WORKING PAPER
2000-7

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Perception of Tree Canopy

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by

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May 2000

ABSTRACT

Deciduous tree canopy was investigated in relation to perception of fecundity and visual attractiveness. Canopy having deliquescent shape was defined by season (in leaf or in branch), fullness (amount of leaf and amount of branch) and in the case of summer trees, combinations of leaf and branch (balance of leaf to branch). Applying the Gestalt principle of closure or completeness three hypotheses were derived. These were 1) trees with the most complete (strongest) canopies will be the most attractive, 2) trees in bare branch will be less attractive than trees in leaf, and 3) the attractiveness of a tree in leaf will depend upon the amount of leaf in relation to amount of branch. A pilot investigation was used to select computer-generated images of bare branch and leafed tree stimuli that were employed in the main investigation. The study required participants (N=239) to view and rate the 12 trees selected. Both in pilot and final phases of investigation, ratings were made on six scales measuring perception of fecundity and six bi-polar scales measuring attractiveness. Results confirmed hypotheses 1 and 2. Supplementary analysis indicated that leaf accounted for more variance than branch. It was concluded that perception of the fecundity and visual attractiveness of a tree reflects the completeness of its canopy. The Gestalt principle of closure was linked to prospect-refuge theory and suggested to be a vestige of evolutionary development and germane to the notion of biophilia.

ACKNOWLEDGMENT

This research was supported by Legacy 2: Strategies for Sustainable Forest Management, Sustainable Forest Management Network, University of Alberta

INTRODUCTION

Trees are the largest and longest lived life form on terrestrial earth and highly important to the preservation of biodiversity and ecosystem integrity. This realization is a factor in the progressive public shift away from an instrumental view of forested land and toward identification with holistic ecosystem management principles (Schindler, 1998). This shift has been accompanied by accelerated desire to experience primal forest. For example, Cordell and Hendee (1982) reported that visits to natural parks in the USA increased at more than three times the rate at which population increased during recent times.

From a great distance a forest canopy appears as a single undulating contour forming a figure against a background of sky. But moving closer, the forest is experienced as a surface created by interlocking canopies of single trees. The forest no longer can be seen apart from the canopies of these individual trees, and inside the forest, single trees attract attention and become the forest in a perceptual sense. In extreme cases, individual trees even gain a special identity, such as has been the case for the Greendale Oak, Cowthorpe Oak, the Grizzly Giant, and Nature's Garage (Schama, 1995). And growing alone outside the forest, the canopy of the ordinary untended tree takes on the special characteristics of its species. The precise features displayed in the canopy reflect the health, growing conditions and age of the tree.

Interaction with trees can result in emotional experience. Herzog and Miller (1998) found that attraction is the common response to forest and field settings whereas urban alleys evoke an experience of danger. Parsons (1991) reported that contact with nature elicits psychological and physiological benefits. Ulrich (1984) found that post-operative patients exposed to natural settings recovered faster than patients in rooms opening on an urban scene. A related investigation reported that natural views reduce stress (Kaplan & Kaplan, 1989). Interesting and contrary to the notion that vegetation provides hiding places for criminals and thus serves to increase apprehension among urbanites, scenes showing treed parks were discovered to promote a sense of safety in residents of a Chicago inner-city neighborhood (Kuo, et. al., 1998). Consistent with this, Schroeder and Cannon (1983) reported favorable emotional responses to treed as compared to untreed streets. All such things are related to the desire of the public to preserve and visit forestlands and disapprove of clear-cut harvesting practices.

Sommer and Summit (1995) investigated preferences for tree form using computer generated tree icons differing in canopy size, trunk height and width. Preference was strongest for trees having larger canopies, and smaller thinner trunks. Legg and Hicks (1976) tested preferences for spreading branched and vase shaped trees vs. columnar and narrow-conical shaped trees. Exemplars of the first two types were preferred over the latter types both by residents and nurserymen. Investigating extremes of tree form, Chan (1998) discovered deliquescent preferred to excurrent tree forms.

Aesthetic Problems

Aesthetics as an area of study dates from mid-eighteenth century and Edmund Burke who was the first to make detailed analyses of landscapes as sources of emotional experience. The practical results of his observations were registered in the landscaping of the managed environments of his day. In his time the sources of beauty in nature were sought by private estate owners who wanted to make their lands attractive and stimulating (Appleton, 1975).

This original desire to explore the biophysical basis of aesthetic response to the environment was long lost sight of. In ensuing centuries, the study of aesthetics became focussed on art forms rather than natural landscapes (Hepburn, 1968). Unfortunately this has not benefited the understanding of beauty. Eaton (1998) after reviewing the topic of aesthetics in the Encyclopedia of Philosophy was unable to identify a satisfactory theory of aesthetics ("Aesthetic concepts are learned in contexts where – roles – are learned" pg. 58). Also the review of Budd (1998) denied the existence of an aesthetic attitude that would govern perceptions of artistic expression ("Hence, the aesthetic attitude is either a myth or of little interest" pg. 54).

