A METHOD FOR DEMONSTRATING AESTHETIC PREFERENCES WITHIN ARTISTIC PICTURES

by

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Abstract

Berlyne (1971, pp. 28-29) acknowledged that "Reactions to artificially simple sights and sounds are admittedly a long way from appreciation of art." However, a concern regarding the use of art is an absence of control over the determinants of the subjects' preferences. This research attempted to overcome these methodological problems through the use of artistic pictures with the variation of a single stimulus within each picture, and consisted of two experiments, with university students as subjects.

Experiment 1 determined aesthetic preferences for size and location of the moon. Forty redrawn photocopies of "Moose at Night (Moonlight)" of Tom Thomson, were put on slides and used for eliciting aesthetic preferences. The moon was varied on each slide, with 5 different elevations and 8 different sizes. For each subject, 13 transition points were calculated, using the method of random scaling. Using analysis of variance for correlated groups, significant results were found for both average preferred size as a function of elevation, $F(4,236) = 3.61$, $p < .01$, with the larger moon being preferred at the horizon and the smaller moon being preferred at the zenith; and average preferred elevation as a function of size, $F(7, 59) = 8.31$, $p < .001$, with the higher moon being preferred if it was smaller

and the lower moon being preferred if it was larger. These results were discussed in relation to the moon illusion.

Experiment 2 tested aesthetic preferences for Hogarth's (1753/1955) line of beauty. "The West Wind (sketch)" of Tom Thomson was redrawn, giving the tree 7 different degrees of curvature. Preferred curvature was determined using the method of random scaling and compared with Hogarth's prediction. The results were analyzed using a t-test and the preferred degree of curvature was found to be significantly less than that predicted by Hogarth, $t = -11.37$, $p < .01$.

The roots of an interest in aesthetics go back far in history, with the earliest approach having been a philosophical one. For example, Birkhoff (1933) presented the philosophical theories of Plato and Aristotle regarding aesthetics and summarized the Greek view as emphasizing the importance of the formal elements in art; dealing with such concepts as unity in variety; and the definition of beauty in terms of form, ratio or proportion. Cicero is quoted by Kennedy (1980) as having outlined three functions of art: that art pleases, moves and informs us. These concerns of the early philosophical approach continue to have an influence on present day aesthetics. Within psychology as well, aesthetics was one of the first areas to be studied. Experimental aesthetics is the second oldest area in experimental psychology, having been founded by Fechner a few years after he established psychophysics (Berlyne, 1971, 1972a, 1972c).

Part of the importance of aesthetics may lie in its many practical applications. Although aesthetics is concerned with the arts, it is not confined to the arts (Berlyne, 1974a; Moles, 1958/1968). Aesthetic preferences have been applied to such diverse areas as education (Arnheim, 1966; Mueller, Kennedy & Tanimoto, 1972), environmental design (Berlyne, 1972a; Wohlwill, 1980), sculpture (Machotka, 1979), and use of leisure time (Berlyne, 1972a).

Inspite of its early beginnings, there is still a need for research within experimental aesthetics to define what constitutes beauty, particularly in relation to art. This study will review some of the theories, methodology, and empirical research within experimental aesthetics and then, present a method for empirically validating previous concepts of beauty through the use of artistic pictures and the variation of stimuli within them.

Definition of Aesthetics

The area of experimental aesthetics has been difficult to define because of its broadness. Since the beginning, aesthetics has been linked to perception. This can be seen in the terminology used, since the term 'aesthetics' is derived from the Greek verb 'aisthanomai' meaning 'to perceive' (Berlyne, 1974a). As well, Moles (1958/1968) pointed out that the etymological origin of the word aesthetics goes beyond the problem of art and studies our way of experiencing the surrounding world.

Experimental aesthetics was separated from its philosophical roots by Fechner who distinguished 'an aesthetics from below', which concerns itself with the elementary determinants of liking and disliking from 'an aesthetics from above', which is philosophical and emphasizes lofty and abstract concepts (Berlyne, 1972c). In focusing on the elementary determinants of liking and disliking, Fechner established experimental aesthetics as the second oldest area in psychology (Berlyne, 1971, 1972c).

As part of experimental psychology, various aspects of aesthetics began to be delineated. One of the first suggestions was that there may be intellectual as well as emotional aesthetic judgements (Feasey, 1921-22). Brighouse (1939) included apperception, the process of acquiring a clear focused awareness of the structure of a painting, including the perceptive function of evaluation, as part of a definition of aesthetics. Finally, it was pointed out by Peters (1942) that there are three aspects of aesthetic experience: attitudes (the response aspect of pleasantness and unpleasantness), perception (the stimulus aspect of aesthetic experience), and experience (the genetic aspect of affection).

Early attempts to operationalize aesthetic judgement focused on the subject's response to art. Aesthetic judgement was defined by Cahalan (1939) as the ability to judge between varying degrees of merit in art situations and by Brighouse (1939) as the feelings of pleasantness and unpleasantness aroused by the qualities of beauty and ugliness in an art object. Peters (1942) seemed to characterize the earlier approaches and link them to later research when he suggested that the field should be operationally defined in terms of evaluating judgements.

This characterization of aesthetic preferences as evaluating judgements can be seen in more recent attempts to define aesthetics. Kennedy (1974) gave a narrow definition of aesthetics as the study of taste and preference and then broadened this definition to include all the relations between the meanings and manners (style) of a work of art. This would be compatible with Berlyne's (1971) definition of aesthetics in terms of collative variables, which focused on subjects' preferences for stimuli varied among various dimensions such as complexity, novelty, surprisingness, and ambiguity. Finally, Hardiman and Zernich (1977), in a review of studies on preferences for the visual arts, found the key terms in defining aesthetic preference to be like and dislike and suggested that regardless of the stimulus used, aesthetic preference is a general evaluative factor that is unidimensional and consistent.

The emphasis in defining aesthetics would seem to have been on the subject's judgement and evaluation, which is related to their taste or preference, with respect to the stimulus or work of art used. For the purposes of this research then, the focus will be on what Peters (1942) labelled the perception aspect of aesthetic experience, and aesthetic preference will be defined as the subject's judgement or evaluation of variations in art, based on their preference or taste.

Theoretical Background

Several theories have been proposed to account for aesthetic preferences. Most of the theoretical background in this area is based on general psychological or perceptual theories which have then been applied to aesthetics. This section will review several of these approaches which include: structuralism, psychoanalysis, mathematical theories, type theories, Gestalt theory, information theory and Berlyne's work.

Structuralism. Structuralism was one of the earliest approaches in perception to be used for the study of aesthetics. By using sensory psychophysics, the early psychologists attempted to break down the optic array into elementary components or sensations (Hochberg, 1962, 1964). However, as Hochberg (1964) pointed out a major problem with this approach is that complex stimuli do not appear as expected, based on how their parts appear.

An application of structuralism to aesthetics can be seen in the work of Kennedy, which reportedly is based on the Gibsons' registration theory. Registration theory is founded on the hypothesis that perception is determined by the data available to the perceiver, not by processes that alter or supplement the available data (Kennedy, 1974). This section will review some of the research of the Gibsons and then, applications of this work to aesthetics.

The Gibsons focused on various aspects of picture perception such as form perception (Gibson, 1951) and the role of perspective in picture perception (Gibson, 1961), in order to arrive at a theory of picture perception. According to Gibson (1971) this theory of picture perception is based on registration theory, which looks at the information light conveys about the world. This information is defined by Gibson as certain specifiable relations in the light to the eye reflected from the object, which are in one-to-one correspondence with some aspects of the object and are invariant across certain transformations (Hagen, 1980). Therefore, the concept of optical information, which consists of invariants of the structure of an optic array (Gibson, 1971) is crucial. (An optic array has been described by Kennedy (1974) as the structure or pattern made by the contrasts of light from different directions, which at a given station point is ambient since it fully surrounds the station point). The optic array from a picture and the optic array from the world can provide the same information without providing the same stimulation, enabling an artist to capture the information about something without replicating its sensations (Gibson, 1971).

Hagen (1980) has proposed a variation of Ecological Optics, which is Generative Theory. Her position was that no art style is ever one of invariants depiction, since such a thing is not possible. Instead, Generative Theory categorizes paintings in terms of: 1) the station point(s) assumed; 2) the relative emphasis on variant and invariant projective aspects; and 3) the balance between two- and three-dimensional compositional concerns.

Kennedy has used Gibsons' theory of picture perception to develop further evidence for the structuralist approach. This research shows that a line figure does not depict the sum of the things depicted by its contours (Kennedy, 1972) and that subjects are motivated by the gradual appearance of recognizable structure, which does not necessarily have to consist of an interesting end-point.

Kennedy (1974) suggested that a psychology of information and pictures will be helpful to aesthetics by revealling some of the mechanics linking the effects and devices of paintings. It has also been suggested that structuralism and experimental aesthetics can be linked by integrating Berlyne's concern with motivation with structuralism's emphasis on understanding (Kennedy, 1980). The structuralist approach to aesthetics is summarized as emphasizing the person's understanding of the nature of the elements and their relations using any suitable method that makes things intelligible, and based on the assumption that preferences reflect comprehension and follow from a good fit between meaning and the medium (Kennedy, 1980).

The structuralist approach has enjoyed a recent revival in its application to aesthetics and an example of this is a recent collection of essays edited by Hagen (1980) on the application of this approach to picture perception.

Psychoanalysis. The psychoanalytic approach to aesthetics has been criticized by other researchers in the area, for example, by Berlyne (1971) and Arnheim (1964). Criticisms levelled at psychoanalytic aesthetics have included that the Freudian approach to aesthetics was highly subjective and had little to do with central aesthetic questions (Spector, 1972) and that there is little focus in psychoanalytic aesthetics on the formal or structural aspects of art (Berlyne, 1971, 1972c). In fact, Spector (1972) argued that no comprehensive aesthetic can be derived from psychoanalysis without more emphasis on perception, form, and value. More recently, Machotka (1979) has attempted to integrate the perceptive and projective functions of art in a psychoanalytic study of the perception of the nude. His conclusion, in this regard, was that as one becomes a good judge of art, the importance of perception increases and that of projection decreases (Machotka, 1979).

Mathematical Theories. An early approach to the study of aesthetics was the attempt to establish mathematical principles which would underlie aesthetic forms. One of the earliest such attempts was that of Emch (1900) who suggested that the principle factor in our judgement of aesthetic forms was symmetry.

The major work in this area was done by Birkhoff (1933). Birkhoff reportedly based his approach on the unity-in-variety principle, which was first postulated by Fechner in 1876 (Davis, 1936; Brighouse, 1939; Eysenck, 1957). This principle was applied as a formula for aesthetic measure based on the relationship between order and complexity, the formula was then used to determine the aesthetic value of various polygonal forms, ornaments, and vases (Birkhoff, 1933).

There were numerous attempts to validate Birkhoff's method (Davis, 1936; Beebe-Center & Pratt, 1937; Harsh, Beebe-Center & Beebe-Center, 1939; Brighouse, 1939). Beebe-Center and Pratt (1937) found that Birkhoff's formula was valid for determining the aesthetic measure of polygons and vases, and concluded that Birkhoff's formulas were valid as first approximations to quantitative rankings of aesthetic value. Previously, Davis (1936) had found no support for Birkhoff's formula for polygons. However, his procedure differed from that recommended by Birkhoff, with respect to having a vertical position and distinguishing between formal and connotative associations in the instructions. Brighouse (1939) obtained the opposite results from those that would be predicted from Birkhoff's formula, in that there was an increasing preference for simpler forms with increasing age and art experience.

