Affective responses to visual forms of varying complexity

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AFFECTIVE RESPONSES TO VISUAL FORMS OF VARYING COMPLEXITY

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ABSTRACT

Experiments are reported which investigate several problems in the developmental study of aesthetics. The experiments contribute primarily to the area of research identified by Berlyne as the 'new experimental aesthetics', and they are conducted with basically a 'Fechnerian' approach. They extend and broaden previous research in that two different aesthetic responses (preference and duration of viewing time), and three aesthetic stimulus variables (complexity, colour and symmetry) are investigated.

Chapter One deals with the dependent variables. Hutt's hypothesis that children's preferences are based upon attention value (measured by viewing time) is introduced, and the need to provide a more thorough test of the relationship between measures is demonstrated. Her prediction that younger children's preferences should show greater dependence upon attention value than older children's is discussed. Also introduced is the hypothesis that longer viewing times will be sustained by visual stimuli which include pleasing (preferred) properties.

Chapter Two deals with the three independent variables, and reviews the research investigating their effects on preference and viewing time. A new topic of study to experimental aesthetics is introduced, affective salience, which investigates whether some aesthetic stimulus variables are more influential determinants of preference than others. Measurement of the relative affective salience of the three variables is discussed, and experiments are proposed.

Chapters Three, Four and Five report the experimental work. In Chapter Three seventy-two 6 to 11 year olds viewed freely 40 asymmetrical polygons each, which varied in complexity (4 to 40 sides) and in colour. The same subjects later rank ordered for preference the polygons in sets of 10. Results showed that both the level of complexity and the presence of colour significantly affected viewing times for children of all ages. Polygonal complexity also affected preferences, and age differences were apparent with both measures. The two measures were shown to be positively but not closely related, thereby only partly confirming Hutt. Hutt's hypothesis about the effect of age received no support. Colour was shown to have significant affective salience in that it effectively competed with complexity as a determinant of preference.

The two experiments in Chapter Four were similarly designed, but included the third variable, symmetry. Sixty subjects viewed 40 polygons each and later evaluated them for preference. Again, complexity and colour affected viewing times, but symmetry had no effect. The effect of complexity on preferences was also confirmed for symmetrical stimuli. Symmetry was highly preferred to asymmetry. The relationship between response measures was confirmed, but the effect of age on that relationship predicted by Hutt was again not supported. Symmetry, like colour was also shown to be affectively salient relative to complexity, and statistical analysis suggested that it had greater hedonic impact than colour.

The experiment in Chapter Five was designed to determine whether colour or symmetry was more affectively salient. Sixty subjects rank ordered sets of polygons designed to produce competition between the two variables. It was convincingly demonstrated that the salience of symmetry outweighed that of colour.

Each experimental chapter includes a discussion of results, and a summary chapter is included at the end.

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INTRODUCTION

INTRODUCTION

The new experimental aesthetics

Founded by Gustav Fechner over 100 years ago, the experimental study of aesthetic behaviour is now entering its second century. While experimental aesthetics proceeded slowly under Fechnerian guidelines, it reflected and incorporated many of the developments which occurred in other areas of psychological inquiry, among them the inclusion of children as subjects of study, the improvement of stimulus specification, and the employment of more varied and sophisticated response measures.

It was Berlyne's influence however, which historians will note provided a vitality to the Fechnerian method of approach. His scholarly appreciation of traditional problems, coupled with an energetic productivity in the laboratory, renewed interest in the field and increased the pace of published research. Collectively, this recent research (since 1960) has been identified by Berlyne as the *new experimental aesthetics* (Berlyne, 1960, 1967, 1971, 1973a, 1974). Whether or not the rubric itself survives will bear testimony to Berlyne.[1] The fact that experimental aesthetics has been redirected is irrefutable.

According to Berlyne (1974) research which may be classified under the 'new experimental aesthetics' is characterized by one or more of the following features:

1. It concentrates on collative properties of stimulus patterns;
2. It concentrates on motivational questions;
3. It studies nonverbal as well as verbally expressed judgments;
4. It strives to establish links between aesthetic phenomena and other psychological phenomena (human psychology in general).

The experiments to be reported here are addressed to several topics in visual aesthetics. These include the study of children's responses to variations in visual complexity (a collative stimulus property, see below), as well as the study of relations between a verbal and a nonverbal response measure (items 1 and 3 above). Accordingly, they may be viewed as contributing to the new experimental aesthetics.

Research with children

Berlyne's own experimental studies (see Berlyne, 1971, for a representative review) have been aimed at the understanding of adult aesthetic behaviour, and he only acknowledges the importance of gaining a similar understanding with children. Developmental research inspired by the new experimental aesthetics has been conducted by others in the field (Cantor et al, 1963; Munsinger & Kessen, 1966a; Clapp & Eichorn, 1965; Thomas, 1966; Rabinowitz & Robe, 1968; Aitken & Hutt, 1974; May & Hutt, 1974; Kreitler et al, 1974; Wohlwill, 1975a,b). As will be described later, this research abounds in conflicting results and leaves several central problems unresolved, and it is to these problems that the present experiments are addressed.

Any study which investigates aesthetic behaviour in children immediately raises the question of whether children can be said to have (or be capable of) behaviour which is actually 'aesthetic' in nature. That children respond to aesthetic stimuli does not in itself imply that aesthetic responses are involved. That developmental research is published in journals which deal exclusively with aesthetic behaviour is again a rather tautological argument in favour of children being aesthetic. And clearly, it is not satisfying to show that, because certain response measures employed in adult studies can be used successfully with younger subjects, then children are therefore capable of responding aesthetically.

A resolution to the question comes from a line of research which suggests that 'aesthetic sensitivity' requires deliberate exposure to artistic products and specific types of training. Gardner (1972a,b) for example, has demonstrated that by the age of seven, aesthetic sensitivity directed towards identifying artistic styles is possible, when subjects are properly trained to do so. And yet, by the same token, we would hesitate to judge adults who may never have been exposed to such training as 'non-aesthetic', or as aesthetically insensitive.

Whether children are indeed aesthetically-minded human beings raises unanswerable questions which will probably remain so for some time. Part of the difficulty lies in the fact that there is really no consensus as to what is meant by aesthetic behaviour when it pertains to adults.[2] Berlyne (1971) actually classifies children as 'less aesthetic' than adults and states that:

> We must naturally concern ourselves principally with experiments on human adults and, to a lesser extent, on children of school age, since these are the only organisms credited with 'aesthetic taste' or 'appreciation of art'.
>
> (p.181)

Gardner's investigations on the other hand, deal entirely with children. His belief that children have aesthetic capabilities is unwavering, and he has dedicated himself to delineating the development of early creative and evaluative capabilities (see Gardner, 1973, for a review).

There are several reasons why children may be regarded as eligible subjects in an experimental study of problems in aesthetics, but two reasons are particularly salient. The first is that children f r e e l y engage in a wide range of artistic productivity. They paint, draw pictures, colour diagrams, create patterns and embellish objects of their own choosing without encouragement to do so. The enormous wealth of artistic materials available in today's primary schools is evidence that such behaviour is recognized, supported and sustained. The availability of such material clearly points to the need to study how it may be utilized to the child's advantage.

The second reason is that children spontaneously respond with pleasure and with interest to a broad spectrum of visual stimuli, and they have definite patterns of preference for what it is they like and do not like to look at. The fact that some such stimuli generating pleasure and interest in children are not 'art' (and hence may be said to have no aesthetic value or merit) is not as important today as it was some years ago, for as will be discussed and illustrated later, the boundaries between art and non-art have radically changed.

These two reasons then, a natural, active, artistic production and a more passive contemplation of the pictorially expressive, argue in favour of applying methods of studying aesthetic behaviour to children.

At the very least, children must be regarded as protoaesthetic.

Collative variability

In the new experimental aesthetics, several new ideas have emerged. One of these, the notion of collative stimulus properties, or collative variables as they are also called, deserves attention. The concept is frequently referred to by Berlyne, and the variables involved have been particularly emphasized in developmental research (Hutt, 1970; Nunnally & Lemond, 1973). It should be noted that Berlyne is fundamentally behaviouristic in his approach to aesthetics, and as such advocates that stimulus properties are primarily responsible for affecting the hedonic value of an aesthetic response (Berlyne, 1972a), compared to Eysenck's (1973) or Helson's (1973) approach, for example, in which personality characteristics or adaptation level of the aesthetic perceiver, respectively, are emphasized.

Berlyne distinguishes three types of stimulus properties which affect hedonic value. These are the psychophysical, the ecological and the collative. Psychophysical properties such as stimuls intensity, auditory pitch, colour, or rate of change depend upon spatial and temporal distribution of energy, and are customarily measured through psychophysical techniques. These variables have always been the traditional concern in experimental aesthetics (see Valentine, 1962, for example).

Ecological stimulus properties are those which have learned associations with events having biological importance, events that is, which may threaten or promote biological adaptation and which may affect motivation. Ecological properties refer mainly to the content of aesthetic stimuli (funeral music, war or sexual imagery, for example).

Collative stimulus properties are regarded by Berlyne as the most important contributors to aesthetic responses, and these he identifies with form, structure, and composition in the arts. Properties such as the simplicity or complexity of a stimulus, its novelty or familiarity, its relative clarity or ambiguity, its surprisingness, puzzlingness, or incongruity value are those which Berlyne calls collative. They are collative because the viewer must compare, or collate information from two or more sources. All such properties are said to involve the viewer responding to relations of similarity and dissimilarity among stimulus elements.

A more precise definition is not available. In fact, the actual processes involved in collating information are rather poorly formulated. With some collative variables, such as novelty-familiarity, it would appear the viewer must collate information in a temporal sense, by comparing what is visually present with what has been experienced in the immediate or distant past. With other collative variables, such as complexity or incongruity, it appears that the viewer collates information in a spatial sense by "noting, putting together, and summing up characteristics that are present simultaneously" (Berlyne, 1971, p.69). Moreover, as Cantor (1963) and Hutt (1970) have pointed out, the collative variable of complexity can be described in terms of the physically measurable attributes of a particular stimulus, and thus refers to variety in the stimulus, whereas a definition of novelty must resort to the immediate, recent, or past experience, of the o r g a n i s m.

The vagueness of the central idea underlying collative stimulus properties, namely, the collating of information, does not really give the concept immediate practical value. It is difficult to pin down what is or is not collative in nature, especially when it is asserted that collative variability is "virtually identical" with the constituents of form, structure and composition. These three factors alone are difficult to define operationally, and together subsume an incredibly wide array of stimulus parameters important to the visual arts.

A further problem with the notion of collative variability is that it is possible to apply it to certain visual properties which also exhibit psychophysical and ecological variations. Consider the variable of colour for example, which has always been regarded as an important emotive property affecting aesthetic responses. In a study of colour preferences, the coloured stimuli presented clearly represent changes in the distribution of energy. Colour can therefore be safely classed as a psychophysical stimulus property, and Berlyne refers to it as such. However, colour can also be thought of as having ecological value, in that certain energy distributions have definite associations with biological events. That the male stickleback attacks at the sight of red is a now familiar example (Tinbergen, 1951). Human beings also undergo physiological changes when confronted with certain colours, which may have biological significance (Erwin <u>et al</u>, 1961; Wilson, 1966; Nourse & Welch, 1971; Smets, 1973; Jacobs & Hustmeyer, 1974). The ecological value of colour is further recognizable when considering symbolic and cognitive associations (the colour red with: loving, fire, blood, traffic lights, danger, for example), any of which may kindle a particular response to red when it is presented as a stimulus in a colour preference study (see Kreitler & Kreitler, 1972, chap.3).

Finally, colour can also be collative in nature, according to Berlyne's definition of the term. There is good evidence (Helson & Lansford, 1970) that when a colour is paired with its background or with accompanying colours, the viewer will respond to the contrast, or in Berlyne's terminology, to the relative similarity-dissimilarity of the stimulus configuration. In fact Berlyne, in an exemplification of colla.ive variability (1971), cites the colour harmony study of Granger (1955b) to make just that point.

And so it can be seen that collative stimulus variables do not form a domain of their own in the new experimental aesthetics, and confusions concerning the classification of certain visual properties may easily arise. One must conclude that the concept of collative variability is not a particularly exact introduction into the area of research, and that further employment of the term must bear these shortcomings in mind.

Nevertheless, the individual variables which are collectively identified, however vaguely, as having collative properties, are highly appealing subjects of study in their own right, principally for two reasons. First, some collative variables can readily be quantified with measures from information theory. By systematic manipulation of parameters which contribute to the information content of a visual pattern (its redundancy, its uncertainty), a stimulus can be made more or less complex, more or less novel (Garner, 1962; Terwilliger, 1963; Dorfman & McKenna, 1966; Driscoll & Sturgeon, 1969; Smets, 1973). Furthermore, there is good evidence that subjective evaluations of stimuli varying in informationally-determined collative variability accord well with the objectively measured parameter values (Attneave, 1957; Vitz, 1966a,b; Day, 1967; Driscoll & Sturgeon, 1969; Kubovy & Tzelgov, 1975; Chipman, 1977). This asset of some of the collative variables makes them very attractive in the empirical study of aesthetics.

The second reason why the collative variables themselves are so interesting is that they form important and basic response dimensions in our everyday aesthetic and critical appreciation of the visual arts. Insofar as collative variables are said to characterize and describe certain known stimulus parameters, they also reflect a large part of our experiential repertoire of aesthetic responses. The very name Art Nouveau for example, at one time encouraged a judgment about a stimulus of that type as to its relative 'novelty'.

There are many examples in which the aesthetic merit of a completed work of art is determined to a large extent by the impact of an implicit and pronounced collative property. Students of Oriental art are taught to attribute aesthetic value to Sesshu's Zen-inspired, single-brush-stroke, monochromatic circle because of its sheer 'simplicity', while Renaissance scholars find the market-place busyness in Bosch's paintings to be so expressive because of its relative 'complexity'. The skill with which Bridget Riley creates visual illusions imbues her finished products with a high degree of 'puzzlingness', while Salvador Dali's distortions and juxtapositions epitomize the 'incongruous'. And perhaps it is the 'familiarity' invoked when contemplating the subtle smile of the Mona Lisa that contributes to its affective value.

These few examples serve to illustrate that the so-called collative variables, when pronounced in genuine art, collectively form an intriguing core of stimulus-response parameters, which artists have always manipulated to affect aesthetic impact. Each of the variables identified by Berlyne as collative is an intuitively appealing subject of study in its own right. Hence the enthusiasm generated when they were subjected to experimental manipulation in the laboratory.

There is an unfortunate outcome to the increased interest in collative variables however, and that is the lessening of interest in the more traditional aesthetic variables, such as colour, curvature, proportion, or balance. With few exceptions, experimental stimuli are presented that represent variations along one collative variable only, and it is more often the case than not that these stimuli are presented in black-and-white. Colour has been particularly excluded as a stimulus variable in the new experimental aesthetics.

One of the aims of this thesis is to demonstrate that children's responses to collative variability need not be studied in isolation from such variables. Experiments forthcoming show that visual complexity can be studied in conjunction with two 'non-collative' visual properties of importance to aesthetics, colour and symmetry.

Aesthetic research and genuine art

Although the following experiments contribute to the new experimental aesthetics for reasons already stated, they are conducted with basically a 'Fechnerian' experimental approach. A century ago, Fechner (1876) published guidelines for research in the field of aesthetics, a province of thought which before that time remained accessible only to philosophical argument and speculation. Religious and ethical considerations were often confused with the artistic, the creative. Fechner argued that aesthetics could be studied empirically, that it could become a normative science available to laboratory techniques of investigation. He termed the new approach aesthetics 'from below' (von unten), a term which implied comparison with the previous, speculative aesthetics 'from above' (von oben).

Essentially what from below referred to was the quantitative analysis of art forms, mainly the pictorially expressive, from the point of view of their component parts. That is to say, Fechner, realizing that a painting was a complex combination of visual properties (lines, colours, forms, curves, spatial distributions), arranged in an orderly fashion so as to produce a complete whole, perceptually recognizable as such, argued that any analysis must begin with inspection of the response to the individual properties which constitute it. A finished work of art was too complicated a stimulus to examine as a single unit; it had to be analyzed into operational variables, and only when these had been examined, should an attempt be made to synthesize the results.

Experiments were thus initiated which dealt with responses to single dimensions: varying colours, or forms, or proportions, for example. The approach concretized, with the consequence that laboratory investigations into the realm of aesthetics became firmly established as an area of psychological research. Berlyne, who could be regarded as a third or fourth generation experimental aesthetician, is basically a follower of Fechner's original guidelines.