During the last 30 years, progress has been made toward development of a scientifically admissible study of aesthetics that has involved a return to the study of nature (Heerwagen and Orians, 1993). The results of investigations conducted within this perspective have led to the conclusion that human aesthetic experience is partially determined by genetic inheritance and that learning and culture are correspondingly less important (Ulrich, 1993). This is exemplified by observations that similarities in aesthetic response to natural scenes have been discovered to be the same across individuals, social groups and ethnic backgrounds. Also, rural and urban differences in backgrounds and cultures appear to exert minor influences in preference for natural environments. This would explain the failure to identify broad principles governing the aesthetic appeal of architectural styles and other art forms, which are in their very nature cultural expressions. Wilson (1993) touched on this where he stated "It suggests that when human beings remove themselves from the natural environment, the biophilia learning rules are not replaced by modern versions equally well adapted to artifacts" (pgs. 31-32). He proposed that a condition called biophilia exists as a component of human genetic make-up and is defined as "the innately emotional affiliation of human beings to other living organisms" (pg. 31).

Investigation

The canopy of the growing tree is shaped by leaf and branch. When a hardwood is in dormant condition, canopy is shaped by the branches alone. Because growth of branches and leaves are stereotyped for a given tree species, it is possible to apply Gestalt grouping principles to predict that canopies comprised of dense branches and/or many leaves will evoke strong experiences of tree form. Gestalt factors of similarity and nearness are evoked as determinants of spontaneously perceived tree form. The operation of these two factors fosters a cognitive outcome called closure, which favours seeing closed or complete forms (Schiffman, 1990). Because of the operation of such factors, a tree of given size with many branches or many leaves will produce a strong experience of canopy as compared with a weak tree having fewer elements fostering closure.

Present inquiry focused on three questions related to differences in the canopy of deliquescent tree from. The first concerned the perceptual significance of strong vs. weak canopies. The second referred to differential perceptual properties possessed by canopies in bare branch vs. canopies in leaf. The third concerned how the balance between leaf to branch is represented in perception.

The first expectation was that trees with the strongest canopies would be most attractive overall. Therefore, when response to tree canopies are measured on scales of natural fecundity (Nelson & Taerum, 1999) or on appropriate meaning dimensions represented by semantic differential polarities, trees having the stronger canopies should elicit the most favorable responses whether the tree is seen in winter (in bare branch) or is seen in summer (in leaf). This hypothesis was suggested by knowledge that richness of canopy indicates tree health (Heerwagen & Orians, 1993) and also suggests the capability of the environment to support vegetation favorable to human existence (Orians, 1986). An exception was predicted for passage of natural light where weak foliage has the advantage.

Our second expectation was that attractiveness of trees in bare branch should be diminished generally as compared to that elicited from trees in leaf. This is because the canopy in bare branch is less complete and, therefore, sends an ambiguous environmental message. It may be dormant but could be dead and, hence, denote an unfruitful source and unfavorable habitat. Also, when fecundity is measured on scales such as *provides good protection from wind and rain,* or *plenty of fruit and berries to eat,* or *plenty of birds and small animals*, attractiveness should be higher for the canopy in leaf. In terms of semantic properties conveyed by the polarities *living-dying*, *active-inactive*, *healthy-sick*, the prediction must be that summer canopies will better convey the favorable properties living, active, and healthy than winter canopies. However, canopies in bare branch have merit. They provide a less obstructed view of the landscape and their openness gives certainty that nothing undesirable is hidden from view. Therefore, trees in bare branch were predicted to be superior to those in leaf in relation to the properties *allows for human movement*, *allows a good view of surrounding environment*, and *allows entry of light*. No prediction was made about differences between winter and summer canopy with respect to polarities *beautiful-ugly*, *smooth-rough*, and *pleasant-unpleasant*.

Our third expectation was that aesthetic response to trees with canopy in leaf will reflect the amount of leaf in relation to amount of branch. Therefore, attractiveness should be greater for tree canopies where plentifulness of leaves is high in relation to plentifulness of branches, than for tree canopies where the plentifulness of branches is high relative to leaves. This hypothesis was suggested by the observation that indications of resource depletion in the form of defoliated branches or unhealthiness in the form of dead branches, negatively affects aesthetic appreciation (Heerwagen & Orians, 1993).

METHOD

Pilot Study

Part A: Deriving Bare Branch Canopy Stimuli

Participants

A group of 17 undergraduate university students served as participants in a study of perception of tree form. Participants were 10 females and 7 males, ranging in age from 18 to 24 years and enrolled in introductory psychology. The same participants served in Part A and Part B of the pilot study.

Materials

A deciduous tree in dormant or winter state taken from American Forests was adapted as the prototype tree. A black and white illustration of this tree devoid of foliage served as the deciduous tree template. To provide a range of possible stimuli, the template was altered in regard to number of branches. Branches were either removed or added to arrive at a series of 9 stimuli representing 9 different levels of bare branching. These served as winter tree stimuli and were prepared as overhead transparencies for pilot presentation to participants. Modifications of the template tree were accomplished using the Adobe Photoshop 3.0.5 graphics program.