This inconclusive evidence led to alternative mathematical definitions of aesthetic measure. Harsh, Beebe-Center and Beebe-Center (1939) using factor analysis found four factors involved in aesthetic judgements for polygons (smoothness, simplicity, symmetry and odd points) and suggested Birkhoff's formula is a transformation equation which is a fusion of simplicity and symmetry. Rashevsky (1938) suggested an alternate approach, based on previous mathematical and biophysical studies, where in looking at the total excitation corresponding to a given polygonal contour, its intensity may be considered a measure of the aesthetic value of a given contour. Finally, Eysenck (1941b) found two factors which underlie Birkhoff's results, a general T-factor (good taste) and a bipolar factor, which divided the people preferring the simple figures from those preferring the complex figures. Later, Eysenck (1957) suggested that Birkhoff's general formula was wrong and that aesthetic measure is the product of the order and complexity elements, with the most preferred objects being those with a high degree of both order and complexity. Berlyne (1972c) in his review of Birkhoff's work also concluded that the implication that the less complex patterns are more aesthetically pleasing was wrong.

Although the attempt to derive a mathematical formula accounting for aesthetic preference was unsuccessful, the importance of this approach lay in the attempts to quantify aesthetic preference and the emphasis on factors such as complexity, order and symmetry; all of which played an important role in future research. In fact, it has been suggested that Birkhoff's two factors could be identified in information theory terms as uncertainty and redundancy (Gunzenhauser, 1968 cited in Wohlwill, 1980; Berlyne, 1972a).

Type Theories. In an attempt to account for differences in judgements of the same stimuli along with differences in the reasons given, subjects were categorized into aesthetic types by numerous researchers (Peters, 1942).

One of the earliest categorizations of subjects into aesthetic types was by Bullough (1922). Based on research on colour preferences, Bullough found four types of aesthetic apperception which he labelled the objective, physiological, associative, and character types. Bullough's findings were supported by Feasey (1921-22), who found that the four perceptive types appear in the aesthetic appreciation of simple forms. However, for more complex material three additional categories were needed (judgements referring to the artist, imaginativeness of the design, and the presence or absence of meaning).

Eysenck (1941a; 1940-41) has also studied aesthetic types. In the first study, Eysenck (1941a) focused on the general factors in aesthetic judgements. Using 18 different sets of pictures with 18 subjects, Eysenck found evidence for a general objective factor of aesthetic appreciation (T; good taste). When this general factor was eliminated, a bipolar factor was left, which seemed to divide the formal from the representative type of picture. In the second study, Eysenck (1940-41) focused on the bipolar factor, which divides subjects into types. The bipolar K factor divided the population into two types based on a preference for a modern versus an older style of painting, and was correlated with several personality variables, particularly extraversion.

One researcher focused on the qualities of the work of art instead of the temperamental qualities of the person in determining aesthetic types (Peel, 1945). A set of artistic criteria was selected and compared with the person's orders of aesthetic preference. The results showed that non-expert adults have a marked preference for naturalistic pictures (landscape) and are less influenced by composition than artists, who have a definite preference for good composition and tend to prefer landscape paintings which are less detailed in representation.

The major contribution of studying aesthetic types would have to be that it led to an understanding of the importance of taking individual differences into account when doing research on aesthetic preferences.

Gestalt Theory. The Gestalt approach came about as a reaction to structuralism (Hochberg, 1962; 1964). The point of Gestalt psychology in opposition to structuralism was that there are lawful ways in which the overall configuration determines the action of any part (Hochberg, 1962) and that there is a need to focus on the rules governing the appearance of shapes and forms before undertaking detailed psychophysical measurement (Hochberg, 1962). Eysenck (1957) pointed out that if the Gestalt approach is correct then the attempt to derive laws governing appreciation of complex works from experiments dealing with relatively simple objects would be impossible. He argued for generalizing from simple to more complex stimuli, but pointed out that this generalization may not hold for objects of very high complexity, such as paintings (Eysenck, 1957).

Much of the focus of Gestalt psychology was to demonstrate that the appearance of any element depends on its place and function in the pattern as a whole (Arnheim, 1964). A major preposition of the Gestalt approach was the concept of goodness of configuration, which means that the brain tends to gravitate towards the better organized patterns (Berlyne, 1971). However, problems with the Gestalt concept of goodness of configuration were that it was poorly specified in terms of measurement, that it led to the mistaken assumption that good forms are the most aesthetically appealling and that it emphasized form, saying little about content (Berlyne, 1972c; 1971).

Early studies in Gestalt psychology which were related to aesthetics focused on such aspects as the function of unity in aesthetic perception (Kellett, 1939), the "Good Gestalt" (Eysenck, 1942), and the Gestalt theory of expression (Arnheim, 1949). Kellett (1939) studied the function of unity in aesthetic perception using 14 paintings paired with similar photographs, with high school students participating as subjects. The major finding was that subjective factors were crucial in the reports of preference. Eysenck (1942) attempted to operationalize the concept of goodness in Gestalt theory by reducing the laws of aesthetics to those of perception, and presenting a Gestalt theory of aesthetics. Finally, Arnheim (1949) defined expression as the psychological counterpart of the dynamic processes which result in the organization of perceptual stimuli, and which play an important role in perception and art theory.

One of the major researchers who has used Gestalt theory to study the psychology of art has been Arnheim (1964, 1966, 1969). Arnheim (1964) has examined various aspects of art (balance, shape, form, growth, space, light, colour, movement, tension and expression), and argued that all perceived patterns are dynamic. At the same time, he has used various art works as examples, to demonstrate that the appearance of any element depends on its place and function in the pattern as a whole. In a collection of essays, Arnheim (1966) attempted to describe more explicitly the symbolism conveyed by visual form and began a presentation of visual thinking as the common and necessary way of productive problem solving. This latter theme was continued in a later work where Arnheim (1969) dealt with visual perception as a cognitive activity, argued that art cannot exist unless it is a property of everything perceivable, and described shape perception as the grasping of generic structural features. This emphasis on the importance of taking any work of art as a whole would have to be the major contribution of the Gestalt approach to aesthetics.

Information Theory. Information theory developed out of Wiener's work on cybernetics and Shannon's work on the mathematical theory of communication (Berlyne, 1971). Moles (1958/1968) has characterized information theory as similar to the structuralist approach, since he defined information theory as a point of view on the possibility of quantifying phenomena having a statistical character, and of building into patterns objectivable elements, taken out of a definable repetoire and put together according to known rules. However, information theory deals with the informational as opposed to physical properties of stimuli (Garner, 1970), with information being defined as the number of different items which must be given in order to specify or reproduce a figure along one or more dimensions which can be abstracted from it (Hochberg & McAlister, 1953).

It is pointed out that information theory and Gestalt theory are opposed to each other (Margolis, 1980). Yet, Berlyne (1971) pointed out that the aim of information theory was to quantify and measure what the Gestalt school called "goodness of configuration" and that this is important for an understanding of aesthetics since terms like "goodness" and "structure" also refer to characteristics of aesthetic reactions to patterns. Examples of the attempt to quantify goodness of configuration through information theory can be seen in the work of Hochberg and McAlister (1953), Attneave (1954), and Garner (1970). Hochberg and McAlister (1953) found some support for the hypothesis that the probability of a given perceptual response to a stimulus is an inverse function of the amount of information required to define that pattern, through the use of Kopfermann cube figures, and studying the probability of alternate perceptual responses as an approximate quantitative index of goodness of the figure. Attneave (1954) defined the good Gestalt as a figure with a high degree of internal redundancy. Garner (1970) also emphasized the importance of redundancy in understanding the Gestalt concept of goodness and found that good patterns are those which are redundant and have few alternatives.

Finally, another study illustrating the role of information theory in aesthetic preference was done by Munsinger and Kessen (1964), who reported on a series of nine experiments done on expressed preference and differing amounts of variability of stimulation which found: a sensitivity to differences in variability of stimulation, that an intermediate amount of uncertainty is preferred where uncertainty is determined by the number of independent characteristics of the stimuli and their judged meaningfulness, and finally, that preference varies with the experience of variability.

Berlyne's Work. The work of Berlyne and his associates has had a major impact on the North American approach to aesthetics. His influence has been acknowledged by many researchers in the area including Wohlwill (1980a,b), Walker (1980), Machotka (1980), and Crozier (1980).

The theoretical roots of Berlyne's position include Hullian theory (Walker, 1980) and information theory (Berlyne, 1963a, 1971, 1972c, 1974a, 1974f; Margolis, 1980). Berlyne (1971) described his approach to aesthetics as psychobiological. This means it focuses on the empirical testing of the effect of informational elements on aesthetic perception and preferences, through the manipulation of independent causal factors (Margolis, 1980).

A major emphasis of the work of Berlyne and his associates has been on the motivational effects of collative variables such as novelty, complexity, surprisingness, change, ambiguity, blurredness, and power to induce uncertainty (Berlyne, 1963a, 1971, 1972a, 1972c, 1972d). These variables all involve the comparison or collation of several stimulus elements or items of information that may be present together or at different times (Berlyne, 1963a, 1971, 1972c, 1972d). Furthermore, Berlyne (1972d) considered these variables to be the constituents of aesthetic form or structure and suggested that they can be subsumed under the term "degrees of complexity", which is opposite to the properties that the Gestalt school associated with "goodness of configuration" (Berlyne, 1963a).

An excellent summary of research done on collative variables and aesthetic preference can be found in Berlyne's (1971) book "Aesthetics and Psychobiology". Most of this research has focused on the role of complexity, particularly subjective or judged complexity, in determining aesthetic preferences. For example, Houston, Garkof and Silber (1965) examined the informational basis of judged complexity and tested the hypothesis that stimulus redundancy is an important determinant of judgements of stimulus complexity, when the amount of physical change occurring within a stimulus is unrelated to its judged complexity. Using strips of black and white squares, they found both redundancy and the amount of physical change to influence judgements of stimulus complexity, with redundancy accounting for a greater portion of the variance. Day (1967b) attempted to derive a subjective definition of complexity by rating the concept of complexity along 19 semantic scales. He concluded that complexity was related to all three of Osgood's dimensions: activity, evaluative, and potency. Furthermore, his results indicated that complexity was interesting rather than boring, but neither pleasant nor unpleasant. Finally, Berlyne (1972e) used Catania's technique of concurrent variable interval performances to confirm that more complex visual patterns have a greater reinforcement value than less complex patterns.

Another group of studies examined the relationship between subjective complexity, pleasingness and interestingness. Berlyne, Ogilvie and Parham (1968) applied multidimensional scaling to judgements of complexity, interestingness and pleasingness using visual patterns. Their results indicated that judged complexity is a major determinant of judged interestingness and judged pleasingness, and that subjects tend to agree on ratings of stimulus patterns varying in interestingness and pleasingness, even though the regions they find most interesting or pleasing may differ. Day (1967a), comparing random-shaped figures varying in number of sides and in complexity, pleasingness, and interestingness, found that pleasingness was high for low levels of complexity, but low for extremely high levels; and that interest increased with complexity to a peak and then remained high. In an extension of this study, Day (1968b) examined the influence of symmetry on these judgements and found that interest is directly related to complexity while pleasure is inversely related, with both being higher for symmetrical stimuli.

