduced when observers are aware that the slides they are seeing form an ordered sequence of views from along a road. This implies that the information supplied by a scenic beauty map about the scenic quality at locations in a forested area may be applied directly to the selection of scenic road corridors through the area. The motorist's aesthetic perception of scenes will not be influenced greatly by the order in which he sees them, and his aesthetic evaluation of the view from the road will be independent of the direction in which he happens to be driving.

Second, a valid procedure for combining estimates of the scenic quality at individual locations to obtain an estimate of the scenic quality of a whole section of road is needed. Overlay mapping techniques generally assume that the desirability of a path through an area is measured by the sum or average of the values at all points along the path. The results of Experiments II and III and the related analyses support the validity of this assumption for the scenic beauty variable, at least for short sections of road, represented by five slides at one-tenth mile intervals. While it is possible that more complex methods of combining SBE's of individual slides to predict sequence SBE's might slightly improve the correlations reported, the small gain would probably not justify the extra work required. Also, the resulting predictors of scenic quality would be more difficult to apply to corridor selection decisions. Note that the correlations between mean SBE's and sequence SBE's are generally as large as the intergroup reliability correlations between replications of sequence SBE's. Thus, there appears to be little room for improvement over the mean SBE as a predictor of the scenic quality of a sequence of slides representing a section of road.

With regard to corridor selection, these results support the use of procedures which maximize the average scenic quality of the route. Observers apparently use a

subjective average of the scenic quality of component views to evaluate the overall quality of a whole visual sequence. It is reasonable to suppose that a motorist on a forest road will do the same as he experiences the changing sequence of visual scenes from one part of the road to the next. This conclusion, of course, assumes that a sequence of color slides provides an adequate representation of the driver's visual experience on the road. An empirical test of this assumption is still needed.

Caution must also be applied if an area is homogeneous in scenic quality. The results of Experiment II show that if a set of views is too uniform, the mean SBE is not very useful for predicting SBE's of sequences of those views. Thus, in an area of uniform scenic quality a corridor selected using scenic beauty maps might be no more scenic than any arbitrary corridor. The use of scenic beauty maps to select road corridors in this case would not be justified.

A Corridor Selection Procedure

The results of the empirical studies described above suggest that composite mapping techniques may be applied in a straightforward way to the selection of scenic road corridors in forest areas heterogeneous in scenic quality. A corridor with a high average scenic value on the scenic

beauty map should be scenically attractive to a person actually driving through the area.

A computer program currently under development by the author demonstrates one way in which overlay maps may be used in studying possible road corridors in forest areas. The program PSORCA (Program for Selection of Road Corridor Alternatives) uses a version of the method described by Weisz et al. (1976) to construct corridors, using the data contained in a SYMAP output matrix. The procedure involves several basic steps. First, measures of the relevant variables are obtained at specified ground locations. Then weights must be determined for the variables which reflect their relative importance to the decision process. This is, of course, a difficult and important step which requires careful thought and consideration (Weisz et al. 1975). Next, the weighted values for each data point are combined and submitted with point locations to SYMAP. (Alternatively, if data for the different variables are not available for the same set of data points, the variables may be input to SYMAP separately and the resulting output matrices weighted and combined.) Finally, the SYMAP matrix and the starting point and destination point coordinates are input to PSORCA. The user may specify values of parameters which determine how close the corridor must stay to a straight line connecting the starting and destination points, as

well as locations of specified intermediate points through which the corridor must pass. For each set of values PSORCA will print out a map of the selected corridor, a list of points in the corridor and their associated values, the length of the corridor in map units, and the average value of the corridor.

Optionally, the user may instruct the program to perform a "multistage search." The program will look ahead a specified distance from its current position in the map and select the point with the highest value, then construct a corridor to that point. From there it again searches ahead for another highly desirable point and constructs a corridor to that point. It continues in this way until it reaches the destination point of the route. This option enables the program to cross areas of low desirability in order to reach locations of exceptional desirability, and guarantees that the corridor will pass through the highest points in the map. If scenic beauty is a variable of primary concern, this option may be especially useful, in view of the results of Experiment I which suggest that observers may recall areas of high scenic quality more often than areas of low scenic quality.