Stimuli were presented one at a time via overhead projector. Participants first categorized the density of each tree canopy as *low*, *medium* or *high*, and then rated each tree on a 10-point scale, anchored with *scarcity of branches* at one extreme and *an abundance of branches* at the other. Using data derived from the first item, it was possible to identify the best exemplar of each category. The second item provided rating data confirming or disconfirming the categorization.

Procedure

Upon arrival, participants were given a description of the purposes of the study and asked to read and sign a consent form. Following this, participants viewed 9 overhead transparencies each depicting a tree, one at a time. Participants were able to complete the experiment without difficulty.

Results

Responses were analyzed by ANOVA which showed the presence of reliable ($p < 0.05$) differences among the 9 trees. Using mean ratings from the categorization task and confirming data from rating scale responses, three stimuli were selected. The three trees labeled B_W, B_M, and B_S in Figure 1 became the independent variables for experiment 1. These 3 trees represent, respectively, a weak bare branch canopy (B_W), a medium bare branch canopy (B_M), and a strong bare branch canopy (B_S).

(Figure 1 about here)

Part B: Deriving Leafed Canopy Stimuli

Materials and Procedure

The original 9 bare branch trees from Part A served as templates. Leaves were added to each tree to create summer or growing trees showing weak, medium and strong levels of foliage. This resulted in a set of 9 leafed trees organized along 2 dimensions, i.e. 3 trees differing in density of branches by 3 trees differing in density of leaves. Leaves were added using the Adobe Photoshop 3.0.5 graphics program. These were transferred to overhead transparencies to make 9 summer season tree stimuli.

As in Part A, participants first categorized each tree according to appearance of leaf architecture as *none at all*, *very few*, *some*, or *plenty*, and then rated each tree on a 10-point rating scale anchored by *no leaves* and *extremely full of leaves*. Canopies were displayed in a random order.

Results

Responses were analyzed by ANOVA which showed the presence of reliable ($\underline{p} < 0.05$) differences among the 9 trees. Three leaf stimuli were selected based on categorizations of leaf architecture and rating scale responses.

The three levels of foliage were transferred by computer to each level of bare branch stimuli (B_WL_N, B_ML_N, B_SL_N) identified in Part A resulting in a new array of 9 leafed tree stimuli. This resulted in a set of tree stimuli consisting of B_WL_W (weak branch - weak leaf), B_WL_M (weak branch - medium leaf), B_WL_S (weak branch - strong leaf), B_ML_W (medium branch - weak leaf), B_ML_M (medium branch - medium leaf), B_ML_S (medium branch - strong leaf), B_SL_W (strong branch - weak leaf), B_SL_M (strong branch - medium leaf), and B_SL_S (strong branch - strong leaf). These are shown in Figure 2 combined with winter tree stimuli derived from Part A.

(Insert Figure 2 about here)

Main Experiment

Participants

Two hundred thirty nine (239) undergraduate university students enrolled in introductory psychology served as participants. Participants were 167 females and 72 males ranging in age from 18 to 39 years. Each received course credit for participation.

Materials

The 12 black and white illustrations of trees derived in the pilot study served as stimuli (Figure 2). The 12-item Tree Form Rating Scale shown Figure 3 was used to record responses to each tree. The scale consisted of two groups of items. The first six items referred to six conditions of fecundity. Five of these referred to differing types of environmental affordances - natural occurrences conducive to human adaptation and survival in a new environment (Gibson, 1979). The remaining scale (item 4), referred to prospect, or unimpeded opportunity to see the surrounding environment (Appleton, 1975). The 7-point fecundity scales were anchored by *not at all* and *extremely well*. Items 7 - 12 were semantic meaning items taken from Nelson and Taerum (1999). These items required participants to rate each stimulus on the 7-point scale bounded by polar terms. Responses to these two groups of items together constituted the aesthetic measurement.

(Insert Figure 3 about here)

Procedure

Participants were randomly assigned to one of 12 conditions. Specifically, 18 participants rated only the B_WL_N tree, 25 participants rated only the B_ML_N tree, 20 participants rated B_SL_N, 23 participants rated B_WL_W, 17 participants rated B_ML_W, 19 participants rated B_SL_W, 17 participants rated B_WL_M, 20 participants rated B_ML_M, 18 participants rated B_SL_M, 21 participants rated B_WL_S, 21 participants rated B_ML_S, and 20 participants rated B_SL_S.

Upon arrival, participants listened to a description of the study and read and signed a consent form. A Tree Canopy Rating Scale was then given to each participant and explained. Each participant saw and rated only 1 of the 12 tree canopies projected on a screen from overhead transparency. All participants were able to fulfill experimental requirements without difficulty.

Results

All responses were analyzed with a 3 x 4 MANOVA employing 3 levels of Branched Canopy (Weak, Medium, Strong) and 4 levels of Leaf Canopy (None, Weak, Medium, Strong) with fecundity and semantic differential items analyzed separately. Duncan's Multiple Range Test was used to confirm or disconfirm interpretations based on MANOVA alone.