The interaction between complexity and other collative variables in determining aesthetic preferences has also been considered important. Studying novelty, Berlyne (1970), using coloured shapes, found that pleasingness and interestingness increase with novelty; that homogeneous sequences declined more in judged pleasantness than sequences in which several stimuli were interspersed; and that simple stimuli became less pleasant as they became less novel, while complex stimuli declined less or became more pleasant. Using patterns varying from simple to complex and from non-representational (line drawings) to representational (paintings), Berlyne (1974c) found that complex and representational patterns were more interesting and that there was a decline in judged interestingness with a loss of novelty.

Uniformity in variety has also been examined. Berlyne and Boudewijns (1971) used visual patterns consisting of two elements differing in 0 to 4 properties, which were rated in simultaneous and successive presentations for pleasingness, interestingness, liking and complexity. The results showed that pleasingness and liking was highest when there were both differences and similarities with successive but not simultaneous presentations; interestingness increased with the number of differences for both modes of presentation; and judged complexity increased with the number of differences, but was significantly higher when elements appeared simultaneously. In an extension of these findings to three-element visual patterns, Berlyne (1972b) found that judged complexity varied inversely with the number of identical elements in a pattern and directly with the number of properties in which elements differed; interestingness behaved like complexity with successive presentation but not simultaneous presentation; and pleasingness was heightened by the presence of similarities between elements when presentation was simultaneous and by the presence of variety when elements appeared successively.

Finally, the influence of uncertainty on aesthetic preference has also been looked at. For example, Nicki (1970) found that there is a preference for viewing a clear version of a preceding blurred object over viewing an unrelated but comparable clear object, when the identity of the blurred object was unknown; and that subjective uncertainty, equated to the average information formula; and the number of key-presses obtaining clear versions of blurred objects were both an inverted U-shaped function of blurredness. Hare (1974) used circles with coloured sections to manipulate the amount of distributional redundancy and the amount of variety, and found that the distributional redundancy manipulation showed a significant effect of uncertainty on interestingness and pleasure.

Another major focus of the research of Berlyne and his associates has been to measure the influence of collative variables on various measures of arousal. Berlyne (1963b) described the fact that collative properties of stimulus patterns affect the level of arousal or drive, regardless of content as a basic assumption of his research. One example, perceptual curiosity was interpreted by Berlyne (1957) as a drive which is reduced by perception. Using tachistoscopic exposures of visual figures to study perceptual curiosity, Berlyne found four factors which increase curiosity: incongruity, surprisingness, relative entropy (uncertainty), and absolute entropy (absolute amount of information). Berlyne (1958) extended the results of this experiment in a study of the influence of complexity and novelty in visual figures on orienting responses, particularly attention. In the first experiment, six forms of complexity were examined and in all cases more time was spent looking at the more complex figure. In the second experiment, it was found that fixation time for the varying stimulus progressively increased at the expense of the recurring stimulus.

Another component of the orientation reaction is the G.S.R. response. Berlyne (1961) reported the results of three experiments which studied the influence of collative stimulus properties on the orientation reaction, as measured by the G.S.R. response. Using forced-choice and free-choice reactions, as measured by lights on a stimulus panel; a word association task and stimuli that were surprising without being novel, it was found that the G.S.R. increased with all forms of conflict. Berlyne, Craw, Salapatek and Lewis (1963) reported the results of two experiments on the effects of novelty, complexity, incongruity and extrinsic motivation on the G.S.R.. Using more and less irregular patterns, it was found that there was some indication of a greater incidence of G.S.R.'s with more complex or incongruous visual patterns, but only when subjects are highly attentive; that G.S.R. incidence increases with novelty and with extrinsically motivating instructions; and that G.S.R. amplitude increases with incongruity. However, these results were not supported by Berlyne and Lawrence (1964). Here, complexity or incongruity was not found to have any effect on the magnitude of the G.S.R., although the G.S.R. declined with repeated presentation of a figure unrelated to the variables. Berlyne, Craw, Salapatek and Lewis (1963) suggested that this discrepancy may have been due to differences in the length of time the figures were exposed, with a need for longer exposures of the figures. Finally, Evans and Day (1971) used a series of figures differing in complexity with monitoring of the G.S.R. and heart rate, as well as ratings on 20 semantic differential type scales.

Factor analysis showed four factors, three of which were Osgood's activity, evaluative and potency factors; with the fourth being heart rate. The heart rate response was found to be unrelated to the other three factors, however, the G.S.R. factor was found to be highly loaded on the activity dimension.

E.E.G. desynchronization, another component of the orientation reaction, has also been examined. Berlyne and McDonnell (1965) found that more complex or incongruous patterns evoked longer desynchronization than less complex or incongruous patterns, and concluded that the duration of desynchronization somehow measures the extent to which the impact of a stimulus pattern activates the arousal system. Nicki (1972) also studied the effect of complexity on E.E.G. desynchronization, and found that when subjects were required by means of a key-press to view checkerboard patterns of varying complexity, that they key-pressed more to view slides of intermediate rather than low or high complexity, and concluded that E.E.G. desynchronization was an inverted U-shaped function of complexity. Finally, Berlyne and Borsa (1968) studied the effects of uncertainty on E.E.G. desynchronization and found that blurred pictures evoke longer desynchronization when they are associated with subjective uncertainty, but not when this uncertainty is eliminated by having the blurred pictures preceded by corresponding clear pictures.

Exploratory behaviour and choice have been another major focus of research. Studying exploratory choice, Berlyne (1963b) reported the results of two experiments on the effects of complexity and incongruity using nine categories of pairs of visual patterns with less and more irregular members. It was found that more irregular patterns were chosen with shorter exposures and less irregular patterns were chosen with longer exposures. As well, more irregular patterns were rated as more interesting and less irregular patterns as more pleasing. Berlyne and Crozier (1971) in a series of four experiments on exploratory choice and varying complexity, found evidence against perceptual curiosity being a prime factor in determining the attractiveness of more complex stimulation. Instead, the results for four conditions (choice following near darkness; duration of postchoice exposures being increased from 1.5 seconds to 5 seconds with near darkness being replaced by prechoice exposure to the patterns; a recurrent coloured picture preceding the choice; and a different coloured picture on every trial) showed a decline in the proportion of more complex choices and supported the hypothesis that the attractiveness of more complex stimulation varies inversely with the level of prechoice stimulation. Berlyne (1972b) also found that exploratory choice favoured two-element patterns that had been judged more complex and more interesting but less pleasing. Finally, Berlyne (1974b) using matrix patterns and Smets patterns, studied how various information-theoretic independent variables affect verbal judgements and exploratory responses. Using matrix patterns, Berlyne examined the effects of number of elements and of uncertainty per element on exploratory choice, and found that a 36-element pattern was significantly more likely to be chosen when paired with a 9-element pattern of the same variability level; and that the more pleasing patterns were more likely to be chosen. For Smets patterns, Berlyne found that patterns with many elements were more likely to be chosen when there is a great deal of redundancy and patterns with relatively fewer elements when there is little redundancy, with a preference for intermediate levels of uncertainty per pattern.

With respect to looking time, Berlyne and Lawrence (1964) confirmed the earlier findings with respect to exploratory choice in a study where exploration of more irregular figures was significantly longer with all five variables studied with low-complexity material and one of three variables studied with high-complexity material. Verbally expressed preference was not positively related to exploration time since less irregular patterns were preferred. Leckart and Bakan (1965) extended the generality of previous research on the relationship between complexity and visual exploration by showing that the relationship between complexity and looking time holds true for realistic photographs as well as for designs and line drawings. In a further study on looking time using photographs, Leckart (1966) had subjects receive 0, 10, or 20 seconds of familiarization on stimuli of low, medium or high complexity, which were then used in a free looking time task either immediately after the first task or 48 hours later. The results showed that free looking time is inversely related to stimulus familiarity and directly related to complexity; and that with a 48 hour delay, a stimulus can recover from the decrement in looking time produced by familiarization. Day (1966) examined the function of stimulus variables and individual differences in determining looking time and found that looking time was dependent on stimulus variables such as content of the slides, position in the series, level of complexity, and affect level of the figures; and that although there were individual differences in looking time, these were unrelated to any of the personality traits studied. Day (1968a) confirmed the importance of stimulus variables in determining looking time, where different instructional sets (based on pleasingness, interestingness, later recognition, and caring to look) were used. Although there were significant differences in looking time under the different instructional sets, the results showed that looking time was affected by the complexity and asymmetry/symmetry dimensions, leading to the conclusion that looking time is primarily a measure of exploratory behaviour. This was supported by Leckart et. al. (1970), who studied the effects of perceptual deprivation on looking time and found a direct relationship between the duration of perceptual deprivation and the duration of attention. Berlyne (1973) used factor analysis of 40 visual patterns, which had been rated on 12 scales and found three factors which were labelled complexity-uncertainty, hedonic value, and cortical arousal. Looking time was measured in a separate experiment and was found to be most significantly correlated with complexity-uncertainty; but was also significantly correlated with hedonic value and cortical arousal. Finally, Berlyne (1974b) in the previously described study using matrix patterns found that 36-element patterns were examined significantly longer than 9-element patterns; looking time was found to increase monotonically with an increase in complexity, information content and factors conducive to arousal; looking time was influenced by hedonic tone when the effects of complexity and cognate variables are held constant; and looking time was correlated with rating time. For Smets patterns, Berlyne found that patterns possessing some relative uncertainty were looked at longer than patterns possessing none.

Berlyne (1963b; Berlyne & Peckham, 1966) drew a distinction between specific and diversive exploratory behaviour; with specific exploratory behaviour occurring in response to an increase in arousal that is due to conflict stemming from incomplete information leading to perceptual curiosity, and diversive exploratory behaviour being reinforced by stimulation with optimal collative properties regardless of source or content, including aesthetic behaviour. Berlyne and Peckham (1966) had subjects rate visual patterns, representing a number of complexity or irregularity variables on

Osgood's semantic differential scales and found that mean ratings on the evaluative and potency dimensions were similar bimodal functions of judged complexity, while ratings on the activity scale were an inverted U-shaped function of judged complexity. These reactions to complexity were concluded to be related to two distinct clusters of variables involving specific exploration (evaluative and potency dimensions, pleasingness and duration of E.E.G. desynchronization) and diversive exploration (activity dimension, interestingness, and perhaps, phenomenal complexity). Further support for Berlyne's distinction between specific and diversive exploration came from a study by Wohlwill (1968), who in studying amount of exploratory behaviour and preference for slides of geographic scenes and modern art scaled for complexity, found that exploratory behaviour increased linearly with complexity, while the relationship between complexity and preference was curvilinear, with a maximum at an intermediate level of complexity. Dent and Simmel (1968) criticized the previous work on diversive exploration since subjects were allowed familiarity with the stimulus material before their attention to it was measured, which would mean a tension-reduction paradigm could account for the data, ruling out diversive exploratory behaviour. These experimenters found support for Berlyne's concept of diversive exploration by eliminating previous exposure to the particular stimulus material subjects were electing to see, and still finding that subjects chose to increase their arousal level by choosing designs that they knew would be more complex.

The research of Berlyne and his associates has been reviewed in detail, with a focus on methodology as well as results, since it constitutes most of the research done in the area of experimental aesthetics. However, Berlyne (1971, 1974a) acknowledged that the use of stimuli such as in his research is a long way from appreciation of art. Ideally, research in the area of experimental aesthetics would be able to use copies of actual works of art. However, a major concern regarding use of art is an absence of control over the determinants of the subjects' preferences (Berlyne, 1974a), making a major problem in the area of experimental aesthetics a methodological one. This next section will review methodology used in experimental aesthetics and suggest one way of overcoming methodological problems through the use of artistic pictures with the variation of a single stimulus within each picture.

