Environment and Behavior

http://eab.sagepub.com

Responses to Six Major Terrestrial Biomes in Terms of Scenic Beauty, Preference, and Restorativeness

Ke-Tsung Han

Environment and Behavior 2007; 39; 529 originally published online May 21, 2007;
DOI: 10.1177/0013916506292016

Environment and Behavior
Volume 39 Number 4
July 2007 529-556

10.1177/0013916506292016
http://eab.sagepub.com
hosted at
http://online.sagepub.com

Responses to Six Major Terrestrial Biomes in Terms of Scenic Beauty, Preference, and Restorativeness

Ke-Tsung Han
National Chin-Yi Institute of Technology, Taiwan

This study examined 274 college students' psycho-physiological responses to the six major terrestrial biomes (desert, tundra, grassland, coniferous forest, deciduous forest, and tropical forest), while taking into account the influences of three perceived physical variables (complexity, openness, and water features) presented in the biomes. The purpose of the study was to examine which specific natural setting can evoke the most positive reactions from people. ANCOVA tests and post hoc comparisons using the setting scores across the participants' data on the responses to 48 biome slides regarding scenic beauty, preference, the Short-version Revised Perceived Restorativeness Scale and the Short-version Revised Restoration Scale were performed. The results indicated that tundra and coniferous forest were the most favored biomes, whereas desert and grassland were the least favored. These findings appeared to support the forest hypothesis rather than the long-held savanna hypothesis. In addition, the results of multiple regression analyses indicated that the three perceived physical factors explained 9% more variance of the respondents' reactions than the biome classification. This finding suggested that a nonhabitat-specific approach to environmental responses holds more promise than a habitat-specific approach.

Keywords: *human evolution; savanna hypothesis; forest hypothesis; habitat-specific approach; nonhabitat-specific approach*

Introduction

Contemporary research on evolution, habitat selection, and landscape aesthetics raises the question of whether there is a specific natural setting

Author's Note: The author wishes to express great appreciation to the anonymous reviewers for their valuable comments and patience and special thanks to Bob Bechtel, editor of *Environment and Behavior*, for his kind assistance. Correspondence regarding this article may be sent to k0h5757@hotmail.com or kthan@ncit.edu.tw.

most suitable for humans. Though there have been numerous studies on how humans react to their natural environments (e.g., R. Kaplan & Kaplan, 1989), they still suffer from certain limitations. First, most of these studies do not encompass a broad range of natural environments (see reviews in Balling & Falk, 1982; Ulrich, 1983, 1993). There is general agreement among ecologists that our complex natural world can, based on temperature and rainfall, be classified into six major biomes: desert, tundra, grassland, coniferous forest, deciduous forest, and tropical forest (Odum, 1989). Most studies often include only one or two of the six major terrestrial biomes and do not specify biomes as the categorical units representative of the relatively limited natural environments. It should be further noted that these selected settings have frequently not been examined by experts for their appropriateness or suitability as representations of a given environment. Moreover, these studies usually focus on preference alone, whereas preference constitutes only one response among many psychological mechanisms (Ulrich, 1989). Not only do these studies not include a broad spectrum of psychological aspects, but they also seem to disregard the possible physiological and behavioral responses of the subject.

Related Theories

General evolutionary theory postulates that "natural selection should have favored individuals who were motivated to explore and settle in environments likely to afford the necessities of life but to avoid environments with poorer resources or posing higher risks" (Orians & Heerwagen, 1992, p. 557). Natural selection is regarded as the major mechanism by which organisms change adaptively and persistently in response to their environment (deMenocal, 2004). Similarly, habitat selection theory claims that selecting proper settings in which to live is an essential and necessary activity for both animals and human beings because habitat selection is closely related to the successful survival, prosperous reproduction, and well-being of a species (Orians & Heerwagen, 1992).

To survive, human responses to environments that are based primarily on the differentiation of habitable from inhabitable settings have to be both rapid and motivationally powerful (Parsons, 1991). In line with the earlier notions, the psychological perspective on environmental aesthetics advocates that high-quality landscapes should evoke positive responses, whereas low-quality landscapes should evoke negative reactions (Daniel & Vining, 1983). Because emotional responses are such powerful motivators of human behavior, they would surely have contributed substantially to human survival and reproduction, otherwise they would not have evolved and been brought forward in the human species during thousands of years (Orians & Heerwagen, 1992).

Among the emotions, preference is regarded as the first response to an environment that has developed through human evolution (Hartig, 1993; S. Kaplan, 1987; S. Kaplan & Kaplan, 1982). Hence, preference signals whether an environment can support human survival, functioning, and well-being (Hartig, 1993; R. Kaplan & Kaplan, 1989). Nevertheless, Ulrich (1993) further speculates that the positive responses of humans to natural environments should cover like–dislike and approach behavior, as well as cognitive functioning and restoration from stress, of which the research on the last two responses is much less than that on preference.

There are two general approaches to environmental aesthetics along with the theories of evolution and habitat selection. One approach focuses specifically on human responses to biomes in which Homo sapiens evolved. The other is not confined to any specific habitat (Orians & Heerwagen, 1992). There are three major hypotheses with respect to the specific habitat(s) where humans have evolved (deMenocal, 2004). One is the long-held savanna hypothesis, which proposes the spread of savanna grasslands in Africa resulting in hominids (Balling & Falk, 1982; Bobe & Behrensmeyer, 2004; Dart, 1925; deMenocal, 2004; Jolly, 1970; Klein & Edgar, 2002; Orians, 1986; Robinson, 1954). Another is the forest hypothesis, which argues that human evolution took place in closed, forested settings (Andrews, 1989; Berger & Tobias, 1996; Clarke & Tobias, 1995; Rayner, Moon, & Masters, 1993; WoldeGabriel et al., 1994). The third is the grassland–woodland hypothesis, which proposes that a mosaic of both settings was the adaptive environment for hominids (Blumenschine, 1986).

Given that adaptations molded by natural selection can persist in some species for thousands of generations after the sources of selection no longer exist and that humans might retain psychological and behavioral relics under relaxed selection that exceed a time frame of a million years (Coss & Moore, 2002), it is speculated that humans have an innate predisposition for the habitat where they evolved. It is surmised that because of their prolonged evolutionary history, human beings have developed mechanisms of an emotional, perceptual, cognitive, physiological, and behavioral nature that mold adaptive responses to evolutionary habitats (Balling & Falk, 1982).

There are three major theories underlying a nonhabitat-specific approach to landscape aesthetics. Appleton's (1975/1996) prospect-refuge theory states that people prefer locations similar to the savanna grasslands in

Africa where grasses provide easy lookouts for spotting prey and threats, and scattered trees offer hiding places from enemies and predators. He further advocates that these settings which afford prospects and provide refuge, either physical or symbolic, for the opportunity to "see without being seen" will evoke people's positive reactions. In line with Berlyne's (1971) information theory that advocates human preference for an optimal level of environmental stimuli, Rachel and Steven Kaplan state that for evolutionary success, human beings need to explore their surroundings to acquire information and to understand as well as interpret that acquired information quickly (S. Kaplan, 1987; S. Kaplan & Kaplan, 1982; R. Kaplan & Kaplan, 1989). Environments in which people can readily do so tend to be liked, approached, and furthermore to have higher restorative potential from mental fatigue. Otherwise, they tend to be disliked and avoided (S. Kaplan, 1987; R. Kaplan & Kaplan, 1989). Similarly, Ulrich (1983) claims that responses (including emotion, physiology, behavior, and recovery from stress) to environments are triggered by preferenda (Zajonc, 1980). In general, the preferenda of natural settings can be classified into three groups: (a) gross structure, such as complexity, order, and focality; (b) gross depth cues, such as spaciousness, ground surface texture, and deflected vista; and (c) general environmental content, such as perceived threat, or support, such as water and vegetation.