Preliminary results of multivariate tests for fecundity showed significant main effects for Branch ($F(12, 440) = 5.6$, $p < .00$) and Leaf ($F(18, 623) = 7.97$, $p < .00$), and a non-significant interaction of Branch and Leaf ($F(36, 969) = .625$, $p > 1.0$). Analysis of semantic differential items revealed a main effect for Leaf, ($F(18, 228) = 10.31$, $p < .00$), a marginally significant effect for Branch ($F(12, 444) = 1.6$, $p < .09$), and a non-significant interaction between Leaf and Branch ($F(36, 978) = 1.08$, $p > .05$). Individual item means for the Branch and Leaf main effects are shown in Table 1 and Table 2, respectively.

TABLE 1
SCALE ITEM MEAN RATING AND STANDARD ERROR BY LEVEL OF BRANCHED CANOPY

Tree Form Rating Scale Item	Strength of Branched Canopy: Weak		Medium		Strong	
	χ	est. σ_M	χ	est. σ_M	χ	est. σ_M
1) Provides good protection from wind and rain***	2.64	0.15	3.19	0.15	3.89	0.16
2) Plenty of fruit and berries to eat °	1.50	0.14	1.87	0.14	1.83	0.14
3) Allows for human movement °	4.71	0.18	4.27	0.17	4.48	0.18
4) Allows a good view of surrounding environment**	4.60	0.16	4.36	0.16	3.86	0.16
5) Plenty of birds and small animals*	3.04	0.23	2.70	0.22	3.52	0.23
6) Allows entry of natural light**	5.26	0.16	5.38	0.16	4.60	0.16
7) Living – Dying**	3.42	0.18	3.12	0.17	2.63	0.18
8) Active – Inactive°	4.21	0.20	4.07	0.19	3.94	0.20
9) Beautiful – Ugly**	3.45	0.16	3.45	0.16	2.89	0.16
10) Smooth – Rough°	4.52	0.14	4.49	0.14	4.35	0.14
11) Healthy – Sick**	3.32	0.16	3.39	0.16	2.78	0.16
12) Pleasant – Unpleasant***	3.17	0.15	3.35	0.15	2.61	0.15

$p > 0.05$°
$p < 0.05$*
$p < 0.01$**
$p < 0.001$***

TABLE 2
SCALE ITEM MEAN RATING AND STANDARD ERROR BY LEVEL OF LEAF CANOPY

Tree Form Rating Scale Item	Strength of Leaf Canopy: None		Weak		Medium		Strong	
	χ	est. σ_M	χ	est. σ_M	χ	est. σ_M	χ	est. σ_M
1) Provides good protection from wind and rain***	1.95	0.17	3.06	0.18	3.81	0.18	4.17	0.17
2) Plenty of fruit and berries to eat *	1.42	0.16	1.60	0.16	1.93	0.17	1.97	0.16
3) Allows for human movement °	4.63	0.20	4.69	0.20	4.54	0.21	4.10	0.20
4) Allows a good view of surrounding environment***	5.21	0.18	4.47	0.19	3.80	0.19	3.62	0.18
5) Plenty of birds and small animals**	2.47	0.25	2.91	0.26	3.38	0.27	3.58	0.25
6) Allows entry of natural light***	5.60	0.18	5.48	0.19	4.71	0.20	4.54	0.18
7) Living – Dying***	4.55	0.20	3.66	0.20	2.41	0.21	1.61	0.20
8) Active – Inactive***	5.06	0.22	4.19	0.23	3.67	0.24	3.37	0.22
9) Beautiful – Ugly***	4.33	0.18	3.75	0.19	2.86	0.19	2.11	0.18
10) Smooth – Rough***	5.42	0.16	4.64	0.16	4.05	0.17	3.71	0.16
13) Healthy – Sick***	4.21	0.18	4.14	0.19	2.48	0.19	1.81	0.18
14) Pleasant – Unpleasant***	4.20	0.17	3.77	0.17	2.36	0.18	1.84	0.17

$p > 0.05$°
$p < 0.05$*
$p < 0.01$**
$p < 0.001$***

Hypothesis 1: Fullness Property

Fecundity Items. The hypothesis that trees with the most complete canopies would be perceived as most attractive was confirmed for fecundity descriptions 1 and 5 for Branched Canopies (Table 1), and measures 1, 2, and 5 for Leaf Canopies (Table 2). Specific to Branched Canopies, Table 1 means show all weak canopies were inferior to all medium canopies, and medium canopies inferior to all strong canopy trees. A similar pattern emerged for Leaf Canopy items such that fecundity ratings tended to increase with increases in strength of canopy. Overall, ratings indicated aesthetic response was most favorable for strong canopies, whether in dormant or summer state**.** Note that the two exceptions to this pattern were for the items *Allows a good view of surrounding environment*, and *allows entry of natural light* where strong canopy would be expected to block more light than weak canopy.