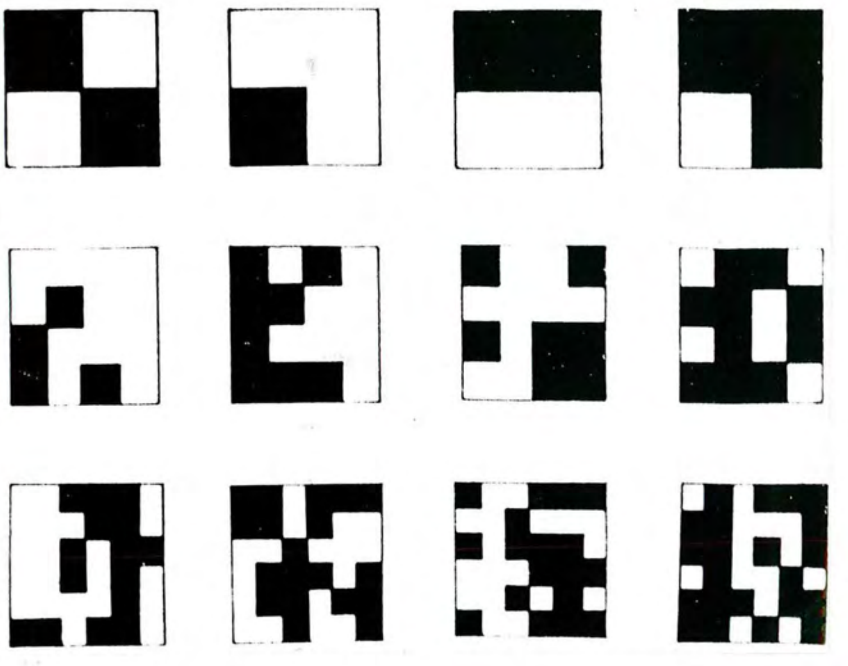
There are certainly those who repudiate the value and usefulness of Fechnerian-based aesthetics as a branch of psychology sui generis (Bullough, 1921; Murray, 1942; Morgan, 1950; Arnheim, 1952; Munro, 1956; Pratt, 1961; Bloom, 1961), and its development has not progressed without opposition, some of it expressed quite adamantly. Gibson (1975) recently remarked that in his opinion "a whole century of experimental aesthetics had failed to discover what it had hoped to discover and the enterprise should be abandoned". Critics cite the impossibility of ever understanding the deep cognitive and emotional responses to a complex work of art by individual analysis of its component parts.

Counterarguments may be raised that the study of preferences for individual, isolated visual properties is of interest in its own right, and, that no one to date has systematically brought together the various findings from different studies into a comprehensive whole. Such a position is only partly satisfactory however, and in time critics of the elementarist approach to aesthetics may prove to be correct. Certainly at present, we do not have a clear picture of man's response to artistic material. We still do not understand how the forest is appreciated by virtue of investigating the component trees. Despite the scholarly attempts of Berlyne, experimental aesthetics from below remains in the preparadigmatic stage as a science, in Kuhn's (1963) sense of the term. And much of the experimental work conducted in laboratories is still very exploratory in nature. The experiments forthcoming are no exception.

There is however a rather persuasive argument which supports the value of studying aesthetic responses to simple laboratory-designed stimuli. In Fechner's day, it must be remembered, art was primarily representational. The task of analyzing an impressionist Monet by Fechnerian methods was surely a formidable one. It is no wonder that success was not forthcoming. To be kind to Fechner however, one can credit him with considerable foresight, for the boundaries between art and non-art, between the aesthetic and the non-aesthetic, have radically changed. Andy Warhol's 'artistic stimuli' easily bring to mind the elusive nature of that boundary. The task of analyzing certain types of abstract, nonrepresentational art into their component visual elements is much simplified, and paradoxically, the very same randomly designed visual stimuli which we currently present to our subjects in the laboratory may well be 'artistically' comparable with products on the open market.

Consider the illustrations mounted in Fig. 1.[3] On the left hand side of each page are examples of nonrepresentational art. On the right hand side are laboratory-designed stimuli. The first example on the left (Fig. 1a) shows a black and white oil painting by Kasimir Malevich, titled "Cross", and painted in 1915. Malevich, the founder of Suprematism, a movement which emphasized basic forms and pure colours, claimed that the feeling evoked by such simplified paintings was the basis of all art. In terms of general appearance and design, Malevich's Cross can be seen to be

a. "Cross" by K. Malevich (1915)

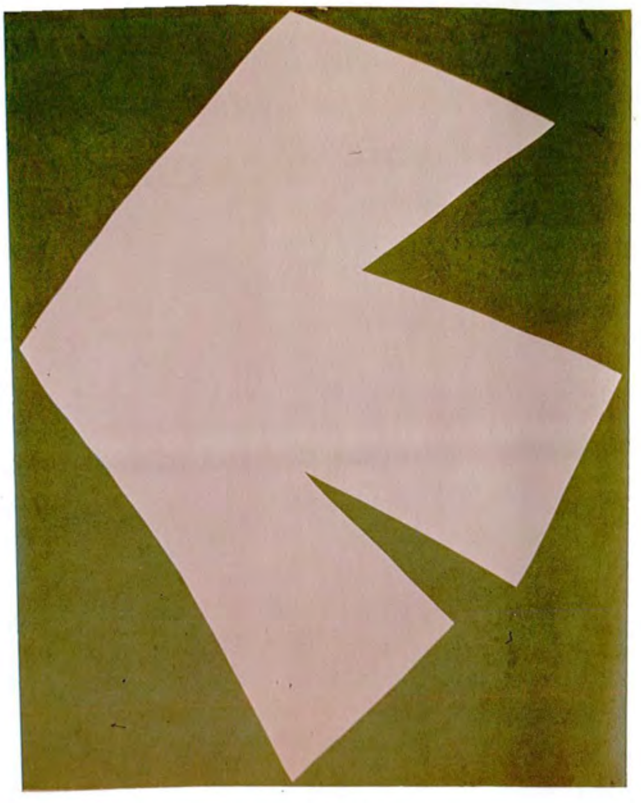


b. Laboratory-designed stimuli used by Dorfmann and McKenna (1975)

c. "Study for a Sculpture" by E. Kelly (1959)

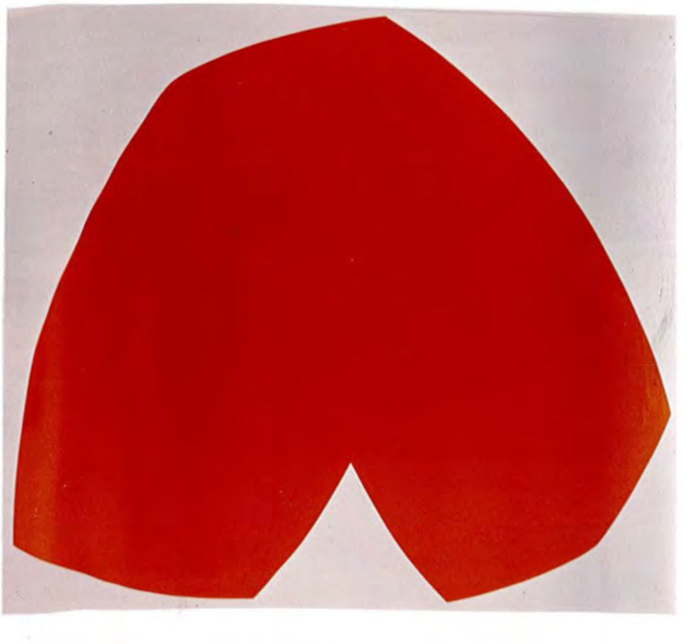
d. Six-sided asymmetrical polygon used in the present study

Fig. 1. Examples of similarities between nonrepresentational art and laboratory-designed aesthetic stimuli.



e. "White on Green" by E. Kelly (1961)

f. Twelve-sided asymmetrical polygon used in the present study



g. "Red White" by E. Kelly (1963)

h. Twelve-sided symmetrical polygon used in the present study very similar to checkerboard stimuli that have been presented for aesthetic judgments in experimental studies, examples of which are shown in Fig. 1b[4] (published in Smith and Dorfman, 1975, also used in Dorfman and McKenna, 1966).

The paintings illustrated in Fig. 1, c,e and g, were all painted by Ellsworth Kelly in the years 1959 to 1963. These examples were chosen from a selection of Kelly's polygon paintings because they show obvious similarities in appearance to the type of randomly designed polygonal stimuli used in the present study, examples of which are illustrated in Fig. 1, d, f and h.

It is not difficult to find further examples of checkerboard and polygon stimuli used in laboratory studies of aesthetics (see the illustrations in Vanderplas and Garvin, 1959; Munsinger and Kessen, 1964; Smets, 1973, Chipman, 1977, for example) that closely approximate other paintings in 'modern art'. However, the selected paintings and experimental stimuli illustrated in Fig. 1 should be sufficient to make the point that the existence of certain types of abstract and non-representational art provide direct meaningfulness and relevance to experimental studies in aesthetics. The criticism that laboratory studies deal only with 'simplified analogs' as Child (1972) calls them is clearly not altogether applicable. Gardner, a long-standing critic of the Fechner-Berlyne 'from below' approach, recently stated that the approach

> is not suitable when the artistic object does not allow a unit by unit analysis ... Berlyne's techniques may turn out to be more appropriate for nonaesthetic objects or for art objects treated in a nonaesthetic way.
>
> (1974, p.209)

Such statements are not entirely accurate, as the illustrations above would suggest. The spirit of Fechner is probably hovering with satisfaction at the way in which 'nonaesthetic' art objects of his time have become 'aesthetic' in ours.

If simplified and abstract art continues in its popularity, and there is no reason to suggest that it will not, then the study of children who have had little exposure to art history, becomes particularly interesting. For the artificial stimuli we present to them in the laboratory are not dissimilar in structure and composition from what they will soon visit in the art gallery across the street. By carefully manipulating parameters of artificial stimuli, we expose children to variations in some of the basic ingredients which constitute genuine abstract art - figural complexity, colour and symmetry for example. The elicited responses of children in the laboratory then, are not at all unlike the 'natural' responses they will direct to genuine art later in life.

General Aims

Research in experimental aesthetics is largely exploratory in nature. In general, it lacks any firm theoretical basis from which to generate specific hypotheses, and as Pratt (1961) and Child (1972) have noted, it is extremely diverse in its scope and in its aims. Moreover, it abounds in conflicting results, particularly in developmental research.

The experiments in this thesis are also exploratory. Their general aim is to gain a broader understanding of children's aesthetic behaviour, and they do so first, by eliciting more than one type of aesthetic response from subjects, and second by varying the aesthetic stimuli along more than one variable. The experiments are designed in some cases to test specific hypotheses, in others to resolve conflicting results from previous research. The need to study multiple aesthetic responses and to understand how such responses relate to each other, and the need to include multiple stimulus variables and to understand their independent and interactive effects on aesthetic responses, are I believe central problems in aesthetic research.

Chapters One and Two deal with dependent and independent variables, respectively. More specific aims will be stated in these chapters. Chapter One introduces the two dependent measures selected for study - the duration of affective viewing and the expression of preference. Both measures, it will be shown, are important and representative components of aesthetic behaviour. They may be said to represent two different stages of aesthetically oriented behaviour, the initial interest in or exploration of a stimulus, and the subsequent expression of affective choice or preference. Chapter One also discusses how these measures relate to one another, the measurement of which is one of the main aims in this thesis.

Chapter Two deals with aesthetic stimulus variables. The decision to employ more than one independent variable stems from the fact that too few studies in the new (and the 'old') experimental aesthetics have examined the interaction of multiple visual elements in a stimulus, and have tended instead, to investigate preferences for levels of only one variable at a time. The forthcoming experiments are the first to study the effect of a collative variable (visual complexity) interacting with non-collative variables (colour and symmetry). Chapter Two introduces the three independent variables and reviews the relevant research.

Chapter Two also introduces an entirely new topic of study to experimental aesthetics, the determination and measurement of affective salience. Briefly, the affective salience of a stimulus property describes the weight or influence of that property, relative to the weight of other properties, in determining preferences. It refers to the fact that some visual properties can have more appeal than others. They stand out as more pleasing properties of stimulus configurations; they have greater 'hedonic pull'.

The term salience is borrowed from an area of developmental research which is cognitive in nature - the study of dimensional dominance.

Research in this area investigates which visual dimensions (form, colour, size, for example) children choose to make judgments of similarity between stimuli. The frequency with which these dimensions are selected (preferred) determines their dimensional dominance, or salience. The following experiments investigate a visual property's salience in determining an affective response, preference. By presenting children with a set of figures that have differential appeal, the extent to which some of the figures are preferred to others will be viewed as evidence of the affective salience of the properties that constitute the figures.

At first, it will be important to investigate and measure preferences for visual complexity. Once a baseline preference for complexity function is established, the strength of complexity as a determinant of preference will be compared with the strength of colour. A further experiment will compare complexity with symmetry. Thus, the affective salience of two non-collative stimulus properties will be measured relative to the salience of a collative property. Finally, an experiment will investigate the comparative salience of all three variables interacting in sets of multidimensional stimuli. The method of testing salience which will be introduced is designed to allow for the establishment of an 'affective salience hierarchy' of stimulus properties.

Chapters One and Two then, deal with dependent and independent variables, respectively. Three further chapters then report the experimental findings. These are followed by a final, summary chapter. Where possible in the forthcoming reviews, developmental research will be emphasized. At times however, the discussion will be more general in nature.

CHAPTER ONE

DEPENDENT VARIABLES IN EXPERIMENTAL AESTHETICS

Affect and Preference

The term affect is a peculiar one in psychology, with a long history of measurement and classification, beginning with Wundt (1896) and Titchener (1899). It continues to sustain interest today (Cooke et al, 1976; Basch, 1976; French, 1977). The term affect is frequently used but seldom defined, although in a general sense it is regarded as synonymous with emotion and feeling (Schachtel, 1943). It may refer to a felt state induced by an external stimulus (a predator, a poem), or to one which emerges without obvious cause (spontaneous joy, internal stress). It is recognized as a property pertaining to a stimulus (the affective value of blue), as well as a characteristic of a response (an affective reaction to blue).

The main problem in identifying what is meant by affect relates to the variety of methods by which it has been investigated. Affect has been measured physiologically (Libby et al, 1973; Payne & Shean, 1975), it has been reported verbally (Guilford, 1940, 1959; Terwilliger, 1963; Berlyne & Lawrence, 1964), it can be visually observed (Tomkins, 1962-63; Hill, 1966, 1974), it can be clinically inferred (Rorschach, 1942; Alschuler & Hattwick, 1947; Apeldorf et al, 1974), or it can be hypnotically induced (Aaronson, 1971). It is a polymorphic concept.

In the field of aesthetics, the concept of affect is important because it connotes the emotional feelings which accompany contemplation, apperception, and appreciation of aesthetic stimuli. While the nature of affect in aesthetics is recognizably complex and multidimensional, in experimental aesthetics it is often practical to view it as unidimensional. Thus, positive affect refers to, and includes the pleasurable personal reactions that arise when a subject views an aesthetic stimulus, while reactions which are not pleasant in nature are regarded as indicating negative affect. Once the nature of the affective response is determined, as either positive or negative, the aesthetic stimulus in question is then classified accordingly, as having high or low affective value, respectively.

In experimental research, there is one response which has been employed more often than all others to indicate personal affect. That response is preference. Acknowledging its usefulness, Berlyne states that:

> the most convenient and most frequently used way to obtain data from which conclusions can be drawn about pleasantness and unpleasantness is that old standby of experimental aesthetics, the verbal expression of preference.
>
> (1971, p.75)

Preference has in fact been regarded as the focal point of dependent measures of aesthetic behaviour.

Preference

In the 100 years since Fechner's publication (1876), visual preferences have been assessed by a variety of measurement techniques. The method of choice still remains the most popular, owing to the ease with which it may be employed; and the three most widely used means of measuring choice - paired comparisons, rating scales, and rank ordering - have been subjected to ever-increasing sophistication of statistical analysis (Coombs, 1964, or Bogart, 1973, for example, or a recent summary by Calfee, 1975, Chap. 7).

Preference, like affect, is a conglomerate concept, without a single, specific meaning. It has often been used rather ambiguously in the literature, because it can refer to numerous verbal, or behavioural indices of choice. The most common meanings, or equivalents of preference however, are liking, pleasingness, and pleasantness. Thus, if a child states he likes visual stimulus A more than visual stimulus B, or rates A more pleasing than B, or ranks A more pleasant than B, it is concluded that A is preferred to B. Similarly, a judgment of preference implies, or is regarded as synonymous with, judgments of attractiveness, appeal, favourability, value, enjoyment, goodness, beauty. To a large extent these judgments do share high correlations with one another, as factor analytic studies have demonstrated (Osgood et al, 1957; Evans & Day, 1971; Libby, Lacey, and Lacey, 1973; Berlyne, 1974).