Although PSORCA does not necessarily locate routes which are strictly optimal, it does consistently construct corridors which are substantially higher in average value

than a straight-line route connecting the endpoints. Different specifications of the parameters may result in different corridors being selected, and in its current form the program will in general select different corridors depending on which of the endpoints is used as the starting point. The best approach at present seems to be to generate several different corridor alternatives, starting at each of the endpoints, and then select the ones that are highest in their average value for further study and evaluation. Above all, it should be remembered that the computer-assisted procedures for corridor selection outlined in this study are intended only to supplement and support human decision-making, not to replace it.

Directions for Further Research

The results of this study generally support the use of composite mapping techniques for the selection of scenic road corridors in forest areas. There are, however, still several important questions which need to be investigated further.

First is the question of the validity of slide sequences as representations of forest roads. Individual slide SBE's have been validated against judgments made by on-site observers, but the procedure of showing sequences of slides to represent sections of road has not been validated in the field. There is no guarantee that a slide sequence

is an adequate proxy for actually riding on the road. Such factors as the quality of the road surface, the feeling of movement, the continuous nature of the changing scenes, and the sense of direction and location are all lost in a slide presentation, and these may be important determiners in road aesthetics. Also, the procedure may be valid for some situations and not for others. For example, slide sequences might adequately represent a ride on a smooth, paved road, but not on a rough jeep trail. Further, the question of sample density should be considered. We have not determined how many slides per mile of road are best for representing the road. The time and expense involved in field validation are considerable, but if these results are to be applied to road corridor decisions, the problem should be dealt with.

Next, the use of the mean SBE as a predictor of the scenic quality of a section of road should be tested for longer sections of road, and for entire routes. The results of the cumulative judgment group in Experiment I may provide some preliminary information about this. The high correlations between this group's SBE's and the individual judgment groups' SBE's suggest that the cumulative judgment of the road route at each point was largely determined by the view which had just been presented. The cumulative judgments did, however, tend toward a constant value at the end of the presentation, and the final cumulative SBE was approximately

equal to the mean of the SBE's given to slides by the area instruction group. (The final cumulative SBE was 0, and the mean area SBE for the route was -6. The standard deviation of area SBE's was 37.5.)

Even if the mean SBE is a good predictor of evaluations of the overall quality of an entire road route, other methods for representing the scenic quality of a route should be examined. A single index, such as the mean SBE, loses most of the information about the unique point-to-point variations in scenic quality of each route. Scenic profiles (e.g., Figures 2 and 3) on the other hand, retain all this information, but are difficult to interpret and compare. Representations of intermediate complexity may provide a better balance between informational content and ease of application.

The role of attention and memory in road aesthetics is another important topic. A person travelling on a road selectively attends to various features, and this affects his later recall of features seen along the road (Carr and Schissler 1969). This, in turn, may influence the driver's subsequent aesthetic impression of the road. Distinctive views may be more easily remembered, and may have a disproportionate influence on the observer's final evaluation of the road. The descriptions and ratings of distinctive slides obtained in Experiment I suggest that while both

attractive and unattractive scenes are remembered, there may be a somewhat greater tendency to recall views of high scenic quality. If this is the case, then a corridor selection procedure which not only seeks to maximize the average scenic quality over the corridor, but also goes through as many scenically attractive locations as possible may be especially useful. Further research will be necessary to verify the existence of such an effect, and to determine its significance for the corridor selection process.

Finally, the placement of roads in forest areas should depend not only on the aesthetic quality of the view from the road, but also on the scenic impact on people such as hikers and hunters, who are not actually using the road. The visibility of the road is an important aspect of this question, and becomes a complicated problem in forest areas, where trees of various sizes and densities stand between the road and the potential observer.

Ultimately, the selection of corridors for scenic forest roads should take into account all of these issues. In this way the placement of forest roads will be based on the most accurate and complete information available.