Semantic Meaning Items. Mean ratings for semantic meaning items 7 – 12 in Tables 1 and 2 exhibited a pattern similar to fecundity items. Although ordering among means was not as strong for branch compared to leaf canopies, trees with strong canopy were rated as more alive, more active, more beautiful, smoother, healthier, and pleasant than were trees with weaker canopies for both leaf and branch canopies. As with fecundity items favorableness tended to increase across conditions with increases in strength of canopy.

Hypothesis 2: Seasonal Property

Fecundity Items. While hypothesis 1 asked whether trees with strong canopy would be perceived more favorably than weak canopy trees, hypothesis 2 concerned the different characteristics of trees without leaf, termed winter canopies (L_N), and those with leaf, termed summer canopies, (L_W, L_M and L_S). As can be observed in Table 2, summer canopies represented by weak, medium, and strong leaf canopy were perceived to be superior to winter canopies (L_N), in providing *protection from wind and rain*, *plenty of berries and fruit*, and *plenty of birds and small animals*. Tests also confirmed the prediction that winter canopies would outrank those of summer on Fecundity scales 4 and 6 in respect to *allows a good view of surrounding environmen*t and *allows plenty of natural light*.

Semantic Meaning. Significant differences between winter and summer canopies were observed also on semantic differential items. Winter trees received low ratings for properties beautiful, living, active, healthy and pleasant, compared to trees in leaf, and low ratings on the smooth – rough dimension. These findings were taken to reflect that winter trees held less aesthetic appeal and were generally perceived less favorably and as less attractive than summer trees.

Hypothesis 3: Relational Property

The third hypothesis was based upon a relational property possessed by summer tree forms, namely, the ratio of leaf to branch. This hypothesis predicts that the aesthetic appeal of trees displaying differing levels of branch will depend upon the absolute amount of leaf in the canopy such that high ratios of leaf to branches will be preferred over low leaf to branch ratios. Thus as number of branches is held constant, trees with greater numbers of leaves will be viewed more positively than the same tree with fewer leaves. Alternatively, lack of support for this hypothesis would suggest that aesthetic appeal depends on fullness of canopy alone.

Results of analyses on this question provided mixed support for the relational propriety and suggested that leaf alone accounted for the majority of variance in aesthetic appeal. Main effects analyses for leaf data (Table 2) exhibited predicted linear trends ($p < .05$) such that favorableness of ratings increased with increases in leaf. However, analysis of branch data revealed significant trends ($p < .05$) in the reverse direction such that more favorable ratings occurred with increases in branch relative to leaf. Thus, when leaf was held constant, attractiveness of tree increased as the number of branches increased – a finding opposite to the relational prediction.

Finally, a non-significant interaction was observed between leaf and branch for both fecundity and semantic differential items, suggesting that leaf and branch are aesthetically independent factors. Overall, the weight of the evidence suggested that aesthetic impressions were mediated by general fullness of canopy, irrespective of the relationship between numbers of branches and leaves.

Given this result, additional analyses were undertaken to determine the relative contribution of leaf and branch to perceptions of canopy. Comparison of the proportion of variance accounted for by branch and leaf, revealed that foliage accounted for approximately twice as much variance as did branch overall both on fecundity and semantic meaning dimensions. Taken together these data suggest perceptions of tree canopy were primarily determined by fullness of canopy and that variation in leaf was a more important cue in assessing fullness than variation in branch.

DISCUSSION

This study involved perception of tree canopies in leaf (growing or summer state) or in bare branch (dormant or winter state). Canopies in leaf were varied in respect to the balance between leaf and branch. Both canopies in leaf and in bare branch were defined on a weak-strong dimension based upon how well a canopy reflects Gestalt principles of closure or completeness. Perception of ecological properties was measured on scales of fecundity and perception of aesthetic properties on bi-polar semantic differential scales.

Results confirmed that stronger canopies elicited more favorable perceptions of fecundity and beauty. This was true both for canopies in winter and in summer states. In addition, summer canopies were rated more favorably than winter canopies having the same strength of branching. The latter perception reflected only structural differences between winter and summer canopies and did not involve seasonal variations in color since all stimuli were monochromatic. Consistent with the preference for summer trees, variation in level of leaf produced a greater effect than variation in level of branch.

We conclude as Orians (1980), that canopy characteristics evoke expectations about the nature of the environment in which the tree is growing. Taken together, fecundity and semantic meaning scales measure types of information and feeling states conveyed by tree canopies that could play a role in habitat selection. They provide a way to account for the difference in natural attractiveness of environments, given that environmental preferences are attached to objects that favor survival. The ability to choose between options in different directions at a distance would be highly adaptive for an individual in search of food, water and a safe place for eating and sleeping.

Reading ecological signals from remote canopies depends on more than perception of amounts of branch and leaf in the canopy. Learning adds to and modifies genetically based impressions of natural beauty. The importance of factors such as leaf shape, angle at which branch meets trunk, color of bark and leaf have to be acquired. For example, Salix babylonica (Weeping Willow) with fine branching drooping downwards and densely covered with long narrow pointed leaf signals a wet landscape. Quercus bicolor (Swamp White Oak) with smooth lobed cone shaped leaves, light gray in color and attached to stiff long-reaching ungainly limbs provides a learned sign of a landscape varying between wet and dry. The environment in which Carya ovata (Shagbark Hickory) grows is signaled by long loose strips of gray bark which are oftentimes unattached at top and at bottom. The leaves are compound and each leaflet is seriated. Such features identify fecund conditions. Historically, the tree was an indicant of a good place to settle, clear and plant. In present day a healthy Shagbark Hickory identifies a place with an unpolluted atmosphere.