Previous Studies

Thus far, only three studies have specifically investigated human responses to biomes. Balling and Falk (1982) examined 548 respondents' preferences for both residing in five biomes during extended time periods and visiting the five biomes during relatively short time periods. These five biomes included tropical rain forest, temperate deciduous forest, coniferous forest, savanna, and desert. Each biome was represented by four slides. They found that the participants of the various groups exhibited a significantly higher preference for savanna, deciduous forest, and coniferous forest than for tropical forest and desert. Their results suggested that there was some support for the savanna hypothesis and perhaps even for the forest hypothesis. One year later, Lyons (1983) all but replicated Balling and Falk's study using the same visual stimuli with different background participants. The study showed that the 281 respondents all appeared to prefer coniferous forest, deciduous forest, and tropical forest to desert. In addition, Woodcock (1982) examined 200 college students' preferences for three biomes: savanna, hardwoods, and rain forest. Each biome was represented by 24 slides, which included the same four exemplars used by Balling and Falk in their studies. His research showed that hardwoods had the highest preference, whereas the other two biomes were rated as being very close. The results obtained from the studies of Lyons and Woodcock appeared to favor the forest hypothesis.

Nevertheless, these three studies still shared three drawbacks that were similar to those studies conducted without using biomes as the natural setting. First, they did not cover the full range of terrestrial biomes. Second, in selecting slides for biome representativeness, the researchers did not check for any other variables, such as complexity, openness, and water features, and the effect that they had on the psycho-physiological responses of people. Complexity, openness, and water features have been known to have a considerable impact on a person's psycho-physiological reactions (Berlyne, 1971; Mehrabian & Russell, 1974; Ulrich, 1979, 1983, 1993). The biome context alone may thus not have been the only source of response differences. Third, Balling and Falk (1982), Lyons (1983), and Woodcock (1982) tested only one psychological factor, preference, as the dependent variable in their studies and neglected to take into account the other variables such as behavior, cognition, and restoration. Although Woodcock included legibility, mystery, prospect, and refuge as the predicting variables, he did not control for the influences of these four predictors on preference across the three biomes.

In spite of the importance of human responses to natural settings as interpreted from the theoretical perspectives of evolution, habitat selection, and environmental aesthetics, the findings in the foregoing research seem to preclude certainty. The purpose of this study is therefore to rigorously examine the human reactions to the six major terrestrial biomes while taking into account the influences of complexity, openness, and water features presented in the biomes. Furthermore, the investigated responses are extended from preference to scenic beauty, recovery from mental fatigue, and psychophysiological stress to determine which biome can evoke the most positive reactions from people. In this way, the study hopes to provide a deeper and broader understanding of human psycho-physiological responses to nature in general and to biomes in particular, which arguably might shed some light on whether there is a specific natural setting most suitable for humans.

Method

This study employed a completely within-participants design involving three experiments. All the experiments involved small groups of undergraduate students at Texas A&M University in the United States. All of the experiments were conducted in the same auditorium in the university's College of Architecture. The participants' task was to view each of the randomly ordered color slides as surrogates of the actual biomes and to record their responses in terms of scenic beauty, preference, and restoration.

Stimuli

The following four steps were used to select slides that were appropriate to and representative of the actual biomes. To begin with, the author selected 200 slides from thousands of color slides owned by two doctoral students and seven professors in the departments of Forest Science, Geography, Landscape Architecture and Urban Planning, and Rangeland Ecology and Management at the university. These slides were taken around the world without any specific aesthetic considerations or constraints. The selection of the slides was based on the following three criteria: the presence of natural landscapes and terrestrial biomes, good photographic quality with as little distortion as possible, and horizontal photographic shots taken at approximately eye level without looking up or down. Among these 200 slides, 27 slides were of desert, 38 were of tundra, 35 were of grassland, 33 were of coniferous forest, 31 were of deciduous forest, and 36 were of tropical forest. The next step was to invite three different groups of judges to evaluate the 200 color slides on a 5-point scale, with five denoting the highest level. Evaluations of these 200 slides followed the same procedure using a blocked format, where slides of a given biome were presented one-by-one to the judges for rating.

The first group of judges, which consisted of three graduate students in the College of Architecture at the university, evaluated the slides in terms of their photographic quality. The judges had an average of 12 years' experience in photography. The second group of judges, which consisted of two graduate students and one postdoctoral researcher in the college, evaluated the slides according to the three perceived physical variables: complexity, openness, and water features. The final group of judges, which consisted of four professors from the departments of Forest Science, Geography, Landscape Architecture and Urban Planning, and Rangeland Ecology and Management at the university, evaluated each of the slides in terms of their appropriateness as a biome type. The evaluations of appropriateness were based on Odum's (1989) definitions of terrestrial biomes and the judges' expertise.

As a result of the judges' ratings of the 200 slides, 48 slides were selected and were later used in three experiments as the visual stimuli. Each of the six biomes was represented by 8 slides, which had been judged to have good photographic quality (mean = 3.6/5.0), to be the most appropriate samples for that biome (mean = 4.2/5.0), and to exhibit varying degrees of the three perceived physical variables. The judges' ratings for the 8 slides for each biome were averaged to form a setting score for biome appropriateness, photographic quality, complexity, openness, and water features for later statistical analyses (Herzog & Chernick, 2000). The use of setting score has several advantages (Herzog & Barnes, 1999; Richards, 1996), such as that it is a summary of central tendency and variability across raters (Herzog & Stark, 2004), it provides conservative analyses because the number of settings is usually less than that of raters (Herzog & Barnes, 1999), and it focuses on the perceptual quality of settings rather than individual differences among raters (Herzog & Barnes, 1999; Hull & Stewart, 1992).

Procedure

Experiment 1 involved the collection of data on scenic beauty and preference from 92 participants. Of these 92 participants, 47 were male and 45 were female, with the average age of all participants being 19.30. Both measures were recorded on 9-point scales, with 9 denoting the highest level. The definition of scenic beauty selected for this research was a perceptual evaluation in response to the visual attributes of the presented landscape (Daniel & Vining, 1983; Gritter, 1997; Jang, 1998; Yhang, 1994). Preference was defined as a personal liking for the presented landscape for whatever reason (Herzog & Bosley, 1992).

Experiment 2 entailed collecting data for 93 participants using Hartig's (Hartig, Korpela, Evans, & Garling, 1997) Short-version Revised Perceived Restorativeness Scale (SRPRS). Hartig's SRPRS has three dimensions (being away, fascination, and compatibility) together with 12 items and is based on the Kaplans' (R. Kaplan & Kaplan, 1989) Attention Restoration Theory. The SRPRS is specifically designed to measure one type of cognitive functioning, namely, the recovery of directed attention from mental fatigue (Table 1). The research findings indicate that the validity and the reliability of the SRPRS were satisfactory (Herzog, Black, Fountaine, & Knotts, 1997). Of the 93 respondents, 45 were male and 48 were female, with their average age being 18.87.