However, because the term preference is semantically interchangeable with other terms in the literature, there is an unfortunate tendency to regard preference as conceptually equivalent as well. This can be misleading. Recent investigators acknowledging this (Day, 1966, 1967; Hutt & McGrew, 1969; Hutt, 1970; Lindauer, 1971; Nunnally & Lemond, 1973; Wohlwill, 1975b; Hutt et al, 1976) have begun to make, and insist upon appropriate differentiations between preference and other measures.

A major problem in soliciting preferences from children is that below a certain age they cannot state what it is they like best, or cannot do so reliably (Aitken & Hutt, 1974). Thus, in research with infants and very young children preference has to be equated with non-verbal measures, such as the number of eye fixations (McCall & Kagan, 1967; Koopman & Ames, 1968; Brown, 1974; Leahy, 1976), first fixations (Berlyne, 1958b), length of first fixation (Fantz, 1961, McCall & Kagan, 1967), or total fixation time (Spears, 1964; Kagan & Lewis, 1965; Karmel, 1969; Cohen, 1972; Brown, 1974; Sigman & Parmelee, 1974; Bornstein, 1975).

These measures do not indicate preferences which are aesthetic in nature, although Bornstein (1975) would argue that even very young infants look longer at whatever gives them pleasure. Nevertheless, the young ages of these subjects involved in the studies cited above suggests that the term aesthetic is inappropriate. Few would wish to argue that premature babies or that Fantz's infants were making aesthetic judgments. And yet the very same techniques have been used with older children and adults where the responses solicited were regarded as affective-aesthetic in nature, and were referred to as representing preferences (Cantor et al, 1963; Thomas, 1966; Munsinger & Weir, 1967; Nicki & Moss, 1975 (summary); Hyman et al, 1975).

Clearly the semantic and conceptual ambiguities surrounding aesthetic preferences are exacerbated by the very profusion of techniques by which it is measured.

The meaning of preference

One thing clear about a visual preference is that it implies a visual discrimination, and it is to this point that Irwin (1958) directs an analysis. He argues that preference and discrimination are both broad categories of motivated behaviour "so intimately related ... that if the organism exhibits a discrimination, it must also exhibit a preference, and conversely". They are different from one another however, in that objects of preference are features of the outcomes of responses, whereas objects of discrimination are features of the stimuli which exist before the organism responds.

Irwin distinguishes between a preference and a discrimination on the one hand, and a bias and a differential response on the other, the difference being that the former two are dependent upon an outcome whereas the latter two are not. The key concept is outcome. Without the measurable presence of an outcome, a preference is relegated to a bias, a discrimination to a differential response.

Outcomes, according to Irwin, include reinforcements or rewards, but are defined as "any state, or change of state of the organism or its relation to the environment" that results from responding identifiably to a stimulus. Essentially he is arguing that there must be a detectable incentive for the subject before a genuine preference can be said to be operative. A preference can occur then, if and only if the choice among alternative responses depends upon the occurrence of one outcome rather than another. Because a preference for the colour blue over the colour purple for example, does not involve any outcome for the subject, it is not justifiable to refer to 'preference' in such a case. Preferring coffee to tea is allowable if preference is contingent upon the outcome of purchasing (or drinking) the one, and not the other.

Irwin's definition of preference has certain implications.[5] His argument implies that for the majority of studies in the last 100 years conclusions about aesthetic preferences are not justified. Studies of personal preferences are thus to be understood as studies of personal biases, for seldom are there identifiable outcomes for subjects making aesthetic preference judgments.

While Irwin's analysis is not specifically aimed at problems in aesthetics, his inclusion of a hypothetical two-colour, paired-comparison example demonstrates the relatedness to the field. In answer to Irwin the point must be made that generally in experimental investigations of aesthetic preferences, it has not been the practice to consider a reward or reinforcement to the subject a necessary feature of the preference response. That the subject follows instructions and makes a necessary discriminatory response, albeit it forced choice in nature, has always been regarded as sufficient. Two factors continually reinforce this mode of investigation.

First, subjects frequently have definite reasons for their preferences. More often than not, the reasons offered (or solicited) will reflect some degree of pleasure[6] experienced through the expressive qualities of the stimulus in question; or subjects will acknowledge an accompanying affective state when viewing or thinking about the preferred stimulus. Pleasurable and affective states are not susceptible to Irwin's behaviouristic analysis. They are not measurable outcomes.

Second, whether the primary affective response in experimental aesthetics is called a bias or a preference is not in itself important to the field. The distinction does not detract from the empirical foundations. 'Aesthetic biases' clearly exist. They emerge with considerable consistency and reliability, for a great many subject populations, and with a wide variety of stimulus variables.

<u>Viewing as an outcome of preference</u>

In view of the problems of defining preference, it is interesting to note that a few developmental studies in the new experimental aesthetics (Hoats, Miller & Spitz, 1963; Leckart <u>et al</u>, 1968; Hutt & McGrew, 1969; Hutt, 1975; Aitken & Hutt, 1975) have selected measures which approximate Irwin's definition. These studies have investigated exploratory choice as a function of collative variability. The response in question is measured by a subject's choice to view a particular stimulus. For example, Leckart <u>et al</u> (1968) had children choose between two windows, behind which a number of pictures differing in novelty could be seen. Hutt and McGrew (1969) required their subjects to press one of two buttons which exposed various patterns differing in complexity. Also investigating complexity as well as incongruity were Hoats <u>et al</u> (1963), who first exposed children to pairs of patterns simultaneously for 3 seconds, and then asked them to select one of the two for further viewing. This basic design has more recently been extended to include a choice of three different types of stimuli to view (Hutt, 1975; Aitken & Hutt, 1975; Hutt <u>et al</u>, 1976).

All of these studies demonstrate the close interrelationship between visual preferences and viewing. They raise the possibility that viewing itself is a rewarding activity,[7] that it could be regarded in Irwin's terminology as an outcome. Clearly in these studies, viewing is a 'state or change in state' which is immediately subsequent to, and dependent upon the preference response, and in this sense the viewing of one stimulus as opposed to another satisfies the criterion of an outcome. And yet, the nature of the state or the kind of changes involved are not at all easy to identify. The relationship of viewing behaviour to preference behaviour is very complex, particularly so because the reasons for viewing may be subject only to phenomenological analysis.

As an outcome, viewing can have many different values to a subject. In the Hoats et al study (1963) for example, perceptual curiosity was intentionally induced in the subjects by initially allowing them only short exposures to the two stimuli. A subsequent choice to view a stimulus would presumably be motivated by a desire to reduce curiosity. In the Hutt and McGrew study (1969) on the other hand, subjects could alternate viewing between stimuli, and they had unlimited time in so doing. The motive to view in their study is less related to curiosity, and its value, or reward to the subject is more difficult to detect and measure.

Nevertheless, the measures employed in these exploratory choice studies represent a kind of preference which is an interesting development in view of Irwin's analysis, and although not acknowledged, Irwin's views are clearly echoed. As Hutt and McGrew put it:

> If there is a real p r e f e r e n c e for certain stimulus attributes, then these attributes should be capable of acting as reinforcers in an operant task where one of a pair of discriminanda controlled the appearance of these stimulus characteristics.
>
> (1969, p.113)

Pleasure and arousal as outcomes

The discussion of outcomes is perhaps the most important contribution Irwin makes. They allow for an explanation of why a subject makes preferences. They give meaning to the preference response, a question which is central to aesthetics. As Irwin points out "what could be meant by a preference for one disembodied colour over another is not easy to see". The answer usually accepted is that one stimulus is preferred to another because it has greater hedonic impact, it gives greater pleasure, however, as stated before, these cannot be regarded as outcomes. Relative pleasure may *determine* a preference, but it does not necessarily follow that it is *dependent* upon the response.

Berlyne offers an alternative meaning to preferences, fully elaborated (1967, 1970, 1971) elsewhere. Basically, he holds that aesthetic patterns produce hedonic value ("a term meant provisionally to cover both reward value, as judged by the capacity of a stimulus to reinforce an instrumental response, and preference and pleasure, which is reflected in verbal evaluations", 1970, p.284) through fluctuations they cause in arousal, and are preferred for that reason. Stimuli that produce moderate arousal increments will be pleasurable and rewarding, while those that produce sharp rises in arousal will be unpleasant. In relation to Irwin's analysis, Berlyne's arousal-based explanation of preference (like the pleasure-based explanation) raises the possibility that changes in state of arousal may function as outcomes. However, in strict interpretation of Irwin, pleasure through arousal change does not satisfy the requirements of an outcome, for Irwin is quite specific in the sequence of events. Outcomes follow the preference response, they are consequences of action, whereas according to Berlyne a change in arousal is that which determines the response (the act of preferring) in the first place. Arousal fluctuations cannot therefore satisfactorily be classed as outcomes to aesthetic responses.

In the study of preferences then, the mainstay affective response of experimental aesthetics, analysis and measurement come by various methods. Irwin's behaviourist view of preference is intriguing because of its precision. But it is particularly noteworthy in that it demonstrates the problems of terminology in this area of research where semantic and conceptual legislation is sorely needed.

In view of these problems, a definition of preference is in order. In the following experiments, preferences will be experimenter-solicited and verbally reported[8] by subjects. The expression of a preference will be viewed as evidence that affective discrimination has occurred, but it will be measured purely by a child's expression of which stimulus he l i k e s b e s t . Preferences will thus be defined as the degree of liking.

Alternative Aesthetic Responses

In view of the continued emphasis in aesthetic research placed on the solicitation and measurement of preferences, one of the most unusual aspects of the preference response is that it is not an essential part of the aesthetic response in the first place. Outside the laboratory, aesthetic behaviour does not necessarily include spontaneous, comparative judgments of relative liking and pleasingness. Aesthetic stimuli are sought out, viewed, studied, and contemplated on their own merit, often without recourse to interstimuli comparisons. And when such comparative hedonic judgments do occur, they are usually the final stage in the process.

In a number of psychological expositions of aesthetic behaviour, one finds that the act of preferring is not even considered. Lundin (1956) for example, distinguishes 'four kinds of reactions called aesthetic' - the creative, the critical, the evaluative, and the appreciative. He views the appreciative as having three behavioural components: attentional, perceptual, and affective. 'Preferential' is not included in the list. Birkhoff (1933), in a similar vein, regards 'the typical aesthetic experience' as compounded of three successive phases. He distinguishes first, a preliminary effort of attention, followed by a feeling of value which rewards the effort, and finally a realization of implicit order or harmony. The act of preferring is not considered. Hevner (1937) in a 'psychological description of the aesthetic experience' similarly makes no mention of engaging in preference responses as part of that experience. Beardsley (1969) more recently, also does not include 'preference' in a list of general features "peculiarly characteristic of our intercourse with aesthetic objects". And one very specific perspective given to the importance of preferences in aesthetic behaviour can be seen in the writings of Bullough (1912), an early critic of experimental aesthetics. He states that any request for a preference-type response could actually be disruptive to the aesthetic experience. He wrote that:

> to be asked in the midst of an intense aesthetic impression 'whether one likes it' is like a somnambulist being called by name; it is a recall to one's concrete self, an awakening of practical consciousness which throws the whole aesthetic mechanism out of gear.
>
> (1912, p.118) (9)

It would appear to be the case then, that despite the emphasis placed upon the measurement of preferences in the experimental literature, the act of preferring is neither a necessary nor a natural affective component of aesthetic behaviour. Nor should it be the only affective component response to be considered. In fact, the study of preferences to the exclusion of other response measures loses a great deal of information about aesthetic behaviour.

This point has recently been made and elaborated by Lindauer (1973), who argues for a general 'liberalization' of experimental research in aesthetics, and in particular he criticizes the reliance upon a limited range of dependent measures. Lindauer's own work (1969, 1970, 1971, 1973) is part of a growing trend to include more diversified and more representative response components in the study of aesthetic behaviour.

Recent research, using sophisticated multidimensional scaling techniques, has studied similarity judgments applied to pairs of paintings (Berlyne & Ogilvie, 1974; Berlyne, 1975; O'Hare, 1976), semantic differential ratings applied to paintings (Berlyne, 1973b; Libby, Lacey & Lacey, 1973; Ruth & Kolehmainen, 1974), and the relationships between factor analyzed dimensions obtained from similarity analysis and those from semantic differential analysis (Berlyne, 1975; O'Hare & Gordon, 1977). And at least one study (O'Hare & Gordon, 1976) has applied Kelly's (1955) repertory grid method to determine how subjects articulate their perceived similarities and differences among artistic styles. Such methods have produced data pertinent to the very core of aesthetic sensitivity, and there is no doubt that their usefulness will be further acknowledged. The repertory grid method in particular is a valuable application to aesthetic research, because it allows the subject himself to produce his own perceptual dimensions of art. To that extent it is, as O'Hare and Gordon point out, free from any demand characteristics, and it therefore elicits only natural aesthetic constructs.

With the possible exception of the repertory grid however, these methods may prove to be more applicable to adult subjects than to primary school-age children, who have not yet achieved the ability to make systematic scale ratings on bipolar scales. And so, in order to gain a broader understanding of aesthetic behaviour in children, an alternative, complementary response to preference which does not rely so heavily upon verbal and intellectual skills, must be selected. In the following sections, an alternative response is introduced.

Exploratory Measures of Aesthetic Behaviour

A visit to an art gallery provides ample opportunity to observe numerous indices of aesthetic behaviour. The very fact that some works of art are sought out in preference to others is an obvious example. The varying amounts of time that are spent in perusal, investigation, contemplation is another example.

The degree to which attention is captured and held, the degree to which approach or avoidance is elicited are further illustrations. Touching, manipulating, manually exploring works of art are also observable, even encouraged at times. These behaviours, loosely designated as exploratory behaviours, have begun to receive attention in the study of aesthetics.

Measurement of these behaviours as illustrative components of aesthetic behaviour is comparatively recent (Berlyne, 1958a), yet historically they have always been regarded as important. Attention for example, was included as a component of aesthetic behaviour by Lundin, Birkhoff, Hevner, and Beardsley, mentioned in the previous section. Hevner writes that:

> appreciation requires alertness of mind and body. Attention must be directed toward the objective stimulus and 'attention' means that a state of readiness, or partial contraction, is being maintained by the muscles of the body, that the eyes are turned toward the stimulus and actively focussed there ....
>
> (1937, p. 248)

And Valentine (1962) in his 'experimental study of beauty' similarly emphasizes attention as being riveted, concentrated, held, and absorbed during aesthetic behaviour.

Experimental study of exploratory behaviours in relation to aesthetic behaviour is due chiefly to the efforts of Berlyne. He writes as follows:

> There is, as we have seen, a large overlap between aesthetic behavior and exploratory behavior. All the activities of the creative artist, performing artist, or appreciator that lead to the stimulation of sense organs by an art object must inescapably be classifed as exploratory behavior. And the perceptual, intellectual, and emotional processes that follow stimulation and are responsible for its hedonic value are such as typically occur when exploratory behavior has completed its task.
>
> (1971, p.289)

Berlyne makes a distinction between specific and diversive exploration. From an early study (Berlyne, 1963) investigating exploratory choice as a function of collative variability, results showed that the choice of a pattern for further viewing depended upon length of initial exposure.

After short exposures of only .5 seconds, subjects chose the more irregular pattern, whereas after longer exposures (3-4 secs.) the more regular pattern was selected for further viewing. This led Berlyne to postulate two different types of exploration.

Specific exploration occurs as a response to missing perceptual information (.5 sec. exposures for example). It is "prompted by incomplete perception of a stimulus pattern, which leaves the subject with considerable uncertainty regarding its properties" (Berlyne & Peckham, 1966). Such a condition involves conflict, heightened arousal, and is termed perceptual curiosity. The purpose of specific exploration is to reduce the uncertainty, to resolve the conflict by gaining access to specific, additional stimulation containing the information.

The other kind of exploration is diversive in nature. Unlike specific exploration, it does not occur in conditions which generate perceptual curiosity, but rather is directed at stimulation from any source that is intrinsically interesting or entertaining. It is aimed at distraction, amusement, or pleasure, and may often come into play to relieve boredom. According to Berlyne, diversive exploration "therefore includes most aesthetic behavior".

The distinction between the two has been widely acknowledged and accepted (Wohlwill, 1968; Hutt, 1970; Nunnally & Lemond, 1973; Ertel, 1973; Kirkland, 1976). A thorough review of variables affecting children's exploratory behaviour, with a comprehensive analysis of specific and diversive exploration as they relate to curiosity, boredom, investigation, and play has been made by Hutt (1970).

Viewing time

The measure of visual exploratory behaviour investigated in this thesis is duration of viewing time. One of the most natural and most intriguing features of aesthetic behaviour is that people intrinsically motivated to explore aesthetic stimuli will spend measurably different lengths of time passively looking at them. The actual time spent viewing a given stimulus is seldom a matter consciously decided before inspection begins. It is determined largely by the stimulus characteristics. And stimuli vary considerably in the extent to which they initiate and maintain aesthetic attention. The challenge for experimental aesthetics is to delineate those stimulus parameters that differentially affect viewing times. In so doing, we make possible identification of parameters which influence inspection of genuine art.