In his theory of landscape perception, Appleton (1975) proposed that trees occupy a special significance aesthetically because they provide a handy way for an individual to gain a more satisfying view of the surroundings. This is consistent with research (Nelson & Rodrigues, 1996) concluding that forested wilderness providing visual prospect is attractive for camping and hiking. Appleton’s second dimension of human need was refuge. Combining these as a desire for prospect-refuge means that in a group of trees that are equally tall and which, therefore, provide equal amounts of prospect, individual variation in the degree of refuge offered will cause variation in aesthetic approval. Trees manifesting greatest refuge will be perceived most favorably. Present results were consistent with this as trees in leaf provide better cover than the same tree in bare branch and were rated higher in affordance and aesthetically. Also, the most densely leafed of the leafed trees were rated highest on dimensions of fecundity and semantic meaning so that for both affordance and aesthetic qualities there was progressive approval as canopy improved *the ability to see without being seen*. Possibly this explains why trees in bare branch were rated lower than trees in leaf even when the affordance item was *allowed a good view of the surrounding environment*. When we assume, as Appleton, that prospect and refuge gain importance to the extent that each contributes to the need to “see without being seen”, imbalances lowering the accumulative effect will sharply reduce the impact of a high level of either factor taken alone. Unfortunately, the present study did not contain conditions where leaf cover was held constant and height varied to enable test of this proposal. However, there is evidence that large sized trees in a forested landscape are perceived as most pleasing (Rodrigues & Nelson, 1996).

If favorable response to increasing the amount of leaf in the canopy reflects improvement of refuge and strengthening of perceptual closure, a question then arises about the relationship of refuge to closure. Traditional Gestalt theory concerning figural processes is of little help. Such explanation is in terms of physical field forces acting upon cortical tissue in an isomorphic manner, i.e. it is conjectured that visual targets propagate electrical currents which spread throughout brain tissue as a continuous or volumetric conductor (Koehler, 1969). Prospect-refuge theory can furnish an ecological alternative for understanding the familiar figural principle of closure.

In conversation Appleton proposed that perceptual sensitivity to prospect-refuge acted to favor survival of hominoid ancestors by addressing the most prominent need, the need to avoid predation. He pointed out that satisfaction of sexual needs can be postponed indefinitely, deprivation of food can be tolerated for an extended period, water ingestation can be foregone for more than a day but death from predation requires only seconds. Through the instrumentality of seeing without being seen, hominoid ancestors with limited ability to fight or flee survived to procreate. From this position, the more complete a prospect-refuge, the more meaningful it will be in an ecological sense. In the arboreal environment this translates as the more complete the tree leaf cover the more meaningful is the canopy perceptually.

In the Gestalt sense too, the more complete a figure the more meaningful it is. But, one must take cognizance of the fact that figural tendencies illustrating Gestalt principles such as closure are no more than tendencies, e.g. the familiar horse and rider illustration is an ambiguous representation of a real thing. What the Gestalt figural principles show primarily is the ability of the perceptual system to create a meaningful scene out of scraps of information. Such efficient organization and response to environmental conditions could be a perceptual legacy bequeathed by millions of years of human evolution in the natural environment. Taking this orientation, we conclude the Gestalt principle of closure may be a vestige of evolutionary development.

It is upon this basis also that we propose that the powerful perceptual tendencies identified seventy-five years ago by Gestalt investigators are symbolic of real world affordances crucial to ancestral humans. The human is genetically equipped to process visual information in the natural world that wrote our neural script. This would make ecological sense of Gestalt mystery and may shed light on why as humanity retreats from it, wildernesses provokes increasing need on the public to visit it (Cordell & Hindee, 1991). It also suggests how salutary effects are derived from wilderness experience and are transferred to stressed persons, and the sense behind the concept biophilia.

References

Appleton, J. (1975). The Experience of Landscape. London: John Wiley and Sons, Ltd.

Budd, M. (1998). "Aesthetic attitude". In Routledge Encyclopedia of Philosophy. E. Craig (Ed.): London: Routledge.

Chan, Jessie. (1997). *What aspects of Tree Morphology Affect Perceived Environmental Affordance?* Unpublished manuscript, University of Alberta, Edmonton.

Cordell, H. K., and Hindee, J. C. (1992). Renewable Resources Recreation in the United States. Washington, D.C.: American Forestry Association.

Dorfman, P.W. (1979). Measurement and meaning of recreation satisfaction. Environment and Behavior, 11, 483-510.

Eaton, M. (1998). "Aesthetic concepts". In Routledge Encyclopedia of Philosophy. E. Craig (Ed.): London: Routledge.