Experiment 3 involved the collection of data for 89 respondents using Han's (2003b) Short-version Revised Restoration Scale (SRRS). Han's SRRS covers four dimensions (emotion, physiology, cognition, and behavior)

Table 1
Hartig's Short-Version Revised Perceived Restorativeness Scale

Imagine you were in the presented landscape. How would you agree with the following statements?

Being Away:
- It is an escape experience.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- Spending time here gives me a good break from my day-to-day routine.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)

Fascination:
- The setting has fascinating qualities.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- My attention is drawn to many interesting things.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- I would like to get to know this place better.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- There is much to explore and discover here.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- I would like to spend more time looking at the surroundings.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)

Compatibility:
- I can do things I like here.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- I have a sense that I belong here.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- I have a sense of oneness with this setting.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- Being here suits my personality.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)
- I could find ways to enjoy myself in a place like this.
  - (not at all) 1____2____3____4____5____6____7____8____9 (a great deal)

Source: Hartig, Korpela, Evans, & Garling, 1997. Reprinted from "A measure of restorative quality in environments" by Hartig, T. A., Korpela, K., Evans, G. W., & Garling, T. from *Scandinavian Housing & Planning Research* 1997, Volume 14, pp. 175-194, by permission of Taylor & Francis.

together with eight items and is based on the theories of the Kaplans (R. Kaplan & Kaplan, 1989) and Ulrich (1983). In Ulrich's view, restoration is derived from the reduction in stress. The SRRS is thus developed to measure the recovery from psychological and physiological stress (Table 2). The research findings show that the validity and the reliability of the SRRS are acceptable (Han, 2003b). The 89 respondents included 43 males and 46 females, with the average age of all participants being 18.94.

In each of the three experiments, various versions of the questionnaire listed the dependent variables of interest in different sequences. Two identical

Table 2
Han's (2003) Short-Version Revised Restoration Scale

Imagine you were in the projected scene. How would you describe your emotional response?

Grouchy — Good natured
(very much) 1____2____3____4____5____6____7____8____9 (very much)
Anxious — Relaxed
(very much) 1____2____3____4____5____6____7____8____9 (very much)

Imagine you were in the projected scene. How would you describe your physiological response?
My breathing is becoming faster.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)
My hands are sweating.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)

Imagine you were in the projected scene. How would you describe your cognitive response?
I am interested in the presented scene.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)
I feel attentive to the presented scene.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)

Imagine you were in the projected scene. How would you describe your behavioral response?
I would like to visit here more often.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)
I would like to stay here longer.
(not at all) 1____2____3____4____5____6____7____8____9 (very much so)

copies of the 48 selected slides were arranged in random order. It is worth noting that, in both sets, not more than 2 slides of the same biome were arranged in consecutive order (Herzog et al., 1997), and the set of slides that was used during each experiment was randomly determined. The various versions of the questionnaire were distributed evenly among the participants. The combined use of the various questionnaire versions and the two copies of slides attempted to reduce the effect of order.

In Experiment 1, the 92 participants' scores on scenic beauty and preference with respect to the 48 slides were averaged to form two setting scores, respectively. In Experiment 2, the 93 participants' data on the SRPRS were first averaged to form composite scores for each of the three dimensions for each slide and were then averaged to form one setting score for each slide (Hartig et al., 1997). In Experiment 3, the 89 participants' data on the SRRS were also averaged to form composite scores for each of the four dimensions. The composite score of the second dimension was reversed because it measures physiological arousal. Then the composite scores were averaged to form the setting score (Han, 2003b).

Results

The internal reliability coefficients of the judges' ratings for photographic quality, biome appropriateness, complexity, openness, and water features across the 200 slides were 0.76, 0.61, 0.64, 0.87, and 0.96, respectively. The results of the five analyses of variance using the judges' setting scores indicated that there was no significant difference in terms of photographic quality, biome appropriateness, and the three perceived physical features across the biome slides. Of the three perceived physical variables, only complexity and water features exhibited a moderate and significant association ($r = 0.442$, $p < 0.001$). Meanwhile, the internal reliability coefficients of the subjects' data in relation to scenic beauty, preference, SRPRS, and SRRS were all 0.98. As for the setting scores for these four responses, all of them were strongly and significantly correlated ($r > 0.952$, $p < 0.001$). Also, the results of the factor analysis indicated that these four responses formed one component. This was not surprising because both of the theories of the Kaplans (R. Kaplan & Kaplan, 1989) and Ulrich (1983) postulate that visually preferred environments are not only positively correlated with human restoration but also seem to promote it (Hartig, 1993; R. Kaplan, Kaplan, & Ryan, 1998; Korpela, 1991; Newell, 1997; Ulrich, 1984). The dominant factor score for the 48 slides was also calculated for subsequent analyses.

The relationships between the three perceived physical factors and the four responses were preliminarily explored here by conducting regression analyses. More detailed analyses of their complex relationships and the distinction between the four responses are subject to another article under preparation. In short, both the simple linear and quadratic regressions were appropriate models and explained almost the same amount of variance, except for that variance found between scenic beauty, preference, SRPRS, and openness. Because of its parsimony, the simple linear models were preferred to the quadratic models, which provided a basis for multiple regression analyses. The results of the multiple regression analyses specifying the responses as dependent and the perceived physical variables as independent suggested the four responses to be distinguishable from each other in terms of the three perceived physical variables (Han, 2003a). Also, given that the three perceived physical variables and the four response measures were related and that no correlations between the three perceived physical factors were larger than 0.80, they were suitable for running ANCOVAs (Elashoff, 1969).

Four ANCOVAs treating the setting scores on scenic beauty, preference, SRPRS, and SRRS as dependent, the biomes as independent, and the setting scores on three perceived physical factors as the covariates were conducted to determine which biome was most favored by the respondents. Running four ANCOVAs, instead of a single one, which used the dominant factor score was intended to explore a comprehensive picture of human responses to the biomes. These four ANCOVAs met the statistical requirements of equality of error variances and homogeneity of within-class regression coefficients (SPSS Inc., 1999). The results of these four ANCOVAs had two things in common. First, the participants responded significantly differently, $F(5, 39) > 4.752$, $p < 0.01$, to the six biomes in terms of the four measures. Second, the three perceived physical variables significantly explained a large part of the variance of the dependent variable, $F(1, 39) > 5.478$, $p < 0.05$, except for complexity with respect to scenic beauty, preference, and SRRS, $F(1, 39) < 3.920$, $p > 0.05$. This indicated that these three perceived physical factors compensated for the systematic biases among the samples, reduced within-groups variability, and thus increased the precise estimation of the treatment effect (Huck, 1972; Snedecor & Cochran, 1989; Stevens, 1990).

In addition, it should be noted that respondents had almost an identical rank ordering with regard to the four measurement means adjusted for the covariates across the six biomes. Tundra and coniferous forest had the highest and the second highest scores, respectively, in relation to the four responses, and grassland and desert had the second lowest and the lowest scores, respectively, for the four measures (see Figure 1 for examples of the 48 biome slides). The only difference in terms of rank ordering was that grassland and desert exchanged their positions as the lowest and the second lowest items on the SRPRS (Table 3).[1] Bonferroni post hoc comparisons of the six biomes were performed with respect to the four responses adjusted for the covariates. Tundra had significantly higher means than grassland and desert for all four measures. Coniferous forest was rated substantially higher than desert in relation to the four responses and was higher than grassland in regard to the SRPRS and SRRS. In addition, tundra's mean in relation to the SRRS was significantly higher than the deciduous forest's mean.