Methodology Used in Aesthetics

The area of aesthetics has been characterized as a field of inquiry in search of a method. (Pratt, 1961). Methodology used in the area of aesthetics has included the use of psychophysics, paired comparisons, ranking, rating scales, and research involving the use of pictures. Berlyne's use of behavioural measures has come closest to fulfilling criteria for an experimental method of studying aesthetic reactions, however, the other methods will now be reviewed.

Psychophysics. Sensory psychophysics uses procedures for measuring thresholds in order to catalogue sensations and discover their physical bases (Hochberg, 1964). Woodworth (1938), in a review of the psychophysical methods and results, reported that comparisons in experimental aesthetics had similar methods as those used for constant stimuli and single stimuli in psychophysics, with similar results. Hochberg (1962, 1964) also implied that psychophysical formulas can be used to study aesthetic reactions since he stated that provided there is agreement among observers, then there must be some discoverable psychophysical relationship between the objects viewed and the perceptions that result.

Fechner, the founder of both psychophysics and experimental aesthetics attempted to extend his psychophysical methods into the area of aesthetic judgements (Pratt, 1961). One of the earliest applications of psychophysical methods to study aesthetic reactions can be seen in the work of Martin (1906), who used psychophysical methods in conjunction with other methods to test Fechner's principles, particularly the principle of the aesthetic threshold, which defined pleasure or displeasure as a threshold. Some of the more important findings of this study included the conclusion that simple stimuli such as lines are the most satisfactory material in some aesthetic investigations; that liking for circles increases with their size up to a certain size and then decreases; and that the aesthetic threshold is approximately similar to the sensation threshold, although the threshold is somewhat dependent on the method used.

Arnheim (1980) pointed out that one advantage of psychophysical methods is that they can exclude the influence of individual differences, expectation or attention. However, he argued that responses to works of art vary in many ways for many reasons, implying that psychophysical methods are inapplicable (Arnheim, 1980). As pointed out earlier, with reference to Gestalt psychology, psychophysical measurement was rejected for the study of aesthetic reactions since complex units (such as art works) are not built up from simpler units (such as lines) in any easily defined way (Hochberg, 1962, 1964; Eysenck, 1957; Pratt, 1961).

Inspite of the criticisms of psychophysical measurement, there appears to be some support for this method. Pratt (1961) concluded that psychophysical procedures would be a better way of dealing with the formal arts where there is some dependence on stimulus variables. Hochberg (1962) argued that psychophysical formulas can be used to study non-physical experiences such as aesthetic preferences, and that the absence of systematic theories rather than measurement problems is slowing down progress in this area. More recently, Hardiman and Zernich (1977) concluded that one problem area in aesthetics research was little isolation of specific dimensions of stimuli in visual art related to preference judgements. Arnheim (1980), inspite of his scepticism of psychophysical methods concluded that the analysis of the physical situation is helpful to some extent and that only when the objective properties of an art object are reasonably well established, can an analysis of the factors that enable the artwork to convey its message begin. Finally, Beardsley (1980) presented the role of psychological explanation as giving rules constituting aesthetic competence which describes how art-apprehenders react to certain data in artworks, and suggested the use of Mill's method of difference for establishing these rules. However, Beardsley (1980) considered the problem with this approach to be the variation of only one feature and that doing so may affect the way other parts of a painting are perceived. Therefore, it would seem that psychophysical methods are useful for the study of aesthetic preferences, and Ginsburg (1983) has presented the procedure of random scaling, which can be applied to study aesthetic preferences.

Paired Comparisons. The paired comparison procedure was considered by Woodworth (1938) to be the standard method in experimental aesthetics and was found by Hardiman and Zernich (1977) to be still the most common form of instrumentation. The procedure involves presenting two stimuli at a time, and asking subjects to state which is more aesthetically pleasing, with all possible combinations of stimuli being presented (Woodworth, 1938; Eysenck, 1957; Pickford, 1972). This procedure has been considered to be the most effective measure of aesthetic preferences since it yields a detailed record of comparisons among stimuli as well as providing an accounting of the consistency of a subject's response (Woodworth, 1938; Hardiman & Zernich, 1977). Preferences obtained by paired comparisons can then be treated as scores similar to those obtained by using rating scales (Pickford, 1972). However, one problem with this method is that it becomes difficult to administer with a large number of items (Woodworth, 1938), and O'Hare (1977) found that this may cause a great deal of unreliability.

Ranking. Ranking involves providing a series of stimuli whose physical properties are known, and asking subjects to rank them in order of aesthetic merit (Woodworth, 1938; Eysenck, 1957; Pickford, 1972). Eysenck (1957) noted that both ranking and the paired comparison procedure result in an average order of preference, which is similar regardless of the method used. Like the paired comparison procedure, ranking becomes unwieldly with a large number of items (Woodworth, 1938).

Rating Scales. In the rating method, the objects to be judged are presented one at a time and the subject expresses a judgement on each, placing it on an absolute scale (Woodworth, 1938). Rating scales place a subject's preference on a continuum, satisfying the requirements for an interval scale (Hardiman & Zernich, 1977), and go beyond the like-dislike dichotomy of paired comparisons by characterizing a measure of intensity on a 5 or 7-point scale (Pickford, 1972; Hardiman & Zernich, 1977). It resembles the method of single stimuli in psychophysics (Woodworth, 1938). Pratt (1961) suggested that scaling methods could be reserved for aesthetic values which fail to turn up stimulus correlates and that scaling methods are also used with advantage in attempts to assign quantitative relations to subjective experiences. However, Woodworth (1938) considered it difficult to standardize the individual's subjective rating scale, or to ensure uniformity in the scales and rating procedures of different judges.

Picture Research. Researchers who have summarized some of the early work in experimental aesthetics using pictures include Valentine (1962), Child (1969, 1972) (who focused on the social psychology of art) and Pickford (1972). Most of the early research in the area of experimental aesthetics used pictures to study temperamental traits or types (Eysenck, 1941a; 1957). However, Fisher (1980) suggested that the terms describing the aesthetic perceptual qualities of works of art describe observable features of the works, and pointed out that early works in the area did not examine this problem of perception. One exception to this was the study done by Peel (1945) which did focus on the qualities of art instead of the temperamental qualities of the person. As well, Arnheim (1964), writing from a Gestalt perspective, used works of art to demonstrate that the appearance of any element depends on its place and function in the pattern as a whole, and to examine various aspects of art (balance, shape, form, growth, space, light, colour, movement, tension and expression), in support of his position that all perceived patterns are dynamic.

Berlyne's acknowledgement that the use of stimuli such as in his earlier research is a long way from appreciation of art (Berlyne, 1971; 1974a) has led to a renewed interest in the use of actual works of art. Several studies using paintings have been direct extensions of Berlyne's earlier research. Osborne and Farley (1970) had ten graduate art students and ten graduate educational psychology students rate 62 reproductions of paintings in terms of three categories of visual complexity and found a significant relationship between visual complexity and aesthetic preference. Berlyne (1974e) reported the results of two studies using paintings which show that the reward value of a picture increases with its score on the hedonic tone factor and is unrelated to arousal and uncertainty. Nicki, Lee and Moss (1981) found that a number of one second views and verbal judgements of interestingness and pleasingness of cubist paintings were a function of subjective ambiguity, especially when an expectancy had been established regarding the identity of the main object or person in the paintings. Finally, Boselie (1983) used line drawings and found that the presence of disjunctive ambiguity (when two descriptions of a stimulus are both perceptually and physically incompatible) is detrimental to the judged beauty of a pattern, whereas, it adds to its judged interestingness.

Berlyne radically changed his method of studying aesthetic preferences by using reproductions of art works and determining their characteristics through sophisticated scaling techniques (Machotka, 1980). This methodology is based on an extension of factor analysis concepts into multidimensional scaling paradigms such as INDSCAL and MDPREF (Crozier, 1980). The aim of this multidimensional and multivariate analysis included establishing an objective taxonomy of pictorial style (Berlyne, 1974f; Berlyne & Ogilvie, 1974), in order to overcome the fact that if a reliable difference between the reactions to two paintings could be found, any number of factors could be responsible for the difference (Berlyne & Ogilvie, 1974; Berlyne, 1975).

A number of studies have been done using these methods. Berlyne and Ogilvie (1974) reported a series of six experiments which used INDSCAL, NMSCAL, and MDPREF to determine similarity and preference judgements for a variety of paintings. They isolated a number of factors related to perceptual dimensions of paintings and concluded that how complex and realistic a painting is determines how it is classified conceptually and how much it will be liked. Berlyne (1975) confirmed these results in a series of five experiments on 20 reproductions of paintings which used INDSCAL and MDPREF. Three factors underlying collative and affective ratings were found: hedonic tone, arousal, and uncertainty;

significant similarities were found between exotic/pre-renaissance and western post-renaissance paintings, however, different labels were required for the dimensions of these two sets of paintings; finally, it was found that subjects despite differences in taste are in agreement with regard to attributes that determine preference and that attributes determining judgements of similarity and perception of paintings also exert an influence on preferences. Cupchik (1974) used INDSCAL and factor analysis to test dimensions of paintings suggested by art history and found four dimensions which may underlie the perception of artistic style: linear vs. painterly (outline vs. surface qualities); abstract vs. representational (amount of detail); colour vs. somber tones; and complex vs. simple paintings reflecting the artist's feelings. Berlyne (1976) also used these methods for doing cross-cultural research using reproductions of paintings and found cross-cultural similarities and differences for East Indians and Canadians. O'Hare (1977) used the INDSCAL and PREMAP models to study perceived similarity and preference of art and non-art students for reproductions of a group of western landscape paintings and found: degree of realism and clarity to be important in perception of visual art; that non-art and art students differ in the importance attached to the two dimensions and preferences; and that the attributes which govern similarity also govern preference, with clarity being the most important. Finally, O'Hare and Gordon (1977) used an

INDSCAL analysis of 12 landscape paintings and found that three of the principal dimensions of the perception of art are: hedonic-representational; clarity; and a dynamic factor involving activity, balance and symmetry. They suggested that the role of complexity in the perception of paintings is small. Inspite of the wide use of these programs, Crozier (1980) has pointed out that there are problems, namely a lack of accessibility, and their descriptive rather than inferential function.

Other studies have tried to isolate dimensions of the perception of art using other multidimensional methods. Goude (1972) reported the results of five experiments which used similarity estimation and ratio estimation for multidimensional scaling and found five factors which were: motif, lyric tranquility, static stylization, drama, and crucifixion dynamics or colourful lustre. Swartz and Swartz (1977) used factor analysis of a 20-scale form of the semantic differential to conduct cross-cultural research on the aesthetic judgements of Canadian and French students, for Canadian and French paintings. Four factors were found for the Canadians (dynamism, visual tension, tactility, and evaluation), while five factors were found for the French (visual tension, potency, tactility, spatiality, and atmosphere). Finally, Biaggio and Supplee (1983) used the semantic differential scales derived by Berlyne to confirm the validity of three dimensions of aesthetic perception (hedonic value, arousal, and uncertainty), which were supported through the use of factor analysis. They also found that art students differed from non-art students on evaluation of the compositional elements of paintings; and perceived less ugliness and reported less negative affect in conjunction with paintings judged to be unclear, indefinite and unbalanced.