Measurement of viewing times has been utilized in a wide variety of studies with adults, adolescents, children, infants, and animals, as can be seen by the bibliographic entries compiled by Leckart and Faw (1968) ten years ago. Quite apparently, viewing time is not always regarded as a measure of aesthetic behaviour, as the animal and infant studies demonstrate. And in much of the research with older subjects, viewing time is employed as a measure of perceptual-attentional-exploratory behaviour where the authors do not relate findings to aesthetic behaviour (Brown & O'Donnell, 1966; Brown & Lucas, 1966, for example).

Various methods have been used to measure viewing times, but all of them involve presenting a number of stimuli which a subject is allowed to view for varying amounts of time. Berlyne (1971) distinguishes between (1) tachistoscopic presentation of material where a subject presses a key to expose a pattern for as long, or as many times as he wishes, and (2) presentation of two patterns where time spent viewing each is recorded by observing eye movements, and (3) continuous presentation on a screen of a single pattern where a subject activates a control device to expose the next pattern whenever he wishes. The third method is called the free looking time method. Faw and Nunnally (1973) on the other hand classify methods of measuring viewing time according to whether the subject must (1) make gross head movements or (2) make gross eye movements to bring one of two or more stimuli into view. Their third method involves the subject making an instrumental response (button pressing, bar pushing) to bring and/or to keep a stimulus in view. The free looking time method thus involves an instrumental response.

Some methods involve comparative viewing times, others absolute viewing times. The difference depends mainly upon whether the design of the experiment involves a paired comparison of stimuli, or a single stimulus presentation. The paired comparison design, where two stimuli are presented simultaneously, or come into view successively, gives comparative viewing times (gross head movements and visual fixation methods, including Berlyne's method 2). The free viewing time method generates absolute viewing time data.

In the following experiments absolute viewing times will be measured with a variant of the free looking time method. The apparatus is designed to allow children an instrumental response to control continuous presentation, but does not necessitate them sitting in a dark room with a slide projector (details are given later). There are three advantages to studying free (absolute) viewing times. First, it is simple and economical and generates a large amount of data in a relatively short period of time. Second, it allows each stimulus to be inspected on its own merit. Subjects are not forced to study differences between stimuli, or to make comparisons between them. The third advantage follows from the second, and is that it best approximates aesthetic viewing in a natural setting. It allows for relaxed, unrestricted 'visual browsing'.

Explanations of viewing time

Time spent viewing then, is an integral part of aesthetic-exploratory behaviour, perhaps an even more 'natural' component than is the elicitation of verbal preferences. Yet when employed as a response measure, questions inevitably arise as to what it represents. Of what is it a non-verbal, behavioural measure? Does it represent specific or diversive exploration? Can it be likened to interest or attention? There are unfortunately no satisfactory answers to these questions, as the perceptual and cognitive processes involved during time spent viewing are not accessible to evaluation. One can only state with certainty that the duration of viewing a given stimulus represents the amount of perceptual investigation that that stimulus sustains. It probably includes both specific and diversive types of exploration. Whereas initial contact with a stimulus, particularly a novel one, triggers specific exploration, subsequent exploration may well be more diversive in nature. Experimental methods allowing for only short initial exposures to stimuli will most likely elicit specific exploration in a subject, while methods that allow for unlimited browsing probably result in diversive exploration coming into play. Even under the latter conditions however, there are no sound reasons to explain viewing time as representing diversive exploration exclusively.

Viewing time has been conveniently regarded as a measure of the 'interest' that a stimulus generates in a viewer, particularly because there is evidence that verbal ratings of interestingness correlate highly with viewing times (Day, 1966; Evans & Day, 1971; Berlyne, 1973b; Russell, 1975). This should not imply though that viewing time is solely a measure of interest. It is not. Stimuli may be viewed for their pleasantness as well as their relative interestingness (Berlyne, 1973b). Furthermore, there is no evidence in children that viewing correlates with rated interest, because under the age of 10 children cannot differentiate between ratings of pleasingness and interestingness (Aitken & Hutt, 1974). The two measures cannot therefore be equated.

Much of the developmental research on visual exploratory behaviour has concentrated on complexity and novelty as determinants of exploration (reviewed by Hutt, 1970, and by Nunnally and Lemond, 1973). A general overview of visual investigation is that it is primarily an 'information-extraction' mode of response (Wohlwill's term, 1975b), a view which derived originally from Berlyne's theoretical contributions (1960). Nunnally and Lemond in particular place emphasis on information conflict as a determinant of visual exploration and attention. Information conflict, they state, is synonymous with the term incongruity (first put forward by Berlyne, 1960). "It is a purely cognitive term having to do with the relative difficulty of encoding the stimulus configuration" (Nunnally & Lemond, 1973, p.67). When information conflict is perceived in a stimulus, encoding results. The subject attempts to resolve the conflict, to make sense of the stimulus. He strives to make it meaningful. In many ways, these authors liken visual investigation to problem-solving behaviour. A very similar explanation of visual investigation has been put forward by Kreitler et al (1974).

In relation to the actual duration of viewing, what is implied in such analysis is that time spent viewing is time spent encoding. Clearly it is. Whatever degree of information conflict is present in a stimulus, part of the time spent viewing it will automatically result in attempts to encode it. What is not clear in this analysis however, is the relationship between the d u r a t i o n of viewing and the processes of encoding. Do lengthy viewing times imply that lengthy processes of encoding have occurred? Does a long viewing time imply a greater perceptual problem to be solved? Does it mean that more effort has been expended in assimilating and organizing the pattern? Or do short periods of viewing mean that conflict was not present, or that it was minimal and easily resolved? A further problem with this analysis has to do with whether or not the end of a given period of viewing actually coincides with successful encoding. When a viewer stops viewing, does this mean that the perceptual pattern has been organized, or resolved? Cessation of viewing may well be the result of unassimilated, unresolved perceptual effort, where the viewer gives up so to speak.

These are the type of problems that arise with any attempt to explain or categorize the processes involved during viewing time. As Leckart states, research in this area has generally been atheoretical

> concerning itself primarily with investigations of the parameters of exploratory behaviour and relegating the development of a formal theoretical framework to a secondary position.
>
> (Leckart <u>et al</u>, 1972)

Nevertheless, viewing time remains a popular dependent variable, particularly in developmental studies. Children's viewing times are known to be highly dependent upon stimulus characteristics, the two most frequently manipulated collative variables being complexity and novelty. The general finding has been that the more complex or more novel a stimulus is, the longer is the time spent viewing it (Nunnally & Lemond, 1973). There are few exceptions to this, with age of subjects being an important variable capable of reversing this trend (Hutt & McGrew, 1969).

In addition to stimulus characteristics, studies with adults have shown that viewing time is dependent upon the instructions given to subjects (Berlyne & Lewis, 1963; Brown & Farah, 1966; Faw & Nunnally, 1967; Day, 1968b). Brown and Farha (1966), and Day (1968b) presented data indicating that subjects looked longest at patterns under neutral instructions ('look as long as you care to') than under instructions to look as long as the pattern was 'pleasing' or 'interesting'. Berlyne and Lewis (1963), and Day (1968b) have also shown that looking times are longest when a subject is under the impression he will be later tested for recognition of the stimuli.

Although varied instructions have not been studied in children, it is felt that neutral instructions favour the most relaxed viewing conditions, and accordingly they will be used in these experiments. This follows the established method in other developmental studies of free viewing time (see Cantor et al, 1963, for example).

To summarize then, sustained visual attention is a basic means by which a child develops a better understanding and appreciation of the world around him. As directed towards aesthetic stimuli, the amount of that attentive investigation can be measured by duration of viewing. Although encoding, information-extraction, conflict resolution, and specific and diversive exploration must all be involved to an extent during the time spent viewing, any attempt to emphasize one of these components inevitably leaves out other possibilities.

In the following experiments, viewing time is to be thought of purely as a measure of affective-aesthetic perceptual behaviour which can be directed towards stimuli in varying amounts. The emphasis in this thesis is not to delineate the processes involved during viewing, but rather to study the stimulus parameters causing it to vary in children. A second intent is to study the relationship of viewing time to preference. It is felt that the nature of this relationship will give further meaning to both dependent measures.

Relationships between Dependent Measures

Once it is established that aesthetic behaviour is better understood by examining more than one response, it remains to be seen to what extent the responses selected for study relate to one another. As will be seen in the following sections, relations between measures present a complicated picture.

Studies with adults

The relationship between exploratory measures and measures of preference is not a straightforward one, particularly when adults have been studied. In some cases it is the type of exploratory task employed that affects the nature of the relationship. For example, in 1963, results of an experiment by Berlyne and Lewis led them to conclude that "the question whether verbal expressions of preference are related to actual exploratory behaviour has received an affirmative answer". In that experiment the measure in question was exploratory choice. In 1964 however, Berlyne and Lawrence reported that "verbally expressed preference was not positively related to exploration time". In that experiment, the exploratory measure was free viewing time.

In other cases it is the type of verbal rating employed to measure preference or the type of stimulus material presented to subjects that affects the relationship. Day (1966) for example, had students freely view a series of slides of three different types (environmental scenes, Barron Welsh Art Scale selections, and Berlyne figure selections) and later asked them to state which ones were liked. In general, he reported, the distribution of looking times followed ratings of affect. Brown and Gregory (1968) on the other hand, found no clear positive relationships between verbal ratings and free looking time. In their research, subjects verbally rated the 'attractiveness' of dot patterns.

Other contradictory findings have also emerged in studies of adults. Harrison (1968) and Lindauer (1970, 1971) have reported a negative relationship between students' ratings of affect and free looking times, while Wohlwill (1968) showed that ratings of liking and free looking times behaved similarly except at high levels of stimulus complexity. Two other studies, different from most in that they did not rely on collative variables, have also provided support for a positive relationship between the two measures (cited in Berlyne, 1971). The first one, by Sobol and Day (1967), demonstrated that subjects spent more time looking at polygons in colours they preferred. The second, by Bechtel (1967), employed a device called a hodometer that recorded museum visitors' footsteps, and showed a high correlation between the time a visitor spent looking at a museum piece and his preference ranking for that piece.

The picture is further complicated by verbal evaluations of interestingness, which while acknowledged to be closely related to looking times (Berlyne, 1963; Day, 1968b; Wohlwill, 1968) have indefinite relations with ratings of pleasingness and preference (Valentine, 1962, Chap. IX; Day, 1965; Berlyne, 1963, 1970; Berlyne, Ogilvie & Parham, 1968).

Thus did Berlyne in a selected review (1971) of many of these studies conclude that the evidence at that time was inadequate, perplexing, and confusing, and stressed the need to resolve the problem with further research.

Subsequent research among adults has unfortunately not resolved the problem at all. McMullen and Arnold (1976) for example, produced data showing that preference and interestingness ratings, made by university music honours students on pairs of rhythmic sequences varying in complexity, were quite different. Nicki and Moss (1975) on the other hand, showed that viewing times, ratings of preference and of interest for non-representational art all increased linearly as a function of three different measures of complexity applied to the stimuli. Aitken (1974) similarly found positive correlations between levels of polygon complexity found most pleasing and the levels ranked most interesting, although the former reached an asymptote at a lower level than the latter. And results which fall somewhere in between these studies were produced by Francès (1976), who in two studies demonstrated that interest and preference judgments of drawings varying in six measures of complexity showed parallel functions for students, but did not for manual workers. The difference between the two groups was confirmed in the second study in which photographs were used instead of drawings.

It would appear to be the case then, that with adult subjects, relations between affective measures are no less complicated and perplexing now than they were when the research started. Results seem to depend upon a number of factors: the type of subject (student versus manual worker), the type of stimulus material (random polygons versus environmental scenes) and the type of response elicited (non-verbal versus verbal evaluations, paired comparison versus rating scales).

Studies with children

On the basis of some recent developmental research, it has been suggested that the duration of looking time sustained by a stimulus is more closely related to its relative preference value in children than it appears to be in adults (Aitken & Hutt, 1974; May & Hutt, 1974; Hutt, 1975; Aitken & Hutt, 1975). Indeed, research by Hutt and colleagues has led to the statement that differential attention is in fact the basis of children's preferences. Aitken and Hutt write:

> Many of the children under 10 years of age were unable to evaluate the patterns according to whether they were interesting or pleasing, but this does not mean that there is no basis for their preferential judgments. We propose that this basis is attention; children like better what they attend to more .... In other words, amount of visual fixation and ratings of preference should accord well with each other.
>
> (1974, p.429)

And again in 1976, Hutt further specifies conditions under which preference and duration of attentional viewing should be in accord:

> ... in using the term 'like' to describe visually presented material, children most probably are influenced by perceptually salient features of the material (e.g. contours, edges, etc.), and where no structure or organization can be readily imposed, as with randomly generated polygons or other abstract designs, such features determine what is 'liked'. Since these features also determine visual fixation, attention and preference will be isomorphic in such circumstances. However, when organized or meaningful material is presented the nature of what is salient changes ....
>
> (Hutt et al, 1976, p.63)

This hypothesis has not adequately been tested by Hutt. In the 1974 study just cited (Aitken & Hutt), randomly generated polygons were indeed used, but the two responses that were measured were not what they should have been, according to the hypothesis quoted above. Both responses were verbal ratings. Subjects were asked to rate polygons for pleasingness and for interestingness, and the results showed that both functions increased monotonically with complexity (number of sides). However, these results are applicable only to a single and unrepresentative age group of children (9 to 10 years), and furthermore, many of these subjects according to the authors, were unable to distinguish between the two instructions. Preferences of all younger subjects (5 to 8) were determined by ratings of 'liking' only. Thus the 1974 study, despite its title, is more accurately described as a study of children's preferences. Certainly, the data in that study do not warrant the prediction put forward in its conclusion, nor do the data offer any firm support.

Moreover, if one considers the research published prior to 1974, the situation is even more confusing, particularly so because Hutt herself arrived at quite a different conclusion as to the relationship between preference and viewing time. The results of an earlier study (Hutt & McGrew, 1969) showed that pattern complexity affected viewing times in 5 and in 11 year olds, but that it had no significant effect on preferences (measured by exploratory choice). Hutt concluded therefore that viewing time "would be a very poor indicator" of preference in young children. In fact, a similar conclusion had already been reached in an earlier study (Kaess & Weir, 1968) of even younger subjects ($2\frac{1}{2}$ to $5\frac{1}{2}$). These authors wrote that "children of these ages show a preference for looking at figures with higher levels of complexity, while they do not r e p o r t a preference for those figures". In contrast to these two studies is that of Thomas (1966) who reported "a good correspondence between the two measures of preference, judged preference and length of viewing time" for 7, 8, 9 and 12 year olds.

It can be seen then that there is considerable confusion as to the nature of the relationship between preference and viewing time. Certainly the present state of affairs does not allow one to confidently state that attention is the basis of preference in children. Firmly based results are therefore needed to resolve the conflicting evidence.

Aims of the present experiments

A major aim of the experiments to follow is to provide a thorough test of Hutt's hypothesis. Primary school children of all ages will be presented with a set of carefully constructed polygons to look at, one at a time, for as long as they want to in a free viewing time situation. Later on, the children will inspect the same polygons for as long as it takes to rank order them in terms of preference (liking). If viewing times are found to be isomorphic with preferences, then this will be taken as support for Hutt's hypothesis.

The following section reviews in more detail those studies which have presented data relevant to the preference-viewing time relationship. It should be noted at this point though, that while the general problem in consideration is the overall relationship between preference and viewing time, Hutt's prediction involves only a one way relationship, namely, that attention is the basis of preference. Her prediction that stimuli which hold viewing times the longest will be the most preferred, does not imply that stimuli which are highly preferred will sustain longer viewing times. The experiments which follow will test whether the relationship between expressed preference and viewing time is a reciprocal one. By presenting to children sets of stimuli which are known to contain visual properties of high positive affect, the extent to which those stimuli are viewed longer than those which are not as pleasing will also be tested. In other words, the alternative hypothesis that pleasingness is a basis of attention will be examined. This hypothesis will be further delineated after the next section.

Experimental Evidence

Table I summarizes the relevant information collected from developmental studies which have both solicited preferences and measured durations of viewing times. There are eight such studies, arranged chronologically, with Hutt and colleagues contributing most to the area, as can be seen. A study by Wohlwill (1975a) has also been included because it is an interesting replication of the original Thomas (1966) study, with the difference that Wohlwill presented the same shapes made of wood for children to explore manually, rather than to look at.

There are several points which the table illustrates. They are first, that the stimulus variables are, with one exception (Hutt et al, 1976), all collative in nature. Second, each study examines only one such variable at a time. Third, the two dependent measures employed, preference and viewing times, have not been submitted to a direct statistical comparison as they should have been. And finally, conclusions vary as to just how preference and duration of viewing are related.