APPENDIX A

INTERGROUP RELIABILITY CORRELATIONS

Table A-1. Reliability correlations between observer groups for the Woods Canyon point sample.

	Observer Groups								
	2	3	4	5	6	7	8	9	10
1	.895	.875	.904	.885	.868	.928	.881	.878	.885
2		.865	.868	.866	.841	.878	.808	.826	.878
3			.901	.811	.897	.868	.855	.874	.901
4				.830	.860	.848	.814	.793	.846
5					.808	.880	.865	.819	.838
6						.873	.844	.844	.836
7							.910	.921	.887
8								.838	.847
9									.864

Table A-2. Reliability correlations between observer groups for the Woods Canyon road sample.

	Observer Groups										
	2	3	4	5	6	7	8	9	10	11	12
1	.891	.702	.772	.759	.668	.744	.869	.773	.692	.803	.880
2		.884	.860	.866	.858	.878	.917	.812	.865	.935	.890
3			.866	.815	.884	.806	.783	.799	.914	.917	.742
4				.815	.818	.854	.817	.882	.879	.920	.802
5					.867	.900	.787	.835	.830	.876	.811
6						.852	.820	.782	.902	.892	.803
7							.824	.897	.909	.928	.827
8								.814	.831	.868	.885
9									.870	.878	.777
10										.938	.806
11											.858

APPENDIX B

INSTRUCTIONS GIVEN TO OBSERVERS

Random Areas

The U.S. Forest Service manages our national forests and plans for future uses. Each decision about land use involves inputs from many people: foresters, local residents, landscape architects, planners, and the general public. In our own research we are attempting to determine the aesthetic or scenic impact of various management alternatives. Your participation is voluntary; if at any point you do not wish to participate further, please sit quietly until we are finished. Do not put your name on the response sheet; all of your responses will remain anonymous.

I am going to show you some color slides of several wildland areas. Each scene represents a larger area. I would like you to evaluate the scenic quality of the area in which each slide was taken, rather than the slide itself. The first few slides will be a preview just to give you an idea of the kind of areas you will be seeing. After the initial slides, I will announce that you are to begin rating the next slides, using the rating response scale at the top of your response sheet. Note that the scale ranges from

zero, meaning you judge the area to be very low in scenic quality, to nine, indicating very high scenic quality. The number of each slide will appear in the small circle on the left side of the screen. You should assign one rating, from zero to nine, to each slide. Your rating should indicate your judgment of the scenic beauty of the area represented by the slide. Please use the full range of numbers if you possibly can and please respond to each slide. Are there any questions before we begin?

Road Views

The U.S. Forest Service manages our national forests and plans for future uses. Each decision about land use involves inputs from many people: foresters, local residents, landscape architects, planners, and the general public. In our own research we are attempting to determine the aesthetic or scenic impact of various management alternatives. Your participation is voluntary; if at any point you do not wish to participate further, please sit quietly until we are finished. Do not put your name on the response sheet; all of your responses will remain anonymous.

I am going to show you a series of slides which were taken along a forest road. The slides were taken about every one-tenth of a mile, and you will be seeing the scenes in the same order that you would see them if you

were actually driving over the road. Each slide represents the view which you would see from the road at that point. I would like you to evaluate the scenic quality of the view represented by each slide, rather than the slide itself. The first few slides will be a preview just to give you an idea of the kind of views you will be seeing. After the initial slides, I will announce that you are to begin rating the next slides, using the rating response scale at the top of your response sheet. Note that the scale ranges from zero, meaning you judge the view from the road to be very low in scenic quality, to nine, indicating very high scenic quality. The number of each slide will appear in the small circle on the left side of the screen. You should assign one rating, from zero to nine, to each slide. Your rating should indicate your judgment of the scenic quality of the view from that point on the road. Please use the full range of numbers if you possibly can and please respond to each slide. Are there any questions before we begin?

Cumulative Judgment

The U.S. Forest Service manages our national forests and plans for future uses. Each decision about land use involves inputs from many people: foresters, local residents, landscape architects, planners, and the general public. In our own research we are attempting to determine the aesthetic or scenic impact of various management

alternatives. Your participation is voluntary; if at any point you do not wish to participate further, please sit quietly until we are finished. Do not put your name on the response sheet; all of your responses will remain anonymous.