Recently then, the trend in experimental aesthetics has been to use reproductions of actual works of art, and to attempt to classify these paintings along dimensions of perception. As pointed out earlier, this was done in order to overcome the problem that any number of factors could be responsible for differences between the reactions to two paintings (Berlyne & Ogilvie, 1974; Berlyne, 1975). As well, the points of Butler (1982) in regard to the structuralist approach of Hochberg and the work of artificial intelligence workers should be taken into account. Butler (1982) noted that a problem hampering progress in this area is that none of these approaches has progressed to the point of providing any quantitative information about an object represented in a drawing in order to determine the nature of a particular object in the scene. Experiment 1 is a demonstration experiment to show the applicability of the methods-the experiment is on location and size, aspects which apply to any display. Experiment 2 applies the methods to a concept which has been highly praised in aesthetics-Hogarth's line of beauty, a curve which is said to be particularly aesthetic. Experiment 1 shows that the method and manner of instructing subjects obtain clear consistent results.[1] Experiment 2 shows that Hogarth's line is not the one favoured by the subjects.

The Moon Illusion in Art

The moon illusion deals with the fact that the moon and the sun appear larger over the horizon than when elevated in the sky (Rock, 1975; Coren & Girgus, 1978). Numerous theories have been postulated to account for the moon illusion. Tolansky (1964) explained that the moon illusion occurs as a result of the horizon enlargement illusion. On the earth, everything subtends a progressively smaller angle and diminishes in size as it approaches the horizon except the moon, due to its distance. This means that as the moon approaches the horizon it appears larger than it should. Rock (1975) reviewed several theories of the moon illusion and reached a similar conclusion, that the moon illusion depends on the presence of terrain (defined as a plane extending outward from the observer), and specifically, on the distance effect of the terrain, since distance is taken into account when evaluating visual angle. Finally, a similar conclusion is reached by Haber (1980) who pointed out that the relative absence of depth information from far away objects in the sky leads the zenith moon to be interpreted as nearer than the horizon moon, and since the visual angle of the moon is constant, the difference in distance means a perceived difference in size.

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1. The one danger that should be noted is that subjects tend to go for "the middle" of any range that is offered. The results of this experiment indicate that this danger was avoided.

The factors determining the moon illusion are probably not the same as those determining the depiction of the moon in art. Yet, artists have typically depicted the moon illusion in their paintings (Tolansky, 1964; Coren & Girgus, 1978). Tolansky (1964) has studied the depiction of the moon in art, using several paintings as examples ("The Bluestocking" by Daumier, "Coming from Evening Church" by Palmer, "The Sower" by Van Gogh, and "Carnival Evening" by H. Rousseau). It was found that in these paintings, the lower the moon on the horizon, the more enlargement the artist has exploited. Tolansky (1964) considered this enlargement to be due to aesthetic considerations, but suggested the horizon enlargement illusion may also play a role.

Arnheim's comments on the consequences of a shift to a dynamic approach for the theory of art is also applicable to an understanding of the aesthetic considerations in the depiction of the moon in art. In discussing proportion and compositional equilibrium, Arnheim (1980) pointed out that the traditional account of what is seen in perception can refer only to objects of various shape and size occupying visual space at various places and has no way of explaining why certain ratios look better than others. Attention must be paid to the field forces or equilibrium in a composition in order to determine the appropriateness of the distance or location of elements within a composition.

Although these are suggestions as to why the moon is depicted the way it is in art, there has been no empirical evidence on this question. The present study will attempt to demonstrate aesthetic preferences for size and location of the moon within Tom Thomson's "Moose at Night (Moonlight)."

Hogarth's Line of Beauty

Hogarth (1753/1955) first described what he labelled as the line of beauty. The line of beauty consists of a balanced double curve like the curve of a woman's back (Hogarth, 1753/1955). Pickford (1972) has illustrated seven curves varying around and including the line of beauty and described the line of beauty not as an absolute or fixed form but as a central tendency around which there may be a variety of different forms which approximate it.

Although no research has been found validating the line of beauty, Emch (1900) suggested that a tree with a greatly inclined trunk is not aesthetically pleasing, based on the necessity of having symmetry in order to judge something as aesthetically pleasing. "The West Wind (sketch)" by Tom Thomson has a curved centre tree which can be varied around the line of beauty as illustrated by Pickford (1972). This will be done in the second experiment in order to empirically test the line of beauty.

Method

Experiment 1

Subjects. The subjects were 65 male and female university student volunteers. Five subjects were eliminated because they left blank spaces on the questionnaires or lost their place during testing, leaving a total sample of 60 subjects. These 60 subjects were 22 males and 38 females with an age range of 20 to 34 years (mean age 24 years) and 19 to 30 years (mean age 23 years) respectively. Most of the subjects were Canadian, however, they had a variety of years completed at university as well as major areas of study.

Half of the subjects were tested for their size preference first and the other half were tested for their position preference first; which was determined through random assignment.

Apparatus. A redrawn copy of the picture "Moose at Night (Moonlight)", originally painted by Tom Thomson was used as the stimulus for this experiment (See Appendix A). The copy was drawn on an $8\frac{1}{2}$ by 11 inch sheet of 60 lb. weight art paper, using drawing pens from Hunt Speedball Artist Pen Set No. 5, black India ink and translucent green drawing ink.

A photocopy of the redrawn picture "Moose at Night (Moonlight)" was made. This picture was mounted on the bottom of an 11 by 17 inch sheet of paper and carefully alined with a blank sheet of photocopy paper above it in order to increase the amount of sky in the picture. Then, another photocopy of this mounted picture was made in order to eliminate any line between the top and bottom sections. Forty slides were made of this final copy of "Moose at Night (Moonlight)".

Moons were drawn on 40 sheets of blank photocopy paper (measuring 19 by 28 cm; in order to be proportional to the slide), using a Sterling #543 Circle Gauge (with a .040 pencil allowance on all holes), and a fine-point black ink pen. The moon diameter ranged from 5/8 inch to $1\frac{1}{2}$ inches, in 1/8 inch steps. The moon position ranged from 75 mm from the bottom (the 19 cm side) to 235 mm from the bottom, in 40 mm steps. All the moons were drawn 60 mm in from the right of the 28 cm side of the paper.

Slides were made of the 40 sheets of photocopy paper containing these moons. Each of the moon slides were carefully alined and mounted with a slide of the photocopy of the picture. Therefore, the stimulus consisted of 40 slides of "Moose at Night (Moonlight)" with a different size moon in a different position in each slide.

The projector used was a Kodak Ektagraphic Slide projector (Model AF-3) at an approximate distance of $4\frac{1}{2}$ feet from the wall on which the slide was projected.

A recording sheet with space for 40 responses and a cover sheet for demographic data was filled in by each subject.

Procedure. Once the pictures were ready they were placed in order according to the size of the moon for each position of the moon and had identifying values assigned. Each position of the moon was labelled from 1 to 5 (from the horizon to the zenith) and each size of the moon was labelled from A to H (from the smallest to the largest).

The 40 pictures were totally randomized using a random numbers table found in Kerlinger (1973). The numbers were assigned to each picture in the order in which they appeared with no repetitions of the same number occurring in the 40 numbers. The pictures were then placed in order according to the matched random number.

Subjects were obtained through various sources(including the campus newspaper, classmates, friends, and the hallways).

The subjects were contacted regarding the testing time and met at the experimental room. Questionnaires were distributed, which included a cover sheet for demographic data and a response sheet.

The first step in the experimental procedure was to obtain demographic data about each subject. This included name, age, sex, nationality, year at university, any previous art training or experience, and familiarity with the picture.

The following instructions were then read to the subjects.

"Here are several copies of a painting done by Tom Thomson called "Moose at Night (Moonlight)".

In each picture the moon is a different size. I want you to tell me whether the moon is too large or too small. For each picture I want you to make a decision either way. Put a plus sign in the appropriate space if the moon is too large and a minus sign if the moon is too small. Any questions. Here is the first picture. The picture will be shown for 5 seconds with 5 seconds in between slides. (Present set of pictures). As you probably noticed the moon is also at different positions in the sky in each picture. This time when I show you the pictures I want you to tell me whether the moon is too high or too low. Put a plus sign in the appropriate space if the moon is too high and a minus sign if the moon is too low. Any questions. Here is the first picture. (Present set of pictures).[1]

The slides were presented at the appropriate times in the instructions for 5 seconds per slide. Whether size preference or position preference was tested first was determined through random assignment for each group.

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1. The order of instructions will be modified according to which data are collected first.

Data Analysis. The method of analysis that was used is described by Ginsburg (1983), where the subject's preferences are operationally defined as transition points (T.P.). The subjects' responses for each size and position of the moon were recorded as plus or minus. The data were rank ordered with numerical values assigned to each size or position. The value of the transition point was recorded and occurs at the break between minus and plus, after all pluses are arranged to the right of all minuses. The number of inversions were also recorded, which is the number of interruptions in the series of pluses and minuses.

Experiment 2

Subjects. The same subjects participated in both experiments 1 and 2. One additional subject was eliminated because of a large number of inversions.

Apparatus. A redrawn copy of the picture "The West Wind (sketch)", originally painted by Tom Thomson was used as the stimulus for this experiment (See Appendix A). The copy was drawn on an $8\frac{1}{2}$ by 11 inch sheet of 60 lb. weight art paper, using drawing pens from Hunt Speedball Artist Pen Set No. 5, black India ink, and translucent green drawing ink.

Eight photocopies of the redrawn picture "The West Wind (sketch)" were made. The copies were made at the same time and selected to be clear and have little variation from picture to picture.

One photocopy was left with just the stump of the centre curved tree in order to serve as a sample picture. The centre curved tree in the other pictures was drawn on each of the photocopies using a stencil which contained seven curved lines ranging around Hogarth's line of beauty, as illustrated by Pickford (1972). The lines range from a slightly curved line to a line with an extreme curve, with the middle line being the Line of Beauty. The curvature of the lines was determined by measuring the degree of curvature at a height of 140 mm from the bottom and determining the angle of the inner edge of the curved tree at this point. The values for the seven curved trees at this point were 72°, 63°, 53°, 44°, 30°, 22°, and 20°, respectively. (See Appendix A).

The centre curved tree in the picture was drawn on each of the seven photocopies using a stencil made by the experimenter and a fine-point black ink pen. The stencil was made of a clear transparency. Each of the lines illustrated by Pickford (1972) were replicated using an 18 inch flexible ruler and drawn on the stencil enlarged to the appropriate length to fit in the picture. The lines on the stencil were then lined up with the stump of the centre tree and transferred onto the photocopy using heavy pressure on a fine-point black ink pen. Once the tree was drawn in, the branches were extended to join the tree trunk, where necessary.

This procedure was used to draw the centre curved tree on each one of the seven photocopies.

The seven photocopies were then rephotocopied so that the black ink used to draw in the centre curved tree blended in with the rest of the photocopy.

Slides were then made of each of these eight photocopies of "The West Wind (sketch)". Each of these slides were carefully mounted. Therefore, the stimulus consisted of eight slides of "The West Wind (sketch)", one sample slide and seven slides with the centre curved tree varied around Hogarth's line of beauty.

A recording sheet with space for eight responses and a cover sheet for demographic data were filled in by each subject.