Regarding the first point, the profuse but somewhat exclusive interest in collative variability is undoubtably due to the influence of Berlyne. This writer takes the view that this restricted interest in stimuli is unfortunate, because it necessarily limits the application of research to what could be a much broader understanding of children's involvement with aesthetic stimulation. Experimental aesthetics must seek to distinguish itself as a separate field of inquiry from other fields such as children's play, exploration, and problem-solving behaviour, which recently are relying heavily on collative variability in research.

TABLE I. SUMMARY OF THE RESEARCH ON THE RELATIONSHIP BETWEEN PREFERENCE AND VIEWING TIME

Author date,	No. of Ss	No. of groups; ages	STIMULUS CHARACTERISTICS			RESPONSE MEASURE				RESULTS	STATISTICAL MEASUREMENT	CONCLUSIONS
			Independent variable: stimulus material	No. of levels: range of variation	Method of presenting stimuli	PREFERENCE		VIEWING TIME				
						Method of measurement	Subject's task	Method of measurement	Subject's task			
Thomas 1966 (study 1)	53	four; 7,8,9, 12	complexity; randomly generated polygons	five levels: 3 to 40 sides (4 variants each level)	slide projection	paired comparison (5 sec. exposure)	to write choice on numbered sheet	paired comparison	temple bar press used; rocking head exposed one or other	both measures increased with complexity for all age groups	no direct measure	"a good correspondence between the two measures"
Kaess & Weir, 1968	54	three 3,4,5	complexity; randomly generated polygons	four levels; 5 to 40 sides (3 variants each level)	slide projection	paired comparison (30 sec. exposure)	to state choice verbally	paired comparison	to view freely	viewing time increased with complexity; pref. showed no relation; no age effect	analysis of variance on weighted scale scores	very young children's preference for complexity depends upon what response measure is used to indicate preference
Kreitler et al, 1974	84	one; $6\frac{1}{2}$-8	complexity (5 different dimensions); pictures from other studies	two levels; simple and complex for each dimension	presented in pairs in a box (viewing), on a table (pref)	paired comparison	to point to the one preferred	paired comparison	to move head from one side of stimulus display box to other	no effect of complexity on either measure: pref. and viewing related to low degree	t tests/x^2; applicable with 2 resp. types and 2 complexity levels	pref. and viewing time differ: former shaped by associations, evaluations latter determined by difficulty to understand, to organize
Hutt, 1975	24	two; 4,6	novelty; pictures from books	three levels; novel, semi-novel and familiar	slides projected in one of 3 windows	window most frequently opened (choice); most liked (pref)	to open a window; to state pref.	total time spent viewing each window	to hold open open window while freely viewing	novel pictures viewed longest; 6 yr. olds preferred novelty	no direct measure	pref. for novelty depends upon measure used: plausible interpretation: preference depends upon attention value of stimuli
Aitken & Hutt, 1975	36	three; 3/4, 5/6, 7/8	incongruity; pictures from children's books	three levels; incongruous, semi-incongruous, banal	slides projected in one of 3 windows	window most frequently opened (choice); most liked (pref)	to open a window; to state pref.	total time spent viewing each window	to hold open window while freely viewing	viewing time increased with incon'y; older Ss. pref'd incon'y; choice not affected	no direct measure	children under 5 have difficulty selecting, evaluation; by 7 differential attention may be basis of preference
Wohlwill, 1975a	48	three; 6,9, 12	tactual complexity: wooden polygons	five levels; 3 to 40 sides (4 variants each level)	presented behind a screen	paired comparison	to feel with each hand; to tap pref.	presented singly; total time spent feeling each shape	to manually explore each shape	exploration increased with complexity; older Ss. preferred more complex	no direct measure	voluntary tactual exploration and preference similar in older children; but not in young children
Wohlwill, 1975b	192	four; 6 to 14	complexity: postage stamps and environmental scenes	seven levels: based on variety/diversity (2 examples each level)	slide projection	paired comparison	to write choice on numbered sheet	presented singly; total time spent viewing each picture	to view freely	viewing incr'd with comp'y: pref. did as well, but only with stamps; few age diff's	no direct measure	differentiation of information - extraction (viewing) and aesthetic (pref) mode of response confirmed to considerable extent
Hutt et al, 1976	24	two; 5,7	meaningfulness/affect; pictures: cartoons, designs, scenes	three levels; 'nice', 'neutral', and 'nasty' pictures (6 of each) egs.	presented 3 at a time on lecturn	rank ordering	to rank 3 stimuli in each of 6 triads	total time spent viewing each picture	to view freely the set of 3 pictures	attention and preference more closely associated in younger subjects	contingency coefficients between preference and viewing	young Ss. preferences dependent upon attention value, not upon affective content; older Ss. upon meaningfulness (type of picture)

Aesthetic stimuli have always been held to consist of more than collative variability, and it is hoped that noncollative properties will begin to play a more prominent role in future research. The present experiments are a step in that direction. The recent study by Hutt et al, (1976) is encouraging in this respect, although it must be noted that there are inherent problems in representing a single dimension by three different types of stimulus pictures, whatever name is given to that dimension. The study is not at all specific as to what variable is manipulated - affect, meaningfulness, or both conjointly.

Regarding the second point - the use of only one independent variable - this is to be seen as a continuation of what has been regarded as a recurring limitation of experimental aesthetics, and one which has frequently been criticized (Bullough, 1912; Munro, 1928, 1963; Murray, 1942; Bloom, 1961; Pratt, 1961; Gardner, 1974; Gibson, 1975) since Fechner first formulated principles for research in aesthetics. Those who favour single-variable research do so principally for reasons of control over other variables, and argue the impossibility of determining which variables in complex genuine artistic material are responsible for stimulating aesthetic responses. Certainly within the framework of Berlyne's 'new experimental aesthetics' the reliance upon single variables is viewed as a necessary but restrictive aspect of future research. As he puts it:

> for some time to come, we must rely primarily on simple, artificial stimuli, which can be designed to differ from one another in one respect only, leaving other variables rigorously controlled, and will certainly be quite unlike anything that could generate deep aesthetic satisfaction.
>
> (1971, p.175)

In the last few years, his prescription has been largely followed, for much of the research continues in just that way, with the studies in Table I thus seen as no exception to the general trend.

It should be noted however, that some of the stimuli listed in Table I can be described along more than one independent variable. Wohlwill's (1975b) postage stamps of varying colours, sizes, and picture content, or his choice of environmental scenes for example, obviously differ from one another in a number of ways, but the important point is that they have been c h a r a c t e r i z e d, and consequently analyzed as representing variations on one dimension only.

In the light of these two points then, the stimuli in the experiments which follow have been designed to vary along three independent variables (complexity, colour, and symmetry), and to vary with respect to noncollative (colour and symmetry) as well as collative properties (complexity). With the use of multiple stimulus dimensions, a more extensive understanding of preferences, of viewing times, and of the interrelationship between them will be forthcoming.

The third point which the table illustrates is the lack of direct statistical comparison between the dependent measures. Interestingly, two of the three studies which did analyze both responses with a single statistic (Kaess & Weir, 1968; Kreitler et al, 1974) found a negative relationship between them. In other studies (Thomas, 1966, for example), where both types of response showed significant linear and/or quadratic trends with the independent variable, a direct statistical comparison was presumably seen as unnecessary, and graphical illustrations were deemed sufficient. Nevertheless, it is reasonable that the case for, or against a correspondence between aesthetic measures will be considerably strengthened if the measures are properly compared with appropriate analysis. In the experiments which follow, statistical analysis is included which addresses this problem, and thus remedies previous oversights. To compare viewing times, which are parametric, with preferences which are nonparametric, the former will first be converted into ranks. The objective (true) rank order of complexity will be used as a standard against which both ranked viewing times and rank-ordered preferences will be correlated. The two sets of rank order correlation coefficients can then be compared with an analysis of variance. A significant difference will mean then, that the amount of agreement between the observed and the objective rank order of complexity is different for the two response measures. Hutt's hypothesis predicts that there will be no significant differences.

Finally, Table I shows that there are conflicting conclusions about the nature of the relationships between measures. Some studies conclude rather definitely that the measures are in close agreement with one another, others are conclusive that they are not, while others offer suggestive predictions that attention is the basis of preference.

Inspection of the table reveals though, that the conclusions depend to a large extent upon what type of collative variable was chosen for study. For instance, the eight studies may be conveniently divided into two groups - those that manipulated visual complexity and those that manipulated other variables. In the latter group there are three studies, all conducted by Hutt and colleagues, and each deals with a different independent variable: novelty, incongruity, and meaningfulness (and/or affect). As stated earlier, there is some question as to what was varied in the Hutt <u>et al</u> (1976) study although it can be definitely stated that the variable(s) was not (collative) complexity.

What is noteworthy about the three non-complexity studies is that they all conclude, or rather propose, attention to be the basis of preference. The remaining five complexity-variable studies on the other hand, offer conclusions that conflict with one another.[10]

Thus, on the basis of these eight studies, the following synopsis is appropriate: in general, the level of correspondence between preference and duration of viewing in children is dependent upon the type of collative variability the children are exposed to; specifically, manipulations of complexity produce variable correspondence between measures, while manipulations of other variables produce a good correspondence.

Age and the relation between measures

The variable correspondence between preference and viewing time in the complexity studies is better understood if the question of subjects' ages is considered. Hutt (Aitken & Hutt, 1974; Hutt et al, 1976) maintains that with increasing age the dependence of preference on the attention-value of stimuli will decrease. Young primary school age children, she argues, should show a close relationship between preference and viewing, whereas older children, who have gained evaluative experience will make preference judgments on a variety of bases. Their preferences should show less dependence upon the attention-value of stimuli. However, examination of the complexity studies in Table I suggests quite the opposite. As stated previously, two of the complexity-variable studies (Kaess & Weir, 1968; Kreitler et al, 1974) are noteworthy in that they concluded preference and viewing time were unrelated, and, in that they applied a statistic to both measures. They are also noteworthy in that they used younger subjects than the other studies. The age range in the Kaess and Weir study is 2½ to 5½, in the Kreitler study 6.6 to 8.4, with a mean of 7.0 years.

Close inspection of the individual age curves in the remaining studies reveals that as age increases, so does the level of correspondence between the two measures. This is particularly marked in the Wohlwill study (1975a) in which all three age groups (6, 9, and 12 years) showed linearly increasing viewing times with complexity, whereas only the two older groups showed that trend with preference judgments. The youngest group displayed an inverted U-curve. In the other Wohlwill study (1975b), analysis of the two responses showed an effect of age on preference, but not on viewing time, a difference which the data curves show as being due to the youngest age group.

Thus, based on the information in Table I, a corollary of the synopsis is forthcoming: the varying correspondence between expressed preference and duration of viewing found when visual complexity is manipulated (as opposed to other types of collative stimulation) is age dependent; specifically, attention does not appear to be the basis of preference in children below the age of 7 to 8, whereas over that age, the relationship between the two measures is a closer one.

In the following experiments, the full age range of primary school children (6 to 11) will be sampled. Should duration of viewing show less agreement with verbal preferences as age increases, then there is support for Hutt. If on the other hand, the data support the trend already apparent in the other complexity studies, Hutt's hypothesis will require revision.

<u>A Complementary Hypothesis</u>

The hypothesis that viewing times could be dependent in part upon affective content has been infrequently studied, and has received mixed support in the literature. No systematic studies have been conducted with children. In a recent publication, Berlyne (1972a) referred to adult data which showed a significant correlation between the duration of viewing stimuli and a Hedonic Value factor ('factor-analytical') of those stimuli. Pleasingness, it was said, accounted for 16% of the variance of looking time. Berlyne further stated that "we have for the first time, therefore, some evidence that pleasingness can have some degree of influence on looking time."

In fact it was not the first time at all. Some years earlier, the hypothesis had already received partial support with organized, meaningful pictures (pictures of faces, nudes, clothes) in studies by Faw and Nunnally (1967, 1968). These authors showed that adults (1967) and children (1968) looked longer at pictures rated high in affect than they did at neutrally rated pictures. The relationship between affect and viewing times was clouded however, because results from the developmental study showed that highly negative stimuli (deformed faces, for example) received longer viewing times than either highly positive or neutrally evaluated pictures. They concluded that information content and/or novelty predominated over affect in influencing visual investigation.

A similar conclusion was offered by Day (1968b). He presented adult subjects with a series of symmetrical and asymmetrical polygons in a free viewing time situation under four instructional sets. The findings showed that under two instructions, 'as long as interesting' and 'recognize', asymmetric shapes were viewed longer. Under the other two instructions, 'pleasing' and 'care to', there were no differences in viewing times. Day argued that because adults judged asymmetric polygons as more complex but less pleasing than symmetric polygons, that looking time is primarily a measure of the level of collative variability in the stimulus rather than its affect value. He added however, that "looking time is not independent of the observer's affective evaluation of the situation."

Another study with adults (Weiner, 1967), cited by Brown and Gregory (1968), showed an absence of any positive relationship between attractiveness ratings and viewing times for dot patterns varying in three parameters. Patterns which received the highest attractiveness ratings did not sustain the longest viewing times, and in many cases the reverse was true. These authors ruled out "aesthetic appreciation as a significant determinant of the subjects' viewing behavior".

And so, Berlyne's comparatively recent reference to pleasingness affecting viewing times had already received experimental attention, albeit with inconclusive results. The only study which has looked at this problem since his remarks is the study by Hutt et al (1976), already mentioned. Hutt's study is in many respects similar to Faw and Nunnally's developmental study (1968), although the earlier work is not acknowledged. In both cases, pictures were used to represent different levels of affect. The dimension which underlies, and presumably connects the stimuli in the Hutt study however, is even more difficult to identify than in the Faw and Nunnally experiment. Whereas the latter contained pleasant, neutral, and negative facial expressions, Hutt compared cartoons and representational illustrations regarded as 'nice', abstract designs (from the Observer Colour Magazine) regarded as having 'neutral' affect, and frightening, unpleasant pictures (devil-dancer, leper) said to be 'nasty' in affective content. Her results showed that nasty pictures were viewed longer than neutral pictures (which corroborates Faw and Nunnally) by both 5 and 7 year olds, and that the 5 year olds preferred the nasty to the neutral pictures. Both age groups viewed longest and preferred the nice pictures to the other two types, a result which was not found in the Faw and Nunnally study.

Neither study really provides any conclusive evidence as to whether preferred visual patterns will sustain longer viewing times. Not only are these two developmental studies not easily compared because of the obvious differences in stimulus content, but they are also full of ambiguity as to what the main independent variable is. Comparing a leper with an abstract design suggests a host of potential variables to account for the difference between the two. Affective content, relative preference or hedonic value is only one such possibility.

Day's approach (1968b) to the problem, which has not been utilized with children, is much more straightforward. The two types of polygonal stimuli were equivalent in many respects (general appearance, size, number of sides, black on white background), and differed primarily with respect to whether the stimuli were random in shape or symmetrically reflected about a central axis. The addition of symmetry to a stimulus then, increases its affective value without undue alteration to other important stimulus parameters. An even better approach to increasing affective value is to present stimuli in appealing colours. This produces no change at all in the form or structure of the stimuli and coloured polygons can be directly compared with non-coloured polygons in terms of their effect on viewing times.

In the following experiments, both independent variables, colour and symmetry, will be employed to test the hypothesis (complementary to Hutt's) that stimulus patterns with preferred properties will generate longer viewing times than patterns without those properties.

Summary

In summary then, the relationship between preference and viewing time is unknown in adult subjects. From the results of developmental studies, there is insubstantial evidence of a positive association between the two. Nevertheless, recent studies by Hutt and colleagues have led to the hypothesis that attention is the basis of preference in young children, with the prediction that amount of visual fixation will accord well with stated preferences. This prediction will be tested in the following experiments in a manner which will remedy previous shortcomings. These are that only collative variables have been selected for study; that only one variable at a time has been manipulated; that inadequate statistical analysis has been applied to test the main problem of interest.

Furthermore, by investigating the relationship between preference and viewing time in an adequately wide age range of subjects, the importance of age can be examined. Hutt and colleagues propose that the positive relationship between the two measures becomes less pronounced with increasing age, however, studies that have investigated responses to visual complexity point to the opposite trend.

An additional hypothesis, complementary to Hutt's, will also be examined, namely that stimuli which contain preferred visual properties will sustain longer viewing times than stimuli without those properties. It is expected that children will attend longer to coloured and to symmetrical stimuli, which are known to be pleasing, than they will to non-coloured and asymmetrical stimuli.

CHAPTER TWO

INDEPENDENT VARIABLES IN EXPERIMENTAL AESTHETICS

Multiple Stimulus Variables

A persistent problem in the study of aesthetic responses is the choice of different stimulus properties to which responses will be directed. It has already been stated that most experimental studies manipulate only one independent variable at a time, and that recently these have tended to be collative in nature. However, it takes more than one visual property to combine to form a work of art, and our aesthetic responses to works of art are determined by the particular combination and interaction of those properties.