Moreover, to determine whether the three perceived physical variables or the biome classification can explain more variance of the human responses, three multiple regression analyses all specifying the dominant factor score as the dependent variable and using the enter method were performed. The first multiple regression specified the three perceived physical variables as

Table 3
Mean Scores of the Four Measures for the Six Biomes

Biome	Scenic Beauty		Preference		Short-Version Revised Perceived Restorativeness Scale		Short-Version Revised Restoration Scale	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Desert								
M	4.496	4.792	4.369	4.684	3.848	4.192	5.031	5.249
SD/SE[a]	0.473	0.310	0.361	0.304	0.421	0.224	0.298	0.166
Rank	6	6	6	6	6	5	6	6
Tundra								
M	6.351	6.440	6.252	6.350	5.563	5.739	6.470	6.526
SD/SE[a]	1.312	0.310	1.363	0.303	1.362	0.223	0.857	0.166
Rank	2	1	2	1	2	1	1	1
Grassland								
M	5.071	5.018	4.917	4.873	4.135	4.154	5.489	5.411
SD/SE[a]	0.490	0.332	0.484	0.325	0.369	0.239	0.344	0.178
Rank	5	5	5	5	5	6	5	5
Coniferous								
M	6.477	6.349	6.344	6.205	5.617	5.466	6.372	6.283
SD/SE[a]	1.525	0.307	1.533	0.301	1.195	0.221	0.879	0.165
Rank	1	2	1	2	1	2	2	2

Deciduous								
M	5.491	5.408	5.412	5.315	5.042	4.857	5.763	5.729
SD/SE[a]	0.993	0.318	0.988	0.312	0.950	0.230	0.796	0.171
Rank	4	4	4	4	4	4	4	4
Tropical								
M	6.056	5.936	5.871	5.738	5.214	5.011	6.046	5.973
SD/SE[a]	1.197	0.310	1.233	0.304	1.010	0.224	0.761	0.166
Rank	3	3	3	3	3	3	3	3

a. SPSS provided standard errors for adjusted means instead of standard deviations.

Table 4
Summary of the Results of the Three Multiple Regression Analyses

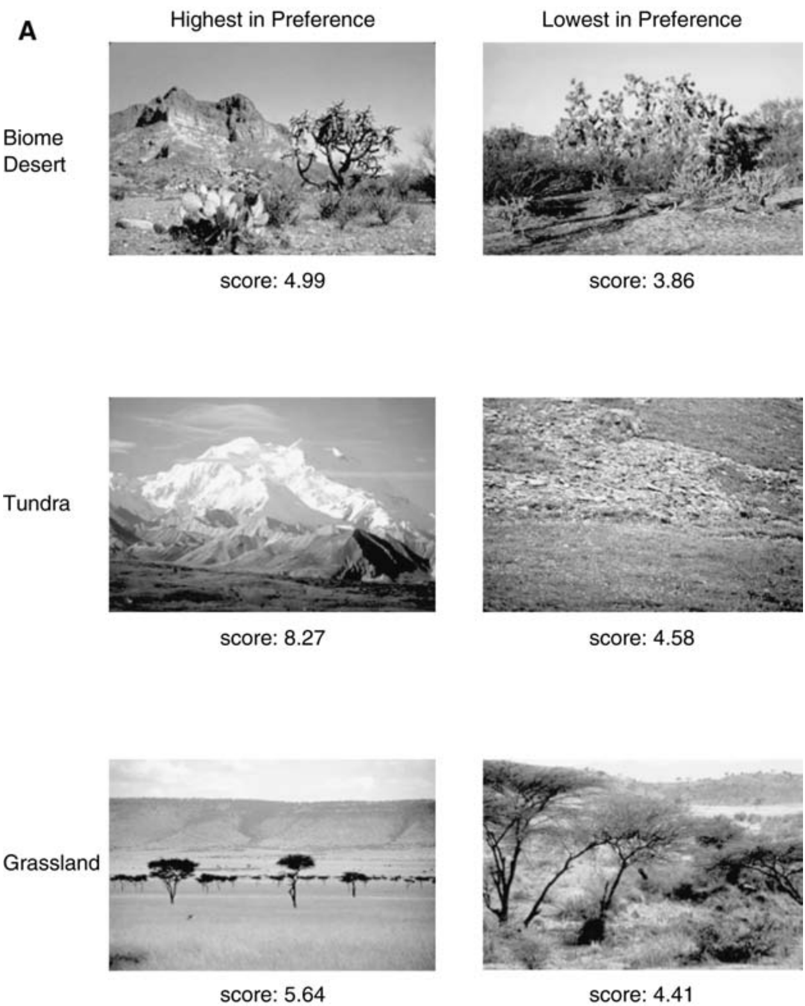
	Equation 1		Equation 2		Equation 3	
Dependent Variable	β	*p* Value	β	*p* Value	β	*p* Value
Complexity	0.274	0.035	0.261	0.021		
Openness	0.172	0.139	0.290	0.005		
Water features	0.455	0.001	0.325	0.003		
Dummy 1 (Desert)			–0.321	0.011	–0.466	0.006
Dummy 2 (Tundra)			0.210	0.086	0.130	0.422
Dummy 3 (Grassland)			–0.273	0.035	–0.303	0.065
Dummy 4 (Coniferous)			0.141	0.226	0.140	0.387
Dummy 5 (Deciduous)			–0.114	0.324	–0.126	0.437
R^2	0.445		0.697		0.355	
F	11.213	< 0.001	4.631	0.002	11.755	< 0.001

independent. The second one treated all the perceived physical factors and five dummy variables transformed from the six biome types as independent. The third multiple regression took only the five dummy variables as independent. All these three multiple regression analyses did not encounter the problem of collinearity as indicated by the Conditional Index (< 15; Belsley, Kuh, & Welsch, 1980). By comparing the values of R^2, the results indicated that the first multiple regression explained 9% more of the variance than the third one (Table 4). This suggested that the perceived physical variables were slightly better than the biome classification in explaining the psycho-physiological response to natural landscapes, though whether this difference reached a statistical significance was not known.