Procedure. Once the pictures were ready they were placed in order according to the degree of curve of the centre curved tree and had identifying values assigned. The sample slide appeared first and the other slides were labelled from A to G (from the least to the most curved).

The seven pictures were totally randomized using a random numbers table found in Kerlinger (1973). The numbers were assigned to each picture in the order in which they appeared (excluding the sample picture which was first) with no repetitions of the same number occurring in the seven numbers. The pictures were then placed in order, according to the matched random number. The only stipulation was that no sequence of any two pictures in either direction could occur. This procedure was followed until the above criteria were met.

This experiment was administered immediately after experiment 1, to the same subjects. A response sheet for this experiment was part of the questionnaire.

The following instructions were then read to the subjects.

> "Here are several copies of a picture done by Tom Thomson called "The West Wind (sketch)." In each picture the centre tree has a different curve. I want you to tell me whether the centre tree is too curved or too straight. For each picture I want you to make a decision either way. But first, here is a sample picture to show you which part of the tree I want you to focus on. Here is the stump of the centre tree. In each subsequent picture the curved part of the tree I want you to judge as too curved or too straight starts above this stump and does not include it. Put a plus sign in the appropriate space if the tree is too curved and a minus sign if the tree is too straight. Any questions. Here is the first picture. (Present pictures).

After the slides were presented for 5 seconds per slide, the questionnaires were collected and the subjects were debriefed and thanked for their participation.

Data Analysis. The method of analysis that was used is described by Ginsburg (1983), where the subject's preferences are operationally defined as transition points (T.P.). The subjects' responses for the curvature of the tree were recorded as plus or minus. The data were rank ordered with numerical values assigned to each of these curves. The value of the transition point was recorded and occurs at the break between minus and plus after all pluses are arranged to the right of all minuses. The number of inversions was also recorded, which is the number of interruptions in the series of pluses and minuses.

Results

Moon Illusion

The transition points for size as a function of height (Range 9-25) and height as a function of size (Range 1-11) were recorded for each subject. The scores for this data can be found in Appendix B and Appendix C. Each subject's mean score for size as a function of height and height as a function of size were also calculated. A Pearson product-moment correlation coefficient showed that there was no significant relationship between each subject's average size preference and their average height preference, $r(60) = 0.17$, ns.

A frequency distribution, along with means, standard deviations, and variances for the size as a function of height data are presented in Table 1. From the frequency distribution, it can be seen that the majority of subjects preferred a moon ranging from 15 to 19 for each position. The means for each position are all around 17. These mean preferred sizes for each position are plotted in Figure 1, and it can be seen that there was a slight downward trend. This was confirmed by an analysis of variance for correlated groups which showed that there was a significant trend for the larger moon to be preferred at the horizon with a smaller moon being preferred at the zenith, $F(4,236) = 3.61$, $p < .01$. This analysis

Table 1

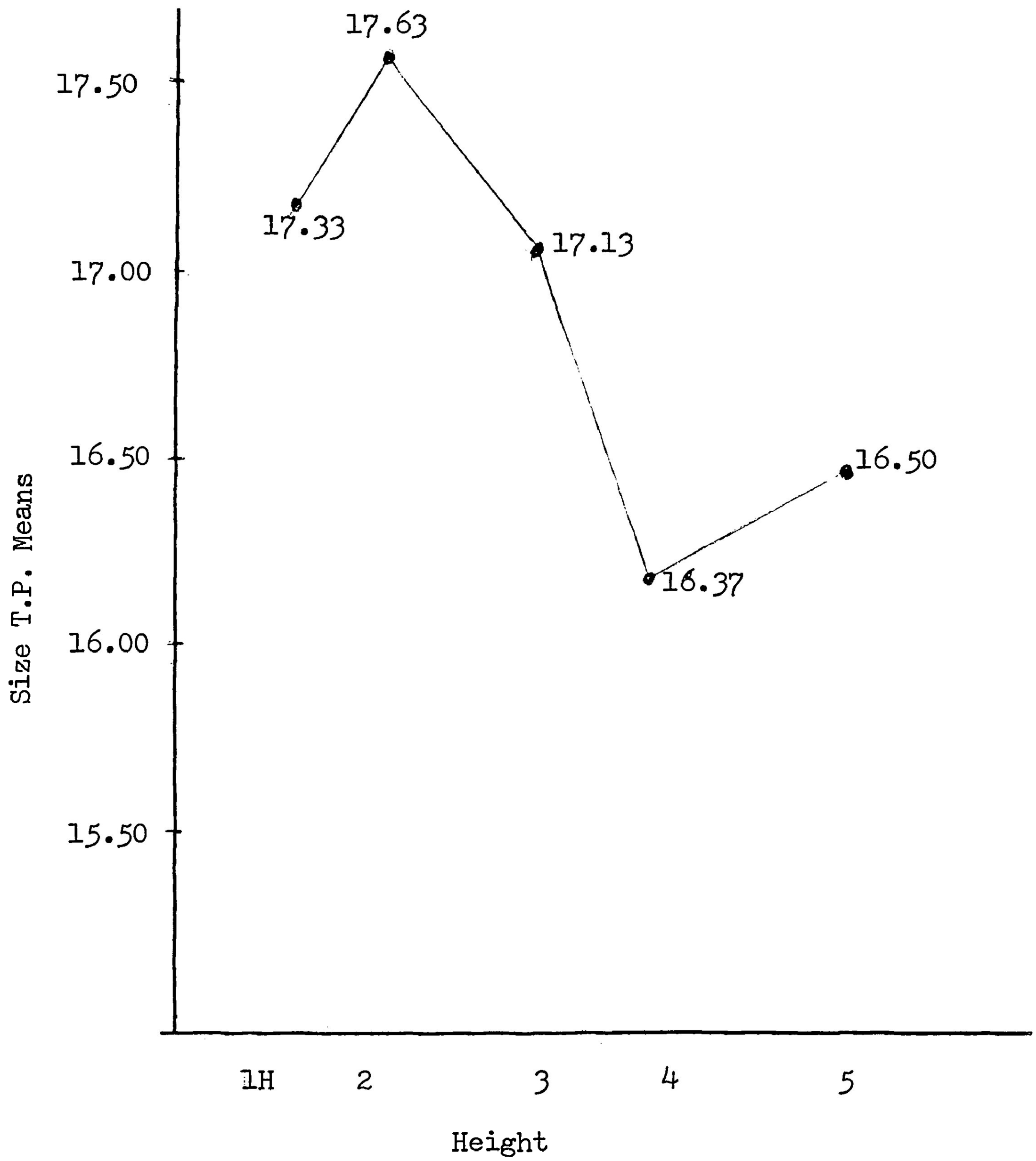
Size as a Function of Height

Frequency Distribution

	Height				
	1H	2	3	4	5Z
Size T.P. (9-25)					
25	1	2	1	1	2
23	3	1	5	2	1
21	8	6	4	4	7
19	10	14	8	10	8
17	13	24	19	16	13
15	22	10	16	13	15
13	2	1	6	10	9
11	1	2	1	2	5
9	0	0	0	2	0
Mean	17.33	17.63	17.13	16.37	16.50
Std. Dev.	2.88	2.67	3.01	3.26	3.39
Variance	8.29	7.12	9.07	10.65	11.47

Figure 1

Size as a Function of Height



is summarized in Table 2. Finally, summarized in Table 3, are reproducibility coefficients, which ranged from .95 to .98; all of which were well above the cut-off of .9 suggested for acceptable data (Ginsburg, 1983).

Similar analyses were performed for the height as a function of size data. A frequency distribution, along with means, standard deviations, and variances for the height as a function of size data are presented in Table 4. From the frequency distribution, it can be seen that the majority of subjects preferred a position ranging from 5 to 7 for each size. The means for each size also ranged from 5 to 7. These mean preferred positions for each size were plotted in Figure 2, and it can be seen that there is a downward trend. This was confirmed by an analysis of variance for correlated groups which showed that there was a significant trend for the higher moon to be preferred if it was smaller, and the lower moon to be preferred if it was larger, $F(7,59)=8.31$, $p<.001$. Table 5 contains a summary of this analysis. Finally, reproducibility coefficients (See Table 6) ranged from .96 to .99; all of which were well above the cut-off of .9 suggested for acceptable data (Ginsburg, 1983).

Table 2

Size as a Function of Height Summary Table

	SS	df	MS	F
Treatments	70.86	4	17.72	3.61**
SS	1591.19	59		
Residual	1157.94	236	4.91	
Total	2819.99	299		

**p < .01

Table 3

Size as a Function of Height Reproducibility

	Height				
	1H	2	3	4	5Z
Reproducibility	.97	.98	.95	.97	.98

Table 4

Height as a Function of Size

Frequency Distribution

		Size							
		A	B	C	D	E	F	G	H
Height	11	5	5	3	0	1	2	1	2
T.P.	9	9	9	12	10	3	9	7	6
(1-11)	7	25	27	21	19	22	19	21	19
	5	15	12	19	19	18	12	13	10
	3	5	6	5	8	14	12	13	14
	1	1	1	0	4	2	6	5	9
Mean		6.70	6.73	6.63	5.77	5.43	5.63	5.50	5.17
Std. Dev.		2.20	2.22	2.03	2.24	2.05	2.64	2.43	2.74
Variance		4.86	4.94	4.14	5.03	4.21	6.99	5.92	7.50