In the previous chapter it was argued that aesthetic behaviour can be better understood by the study of more than one response measure, and hypotheses were advanced concerning the relationship between two such measures - preference and viewing time. The argument applies similarly to the study of aesthetic stimuli. We gain a better understanding of aesthetic behaviour by studying responses to more than one independent variable. By employing stimuli which contain multiple properties, we broaden knowledge about the function of any one aesthetic response, be it preference or viewing time, and we provide a more thorough test of hypotheses predicting a relationship between responses. Moreover, it can be argued that by designing multidimensional stimuli for experimental research, we gain closer approximations to 'real works of art'.

Complexity, Colour and Symmetry

In the experiments which follow, three stimulus variables have been selected for study. These are visual complexity, colour, and symmetry, and they have been chosen primarily for three reasons. First, they represent a wider range of types of aesthetic variables than is currently in use in research, including particularly properties which are non-collative as well as collative. Despite the shortcomings of the concept 'collative', visual complexity can be conveniently regarded as primarily a collative variable, while colour and symmetry are non-collative. Colour is in fact classed by Berlyne (1971) as a psychophysical property, as distinctive from collative and ecological, and symmetry is discussed as a 'special problem' in aesthetics, and is therefore neither collative, ecological, nor psychophysical.

Secondly, they are opportune for testing the hypotheses outlined in Chapter One. The prediction that attention is the basis of preference can be tested with the complexity dimension, by presenting to children a series of figures varying in complexity and determining if those which hold interest the longest are also later judged as most preferred. The alternative prediction (the complementary hypothesis) that high affective value is a determinant of attention can be tested with colour and symmetry. Chromatic and symmetrical stimuli are both more highly judged in terms of preference and positive affect than their counterparts - achromatic, asymmetrical stimulation, and figures which contain colour and/or symmetry are therefore predicted to sustain longer viewing times.

The third reason for the choice of these particular variables is their general importance in the creation and appreciation of art. While it cannot be stated categorically that some visual properties are more fundamental or vital to art than others, this writer believes that complexity, colour, and symmetry are three basic ingredients, which all artists must give consideration to in dealing with their subject matter. They are highly influential properties in our perception and appreciation of art works.

They are properties which are spontaneously apparent to a viewer. A first glance gives us an immediate impression of the relative simplicity or complexity of a work of art, by such factors as the amount of detail and variety it includes, how many figures or elements are depicted, whether there are irregularities, repetitions, homogeneities. We are also quick to perceive whether the artist has chosen to work in colour or in black and white, or whether variations in a single family of colours form his palette. Our initial perceptions and subsequent appreciation are further governed by the extent to which a work of art incorporates a degree of symmetry, although we usually speak of it as a sense of balance (Arnheim, 1954).

Furthermore, relative complexity, the presence of colour, and symmetry are important because they frequently function as primary guidelines upon which aesthetic judgments are made, by layman and critic alike. We speak critically of a painting as having a poor sense of colour, as being unevenly balanced, as being too simple, or as not having enough detail.

Affective Salience

Apart from the usefulness of the three variables in testing the relationship between measures, each is interesting in its own right as a determinant of preference. In any multidimensional stimulus configuration, each property contributes to a part of the overall aesthetic appeal of that stimulus. A visual figure may be liked because it is in colour, because it is symmetrically balanced, and because it is relatively complex, or it may be liked for any one of those reasons.

Some stimulus variables though, may be said to contribute more to the overall appeal than do others. For example, colour may be judged more pleasing than the presence of symmetry, or high complexity more appealing than the presence of colour. With adults, who have been exposed to a wide variety of artistic stimulation, the differential appeal of visual properties is highly individual. Aesthetic tastes vary enormously. Some may like a painting because it is in colour, others the same painting because it has balance.

With children however, discovering the relative affective salience of visual properties in determining preferences presents a challenging possibility, for they have had much less exposure to artistic material and have therefore not had the opportunity to develop individual tastes to the same degree as most adults have had. Their preferences for certain properties of visual designs are not as culturally determined. Moreover, it is reasonable to assume that differential preferences for particular visual properties may change with age.

Part of the following experimental work is directed towards establishing the affective salience the three chosen independent variables have in determining visual preferences. Subjects will be exposed to a series of figures, some of which are appealing because they contain one property (or a certain level of that property), and some of which are appealing because they contain another property. Subjects will thus be confronted with a form of *aesthetic conflict*, where two or more properties are conjointly influencing preferences, in opposition to one another. The extent to which one property is chosen in favour of another will be viewed as evidence of greater affective salience.

Analogies

Although the choices the children will make are in some cases quite complex, such as when all three variables are interacting, the experimental determination of affective salience can be viewed in analogy to a more simple example of consumer behaviour. Consider a consumer looking to purchase a jumper. A salesman presents two jumpers for his perusal. One is judged to have the right amount of detail in the pattern but is only available in black and white. The other is judged to be in the right colour the consumer has been looking for, but does not have enough detail to his liking. Assuming that variables such as texture, warmth, price are constant, the consumer has a conflict of choice between the two properties - detail (complexity) and colour. Which jumper is preferred? Which property is more affectively salient in determining his preference?

A situation more analogous to the actual range of choice subjects will have is as follows: a consumer prefers a complicated and detailed pattern in a wall poster, and also prefers it to be predominantly blue. He is presented with a number of posters which vary in pattern from very simple to highly detailed. Only the simply patterned posters are in blue however; the remainder are in black and white. To what extent will be forfeit his preference for complexity (pattern detail) in favour of his preference for colour? Is the presence of blue a sufficiently salient characteristic to counteract non-preferred low levels of pattern detail? Are there some blue posters with unappealing patterns which are equally or more preferable to black and white posters with appealing patterns?

The problem of establishing salience will be dealt with in more detail later in this chapter, after the following reviews of each of the three independent variables.

Visual Complexity

The main independent variable in the studies which follow is visual complexity. Stimulus complexity has already attracted considerable attention in its capacity to elicit varying amounts of visual investigation, and it has frequently been studied as a determinant of aesthetic preferences. It is held to be particularly important in developmental psychology where relative ability to process varying amounts of information is regarded as a function of age (Dember & Earl, 1957; Wohlwill, 1960, 1975a; Munsinger et al, 1964; Munsinger & Kessen, 1966a; Gibson, 1969; Walker, 1970;

Chipman & Mendelson, 1975), but has also figured prominently in research with animals and adults. Several reviews of research with visual complexity are available (Dember & Earl, 1957; Berlyne, 1960, 1966, 1971; Cantor, 1963; Hutt, 1970; Walker, 1970, 1973; Kreitler & Kreitler, 1972; Nunnally & Lemond, 1973), although these have tended to deal with complexity more as a determinant of exploratory behaviour than of preference.

Measurements of complexity

Like so many terms associated with experimental aesthetics, 'complexity' has taken on numerous meanings, and is measurable by different methods. Many descriptions of complexity refer to the physically measurable, objective properties of a stimulus pattern which can be increased in equal increments, thus forming a dimension ranging from high to low. The number of sides in a polygon (Munsinger & Kessen, 1964; Day, 1967, 1968a), the number of squares in a checkerboard (Dorfman & McKenna, 1966; Gale et al, 1971), or the number of dots in a pattern (Brown & O'Donnell, 1966; Thomas, 1969; Baltes & Wender, 1971) are examples of this approach. Measurement is often expressed in informational terms, such as when number of polygonal sides are transformed into log units (Munsinger & Kessen, 1966b), or when redundancy in a checkerboard is increased (Karmel, 1969; Smets, 1973; Chipman, 1977). In the latter case, complexity varies inversely with redundancy.

Measurement of complexity has also been established with the now well-known 'Berlyne figures', which have been used extensively by Berlyne (1958a, 1963, 1973b; Berlyne et al, 1963; Berlyne & Lewis, 1963; Berlyne & Lawrence, 1964; Berlyne & Peckham, 1966), by his colleagues (Day, 1966, 1968b;) and by others (Hoats et al, 1963; Clapp & Eichorn, 1965; Faw & Nunnally, 1967; Hutt & McGrew, 1969; Kreitler et al, 1974; Wiedl, 1975; Francès, 1976). A full set of these figures can include up to seven different types of complexity: irregularity of arrangement, amount of material, heterogeneity of elements, irregularity of shape, number of independent units, asymmetry, and randomness of distribution. These are generally analyzed independently (Hoats et al, 1963; Kreitler et al, 1974; Francès, 1976) but are sometimes treated as a single dimension (Berlyne, 1958a; Hutt & McGrew, 1969). While these figures have been very popular in developmental studies, they have a great disadvantage in that the actual range of complexity is poorly sampled. Each type of material is represented by only two examples, a high and a low variant. This makes them inappropriate for research where a broad representation of the dimension of complexity is required.

With adult subjects, a dimension of complexity can be established by subjective ratings, as well as objective measures, the basic procedure involving subjects making their own assessment of each stimulus' complexity on a bipolar scale (see Walker, 1970, for example). In some studies subjects are given guidelines for scaling (Moyles et al, 1965; Wohlwill, 1968; Lindauer, 1970; Nicki & Moss, 1975) while in others they must make their own decision as to what complexity means (Lindauer & Dintruff, 1975; Day, 1968b; Chipman, 1977). Subjective ratings are usually found to be in close agreement with objective measures when the latter are available (Stenson, 1966; Day, 1967, 1968b; Driscoll & Sturgeon, 1969; Walker, 1970; Aitken, 1974; Chipman, 1977). Verbal ratings of environmental scenes or real works of art (Wohlwill, 1968; Walker, 1970; Berlyne, 1975; Lindauer & Dintruff, 1975) do not of course allow for comparison with objective standards of complexity, although a recent study by Nicki and Moss (1975) demonstrated that an informational measure of redundancy applied to 18 abstract paintings did correlate with two subjective measures of complexity. While this may be the case, it has also been recently suggested that the importance of the complexity dimension in determining aesthetic judgments is much reduced in real works of art (Berlyne, 1975; O'Hare & Gordon, 1977). O'Hare and Gordon suggest that in certain pre-modern art, the upper ceiling of complexity has been reached.

Polygonal complexity

In the following experiments, the dimension of visual complexity will be represented by the number of sides in randomly generated polygons, a method which has been more extensively used with adults than it has been with children. There are several advantages to the use of polygons.

First, the use of polygons means that each level of complexity, originally defined by Birkhoff (1933) as "the number of indefinitely extended straight lines which contain all the sides of the polygon", can be determined with exactness. Second, the method allows for multiple stimuli to represent each level of complexity, such that at any one level the representative shapes are quite different from one another (by random generation), yet are constant with respect to the number of sides criterion. Third, polygons allow for a wide range of complexity to be sampled, which can be extended to very high levels of complexity (Day, 1967; Wilson & Nunnally, 1973), as opposed to the Berlyne figures, for example, which represent only two levels.

Furthermore, randomly generated polygons are basically unfamiliar to children, as opposed to checkerboard or dot patterns which are more likely to have already occurred in their visual experience. An additional consideration in favour of polygons is that subjective evaluations of their complexity have particularly high correlations with objective measures (Stenson, 1966; Day, 1967; Nunnally & Lemond, 1973). Finally, polygons are flexible stimuli with regard to combination with the other two variables of interest, colour and symmetry. They may easily be constructed in black or in colour, and they may be divided into halves, one half of which is then chosen to be symmetrically reflected.

The Psychophysics of Polygons

Randomly generated polygons obviously differ from one another in more ways than just the number of sides that form their boundaries. They are describable and measurable on many different parameters. In fact the study of polygons has become quite complex in itself. They have become a sort of focal point in attempts to develop a metric of form, where physical form parameters and their intercorrelations are related to perceptual responses.

In the 1950's and 1960's a great deal of effort was expended in identifying relevant polygon parameters and in measuring the extent to which these contributed to the variability of shape (Attneave, 1957; Arnoult, 1960; Zusne, 1965; Michels & Zusne, 1965; Brown & Owen, 1967; Stenson, 1966). Methods of polygon construction were published (Attneave & Arnoult, 1956), which are still used to construct sets of stimuli in studies of aesthetic responses (Eisenman, 1966a; Day, 1967; Aitken, 1974; Aitken & Hutt, 1974). Polygon parameters were also related to judged association values and to relative meaningfulness (Vanderplas & Garvin, 1959; Battig, 1962; Munsinger & Kessen, 1964; Vanderplas et al, 1965; Eisenman, 1966b).

In the original studies, identification of polygon parameters was limited to only a few. Attneave (1957) for example, had subjects rate complexity of polygons which varied in six parameters: matrix grain used in construction, curvedness, symmetry, number of sides, the square of the perimeter divided by area (P^2/A - a measure of compactness), and angular variability (average difference between adjacent angles). Number of turns was found to account for almost four-fifths of the variance of the judgments. Arnoult (1960) found quite similar results.

Since the early studies, the number of identifiable parameters has increased significantly, a fact which led Michels and Zusne (1965) to state in a summary of the research that

> there seems to be no limit, except the ingenuity of the investigator, to the number of measures that may be taken on a simple, two-dimensional black-and-white shape.
>
> (p.82)

Such ingenuity was later to be most strikingly demonstrated by Brown and Owen (1967) who examined 1000 polygons at five levels of complexity and submitted 80 different measures to factor analysis. Using number of sides as the equivalent of complexity, they found five major factors accounted for most of the matrix variance. These were labelled compactness (relative dispersion away from a polygon's centre of gravity), jaggedness (proportion of acute interior angles), location of skewness of area and perimeter with respect to the x axis, with respect to the y axis, and directionality (dominant axis either vertical or horizontal).

The authors discuss their results mainly in terms of the importance of adequately sampling the domain of all possible polygons. The finding that the factor structure was not the same for all levels of complexity has implications for sampling techniques. Jaggedness for example, is decidedly more marked in many-sided figures than it is in simple ones. What this means is that in order to equate this factor in simple and complex stimuli, large samples of simple polygons would be required to obtain the modal jaggedness present in more complex figures. They found, for a different reason, that adequate sampling would also require larger samples for more complex levels of complexity. This is because as number of sides increases, other physical measures exhibit more independence from one another, which means that at high complexity levels, the degree to which shapes are free to be unique also increases.

Implications and applications

The accumulated evidence that polygons represent a range of complex multivariate stimuli is beyond doubt. This has implications for research of various perceptual responses, yet to the author's knowledge the findings from polygon measurement studies have been ignored in experimental aesthetics. In view of the main purpose of the experiments at hand, it is not feasible to do justice to all the findings of polygon variability research. Such an effort would be outside the scope of this work. Yet there are some steps which can be taken to deal with the problem of sampling and with the problem of selecting which physical measures to vary, or to hold constant.

Regarding sampling, nothing is more disconcerting than not being able to generalize results to the greater population of stimuli because of poor sampling techniques. In the study of aesthetics, sampling stimuli is no less a problem than it is in other areas, yet several studies can be cited in this area for using too few examples to represent each level of complexity (Munsinger & Kessen, 1966a; Eisenman, 1967a,b, 1968a,b; Day, 1967, 1968a) which resulted in unexpected dips or peaks in response curves. Good representation on the other hand can be seen in the studies of Munsinger (1966), Stevenson and Lynn (1971), Aitken (1974), and Aitken and Hutt (1974).

Because of the random generation factor, some polygons will unavoidably be idiosyncratic, producing unusual responses. To prevent this in the experiments which follow, a sufficient number of stimuli will be generated to represent each level of complexity, thereby counteracting the effects of any particularly unusual ones.

Regarding selection of relevant parameters, the usual practice in aesthetic research is to generate a set of stimuli according to Attneave and Arnoult's (1956) Method 1, which uses one criterion to define complexity - the number of sides. At first sight, this appears sound practice, as all of the polygon research shows sidedness to be the major factor in accounting for variability. However there are two problems with Method 1. The first is that without modification to the method, the constructed polygons can fail to have the number of sides they should have. The reason for this is that when plotting coordinates, points may fall on a straight line. Thus, where there should be two or more lines (sides), there is only one. All of the plotted coordinates could theoretically fall on one straight line, although in execution it is usually only one or two sides which are 'missing'. Inspection of published polygons, when possible, shows that some of the figures do not represent the level of complexity they should (Vanderplas & Garvin, 1959).

The second problem with the Attneave and Arnoult method is that it can produce polygons which vary tremendously in area, perimeter, (and consequently P^2/A), and angular variability. These parameters have been shown to be influential determinants of perceptual responses (Arnoult, 1960; Zusne, 1965; Stenson, 1966; Brown & Farha, 1966; McCall & Kagan, 1967; Brown & Gregory, 1968). And Washburn et al (1934) much earlier, showed that the area of colour patches was influential in determining preference judgments.