I am going to show you a series of slides which were taken along a forest road. The slides were taken about every one-tenth of a mile, and you will be seeing the scenes in the same order that you would see them if you were actually driving over the road. Each slide represents the view which you would see from the road at that point. As you look at each slide, I would like you to evaluate the scenic quality of the entire portion of the road which you have seen up to that point; that is, after looking at each slide, indicate what you think of the road so far, based on all the slides you have seen. The first few slides will be a preview just to give you an idea of the kind of views you will be seeing. After the initial slides, I will announce that you are to begin rating the next slides, using the rating response scale at the top of your response sheet. Note that the scale ranges from zero, meaning you judge the road to be very low in scenic quality, to nine, indicating very high scenic quality. The number of each slide will appear in the small circle on the left side of the screen. You should write down one rating, from zero to nine, as each slide is shown. Your rating should indicate your judgment of the scenic quality of the entire road which

you have seen up to that point. Please respond to each slide. Are there any questions before we begin?

Road Sequences

The U.S. Forest Service manages our national forests and plans for future uses. Each decision about land use involves inputs from many people: foresters, local residents, landscape architects, planners, and the general public. In our own research we are attempting to determine the aesthetic or scenic impact of various management alternatives. Your participation is voluntary; if at any point you do not wish to participate further, please sit quietly until we are finished. Do not put your name on the response sheet; all of your responses will remain anonymous.

I am going to show you a series of slides which were taken along a forest road. The slides were taken about every one-tenth of a mile, and you will be seeing the scenes in the same order that you would see them if you were actually driving over the road. Each slide represents the view which you would see from the road at that point. After every five slides, the screen will be empty for a short while. During that time I would like you to judge the scenic quality of the section of road represented by the five slides you just saw; that is, after looking at each group of five slides, indicate what you think of that

section of the road, based on the five slides you have seen. The first few slides will be a preview just to give you an idea of the kind of views you will be seeing. After the initial slides, I will announce that you are to begin rating the next slides, using the rating response scale at the top of your response sheet. Note that the scale ranges from zero, meaning you judge that section of road to be very low in scenic quality, to nine, indicating very high scenic quality. The number of each section of road will appear in the small circle on the left side of the screen. You should write down one rating, from zero to nine, after every five slides. Your rating should indicate your judgment of the scenic quality of the entire section of road represented by those five slides. Please make a response for every section of road. Are there any questions before we begin?

Overall Rating and Description of Distinctive Slides

Now please give an evaluation of the overall scenic quality of the entire set of slides you have just seen, using the new response scale on the top of the second response sheet. Note that this scale is different from the one you used before. The new scale has six points instead of ten. On this new scale, a one indicates very low scenic quality, and a six indicates very high scenic quality. You should write a number from one to six in the

space provided on your response sheet to indicate your evaluation of the scenic beauty of the entire set of slides.

Now I would like you to describe briefly, in the space provided, the specific slides which you remember as being particularly distinctive or which stand out in your mind for any reason. In particular, describe any slides which you thought of while making your overall evaluation. For each slide you describe, also please give a rating for that slide's scenic quality, as you remember it, using the new six-point scale at the top of your response sheet.

APPENDIX C

DESCRIPTIONS AND RATINGS OF THE SCENIC QUALITY OF RECALLED SLIDES IN EXPERIMENT I

Following the presentation of slides in Experiment I, observers in all three groups were asked to give a rating of the overall scenic quality of the entire set of slides. They were also instructed to describe any distinctive slides which they recalled and to rate the quality of those slides.

The characteristics of slides most frequently described by observers after the presentation are listed in Table C-1, classified according to whether most observers rated them as being high or low in scenic quality. The third column lists those features which were rated either neutrally or inconsistently.