Gibson, J. J. (1979). The Ecological Approach to Visual Perception. Boston: Houghton Mifflin.

Haekel, E. (1910). The Evolution of Man. London: Watts.

Hays, W. L. (1988). Statistics. New York: Holt, Rhinehart and Winston, Inc.

Heerwagen, J. H. and Orians, G. H. (1993). Humans, Habitats, and Aesthetics. In S. R. Kellert, and E. O. Wilson (Eds.), The Biophilia Hypothesis. (pp. 138-172). Washington, DC: Island Press.

Hepburn, R.W. (1968). "Aesthetic appreciation in nature". In Aesthetics in the Modern World. H. Osburn (Ed.): London: Thames and Hudson.

Hepburn, R.W., Kaplan, R. and Kaplan, S. (1989). The Experience of Nature. Cambridge, UK: Cambridge University Press.

Kaplan, R. And Kaplan, S. (1989). The Experience of Nature. Cambridge, UK: Cambridge University Press.

Knopf, R.C. (1987). Human behavior, cognition and affect in the natural environment. In D. Stokols and I. Altman (Eds.), Handbook of Environmental Psychology. New York: Wiley, pp. 785-825.

Koehler, W. (1969). The Task of Gestalt Psychology. Princeton, New Jersey: Princeton University Press.

Kuo, F. E., Bacaicoa, M., and Sullivan, W. C. (1998). Transforming inner-city landscapes. Environment and Behavior, *30*(1), 28-59.

Legg, M. H. and Hicks, R. R. (1978). Public decision-making in selecting trees for human settlements, (pp. 274-285). Toronto: Toronto Centre for Urban Forestry Studies.

Nelson, A.B. and Rodrigues, P.J. (1996). Influence of forest diversity and understanding upon perception of public land. Book of Abstracts. Victoria, British Columbia: International Conference on Sustaining Ecosystems and People in Temperate and Boreal Forests.

Nelson, T. M. and Taerum, T. (1999). Beauty and the forest. In T. S. Veeman, D. W. Smith, B. G. Purdy, F. J. Salkie and G. A. Larkin (eds), Sustaining the Boreal Forest: Conference Proceedings. Edmonton: Sustainable Forest Management Network.

Orians, G. H. (1986). An ecological and evolutionary approach to landscape aesthetics. In Penning-Roswell E. C., and Lowenthal, D. (Eds.), *Landscape Meanings and Values*, (pp.3-22). London: Allen and Unwin.

Orians, G.H. (1980). Habitat selection: general theory and applications to human behavior. In J.S. Lockard, (Ed.), The Evolution of Human Social Behavior. New York: Elsevier.

Parsons, R. (1991). The potential influences of Environmental Perception on Human Health. Journal of Environmental Psychology, 11, 1-23.

Rodrigues, P.J. and Nelson, A.B. (1996). Attractiveness of Forest Settings Varying in Tree Size, Extent of Tree Branching, Terrain Steepness and Occupancy. Book of Abstracts. Victoria, British Columbia: International Conference on Sustaining Ecosystems and People in Temperate and Boreal Forests.

Schama, S. (1995). Landscape and Memory. New York: Alfred A. Knopf.

Schroeder, H.W. (1991). Preference and meaning of Arboretum landscapes. Journal of Environmental Psychology, 11, 231-268.

Schroeder, H. W. and Cannon, Jr., W. N. (1983). The esthetic contribution of trees to residential streets in Ohio towns. Journal of Arboriculture, (9), 237-276.

Shindler, B. (1998). Does the public have a role in forest management? Canadian and U.S. perspectives. Forestry Chronicle, 74, 700-702.

Sommer, R. and Summit, J. (1995). An exploratory study of preferred tree form. Environment and Behavior, *27*(4), 540-557.

Ulrich, R.S. (1993). "Biophilia, Biophobia, and natural landscapes. In The Biophilia Hypothesis. S.R. Kellert and E.D. Wilson (Eds.): Washington, D.C.: Island Press.

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

Whitehead, A. N. (1920). The Concept of Nature. Cambridge: Cambridge University Press.

Wilson, E.D. (1993). "Biophilia and the Conservation ethic". In The Biophilia Hypothesis. S.R. Kellert and E.D. Wilson (Eds.).: Washington, D.C.: Island Press.

Figure 1. Bare Branch Canopy Stimuli

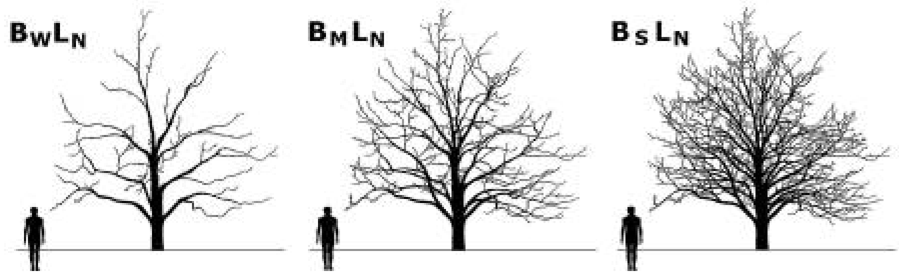

Figure 1: Above set of trees represents increasingly strong canopies in bare branch trees -- no leaf (L_N). Inset silhouette of man provides information about tree size. From left to right, trees are increasing in branch strength -- weak (B_W), medium (B_M) and strong branch (B_S).