Figure 2

Height as a Function of Size

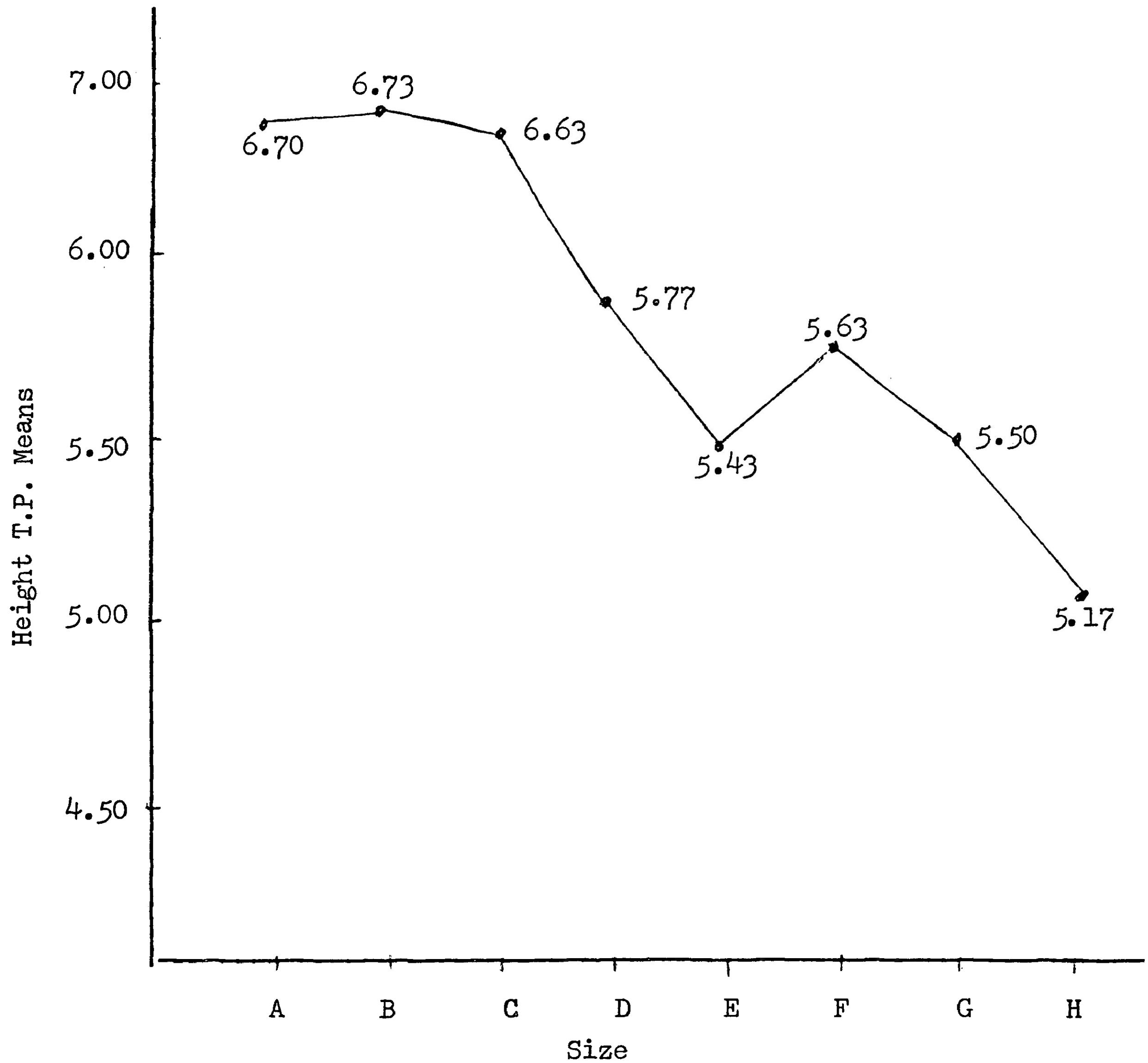


Table 5

Height as a Function of Size Summary Table

	SS	df	MS	F
Treatments	171.59	7	24.51	8.31***
SS	1353.09	59		
Residual	1217.91	413	2.95	
Total	2742.59	479		

***$p < .001$

Table 6

Height as a Function of Size Reproducibility

	Size							
	A	B	C	D	E	F	G	H
Reproducibility	.97	.99	.96	.98	.98	.98	.98	.97

Hogarth's Line of Beauty

The transition points of degree of curvature for the tree data were recorded for each subject. The raw scores for this data can be found in Appendix D.

A frequency distribution, along with means, standard deviations and variances for the degree of curvature of the tree are presented in Table 7. From the frequency distribution, it can be seen that the majority of subjects preferred a degree of curve ranging from 3 to 5 for the trees. The mean for the preferred degree of curvature was 4.59. This was compared to Pickford's predicted mean of 8.00, which corresponds to Hogarth's line of beauty, by means of a t-test (See Table 8). The preferred degree of curvature was significantly less than that predicted by Hogarth, $t = -11.37$, $p < .01$. The reproducibility coefficient was .99, which is well above the level of .9 required for acceptable data. (Ginsburg, 1983).

Table 7

Tree Data Frequency Distribution

Degree of Curve		Degree of Curve	
15	0	7	8
13	0	5	26
11	2	3	12
9	2	1	9

Tree Curve Mean, Standard Deviation and Variance

Mean	4.59
Std. Dev.	2.34
Variance	5.39

Predicted mean according to Pickford 8.00

Table 8

T-test for Tree Curve Means

	A	B
Mean	4.59	8.00
Std. Dev.	2.34	00.00

$t = -11.37$

$p < .01$

Discussion

Theoretical Considerations

The three theoretical positions which form the basis for the present research include structuralism, Gestalt theory and Berlyne's work.

Structuralism was one of the earliest perceptual approaches to be applied to the study of aesthetics, and has recently been revived as a major theoretical approach for research in the area. However, as Hochberg (1964) pointed out, a major problem with this approach is that complex stimuli do not appear as expected based on how their parts appear. To deal with this, Gestalt theory started as a reaction to structuralism (Hochberg, 1962;1964) and pointed out that there are lawful ways in which the overall configuration determines the action of any part (Hochberg, 1962). The focus of Gestalt psychology was to demonstrate that the appearance of any element depends on its place and function in the pattern as a whole (Arnheim, 1964). Therefore, there has been an emphasis in Gestalt psychology on the importance of taking any work of art as a whole.

Hochberg (1972) pointed out that there have been vigorous and at least partially successful attempts to combine positive features of both of these approaches. In this respect, the present study combined the Gestalt approach with its emphasis on the whole, while retaining structuralism's emphasis on the components of sensation, through the use of artistic pictures with the variation of a single stimulus within each picture.

The approach used in this study is also supported by the acknowledgement of Berlyne (1971; 1974a) that the use of stimuli such as in his research is a long way from appreciation of art. Inspite of the numerous attempts to quantify aesthetic preference the emphasis has been on the use of stimuli such as those used by Berlyne instead of the use of actual works of art. This has been the case ever since Fechner distinguished 'an aesthetics from below", which concerns itself with the elementary determinants of liking and disliking from 'an aesthetics from above', which is philosophical and emphasizes lofty and abstract concepts (Berlyne, 1972c) and continues to be the case with the majority of approaches dealing with aesthetics including mathematical theories, information theory and Berlyne's work.

The approaches which were an exception and focused on the use of pictures in research included type theories and psychoanalysis. However, these theories focused on individual differences and the usefulness of this focus can be questioned since it was found by Machotka (1979), writing within a psychoanalytic framework, that as one becomes a good judge of art, the importance of perception increases and that of projection decreases.

Therefore, there is a need to focus on the perception aspect of aesthetic preference. As Butler (1982) noted, though, a problem hampering progress in this area is that none of these approaches has progressed to the point of providing any quantitative information about an object represented in a drawing, in order to determine the nature of a particular object in the scene. The present research has been able to accomplish this through the use of the method of random scaling; the following section will review the methodological reasons for the use of this method.

Methodological Considerations

The area of aesthetics has been characterized as a field of inquiry in search of a method (Pratt, 1961). Methodology used in the area of aesthetics has included the use of psychophysics, paired comparisons, ranking, rating scales and research involving the use of pictures. However, methodological problems have plagued most of the research carried out in the area. Both the paired comparison and ranking procedures are difficult to administer with a large number of items (Woodworth, 1938), and at least for the paired comparison procedure, this may cause a great deal of unreliability (O'Hare, 1977). The problems with the use of rating scales are that it is difficult to standardize the individual's subjective rating scale, or to ensure uniformity in the scales and rating procedures of different judges. Therefore, the present research focused on the use of pictures and psychophysical methods as having the most potential for research in the area.

With respect to artworks, Fisher (1980) suggested that the terms describing the aesthetic perceptual qualities of works of art describe observable features of the works, and pointed out that early works in the area did not examine this problem of perception. Recently, Berlyne's acknowledgement that the use of stimuli such as in his earlier research is a long way from appreciation of art (Berlyne, 1971; 1974a) has led to a renewed interest in the use of actual works of art. Some of this research has been a direct extension of Berlyne's earlier research (Osborne & Farley, 1970; Berlyne, 1974e; Nicki, Lee and Moss, 1981; Boselie, 1983).

However, Berlyne radically changed his method of studying aesthetic preferences by using reproductions of art works and determining their characteristics through sophisticated scaling techniques (Machotka, 1980). This was done in the hopes of establishing an objective taxonomy of pictorial style (Berlyne, 1974f; Berlyne & Ogilvie, 1974), and in order to overcome the fact that if a reliable difference between the reactions to two paintings could be found, any number of factors could be responsible for the difference (Berlyne & Ogilvie, 1974; Berlyne, 1975). This method has been used in a number of studies (Berlyne & Ogilvie, 1974; Berlyne, 1975; Cupchik, 1974; Berlyne, 1976; O'Hare, 1977; O'Hare & Gordon, 1977). The problems with these programs, though, include a lack of accessibility, and their descriptive rather than inferential function (Crozier, 1980). Other studies have used other multidimensional methods in order to isolate the dimensions of the perception of art (Goude, 1977; Swartz & Swartz, 1977; Biaggio & Supplee, 1983).

However, once again, Butler's (1982) point should be noted that none of these approaches has progressed to the point of providing any quantitative information about an object represented in a drawing in order to determine the nature of a particular object in the scene. The present study was able to provide quantitative information about an object represented in a drawing through the use of random scaling, a psychophysical procedure described by Ginsburg (1983).

Further support for the present approach comes from Hardiman and Zernich (1977), who also concluded that one problem area in aesthetics research was little isolation of specific dimensions of stimuli in visual art related to preference judgements. However, Beardsley (1980) considered one problem in the variation of only one feature to be that this may affect the way other parts of a painting are perceived. Yet, Arnheim (1980) concluded that the analysis of the physical situation is helpful to some extent and that only when the objective properties of an art object are reasonably well established, can an analysis of the factors that enable the art work to convey its message begin.

As well, psychophysical methods have the advantage of being able to exclude the influence of individual differences, expectation, or attention (Arnheim, 1980). The method of random scaling has the added advantages of requiring few observations, being easy to administer and score, and being applicable to a variety of measurement situations including aesthetic preferences (Ginsburg, 1983).

The method of random scaling, then, was used in an exploratory study of the moon illusion and Hogarth's line of beauty. Although there have been previous explanations of these two phenomena given in the literature, neither has ever been studied empirically. The following two sections, then will discuss the results obtained in an attempt to empirically test the moon illusion in art as well as Hogarth's line of beauty, through the use of random scaling applied to actual works of art.

Moon Illusion

The purpose of this part of the research was to demonstrate aesthetic preferences for size and location of the moon within Tom Thomson's "Moose at Night (Moonlight)". This was demonstrated for size preferences as a function of height, since there was a significant trend for the larger moon to be preferred at the horizon, with a smaller moon being preferred at the zenith. Similar results were found for height preferences as a function of size since there was a significant trend for the higher moon to be preferred if it was smaller and the lower moon to be preferred if it was larger. Both of these results are consistent with the moon illusion which states that the moon and the sun appear larger over the horizon than when elevated in the sky (Rock, 1975; Coren & Girgus, 1978).

Although there are several explanations for the moon illusion, the most widely accepted explanation would appear to be the horizon enlargement illusion (Tolansky, 1964; Rock, 1975; Haber, 1980). However, the factors determining the moon illusion are probably not the same as those determining the depiction of the moon in art. As Tolansky (1964) has pointed out, aesthetic considerations would seem to play a major role in art, in accounting for the enlargement of the moon as it approaches the horizon. In this study, the demonstration of aesthetic preferences for the size and location of the moon within Tom Thomson's "Moose at Night (Moonlight)", which are consistent with the moon illusion, would seem to support this contention of Tolansky, that aesthetic preferences play some role in determining the depiction of the moon illusion in art.

Arnheim's (1980) points, written within the context of Gestalt psychology, that attention must be paid to the field forces or equilibrium in a composition in order to determine the appropriateness of the distance or location of elements within a composition would seem to be relevant for the aesthetic preferences demonstrated here. For most of the subjects, a clear transition point was demonstrated where the moon appeared too large or too small and too high or too low within the painting. As well, most of the subjects responded consistently for the extreme values, with the most inconsistency occurring around these transition values, for both size as a function of height and height as a function of size. This would seem to suggest that the extreme values looked wrong for the composition while the decision was harder for the transition values. This was supported both by the inconsistency of response for these transition values and the verbal report of many of the subjects who reported that making an aesthetic preference judgement for these values was harder and more frustrating and whether or not there could be a "just right" decision category. One suggestion for future research, now that an aesthetic preference has been demonstrated, would be to focus on these transition values and attempt to outline what factors are influencing the decision of subjects in making these aesthetic judgements.