There were no appreciable differences between the three groups in the way in which they rated the whole set of slides, or the distinctive slides which they recalled. For this reason, the ratings of all three groups were combined. Figures C-1 and C-2 show, respectively, frequency histograms of the overall rating of the route and of ratings of the individual slides recalled as distinctive. While the distribution of overall ratings is fairly symmetric,

the distribution of ratings of recalled slides appears bimodal, with most of the ratings falling at the high end of the scale. Figure C-3 shows a frequency histogram of the difference between each recalled slide's rating and the overall rating which that observer gave to the entire route. This was done to discover whether observers tend to recall slides which they perceived as being more attractive or less attractive than the route as a whole. The result suggests a tendency on the part of observers to recall slides which are attractive somewhat more often than unattractive ones.

Table C-1. Landscape features frequently recalled by observers.

Attractive	Unattractive	Neutral or Inconsistent
Grassy meadows	Fallen dead trees	Large fallen logs
Mountain peak	Stumps and dead branches	Paths or roads
View of tree tops	Barren rocky ground	Rocks
Grass and plush green foliage	Dense stands of small, dry trees	Bent or Leaning trees
Small clearings		Hillsides
Large healthy trees		
Trees other than pines		

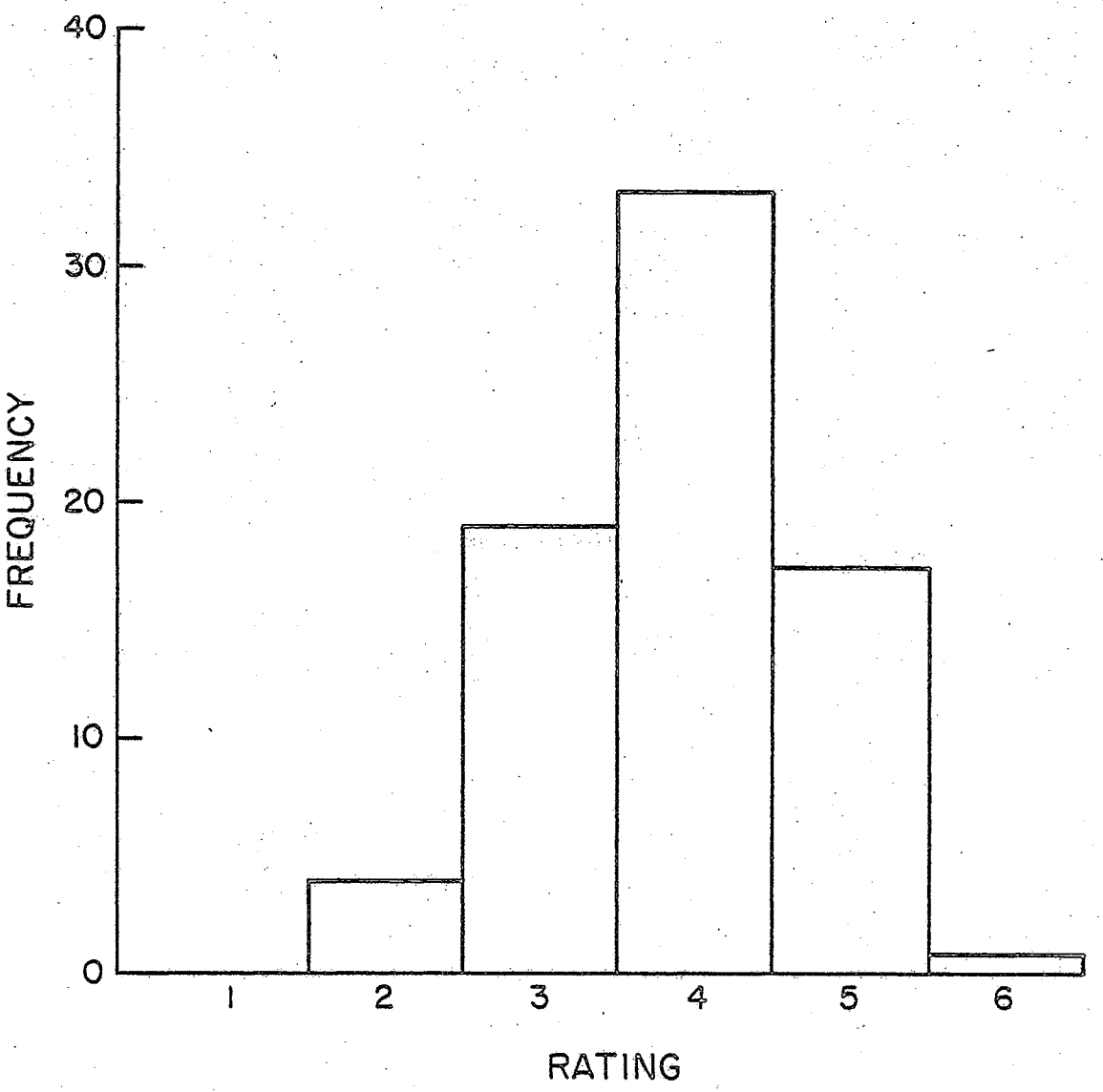

Figure C-1. Frequency distribution of ratings of the overall scenic quality of the slides used in Experiment I.