In view of the polygon research then, the subsequent experiments are designed to include the following points:

- number of sides will be the principal measure of visual complexity;
- the method of construction will be modified to ensure that the main variant, number of sides, is what it should be;
- the dimension of complexity will be represented by 10 levels, and will increase from 4 to 40 sides;
- each level will be represented by four polygons;
- perimeter, area, and P^2/A will be measured after generation, and where necessary, adjusted with as little interference as possible to the concept of random generation.

Complexity and Preference

Any attempt to generate hypotheses regarding preferred levels of complexity must take into account the quite extensive literature already available on the subject. Even a cursory review of the many 'preference-for-complexity' studies demonstrates that results to date are, to say the least, equivocal. With children alone, preference has been found to be an increasing (May, 1963; Thomas, 1966; Munsinger & Weir, 1967; Eisenman et al, 1969; Turner & Arkes, 1975; Wohlwill, 1975b), a decreasing (Hoats et al, 1963), a U-shaped (Aitken & Hutt, 1974), and an inverted U-shaped (Munsinger et al, 1964; Boykin & Arkes, 1974; Wohlwill, 1975b) function of complexity. And at least one study showed no definite preference for any level of complexity (Kaess & Weir, 1968).

These contradictory findings prove particularly problematic to those seeking empirical support for theoretical accounts of preference for complexity (Dember & Earl, 1957; Berlyne, 1960, 1967). Dember and Earl, and Berlyne, although not specifically dealing with children's preferences, both hold that preference for complexity will be an inverted U-shaped function.

Dember and Earl's theory of choice holds that each individual is characterized by a preferred level of stimulus complexity which changes unidirectionally with experience, that is, it takes on increasing values. Individuals tend to react favourably however, to pacer stimuli, those which are perceived as having slightly higher complexity values. The more dissimilar a given stimulus is to the pacer, the less will be the preferential attention apportioned to that stimulus. With any given set of stimuli varying in complexity, it follows that preference (and attention) will be an inverted U-shaped function which decreases on either side of the pacer.

Berlyne, from a somewhat different theoretical viewpoint, similarly predicts that preference will be curvilinear. He holds that stimulus complexity is one of many environmental, collative properties that contribute to the arousal potential of a stimulus, arousal potential being defined as the psychological strength or impact of a stimulus pattern. An individual's judgment of relative pleasingness (his determination of its hedonic value) is mediated through the influence that that stimulus has on arousal. Arousal is thus an intervening variable. Hedonic value is postulated to be a function of the actual arousal increment caused by the arousal potential of a stimulus. The prediction follows that judgments of pleasingness result from moderate arousal increments produced by moderate levels of arousal potential (middle levels of stimulus complexity). High stimulus complexity on the other hand, (theoretically represented as high arousal potential) causes a large and aversive arousal increment which leads to judgments of unpleasantness. The dimension of stimulus complexity then, is accordingly hypothesized to have a curvilinear relationship to preference.

It should be pointed out that this relationship is most likely to best represent the preference response of an organism upon its first encounter with stimuli varying in complexity. Continued encounters with the range of stimulus complexity (including the originally experienced, aversive levels) allow for familiarity to develop. Indeed, Berlyne holds that an arousal-reduction mechanism also operates to produce positive hedonic value by lowering arousal level from aversive, unpleasant levels. Moreover, as Berlyne states (1967), the most highly valued degree of complexity goes up in evaluation with increasing familiarity.

From these points then, it would follow that if a child is calmly inspecting a set of stimuli which include the full range of complexity, that any initially unrewarding large increments in arousal level will be lowered or dissipated as inspection continues. This would result in a more positive evaluation of high complexity stimuli.

Several studies have produced evidence of an inverted U-shaped function with adults (Eckblad, 1963; Dorfman, 1965; Vitz, 1966a,b; Day, 1967; Wohlwill, 1968; Walker, 1970) thus supporting Dember and Earl, and Berlyne. Others have not, as already noted. Naturally, as Berlyne argues, findings of monotonic functions may result from sampling only specific levels of the complexity dimension. As he put it:

> if an inverted U function exists, one would expect only the increasing or only the decreasing part of the curve to appear under some experimental conditions, depending on the population of stimulus patterns, the population of subjects, and other factors.
>
> (1967, p.61)

The problem of clarifying the state of knowledge is made more difficult when the variable meanings of 'preference' and of 'complexity' are realized. Those who have carefully reviewed this literature (Rump, 1968a,b; Hutt, 1970; Nunnally & Lemond, 1973; Kreitler et al, 1974) have arrived at the only obvious conclusion, namely, that unless the type of independent variable representing complexity, and the type of response measure indicative of preference are specified, it is inappropriate, even meaningless to speak of any overall preference for complexity function. One can add to this that in some cases it would also be appropriate to specify the range of complexity which has been sampled (Eisenman, 1967a,b; Walker, 1970; Steck & Machotka, 1975), as well as certain personality characteristics of the viewers (Barron, 1953; Taylor & Eisenman, 1963; Bartol & Martin, 1974).

For present purposes, the most important individual difference is the age of the subjects. Accordingly, the following review will deal with those studies in which children's verbally expressed preferences to varying-sided polygons were under investigation.

Paired-comparison studies: the Munsinger research

The most prolific investigations in the area were conducted by Munsinger and colleagues (Munsinger & Kessen, 1964; Munsinger, Kessen & Kessen, 1964; Munsinger & Kessen, 1966a,b; Munsinger, 1966) who generated polygon figures according to the Attneave and Arnoult method, and had variously-aged youthful subjects make paired-comparison judgments of preference. Under the assumption that human beings possess a limited capacity for processing sensory information, they predicted that if presented with a wide range of stimulus variability (complexity), processing limitations would be seen as a nonmonotonic relation between expressed preference and variability. They predicted specifically, that intermediate ranges of variability would be the most preferred, with preference falling off when variability was above or below the optimal level. Essentially the same inverted U-shape curves relating preference and complexity were predicted by Dember and Earl (1957) and by Berlyne (1960, 1967).

The original studies produced results which partly confirmed the hypothesis. The first two studies with children (Study I, Munsinger, Kessen & Kessen, 1964; Study IV, Munsinger & Kessen, 1966a), using a range of polygons up to 40 sides, showed 'an age-invariant preference for figures of 10 turns', a result which confirmed the earlier finding from a similar study with adults (Munsinger & Kessen, 1964). Inspection of the data curves shows however, that they are not truly inverted U-shaped. After peaking at 10 sides, preference decreased as predicted, but then increased as number of sides approached maximum. In fact, the four youngest-aged subject groups (7 to 10) preferred the 40-sided figures more than the intermediate 10-sided figures, as the graphs show (Munsinger, Kessen & Kessen, 1964, Figs. 3 & 4, pp.9-10).

The claim of an age-invariant peak of preference at 10 sides does not stand up to scrutiny. In the first place, it is not really age-invariant, as the senior author himself later demonstrated. In a study designed to analyze polygon preference data by multidimensional scaling procedures (Munsinger, 1966), preferences of 8 and 9 year olds were stated to be "monotonic and positive", although the actual data were not reported or illustrated. In another study (Study V, Munsinger & Kessen, 1966b), students' preferences for low meaningful polygons ranging in four steps from 5 to 40 sides were also reported to be linearly increasing, whereas preference for more meaningful figures increased linearly up to 20 sides, and then decreased for 40-sided figures.

Secondly, the inverted U-shaped curve relating preference to variability does not seem to hold for symmetrical polygons. When children were asked to express preferences for a set of symmetrical figures varying in 8 steps from 6 to 40 sides, preference increased linearly with number of sides (Study IV, Munsinger & Kessen, 1966b).

In considering the hypothesis of preference for an intermediate range of variability, one expects that the results will allow for a fairly flexible interpretation of 'intermediate'. However, the fact that it is always the 10-sided figure which is the most preferred in the intermediate range, and this regardless of the range or number of steps of complexity sampled, raises the question of peculiarities with that particular level of variability. One answer is probably methodological in nature, in that too few examples of each level of complexity were sampled. In both studies with children (Munsinger & Kessen, 1964; Munsinger & Kessen, 1966a) only one polygon at each level was presented, yet when seven polygons were used to represent each of eight levels of complexity (Stimulus Set II, Munsinger, 1966), preference for 6 to 11 year olds was found to be monotonically increasing. It should be pointed out though, that a methodological explanation is only partly satisfactory, for in the same study with adequate complexity level representation, 12 to 15 year olds again showed a peak of preference at the 10-sided level.

Whatever the reason 10-sided figures are important for older children and for adults, it seems reasonable to conclude from the Munsinger studies that when proper sampling is exercised, young children's preferences for polygon complexity tend in general to increase with number of sides.

A quite unexpected finding from the Munsinger studies was that younger children preferred the higher complexity figures more so than did older children and adults (Munsinger, Kessen & Kessen, 1964; Munsinger, 1966). Although this finding was later discovered not to hold for symmetrical figures (Study IV, Munsinger & Kessen, 1966b), it was basically contrary to the hypothesis, as processing ability, and hence preference for higher variability figures, was expected to increase with age.

The authors interpreted this finding by hypothesizing an age difference in the strategy with which high variability figures were approached. Young children were said to prefer more complex figures because they did not attend to all the variability present, and selected only those parts which they could handle, whereas adults were more likely to tend to the whole figure, thereby placing a demand on structuring which in turn would lead to relative dislike of the high variable figures. This was tested by comparing various categorization abilities of young children with older subjects (Study II and III, Munsinger & Kessen, 1966a). Young children (8 and 9) did indeed show poorer performance than did older children (11 and 12) and adults, and showed less improvement with practice over trials, yet were no worse for highly variable figures than they were for figures of intermediate variability. Thus, whatever the reason young children prefer highly variable figures, differential sampling strategies do not provide a full account of it. Moreover, as Hutt (1970) pointed out in her review, categorization of the 10-sided figure was worse for all age groups, a fact which could lead one to suggest a relationship between "inefficient processing strategy and preference" (sic).

Further paired-comparison studies

Since the Munsinger research, there have been several attempts to confirm the finding of an inverted U-shaped function relating preference to polygonal complexity. The techniques used to measure preference, as well as the age of the children tested, have varied considerably.

Three of these studies (Thomas, 1966; Stevenson & Lynn, 1971; Kaess & Weir, 1968) employed the same technique as Munsinger and colleagues - paired comparisons. Thomas' experiments provided little support. In studies 1 and 2, five levels of complexity with four examples at each level were used. Polygons were photographed as white shapes on black backgrounds, and were projected as slides to children aged 7 to 19, who were asked to write on prepared answer sheets which one they liked best. Results showed that polygonal complexity was monotonically related to preference up to the age of 15, after which there was a change in preference for the less complex shapes. Although Thomas found no significant effect of age, inspection of his graphs shows that for the 7 to 15 year olds, the slope of the preference function was the least steep in the youngest group, becoming steeper as age increased.

Thomas' finding that not until mid-adolescence did preference begin to approximate an inverted U-shaped function provides only partial support to Munsinger's research, for clearly no such function was present among the younger subjects. However, in order to allow a more direct comparison with the Munsinger studies, Thomas presented in a third experiment (1966) some of the original Munsinger shapes (black on white background) to a group of 11 year olds. Again, preference was found to increase monotonically with number of sides. It should be noted though that this finding relates only to a single age group. Furthermore, it can be questioned on the basis of adequate stimulus sampling. As the polygons were taken from Munsinger's stimuli, each level of complexity was represented by only one example.

The Thomas studies are frequently cited because of the large numbers of subjects used (nearly 800). But a note of caution should be exercised when comparing his work with others, in that the children were tested in groups and were allowed to see pairs of polygons for only 5 seconds. Other researchers have presented polygons to one child at a time and for longer periods of inspection, and it can be argued that this allows for a better atmosphere of aesthetic contemplation to occur. Moreover, it allows for proper counterbalancing of left or right positions that each stimulus appears in a pair. It is to be noted further that in Thomas' major studies (1 and 2), the number of subjects in each age group was not controlled and varied from 29 in one group to 107 in another. Although not explained, this quite uneven age balance is most probably due to the convenience of testing subjects in their classroom groups, rather than randomly selecting equal numbers of subjects to represent ages.

A further criticism concerns Thomas' selection of levels to represent the dimension of visual complexity. Five levels were selected, 3-, 6-, 10-, 20-, and 40-sided polygons. If it is assumed that 20-sided figures represent the point of middle complexity, which they do when number of sides is the criterion, then the upper levels of complexity are poorly represented, increasing as they do from the middle to the high point in just one increment. This leaves a considerable range of polygonal complexity unsampled. It is quite possible that between 20 and 40 sides preference may fall and then rise again, as it did in the Munsinger studies between the peak at 10 sides and a second peak at 40 sides.

Unfortunately, the other two studies employing a paired-comparison task (Stevenson & Lynn 1971; Kaess & Weir, 1968) used even fewer levels to represent complexity. Stevenson and Lynn, working with an age group of $3\frac{1}{2}$ to 7, and testing their subjects individually, used four levels (5, 10, 20 and 40 sides) with three examples at each level. Like Thomas' findings, their results also showed preference to be a linearly increasing function of complexity. In addition, preference for more complex forms was found to increase with age. The other study, by Kaess and Weir, used the same four levels of complexity with three examples at each level, and involved presenting pairs of polygons to a very young group of subjects ($2\frac{1}{2}$ to $5\frac{1}{2}$). With this age group however, the authors reported that preferences had no definite relation to any level of complexity. The preference function was flat.

Summary of paired-comparison studies

In summary of the paired-comparison research then, it can be seen that whereas Munsinger and colleagues adequately sampled the range of complexity, they did so at the expense of not enough stimuli at each level. Those seeking to confirm their findings used an adequate number of polygons at each level, but did not employ enough levels. Thus, on the basis of research conducted to date, paired-comparison measurement of preference for polygonal complexity has proved inconclusive. With the Munsinger research producing inverted U-shaped functions, and the subsequent research showing monotonic functions, it may well be the case that with a paired-comparison task, it is the number, and the choice of polygonal complexity levels that determine the shape of the resulting preference function, rather than the number of polygonal sides.

Additional research on polygonal preferences

A study by Hutt and McGrew (1969) cited in Chapter One is of interest here because of the method employed to measure preference. To repeat, these authors contended that if certain stimulus attributes were truly preferred, then they should be capable of operating as reinforcers in an operant task, where one of a pair of discriminanda (buttons) controlled the appearance of that stimulus attribute. A teaching machine was modified so that when a child pressed one button a complex pattern would be exposed, with the other button bringing the simple pattern into view. The dependent measure of preference was the number of button presses. Three groups of children (aged 5, 8 and 11) with eight subjects in each took part in the experiment. They were exposed to two different types of stimulus patterns, a selection of the Berlyne figures, and a set of randomly generated polygons. Two sets of 16 polygons each were constructed, ranging in four steps from 5 to 20 sides. One set was symmetrical, the other asymmetrical, with the latter set being defined as more complex than the former.

Results showed that for both types of stimuli, 'complexity' had no effect at all on button pressing, and, that there was no effect of age. While these results appear to confirm Kaess and Weir's findings for 5 year olds, they stand in marked contrast to findings of other studies with older subjects. Several methodological factors may account for the difference.

First, very few subjects (8) were run in each age group, a number which may have been more appropriate for a pilot study in aesthetic research, given that individual tastes vary considerably in this area. Second, the number of polygon sides was extended only to 20, a point in the complexity continuum which is usually regarded as representing middle complexity. Third, and most important, the authors disregarded number of sides as the measure of complexity, and instead, dichotomized the stimuli into two types - symmetrical and asymmetrical. The reason for this was not given. One can speculate however, that it was most probably done to allow for comparisons with the set of dichotomous Berlyne figures. A second reason suggests itself in that the selected polygon characteristic, symmetry or asymmetry, is particularly suitable for a two-button means of measuring preference. Button pressing is indeed a novel and interesting means of measuring preference, but it is probably useful only for variables which vary at a few levels. It is thus most suitable for use with the Berlyne figures which dichotomize into a high and a low variant, but its use is not appropriate for polygons which are usually, and more accurately thought of as representing a continuous variable. It would seem then, that in order to compare responses to polygons with the responses to the Berlyne figures, the authors confused symmetry with complexity. The results really only justify the conclusion that the stimulus attribute of symmetry did not reinforce a preference response. Of interest would be data relating to whether the 20-sided figures, symmetrical and asymmetrical, were responded to more frequently than the 5-sided figures. The study is thus misleading in its claim that children do not prefer visual complexity.

Another study (Eisenman et al, 1969) which, like the Hutt and McGrew study, is questionable on design, is of interest because of the technique used to measure children's polygonal preferences. Subjects were asked to circle on a sheet of paper containing 12 shapes, the 3 which they liked best. Two different sheets of paper were used - one showed 12 non-randomly designed symmetrical polygons selected from Birkhoff's shapes (1933), the other showed 9 randomly generated asymmetrical and 3 of Birkhoff's symmetrical polygons. Complexity, defined by the number of sides, ranged from 4 to 24 sides. Results showed that the more complex shapes were chosen significantly more frequently than the less complex shapes.