Hogarth's Line of Beauty

The purpose of this part of the research was to demonstrate aesthetic preferences for Hogarth's (1753/1955) line of beauty within "The West Wind (sketch)" of Tom Thomson. The results showed that the preferred degree of curvature was significantly less than that predicted by Hogarth, indicating that the subjects preferred a straighter line than that which contained Hogarth's line of beauty.

Hogarth (1753/1955) had described the line of beauty which is a balanced double curve like the curve of a woman's back, as an absolute which should be preferred no matter what the context. Emch (1900) had also suggested that a tree with a greatly inclined trunk is not aesthetically pleasing, based on the need for symmetry. Finally, Pickford (1972) described the line of beauty not as an absolute or fixed form but as a central tendency around which there may be a variety of different forms which approximate it. None of these descriptions of aesthetic preference for the line of beauty were supported by the present research since the preferred tree had significantly less curvature than the tree which contained Hogarth's line of beauty.

Instead, the results supported the role of context or meaning in determining aesthetic preferences. This is demonstrated by the consistency of the subjects' responses and the verbal report of several subjects that trees do not grow with a large degree of curvature. Hogarth's line would be semantically out of place in many objects and Thomson's tree is one of the few places in nature where a 3-D object might employ it, in a realistic if unusual columnar object. However, the results would seem to indicate that focusing only on what Peters (1942) labelled the perception aspect of aesthetic preference does not give the whole picture of aesthetic preference. Future research, then, could focus on other aspects of aesthetic preferences.

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Appendix A

Copies of Tom Thomson's "Moose at Night (Moonlight)"

and "The West Wind (sketch)"

Appendix B

Scores for size as a function of height

Size Data Trends for each Subject

Size T.P. (9-25)

	1H	2	3	4	5	$\bar{X}$
S1	23	19	15	13	11	16.2
2	21	19	23	21	15	19.8
3	17	17	19	19	19	18.2
4	17	21	17	15	15	17.0
5	15	17	17	17	19	17.0
6	15	17	15	15	17	15.8
7	15	17	15	15	15	15.4
8	15	21	19	21	21	19.4
9	23	25	25	25	25	24.6
10	15	17	17	15	21	17.0
11	15	17	19	19	17	17.4
12	11	11	13	13	13	12.2
13	17	17	15	17	15	16.2
14	19	19	17	13	19	17.4
15	21	19	17	11	11	15.8
16	17	17	17	19	15	17.0
17	21	17	15	15	13	16.2
18	13	11	11	9	11	11.0
19	19	17	17	19	25	19.4
20	15	15	19	17	15	16.2
21	17	17	17	17	17	17.0
22	17	17	15	15	15	15.8
23	23	21	23	23	21	22.2
24	15	17	15	15	13	15.0
25	21	23	19	15	11	17.8

	1H	2	3	4	5	$\bar{X}$
26	15	15	13	13	13	13.8
27	19	17	15	17	17	17.0
28	19	21	19	21	23	20.6
29	25	25	23	23	21	23.4
30	19	19	13	17	15	16.6
31	21	19	21	13	11	17.0
32	15	17	15	13	17	15.4
33	17	19	23	21	21	20.2
34	19	19	17	17	15	17.4
35	15	17	19	17	15	16.6
36	19	19	17	13	15	16.6
37	15	19	21	19	19	18.6
38	17	17	17	15	15	16.2
39	15	15	15	17	17	15.8
40	17	19	13	11	15	15.0
41	15	17	17	17	17	16.6
42	17	19	21	19	21	19.4
43	21	17	15	15	13	16.2
44	21	15	17	17	13	16.6
45	15	17	17	17	19	17.0
46	17	13	15	17	17	15.8
47	15	17	19	17	19	17.4
48	19	21	23	19	19	20.2
49	13	17	17	17	17	16.2
50	19	17	15	13	13	15.4

	1H	2	3	4	5	$\bar{X}$
51	15	15	15	15	17	15.4
52	15	19	17	19	19	17.8
53	19	19	21	19	17	19.0
54	15	15	17	17	17	16.2
55	15	15	15	15	15	15.0
56	15	15	13	13	13	13.8
57	17	17	17	15	17	16.6
58	17	15	17	19	21	17.8
59	15	15	15	13	15	14.6
60	21	21	13	9	13	15.4

Appendix C

Scores for height as a function of size

Height Data Trends for each Subject

Height T.P. (1-11)

	A	B	C	D	E	F	G	H	$\bar{X}$
S1	7	5	7	3	3	5	5	3	4.75
2	9	9	9	5	3	3	3	3	5.50
3	5	7	7	9	7	7	7	7	7.00
4	3	3	3	1	3	3	3	3	2.75
5	5	5	5	5	5	3	5	5	4.75
6	7	7	9	5	3	5	5	5	5.75
7	7	7	7	7	7	7	7	5	6.75
8	5	5	5	7	5	7	5	5	5.50
9	11	11	11	9	11	11	11	11	10.75
10	7	9	7	7	5	3	3	3	5.50
11	5	7	5	5	5	7	7	7	6.00
12	7	11	7	7	5	3	1	1	5.25
13	7	7	5	5	5	5	7	7	6.00
14	5	1	5	7	5	7	7	1	4.75
15	9	9	7	5	3	3	1	3	5.00
16	11	9	7	7	3	3	3	5	6.00
17	9	11	11	7	5	5	3	3	6.75
18	7	7	7	7	7	7	7	7	7.00
19	3	3	3	1	1	1	1	3	2.00
20	5	5	5	5	5	5	5	7	5.25
21	7	5	5	5	5	7	7	7	6.00
22	7	5	9	1	3	1	3	3	4.00
23	7	7	7	7	7	7	9	5	7.00
24	7	5	7	3	1	3	5	1	4.00
25	7	7	9	5	5	7	5	3	6.00

	A	B	C	D	E	F	G	H	$\bar{X}$
26	9	9	9	9	9	9	9	9	9.00
27	3	7	5	7	5	7	7	5	5.75
28	5	7	11	5	7	1	5	1	5.25
29	9	9	5	1	3	5	5	3	5.00
30	11	11	7	5	3	3	1	1	5.25
31	7	7	7	7	7	5	3	3	5.75
32	7	7	7	7	5	5	3	5	5.75
33	5	5	5	5	7	5	5	7	5.50
34	5	7	5	5	7	9	7	7	6.50
35	7	7	7	9	7	9	7	7	7.50
36	7	3	5	5	5	7	5	5	5.25
37	5	7	9	5	7	7	7	9	7.00
38	1	3	3	3	3	1	3	3	2.50
39	7	7	9	7	7	7	7	7	7.25
40	11	5	5	5	3	3	3	1	4.50
41	7	7	9	9	7	9	7	9	8.00
42	9	9	7	9	9	9	9	9	8.75
43	7	5	7	3	5	5	3	1	4.50
44	5	7	5	5	5	5	9	7	6.00
45	7	7	7	7	7	7	7	7	7.00
46	7	5	5	5	7	5	7	7	6.00
47	7	7	7	7	7	7	7	7	7.00
48	7	7	9	9	7	7	5	7	7.25
49	7	5	5	3	5	3	5	3	4.50
50	3	3	3	3	3	1	3	1	2.50

	A	B	C	D	E	F	G	H	$\bar{X}$
51	7	7	7	7	7	7	7	7	7.00
52	5	9	5	9	7	7	7	7	7.00
53	5	7	5	7	5	9	7	5	6.25
54	5	7	5	5	7	11	9	9	7.25
55	3	3	3	3	3	3	3	3	3.00
56	5	7	9	9	7	9	7	11	8.00
57	9	9	9	7	7	9	9	7	8.25
58	9	11	9	9	9	9	9	9	9.25
59	9	7	7	7	7	7	7	7	7.25
60	11	7	7	3	3	1	1	1	4.25

Appendix D

Raw scores for tree data

Tree Data Ranked According to Degree of Curve

	A	B	C	D	E	F	G	T.P.	INVERSIONS
S#1	+	+	+	+	+	+	+	1	0
2	−	−	+	+	+	+	+	5	0
3	+	+	+	+	+	+	+	1	0
4	−	−	+	+	+	+	+	5	0
5	−	−	+	+	+	+	+	5	0
6	−	+	+	+	+	+	+	3	0
7	−	−	+	+	+	+	+	5	0
8	−	−	+	−	+	+	+	7	1
9	−	−	−	−	+	+	+	9	0
10	−	+	+	+	+	+	+	3	0
11	+	+	+	+	+	+	+	1	0
12	+	+	+	+	+	+	+	1	0
13	+	−	+	+	+	−	+	5	2
14	−	+	+	+	+	+	+	3	0
15	−	−	+	+	+	+	+	5	0
16	−	−	−	−	−	+	+	11	0
17	−	+	+	+	+	+	+	3	0
18	−	+	+	+	+	+	+	3	0
19	−	−	+	+	+	+	+	5	0
20	−	−	−	+	+	+	+	7	0
21	−	+	+	+	+	+	+	3	0
22	−	−	−	+	+	+	+	7	0
23	−	+	+	+	+	+	+	3	0
24	−	−	+	+	+	+	+	5	0
25	+	+	+	+	+	+	+	1	0
26	−	+	+	+	+	+	+	3	0
27	+	+	+	+	+	+	+	1	0
28	−	−	+	+	+	+	+	5	0
29	−	−	+	+	+	+	+	5	0
30	−	−	−	+	+	+	+	7	0
31	−	−	−	+	+	+	+	7	0
32	+	+	+	+	+	+	+	1	0
33	+	+	+	−	−	−	−	0	3

Tree Data Ranked According to Degree of Curve

	A	B	C	D	E	F	G	T.P.	INVERSIONS
34	—	+	+	+	+	+	+	3	0
35	—	—	—	—	+	+	+	9	0
36	—	—	+	—	—	+	—	11	2
37	—	—	+	—	+	+	+	7	1
38	—	+	+	+	+	+	+	3	0
39	—	—	+	+	+	+	+	5	0
40	—	—	+	+	+	+	+	5	0
41	—	—	+	—	+	+	+	7	1
42	—	—	—	+	+	+	+	7	0
43	—	—	+	—	+	+	+	7	1
44	+	+	+	+	+	+	+	1	0
45	—	+	+	+	+	+	+	3	0
46	—	—	+	+	+	+	+	5	0
47	—	+	+	+	+	+	+	3	0
48	—	+	+	+	+	+	+	3	0
49	—	—	+	+	+	+	+	5	0
50	—	—	+	+	+	+	+	5	0
51	—	—	+	+	+	+	+	5	0
52	—	—	+	+	+	+	+	5	0
53	—	—	+	+	+	+	+	5	0
54	—	—	+	+	+	+	+	5	0
55	—	—	—	+	+	+	+	7	0
56	—	—	+	+	+	+	+	5	0
57	—	—	+	—	+	—	—	11	2
58	—	—	+	+	+	+	+	5	0
59	—	—	+	+	+	+	+	5	0
60	—	—	+	+	+	+	+	5	0
61	+	+	+	+	+	+	+	1	0
62	—	—	+	+	+	+	+	5	0
63	+	+	+	+	+	+	+	1	0
64	—	—	+	+	+	+	+	5	0
65	—	—	+	+	+	+	+	5	0