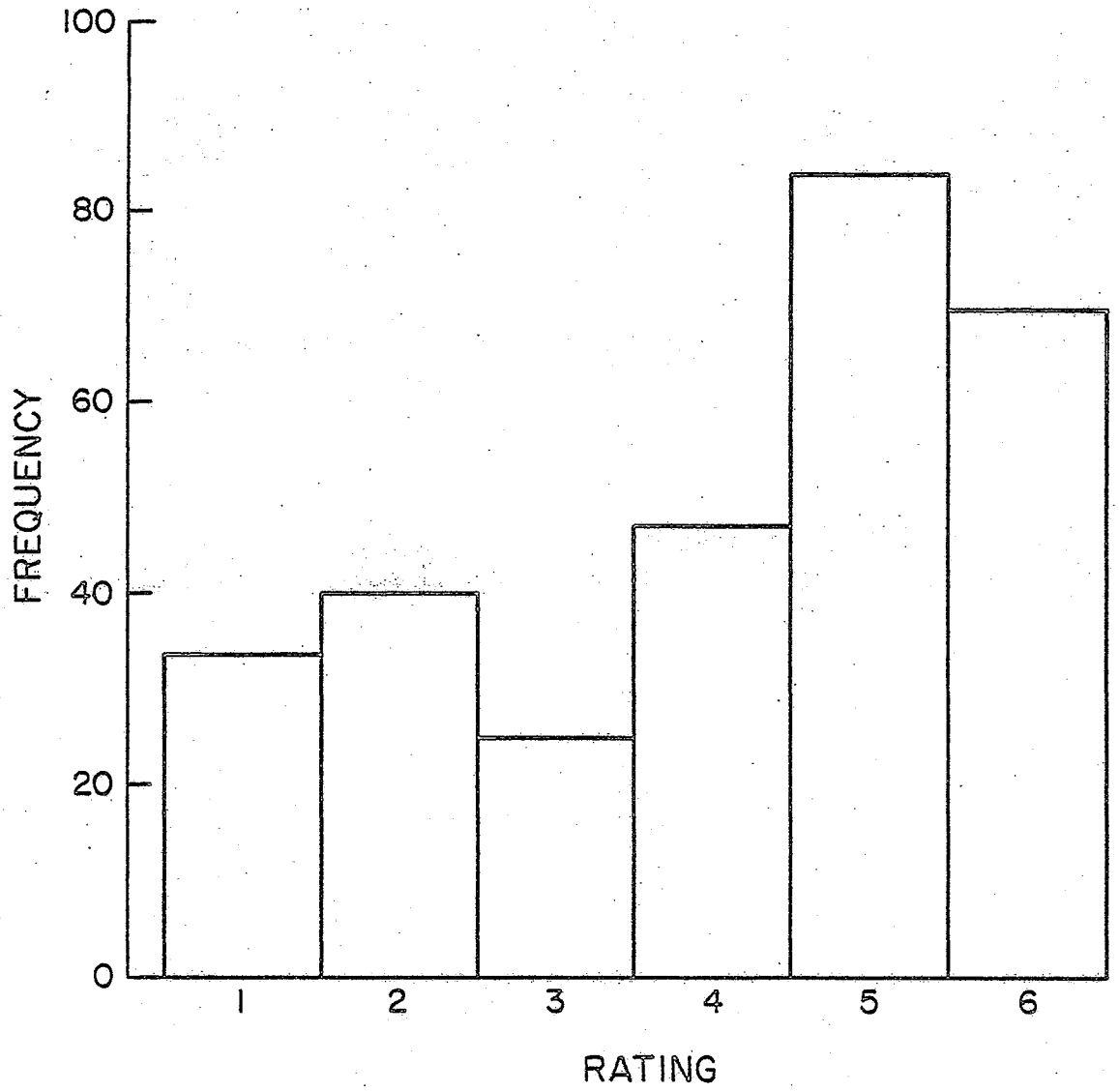

Figure C-2. Frequency distribution of ratings of recalled slides in Experiment I.