Figure 2. Leafed Canopy Stimuli

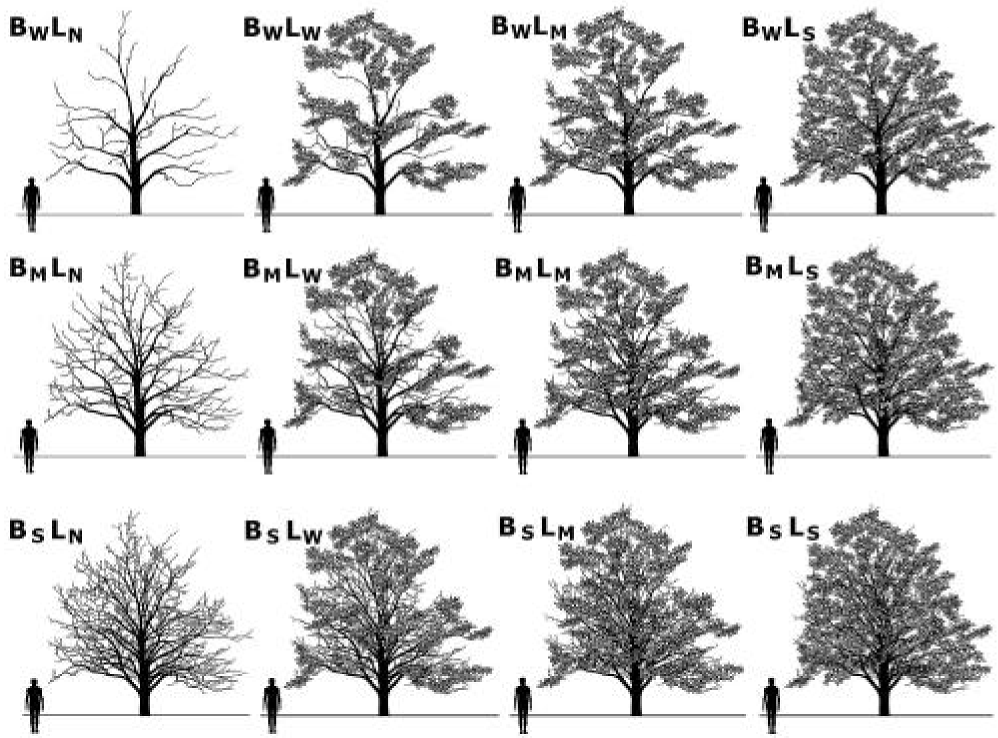

Figure 2: From top to bottom, trees are increasing in branch strength - weak branch (B_W), medium branch (B_M) and strong branch (B_S). From left to right, trees are increasing in strength of foliage - no leaf (L_N), weak leaf (L_W), medium leaf (L_M) and strong leaf (L_S).

Figure 3. Tree From Rating Scale

TREE FORM RATING SCALE

Instructions:
For items 1-6, rate the image on a 7-point scale demonstrated in the following example:

	NOT AT ALL							EXCEPTIONALLY WELL
the tree is beautiful	①	②	③	④	⑤	⑥	⑦	

If you think the statement describes the environment *Not at all*, then fill in ①.
If you think the statement describes the environment *Slightly*, then fill in ② or ③.
If you think the statement describes the environment *Moderately well*, then fill in ④.
If you think the statement describes the environment *Very well*, then fill in ⑤ or ⑥.
If you think the statement describes the environment *Exceptionally well*, then fill in ⑦.

Indicate how well you believe each of the descriptions below apply to the picture:

	NOT AT ALL							EXCEPTIONALLY WELL
1) **provides good protection from wind and rain**	①	②	③	④	⑤	⑥	⑦	
2) **plenty of fruit and berries to eat**	①	②	③	④	⑤	⑥	⑦	
3) **allows for human movement**	①	②	③	④	⑤	⑥	⑦	
4) **allows a good view of surrounding environment**	①	②	③	④	⑤	⑥	⑦	
5) **plenty of birds and small animals**	①	②	③	④	⑤	⑥	⑦	
6) **allows entry of natural light**	①	②	③	④	⑤	⑥	⑦	

Indicate how well you believe each of the descriptions below apply to the picture:

7)	**living**	①	②	③	④	⑤	⑥	⑦	**dying**
8)	**active**	①	②	③	④	⑤	⑥	⑦	**inactive**
9)	**beautiful**	①	②	③	④	⑤	⑥	⑦	**ugly**
10)	**smooth**	①	②	③	④	⑤	⑥	⑦	**rough**
11)	**healthy**	①	②	③	④	⑤	⑥	⑦	**sick**
12)	**pleasant**	①	②	③	④	⑤	⑥	⑦	**unpleasant**