Discussion

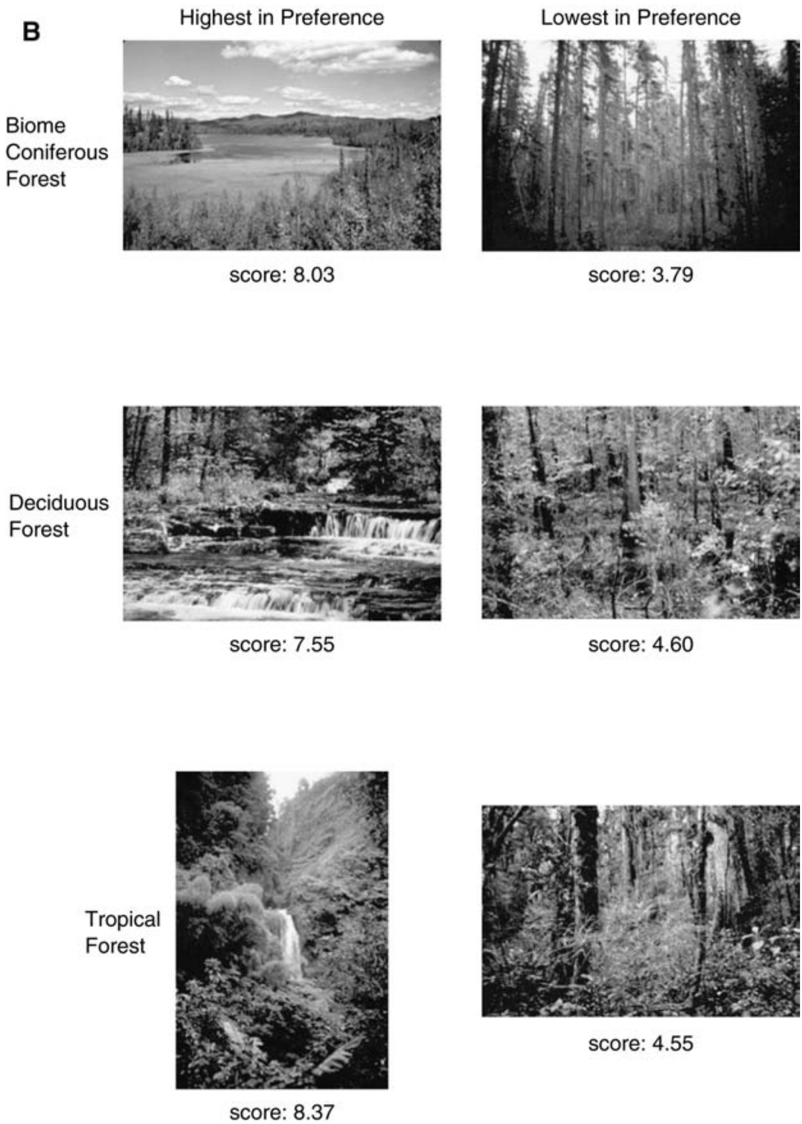
In addition to this research, three other studies (Balling & Falk, 1982; Lyons, 1983; Woodcock, 1982) tested human responses to biomes. Although the participants were of various age groups and a variety of biome categories was used, these four studies gave rise to both similar and contrasting results. The findings from these independent research projects suggest that desert is the least preferred biome. However, the author's study found four results that contrasted from those of the earlier research. First, in this study, tundra and coniferous forest were clearly the most favored biomes, whereas

Figure 1
Sample Slides of the Six Biomes



(continued)

Figure 1 (continued)



other studies did not appear to produce such clear-cut results regarding the most preferred biome(s). Second, in the previous research, deciduous forest tended to be in the top half of the biomes studied in terms of preference, whereas in the present study, deciduous forest was ranked fourth among the six biomes in terms of scenic beauty, preference, and restorativeness. Moreover, grassland appeared to be one of the least favored biomes in this study, whereas savanna was not evaluated as the least preferred biome in the other three studies. Fourth, this study used the three perceived physical features of the six biomes as the controlling variables in the hope that it would lead to a better understanding of human responses to natural settings in terms of scenic beauty, preference, and restoration.

Before going further to the discussions, the author wishes to bring three points to the readers' attention. First, both the SRPRS and the SRRS are instruments to measure perceived restoration or restorative potential of environments rather than actual restorativeness. Second, Balling and Falk (1982) and Lyons (1983) used participants of various ages and found that preferences for biomes differed between age groups. This is regarded as an interaction between innate predisposition of natural settings as advocated by evolutionary theory and experience with or learning about environments as advocated by cultural theory. Because this study focused more on human evolution, the effects of the demographic features of the respondents such as age, gender, residence, education, and occupation on their responses were not examined here. Third, although the biome slides were not photographed based on aesthetic criteria, they were not a random sample of natural landscapes.

Responses to Grassland

Quite unexpectedly, the participants of this research responded very unfavorably to grassland. This was relatively surprising because several studies have demonstrated that participants, regardless of cultural differences, exhibit a significant preference for savanna-like or park-like settings, which are characterized by relatively smooth ground surfaces with scattered trees (Balling & Falk, 1982; Ruiz & Bernaldez, 1982; Ulrich, 1979, 1983, 1986, 1993; Yi, 1992). Balling and Falk (1982) referred to this positive reaction to park-like settings as the support for the savanna hypothesis. Alternatively, this can also be interpreted as support for the grassland–woodland hypothesis because grassland with scattered clumps of trees can be viewed as open woodland or a mix of grassland and forest.

However, the other three studies that specifically focused on human responses to biomes appeared to be nonsupportive of the savanna hypothesis. Researchers could argue that this fact is largely because of the sampled instances for savannas. Balling and Falk's (1982) four savanna slides included a relatively green one that received higher ratings in relation to preference than the other slides. By contrast, Lyons (1983) chose not to include that slide because it was rated as being too different from other savanna exemplars. Furthermore, Woodcock's (1982) 24 savanna slides included the same four instances used by Balling and Falk. Moreover, his slides covered both dry and wet types of savannas in Africa. Out of 8 grassland slides, the current study included 4 relatively lush ground surfaces and 2 relatively smooth ground surfaces with scattered trees. However, neither of these studies found a higher preference for savanna grassland than for other biomes.

Though this study included scenes not only of savannas dominated by C_4 grasses in African tropical ecosystems (Cerling, 1992; deMenocal, 2004; Sarmiento, 1984) but also of grasslands elsewhere, it might shed some light on the savanna hypothesis in particular and on human perceptions of natural environments in general. Balling and Falk (1982) did refer to the natural settings as biomes in their study (p. 11), and they also invited experts to judge the biome representativeness of their slides (p. 12). Since Balling and Falk's study, many researchers and authors have made use of this term in their research. However, it is becoming apparent that the savanna hypothesis with a psychological perspective does not strictly adhere to any bioecological definition. When considered under a strict ecological-biome definition, the savanna hypothesis tends to be rejected, whereas a less biological and more landscape-featured version tends to be supported.

Although the preferred features can be described as relatively smooth ground surfaces with scattered trees, they might be more appropriately classified as psycho-biological rather than bioecological. This is because not every natural setting characterized by the landscape features of smooth ground surfaces with scattered trees meets the bioecological definition of savanna grassland. Furthermore, if the favorable landscape configurations of savannas appear to be preferred irrespective of any official biomes, an interesting issue is raised: Are psycho-biological descriptions more appropriate than bioecological features when studying human responses to natural settings? The answer is perhaps that they are because the findings of this study suggest that the biome classification is not the best factor in determining the psycho-physiological response.

Another possible reason for not finding positive reactions to savanna grassland is some evidence that indicates that C_4 grasslands similar to the savannas in today's Africa were established millions of years after the hominid species developed its obligate bipedal ability (Bishop, 1976; Leakey & Hay, 1979; Cerling, 1992; Cerling & Hay, 1986; Potts, 1998; Senut et al., 2001). Therefore, savanna grasslands were not the evolutionary habitats for humans and human beings did not develop psychological mechanisms that molded adaptive responses to those savanna grasslands.

Responses to Deciduous Forests

In studies by Balling and Falk (1982) and Lyons (1983), deciduous forest was rated as having a very high preference among the general population and by college students in particular. Woodcock (1982) also found that hardwoods were evaluated as having the highest preference among college students. All their slides were photographed during the spring and summer growing seasons. Their findings seem to support the forest hypothesis, as human beings have developed psychological mechanisms that mold adaptive responses to woodland.