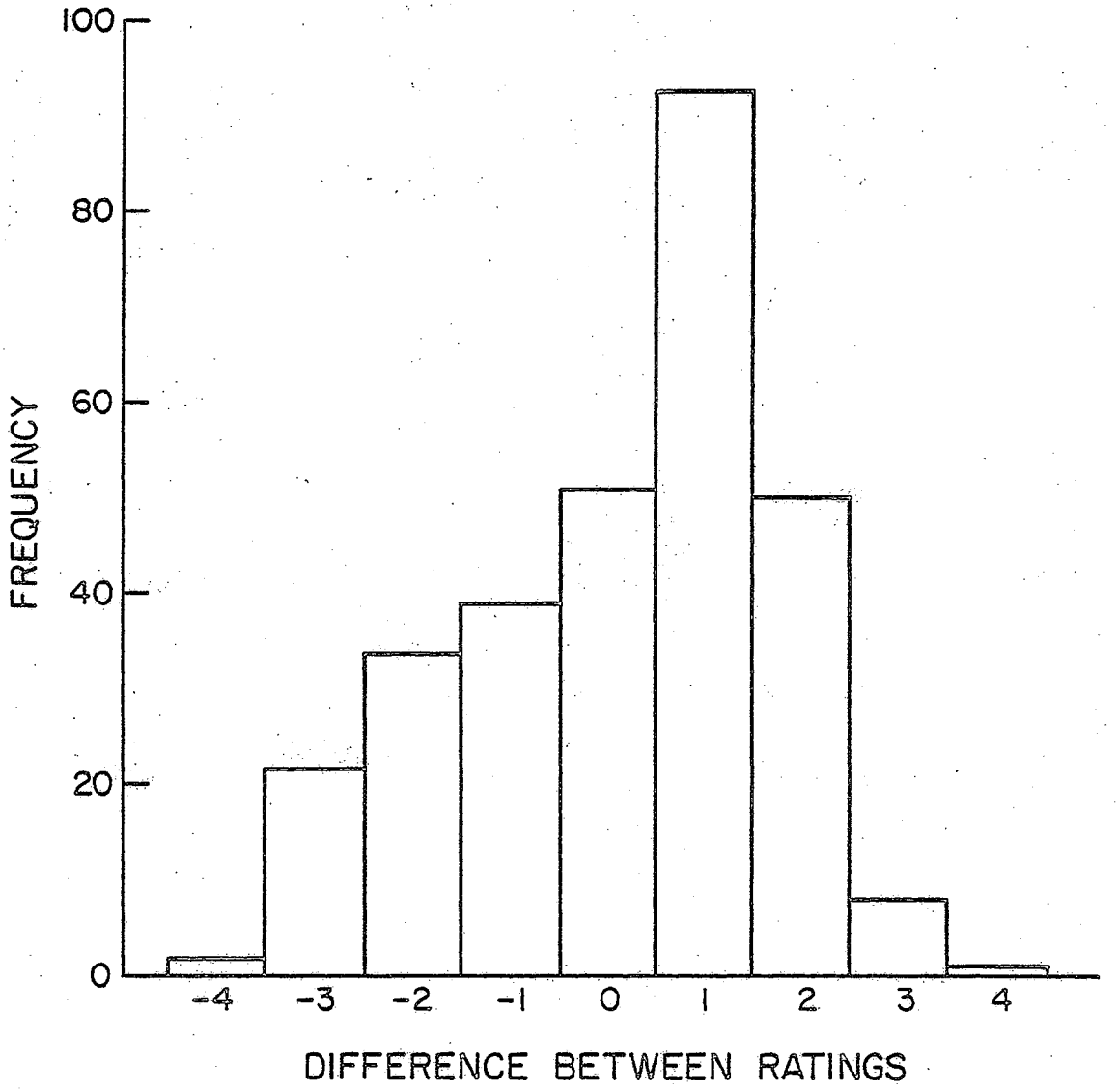

Figure C-3. Frequency distribution of difference between observer's rating of recalled slide and same observer's rating of the overall scenic quality of the slides used in Experiment I.

REFERENCES

Appleyard, D., K. Lynch and J. R. Myer. The view from the road. Cambridge, Mass.: MIT Press, 1964.

Bock, D. R. and L. V. Jones. The measurement and prediction of judgment and choice. San Francisco: Holden-Day, 1968.

Carr, S. and D. Schissler. The city as a trip: Perceptual selection and memory in the view from the road. Environment and Behavior, 1969, 1, 7-35.

Daniel, T. C., L. A. Anderson, H. W. Schroeder and L. Wheeler III. Mapping the scenic beauty of forests. Leisure Science, in press.

Daniel, T. C. and R. S. Boster. Measuring landscape esthetics: The SBE method. U.S.D.A. Forest Service Research Paper, Rocky Mountain Station, RM-167, 1976.

Dudnick, E. E. SYMAP user's reference manual. Department of Architecture, College of Architecture and Art, University of Illinois, Chicago, 1971.

Helson, H. Adaptation level theory: An experimental and systematic approach to behavior. New York: Harper and Row, 1964.

Hornbeck, P. L., R. R. Forster and M. R. Dillingham. Highway aesthetics--functional criteria for planning and design. Highway Research Record, 280, 1969, 25-38.

Hornbeck, P. L. and G. A. Okerlund. Visual quality for the highway user: A study of the relation of factors of visual quality to route design. Highway Research Record, 410, 1972, 52-63.