This study included three slides of deciduous trees that were not taken during the growing season, and it was found that deciduous forest evoked relatively low positive responses. This finding does not appear to support the forest hypothesis. Among the slides used in this study, two had sparse leaves and one showed orange-brown leaves that were changing color. Previous research indicates that the amount of tree crowns visible is positively associated with people's favorable reactions (Buhyoff, Gauthier, & Wellman, 1984; Lien & Buhyoff, 1986; Schroeder, 1989). This perhaps explains the low favorable responses to deciduous trees with small amounts of leaves. However, other studies have also shown that respondents tend to prefer forest slides featuring the orange-brown color (Buhyoff, Wellman, & Daniel, 1982) and a complexity of vegetation color (Pearce & Waters, 1983). This demonstrates both the importance of and difficulty encountered in collecting samples of natural landscapes that are not in a static but rather a dynamic state. Seasonal changes appear to be a very important factor in gaining a proper and accurate understanding of human responses to natural landscapes (Orians & Heerwagen, 1992).[2]

Responses to Coniferous Forest

This study found that the participants responded the second most favorably to coniferous forest among the six biomes. This finding does not seem to support the forest hypothesis because coniferous forests have not been flourishing in tropical Africa. Instead, it seems to favor a cultural theory that advocates that environmental preferences are determined socioculturally through experience or learning because American people are familiar with or frequently exposed to parks or backyards, where coniferous trees are relatively common.

Nevertheless, as bioecological features are not the most appropriate operational definitions for studying human reactions to natural settings, particularly in the case of savanna grasslands, this would also be applicable to forested environments and even any natural setting. Scholars adopting evolutionary perspectives might contend that (a) contemporary humans are supposed to react most favorably to those settings containing features or patterns that are close to or similar to those of the evolutionary habitats and (b) this does not mean that the preferred settings should have bioecological features or patterns that are identical to the evolutionary environments. The earlier notions are advocated by the nonhabitat-specific approach as it is not the habitat per se but certain features presented in the habitat that evoke people's favorable responses. This contrasts with the habitat-specific approach as in the cases of the savanna, forest, and grassland–woodland hypotheses (Orians & Heerwagen, 1992).

It appears that the preferred characteristics are not purely bioecological in nature. Thus, favored woodlands could be deciduous, coniferous, or tropical forests as long as they exhibit the preferred features. By contrast, settings, no matter their official biome types, without these preferred characteristics tend to be disliked. This is illustrated by results showing that one tropical forest slide received the highest preference score, one tundra slide received the second highest preference score, one coniferous forest slide was rated to have the lowest preference, and one desert slide was rated to have the second lowest preference among the total of 48 slides (Figure 1). Therefore, the nonhabitat-specific approach shows its greater flexibility, potential, and promise over the habitat-specific approach when studying human reactions to nature.

Responses to Tundra

An interesting result of this study is that tundra was found to be the most favored setting in terms of scenic beauty, preference, and restorativeness. Thus far, very few studies have attempted to investigate people's psychophysiological reactions to tundra. It is therefore evident that more research will have to be done on the subject before any justifiable claims can be made about it. Nevertheless, people's strong and positive responses to tundra, which by definition is cold and arid, seem unexpected; tundra is considered to be a hostile habitat for most living creatures. It is worth noting that neither an evolutionary perspective nor a cultural perspective can provide reasonable explanations as to how and why people responded so favorably to tundra in the present study. Thus far, no evidence has suggested that tundra plays a vital role in human history in terms of biological evolution or civilization.

Some people might be curious as to why this study included tundra, because the previous studies conducted by Balling, Falk, Lyon, and Woodcock never did. However, tundra deserved inclusion as it is a legitimate type among the six major terrestrial biomes. Balling and Falk (1982) also mentioned that tundra was one kind of natural environment and raised concerns about people's responses to it more than 20 years ago (pp. 6-7). However, why tundra was not included in their study is still not known. The absence of research on people's responses to tundra might have resulted from careless omissions or simply the difficulty of having access to tundra.

Two factors may have played a role in the favorable responses to tundra that were found in this study. The first one is related to the climate of Texas and the other is related to the slide examples of tundra. The participants' data on scenic beauty, preference, and restoration with respect to the six biomes were collected from students at Texas A&M University. Although not all participants were Texans, given that they were recruited in the spring semester, they would have lived in Texas for at least a couple of months. Therefore, the participants' experiences of the humid and hot weather in central Texas might have led to favorable responses to tundra that is dry and cold. However, Balling and Falk (1982) compared the preference data collected from Arizona (a desert climate, $n = 30$) and non-Arizona ($n = 100$) college students in the United States and found a high correlation and no difference for their five biomes. The effect of the experience of weather on responses to landscapes probably deserves attention in future research. It appears that very few discussions have been devoted to this subject so far.

Moreover, most of the tundra slides used in this research were representative examples of alpine tundra on high mountains with few trees (Odum, 1989) and included only a few examples of Arctic tundra around polar icecaps at high latitude, which are usually flat, featureless, and monochromic (Odum, 1989).[3] Several studies have shown that people prefer natural landscapes with great variations in topography or color over those with little or no variation (e.g., Brush, 1981; Bureau of Land Management, 1983; Litton, 1972; Shafer, Hamilton, & Schmidt, 1969; Pearce & Waters, 1983; Zube, 1970). Thus, if the slides had included more examples of Arctic tundra, the participants' reactions in terms of scenic beauty, preference, and restorativeness to tundra may have been less favorable. However, attributing the participants' favorable reactions exclusively to the tundra's changes in elevation seems somewhat inappropriate because the slides for each of the six biomes do show some mountain backgrounds. Nevertheless, it seems to be relatively difficult to use a reasonable number of exemplars to cover even one type of natural setting in a representative and comprehensive manner. This is because each of the major biomes still includes subcategories (Odum, 1989).

Three Perceived Physical Variables

The three perceived physical features explained more variances than the biome classification in the participants' responses. When ignoring the biome classification, people respond most favorably to a natural setting possessing a high level of complexity and a large quantity of water features. Also, even when the biome classification was included in the multiple regression analysis along with the perceived physical variables, complexity, openness, and water features were still significant predictors of the response (Table 4). Convergently, they suggested that a nonhabitat-specific approach to environmental responses is more flexible than a habitat-specific approach; the favorable features appear to be irrespective of biome types. Meanwhile, these preferred characteristics have been identified repeatedly in numerous studies (e.g., Berlyne, 1971; R. Kaplan & Kaplan, 1989; Ulrich, 1983; Yi, 1992) and are congruent with several theories of landscape aesthetics or environmental perception. According to Berlyne's (1971) information theory, human beings should respond favorably to a natural setting with moderate to high levels of information rate because natural environments are less information intensive than man-made settings. In addition, both evolutionary and cultural theories propose that human beings have strong and positive reactions to environments with the presence of water features, given the significance of water for survival and well-being, through either biological needs or learned experiences (e.g., Orians & Heerwagen, 1992; Ulrich, 1983, 1993).

Taken together, it all seems to suggest that human landscape preference or other responses to environments is not one dimensional. A comprehensive understanding of landscape preference or responses to environments should not be limited to any perspective alone. A combination of various theories—such as the evolutionary, cultural, Berlyne's (1971) information, the Kaplans' (1989), Ulrich's (1983), and Appleton's (1975/1996) prospect-refuge theories—is probably the approach that holds the most promise. Note that the author does not intend to nullify any theory of landscape aesthetics nor do the results of this study advocate the need for using the perceived physical variables alone as a theoretical alternative to, or replacement of, any other theories. Furthermore, when integrating these theories, researchers probably need to clarify the exact interrelatedness of biophysical features (such as water bodies, tree crowns, landforms, colors), perceived variables (for example, complexity, mystery, familiarity), and psycho-physiological responses (i.e., preference, restoration, EMG, epinephrine) (Han, 1999).

Conclusion

In line with the perspectives of human evolution, the objective of this study was to test people's responses to the six major terrestrial biomes while controlling three perceived physical variables to investigate which specific natural setting can evoke the most positive responses from the college students. The results indicated that tundra and coniferous forest were the most favored biomes, whereas desert and grassland were the least favored ones. These findings tend to support the forest hypothesis but not the long-held savanna hypothesis. In addition, the nonhabitat-specific approach shows its greater flexibility and potential than the habitat-specific approach. Given that a grassland–woodland setting is not among the six biomes, the grassland–woodland hypothesis was not examined here. Future research might make use of an approach similar to psychological relics to test the grassland–woodland hypothesis. Nonetheless, the hypotheses of the savanna, forest, and grassland–woodland need not necessarily be confined by a purely bioecological point of view.

It appears that no single current theory alone can sufficiently explain the causal processes responsible for any consistently favorable reaction to natural settings in general and to biomes in particular. An approach that integrates multiple perspectives such as evolution and culture seems to hold the most promise for understanding the landscape preferences or responses to environments among humans. In addition, the influence of weather and seasonal changes, which have seldom been taken into account in studies on environmental perception and landscape aesthetics, probably deserves further exploration. Also, the distinction between scenic beauty, preference, and restoration as well as their relationships between other variables (physical and perceived) are worthy of investigation (Han, 2001, 2002, 2003a; Herzog, Maguire, & Nebel, 2003). Finally, the author hopes that social sciences such as psychology and natural sciences such as palaeogeography can work together and complement each other to contribute to a more comprehensive picture of human evolution.

Notes

1. The rankings of the four responses of the unadjusted means for the six biomes only differed from those adjusted for the covariates at the exchanging spots of coniferous forest and tundra.

2. *Landscape Research* recently published a special issue on seasonal landscapes (Palang, Fry, Jauhiainen, Jones, & Soovali, 2005).

3. Odum's (1989) definition of tundra is "Between the forests to the south and the Arctic Ocean and polar icecaps to the north lies a circumpolar band of about 5 million acres of treeless country called the Arctic tundra. Smaller but ecologically similar regions found above the tree line on high mountains are called alpine tundras" (p. 238).

References

Andrews, P. (1989). Palaeoecology of Laetoli. *Journal of Human Evolution*, *18*, 173-181.

Appleton, J. (1975/1996). *The experience of landscape*. New York: John Wiley.

Balling, J. D., & Falk, J. H. (1982). Development of visual preference for natural environments. *Environment and Behavior*, *14*, 5-28.

Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. New York: John Wily.

Berger, L. R., & Tobias, P. V. (1996). A chimpanzee-like tibia from Sterkfontein, South Africa and its implications for interpretation of bipedalism in Australopithecus africanus. *Journal of Human Evolution*, *30*, 343-348.

Berlyne, D. E. (1971). *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts.

Bishop, W. W. (1976). Pliocene problems relating to human evolution. In G. L. Isaac & E. R. McCown (Eds.), *Human origins: Perspectives on human evolution* (Vol. 3, pp. 139-153). Menlo Park, CA: WA Benjamin.

Blumenschine, R. (1986). *Early hominid scavenging opportunities: Implications of carcass availability in the Serengeti and Ngorongoro ecosystems, British Archeological Reports International Series*. Oxford, UK: Archaeopress.

Bobe, R., & Behrensmeyer, A. K. (2004). The expansion of grassland ecosystems in Africa in relation to mammalian evolution and the origin of the genus Homo. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *207*, 399-420.

Brush, R. O. (1981). Landform and scenic preference: A research note. *Landscape Planning*, *8*, 301-306.

Buhyoff, G. J., Gauthier, L. J., & Wellman, J. D. (1984). Predicting scenic quality for urban vegetation measurements. *Forest Science*, *30*, 71-82.

Buhyoff, G. J., Wellman, J. D., & Daniel, T. C. (1982). Predicting scenic quality for mountain pine beetle and western spruce budworm damaged forest vistas. *Forest Science*, *28*, 827-838.

Bureau of Land Management. (1983). *Visual resource management program*. Washington, DC: Department of the Interior, Bureau of Land Management.

Cerling, T. E. (1992). Development of grasslands, savannas in East Africa during the Neogene. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *97*, 241-247.

Cerling, T. E., & Hay, R. L. (1986). An isotopic study of paleosol carbonates from Olduvai Gorge. *Quaternary Research*, *25*, 63-78.

Clarke, R. J., & Tobias, P. V. (1995). Sterkfontein Member 2 footbones of the oldest South African hominid. *Science*, *269*, 521-524.

Coss, R. G., & Moore, M. (2002). Precocious knowledge of trees as antipredator refuge in preschool children: An examination of aesthetics, attributive judgments, and relic sexual dinichism. *Ecological Psychology*, *14*, 181-222.

Daniel, T. C., & Vining, J. (1983). Methodological issues in the assessment of landscape quality. In I. Altman & J. F. Wohlwill (Eds.), *Behavior and the natural environment* (pp. 39-84). New York: Plenum.

Dart, R. A. (1925). Australopithecus africanus: The man ape of South Africa. *Nature*, *115*, 195-199.

deMenocal, P. B. (2004). African climate change and faunal evolution during the Pliocene-Pleistocene. *Earth and Planetary Science Letters*, *220*, 3-24.

Elashoff, J. D. (1969). Analysis of covariance: A delicate instrument. *American Educational Research Journal*, *6*, 383-410.

Gritter, M. K. (1997). *The effect of time-since-treatment and other factors on the perceived scenic beauty of southern pine-oak forest*. Unpublished master's thesis, Texas A&M University, College Station.

Han, K.-T. (1999). A proposed landscape assessment framework: A connection of theories and practical techniques. *Journal of Architectural and Planning Research*, *16*, 313-327.

Han, K.-T. (2001). *A critical examination of scenic beauty, preference, and restorativeness with respect to six major terrestrial biomes*. Unpublished doctoral dissertation, Texas A&M University, College Station.

Han, K.-T. (2002). The mediating effects of scenic beauty, familiarity, and typicality on the relationship between preference and restoration. *Proceedings of the 33rd annual conference of the Environmental Design Research Association*, *33*, 124.

Han, K.-T. (2003a). An examination of two cognitive variables, three physical features, and five human responses with respect to natural landscapes. *Proceedings of the 34th annual conference of the Environmental Design Research Association*, *34*, 225-226.

Han, K.-T. (2003b). A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning*, *64*, 209-232.

Hartig, T. A. (1993). *Testing restorative environments theory*. Unpublished doctoral dissertation, University of California, Irvine.

Hartig, T. A., Korpela, K., Evans, G. W., & Garling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing & Planning Research*, *14*, 175-194.

Herzog, T. R., & Barnes, G. J. (1999). Tranquility and preference revised. *Journal of Environmental Psychology*, *19*, 171-181.

Herzog, T. R., Black, A. M., Fountaine, K. A., & Knotts, D. J. (1997). Reflection and attentional recovery as distinctive benefits of restorative environments. *Journal of Environmental Psychology*, *17*, 165-170.

Herzog, T. R., & Bosley, P. J. (1992). Tranquility and preference as affective qualities of natural environments. *Journal of Environmental Psychology*, *12*, 115-127.

Herzog, T. R., & Chernick, K. K. (2000). Tranquility and danger in urban and natural settings. *Journal of Environmental Psychology*, *20*, 29-39.