Litton, R. B. Forest landscape description and inventories: A basis for land planning and design. U.S.D.A. Forest Service Research Paper, Pacific Southwest Station, PSW-49, 1968.

Litton, R. B. and R. H. Twiss. The forest landscape: Some elements of visual analysis. Proceedings, Society of American Foresters Meeting, Washington D.C., 1967, 212-214.

Lowenthal, D. Environmental assessment: A case study of Columbus, Ohio. New York: American Geographical Society, 1972.

Lynch, K. and M. Rivkin. A walk around the block. Landscape, 1959, 8, 24-34.

Melhorn, W. N. and E. A. Keller. Landscape aesthetics numerically determined: Applications to highway corridor selection. Highway Research Record, 452, 1973, 1-9.

Mulder, W. J. Development of criteria for scenic roads. Transportation Research Record, 508, 1974, 91-104.

Thiel, P. Notes on the description, scaling, notation, and scoring of some perceptual and cognitive attributes of the physical environment. In H. M. Proshansky, W. H. Ittelson and L. G. Rivlin (eds.) Environmental Psychology: Man and His Physical Setting. New York: Holt, Rinehart and Winston, 1970, pp. 593-619.

Weisz, R. N., D. A. King and R. Kingery. Planning for forest roads--state of the art in corridor selection. Unpublished report, 1975.

Weisz, R. N., W. O. Rasmussen, R. S. Boster and T. C. Daniel. Planning for forest roads--a computer assisted procedure for selection of alternate corridors. Unpublished report, 1976.

Winkel, G. H., R. Malek and P. Thiel. The role of personality differences in judgments of roadside quality. Environment and Behavior, 1969, 1, 199-223.