Herzog, T. R., Maguire, C. P., & Nebel, M. B. (2003). Assessing the restorative components of environments. *Journal of Environmental Psychology*, *23*, 159-170.

Herzog, T. R., & Stark, J. L. (2004). Typicality and preference for positively and negatively valued environmental settings. *Journal of Environmental Psychology*, *24*, 85-92.

Huck, S. W. (1972). The analysis of covariance: Increased power through reduced variability. *Journal of Experimental Education*, *41*, 42-46.

Hull, R. B., & Stewart, W. P. (1992). Validity of photo-based scenic beauty judgments. *Journal of Environmental Psychology*, *12*, 101-114.

Jang, H.-C. (1998). *Effect of ecosystem management of public acceptance of visual impacts and perceived scenic value in a tourist destination area*. Unpublished doctoral dissertation, Texas A&M University, College Station.

Jolly, C. J. (1970). The seed eaters: A new model of hominid differentiation based on a baboon analogy. *Men*, *5*, 5-26.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. New York: Cambridge University Press.

Kaplan, R., Kaplan, S., & Ryan, R. L. (1998). *With people in mind: Design and management of everyday nature*. Washington, DC: Island.

Kaplan, S. (1987). Aesthetics, affect, and cognition: Environmental preference from an evolutionary perspective. *Environment and Behavior*, *19*, 3-32.

Kaplan, S., & Kaplan, R. (1982). *Cognition and environment: Functioning in an uncertain world*. New York: Praeger.

Klein, R. G., & Edgar, B. (2002). *The dawn of human culture*. New York: Wiley.

Korpela, K. (1991). Are favorite places restorative environments? *Environmental Design Research Association*, *22*, 371-377.

Leakey, M. G., & Hay, R. L. (1979). Pliocene footprints in the laetoli beds at Laetoli, northern Tanzania. *Nature*, *278*, 317-323.

Lien, J. N., & Buhyoff, G. J. (1986). Extension of visual quality models for urban forests. *Environmental Management*, *22*, 245-254.

Litton, B. R. (1972). Aesthetic dimensions of the landscape. In J. Krutilla (Ed.), *Natural environments: Studies in theoretical and applied analysis* (pp. 262-291). Baltimore, MD: The John Hopkins University Press.

Lyons, E. (1983). Demographic correlations of landscape preference. *Environment and Behavior*, *15*, 487-511.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. Cambridge, MA: MIT Press.

Newell, P. B. (1997). A cross-cultural examination of favorite places. *Environment and Behavior*, *29*, 495-514.

Odum, E. P. (1989). *Ecology and our endangered life-support systems*. Sunderland, MA: Sinauer Associates.

Orians, G. H. (1986). An ecological and evolutionary approach to landscape aesthetics. In E. C. Penning-Rowsell & D. Lowenthal (Eds.), *Landscape meaning and values* (pp. 3-25). London: Allen & Unwin.

Orians, G. H., & Heerwagen, J. H. (1992). Evolved responses to landscapes. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 555-579). New York: Oxford University Press.

Palang, H., Fry, G., Jauhiainen, J. S., Jones, M., & Soovali, H. (2005). Landscape and seasonality: Seasonal landscapes [Special Issue]. *Landscape Research*, *30*(2).

Parsons, R. (1991). The potential influences of environmental perception on human health. *Journal of Environmental Psychology*, *11*, 1-23.

Pearce, S. R., & Waters, N. M. (1983). Quantitative methods for investigating the variables that underlie preference for landscape scenes. *Canadian Geographer*, *27*, 328-344.

Potts, R. (1998). Variability selection in hominid evolution. *Evolutionary Anthropology*, *7*, 81-96.

Rayner, R. J., Moon, B. P., & Masters, J. C. (1993). The Makapansgat australopithecine environments. *Journal of Human Evolution*, *24*, 219-231.

Richards, J. M. (1996). Units of analysis, measurement theory, and environmental assessment: A response and clarification. *Environment and Behavior*, *28*, 220-236.

Robinson, J. T. (1954). The genera and species of the Australopithecinae. *American Journal of Physical Anthropology*, *12*, 181-200.

Ruiz, J. P., & Bernaldez, F. G. (1982). Landscape perception by its traditional users: The ideal landscape of Madrid livestock raisers. *Landscape Planning*, *9*, 279-297.

Sarmiento, G. (1984). *The ecology of neotropical savannas*. Cambridge, MA: Harvard University Press.

Schroeder, H. W. (1989). Esthetic perception of the urban forest: A utility perspective. *Journal of Arboriculture*, *15*, 292-294.

Senut, B., Pickford, M., Gommery, D., Mein, P., Cheboi, K., & Coppens, Y. (2001). First hominid from the Miocene (Lukeino formation, Kenya). *Comptes Rendus de l'Académie des Sciences—Series IIA—Earth and Planetary Science, Paries*, *332*, 137-144.

Shafer, E. L., Hamilton, J. F., & Schmidt, E. A. (1969). Natural landscape preference: A predict model. *Journal of Leisure Research*, *1*, 1-19.

Snedecor, G. W., & Cochran, W. G. (1989). *Statistical methods*. Ames: Iowa State University.

SPSS Inc. (1999). *SPSS base 10.0 applications guide*. Chicago: Author.

Stevens, J. (1990). *Intermediate statistics: A modern approach*. Hillsdale, NJ: Lawrence Erlbaum.

Ulrich, R. S. (1979). Visual landscapes and psychological well-being. *Landscape Research*, *4*, 17-23.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. F. Wohlwill (Eds.), *Behavior and natural environments* (pp. 85-125). New York: Plenum.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, *224*, 420-421.

Ulrich, R. S. (1986). Human responses to vegetation and landscapes. *Landscape and Urban Planning*, *13*, 29-44.

Ulrich, R. S. (1989). The role of trees in human well-being and health. In P. D. Rodbell (Ed.), *Proceedings of the fourth urban forestry conference* (pp. 25-30). Washington, DC: American Forestry Association.

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes. In S. R. Kellert & E. O. Wilsons (Eds.), *The biophilia hypothesis* (pp. 73-137). Washington, DC: Island/Shearwater.

WoldeGabriel, G., White, T. D., Suwa, G., Renne, P., de Heinzelin, J., Hart, W. K., et al. (1994). Ecological and temporal placement of early Pliocene hominids at Aramis, Ethiopia. *Nature*, *371*, 330-333.

Woodcock, D. M. (1982). *A functionalist approach to environmental preference*. Unpublished doctoral dissertation, University of Michigan, Ann Arbor.

Yhang, W. (1994). *The effect of color on the perceived scenic beauty of pine-oak plots in the Ouachita national forest, Arkansas*. Unpublished doctoral dissertation, Texas A&M University, College Station.

Yi, Y.-K. (1992). *Affect and cognition interference in aesthetic experiences of landscapes*. Unpublished doctoral dissertation, Texas A&M University, College Station.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist*, *35*, 151-175.

Zube, E. H. (1970). Evaluating the visual and cultural landscape. *Journal of Soil Water Conservation*, *25*, 1137-1150.

Ke-Tsung Han is associate professor of the Department of Landscape Design and Management at the National Chin-Yi Institute of Technology, Taiwan. He has a BS in landscape architecture from the Chinese Culture University in Taiwan, an MLA from the University of Illinois at Urbana-Champaign, an MArch in urban design from the University of Colorado at Denver, and a PhD in urban and regional science from the Texas A&M University. His current research interests focus on restorative environments and Feng Shui.