This study, in addition to not extending the range of complexity beyond 24 sides, exhibits a somewhat unsystematic choice of polygons to represent complexity. The first sheet of paper contained one 10-, and one 20-sided shape, but three 12-sided shapes. The second sheet contained four 4-sided polygons, one of which was symmetrical, and one 8- and one 10-sided polygon, both of which were symmetrical. There were no 8- or 10-sided asymmetrical shapes. Furthermore, as the second sheet was unevenly balanced regarding the number of symmetrical and asymmetrical stimuli, it could be argued that the three symmetrical shapes which were preferred to the others, were chosen because of their relative novelty, or for the reason that they were non-random. Birkhoff's polygons are all carefully designed stimulus patterns.

The best evidence that preference relates monotonically to polygonal complexity comes from the two most recent studies (Baltes and Wender, 1971; Aitken and Hutt, 1974). Both these studies tested large numbers of subjects, used a wide range of polygonal complexity with adequate numbers and spacing of levels, and sufficient examples at each level. They differ from previous research in the methods employed to measure preference. Baltes and Wender asked children to rate polygons on 9-point scales, and Aitken and Hutt had their subjects rank order sets of polygons.

In the Baltes and Wender study, 120 subjects in four even-numbered age groups (9, 11, 13 and 15), with equal numbers of male and female subjects in each age group, rated 70 stimuli at 14 levels of complexity ranging from 3 to 63 sides. Each stimulus was projected individually onto a screen for 7 seconds, and appeared as a white shape on a black background (like the Thomas stimuli). Prior to rating, each stimulus was presented for 3 seconds, so that subjects were exposed to the available range of shapes before rating them. In addition to the main effect of number of sides being significant, age and the age by complexity interaction also reached significance, with the latter finding being due to the 13 and 15 year old groups rating low complexity shapes less pleasant than the two younger groups.

The Aitken and Hutt (1974) study was originally designed to determine if children would rate polygons differently by pleasingness or interestingness. Accordingly, in experiment 1, thirty-six 9 and 10 year olds, evenly balanced by sex, rank ordered five sets of ten polygons, each set ranging from 4 to 40 sides, under both instructions. Evaluations of pleasingness and of interestingness both increased monotonically with number of sides. However, it was found that many of the subjects were unable to distinguish between the two instructions, and hence in experiment 2, the word 'like' was substituted in the assessment of preferences of younger subjects. Twenty-four 7 to 8 year olds, and twenty-four 5 to 6 year olds rank ordered the same five sets of polygons. The older group preferred more complex shapes, whereas the overall preference function of the 5 to 6 year olds was U-shaped. The authors' inspection of younger subjects' data showed that preferences were of two types. Seventeen (of 24) subjects showed peak preferences between 4 and 20 sides, while the remaining seven preferred shapes between 24 and 40 sides, essentially the same as the 7 to 8 year olds.

As stated before, a monotonic function relating preference to polygonal complexity gains good support from the results of these two studies because the two different methods of measuring preference resulted in the same function, and because both studies employed adequate stimulus sampling and subject selection. The only methodological criticisms which can be made are that Baltes and Wender tested their children in groups, and that neither study controlled for possible size and perimeter variations in the constructed polygons. In the following experiments, which employ the same rank ordering task used by Aitken and Hutt, these oversights will be corrected. In addition, all subjects will have already been exposed to the full range of stimuli before they rank order, as they were in the Baltes and Wender study.

Complexity and Viewing Time

The study of viewing time as a function of complexity has produced results which are less conflicting than the study of preference and complexity. Research has demonstrated that the more complex a figure is, the more time will be spent viewing it. (There are some exceptions to this general rule, particularly with infant subjects.) Since the pioneering infant studies of Berlyne (1958b) and Fantz (1958), several studies have confirmed that infants will spend more time looking at more complex figures than they will at less complex figures (Karmel, 1969; Sigman & Parmelee, 1974; Martin, 1975). That some research reports intermediate or low levels of complexity 'preferred' has been interpreted either as complexity being represented by different stimulus attributes (Greenberg & Blue, 1975), or as due to the very young ages of the infant subjects (Brennan, Ames & Moore, 1965). Investigations which have carefully separated different parameters within the same stimulus type show that infants' attention depends upon factors such as whether it is contour length (McCall & Kagan, 1967; Karmel, 1969), or numerosity of elements (Cohen, 1972), or area (McCall & Melson, 1970) that varies between stimuli. In general however, as the infant grows older, he fixates on more complex stimuli for longer periods of time than he does the simple stimuli.

Certainly in post infant subjects up to adolescence, complex stimuli tend to predominate over more simple ones in holding visual attention.

Of 18 studies relating viewing times to complexity of stimulation which this writer was able to find,(11) just one (Hutt & McGrew, 1969) reported that 'less complex' stimuli were viewed longer, with this result holding for only the youngest (age 5) of three age groups. One study provided partial support (Hoats et al, 1963), and three studies (Clapp & Eichorn, 1965; Faw, 1969; Kreitler et al, 1974) reported no effect of complexity on viewing times. It is of interest that four of these five studies cited can be characterized by the use of Berlyne's multidimensional stimulus figures (which have only high and low complexity variants), and, by the use of younger subjects in the 4 to 8 range. The fifth study (Faw, 1969), while investigating viewing time as a function of incongruity and of complexity in 9 and 10 year olds, used gross head movements to measure viewing times, and therefore may not be comparable with the others for that reason.

Polygonal complexity and viewing time

A review of research investigating the effects of polygonal complexity on viewing times (Thomas, 1966; Munsinger & Weir, 1967; Kaess & Weir, 1968; Faw & Nunnally, 1968; Hutt & McGrew, 1969) reveals several shortcomings. Some of these studies employing polygons have been cited previously, and so criticisms already applied will not be detailed again.

In the first study conducted, Thomas (1966) presented five levels of polygonal complexity (3, 6, 10, 20, and 40 sides) to subjects in five age groups (6, 7, 8, 9, and 12). A temple bar press(12) was used as an instrumental response to bring stimuli into view. Stimuli were presented in pairs for a maximum of 50 seconds, but only one stimulus was in view at a time, depending upon which side the subject rocked his head to trigger the bar press. Subjects had to "exert a slight but continuous pressure" to hold a given stimulus in view. Results showed that viewing times increased monotonically with complexity for the 6, 9 and 12 year olds.

Criticisms of Thomas' study regarding poor sampling of upper levels of complexity, and regarding the uneven balance of numbers of subjects in age groups has already been applied. It should also be pointed out that while the use of a temple bar press satisfies the criterion of free viewing, it does not exactly allow for, or encourage, relaxed viewing conditions; nor might it be thought of as exemplifying an 'aesthetic' response. The fact that children were required to exert a continuous, albeit a slight pressure adds a new and possibly contaminating factor to the measurement of 'free' viewing.

The two studies by Weir (Munsinger & Weir, 1967; Kaess & Weir, 1968) tested children of very young ages. Munsinger and Weir presented paired stimuli to 32 subjects (9 to 41 months, average age 2 years), each of whom was tested on four successive days. There were three examples each of four levels of complexity (5, 10, 20 and 40 sides), with each of the 12 possible pairs presented for a maximum of 45 seconds. Visual fixations were recorded by the experimenter through a one-way mirror. Results showed viewing times significantly increased with complexity, and, that there was a significant day of testing X complexity interaction. The slope of viewing times was steepest on Day 1 and essentially flat on the fourth day. Age of subjects was not significant.

The authors noted that subjects frequently did not look at either of the two stimuli during the 45 second exposure allowed, which is not surprising considering the limited concentration abilities of children at this age. However, in order to submit the data to a complete paired-comparison analysis, they determined missing 'preference' data by a flip of the coin. They report that 12 of the 32 subjects spent 50% of more of their time not looking at either stimuli. When the remaining 20 'good' subjects' looking times were separately analyzed, the day of testing X complexity interaction disappeared, although the overall complexity effect remained significant.

The second study by Weir (Kaess & Weir, 1968) is similar to the first. The same set of polygonal stimuli were presented in pairs to a slightly older age group (29 to 66 months), with each of the 12 pairs presented for 30 seconds. Pairs of polygons were presented four times to each subject in the same random order. Instead of viewing stimuli on consecutive days, subjects in this study were required to give preference judgments on one of two days of testing. Results supported the first study - children fixated longest on polygons of highest complexity. No effects of age were found.

Faw and Nunnally (1968) also found viewing times were longer for the more complex of a pair of polygons. In their study, stimuli were projected for 10 seconds onto a screen at the end of a viewing box. Nineteen boys, aged 7 to 13 (average age 9.5) were tested. Polygonal complexity was represented by three levels (4, 12, and 24 sides) with two examples at each level, and each stimulus was paired with all other stimuli representing the other two levels. There were thus 12 paired-polygon slides.

In addition to these slides, subjects were exposed at the same time of testing to two other sets of slides, one set designed to vary in two levels of novelty (e.g. man and horse, versus a man with a horse's head), and the other set designed to vary in three levels of pleasantness (e.g. attractive, neutral, and marred facial expressions). The three sets of slides were mixed together and presented as a block. Viewing times were scored from movie frames taken of each subject's left eye.

Results of polygon viewing showed that 58.4% of total viewing was devoted to the more complex member of the pair. Compared to the expected value of 50% this was significant. Comparisons between levels of complexity showed that the two 24-sided figures dominated the 12- and 4-sided figures, but that there were no significant differences between the latter two levels. Age effects were apparently not considered.

Faw and Nunnally's study in particular warrants further attention. Apart from the fact that the number of subjects selected was small (19), that they represented a wide age range (7 to 13), that they represented only one sex (selected from a YMCA day camp), that complexity was varied at only three levels, that only two examples represented each level, and that subjects were allowed to view pairs of stimuli for only 10 seconds, an additional criticism is in order. Because subjects saw slides of polygons interspersed with slides of completely different and unrelated subject matter, the individual effects of the three independent variables (complexity, novelty, and pleasantness) becomes highly confused. A subject having just been exposed to an ugly face, may well respond to the sudden appearance of a pair of polygons on the basis of their relative pleasantness. Or similarly, with 12 out of 40 slides containing polygons, their less frequent appearance could render a response based on novelty, and not relative complexity. Further criticisms of the design could easily be made. Clearly, the study needed numerous improvements and must be viewed very hesitatingly as evidence of increased viewing times for more complexity.

The most recent study using polygons and reporting an increase in viewing times as a function of their complexity was conducted by Hutt and McGrew (1969) and has been mentioned on several occasions previously. It is notable for a number of reasons, but is novel for its use of a discriminant response measure. Subjects pressed one of two buttons to expose either a simple (symmetrical) or complex (asymmetrical) stimulus.

One of the buttons exposed either the simple set or the complex set of stimuli, but a given stimulus appeared only once. Like the Faw and Nunnally study, subjects (N = 24; 5, 8 and 11 year olds) were exposed to more than one type of stimuli - a selection of four kinds of Berlyne figures as well as 5-, 10-, 15-, and 20-sided polygons, although in this study at least two hours separated viewing of the two sets of stimuli. Each subject was run through the same experiment on three consecutive days.

The problem with the Hutt and McGrew study, as already stated, is their equation of simplicity with symmetry, complexity with asymmetry. It was speculated that this was done so that polygon viewing could be conveniently compared with the dichotomized Berlyne-figure viewing. The data were in fact not differentiated according to stimulus type in the original publication. Four types of Berlyne figures and the two types of polygons were collectively analyzed as a single stimulus set with a high and a low variant. Results showed that viewing times decreased with age, and in addition showed an interaction between age and 'complexity'. The eight 5 year olds viewed the simple figures longer, the 11 year olds the more complex figures longer. The 8 year olds showed no difference. Data relating to number of sides, or to effects of day of testing were not presented. Hutt and McGrew's conclusions are therefore misleading as they relate to polygonal complexity. The data show instead that viewing time is affected by symmetry, and that symmetry and age interact.

Summary of polygon viewing research

While there is some agreement in results from polygon viewing studies, the numerous shortcomings and flaws in design suggest improvements. A main criticism applicable to all the studies involves the numbers of stimuli and numbers of complexity levels used. The best study in this respect (Thomas, 1966) employed 20 stimuli at five levels of complexity, the worst (Faw & Nunnally, 1968) only six stimuli at three levels. In the following experiments, stimuli generated for use will be an improvement on past sampling techniques, and in particular will represent levels of complexity between 20 and 40 sides, levels which have never been tested for free viewing.

One reason for the limited number of complexity levels has to do with the choice of paired comparisons as a method of presenting stimuli. All five of the polygon-viewing studies reviewed above relied upon variants of the paired-comparison task for measuring viewing times. With children in particular, there are limits to how many pairs of figures subjects will view before they become bored or fatigued. The paired-comparison task means then, that sampling must suffer from point of view of numbers of levels sampled, or of numbers of stimuli representing levels, or both. If stimuli are presented one at a time however, both problems are overcome. A large number of stimuli can be employed, and presented in blocks if necessary, separated by rest periods to prevent fatigue.

An additional, and perhaps more important advantage to the single stimulus presentation method is that each stimulus is viewed on its own merit. Consequently, visual attention is not divided, and stimuli do not'compete' with one another. Such competition is particularly prevalent in the studies cited above, in which subjects were allowed limited exposures to each pair, in one case (Faw & Nunnally, 1968) an exposure of only ten seconds.

In studies of preference which employ paired comparisons, the reason for a short exposure is so that subjects will make their judgments quickly, presumably on first impressions. Why this should be desirable is not exactly clear, and it certainly tends to deny any opportunity of 'aesthetic contemplation'. But in studies of free viewing time, the same reason does not apply, and it can be argued that to allow a subject less than a minute's viewing of two stimuli is contrary in principle to the idea of f r e e viewing. Certainly outside the laboratory, for example in art gallery behaviour, it is not normally the case that viewers must divide a limited amount of viewing time between two objects of art.

In summary then, the evidence from studies conducted to date shows that the more complex a polygon is, the longer a child will spend looking at it. This evidence comes really from only three studies (Thomas, 1966; Munsinger & Weir, 1967; Kaess & Weir, 1968), as the other two (Faw & Nunnally, 1968; Hutt & McGrew, 1969) cannot be seriously considered as supporting evidence for reasons already discussed. Furthermore, the evidence is based entirely upon paired-comparison designs, upon the use of a small number of complexity levels, and upon limited exposure times. Finally, the evidence comes mainly from pre-school subjects. The one study which tested school-aged children (Thomas, 1966) employed apparatus that included a temple bar press, and a chin rest (see footnote)[(12)], and these results need confirmation under more relaxed viewing conditions.

It is intended in the following experiments to prepare a large number of polygons at ten levels of complexity, and to present them singly for free viewing to a large number of school-age children. A further extension involves giving subjects an adequate number of practice trials so that they are well exposed to the range of stimuli available, as well as made familiar with the apparatus. Practice trials were given in two of the studies cited above (Thomas, 1966; Hutt & McGrew, 1969). Thomas presented only two slides of polygon pairs for practice, whereas Hutt presented six, although it was not stated whether these contained pairs of polygons or Berlyne figures, or both.

The effect of age on viewing times is far from clear. Among the polygon research the two studies with Weir as coauthor showed no effects of age for subjects ranging from 9 to 66 months. Faw and Nunnally also reported no effect of age, although they used 19 subjects to represent an age range from 7 to 13. Hutt and McGrew found that viewing times decreased with age, but this finding was based on data from both the polygons and the Berlyne figures. When polygon results were graphed separately (illustrated in Hutt, 1970) viewing times decreased for symmetrical polygons, but showed a slight increase with age for asymmetrical polygons. In the study by Thomas, to which the following experiments most closely relate, monotonic increases in viewing times were reported for the 6, 9, and 12 year olds, but there were no differences in mean viewing times for any of the 10 possible pairs of complexity levels for the youngest of these groups. When the data for the 7, 8, and 9 year olds were analyzed collectively, differences for six of the ten pairs were found to be significant. With 12 year olds, eight of the ten pairs were significant. The data suggest then, that with younger subjects the effect of number of sides is not as pronounced as it is with older subjects. The graphs support this, showing that as age increases so does the steepness of the slope.

On the basis of Thomas' study alone then, there is a suggestion of an age by complexity interaction with viewing times. However, there is as yet no evidence suggesting an overall age effect. Thomas did not present the actual viewing time data, and his scale scores resulting from the paired-comparison analysis do not allow inspection of the graphs to shed light on this matter.

Colour

The history of experimental aesthetics demonstrates how important the property of colour has been regarded as an affective contributor to aesthetic responses. The many detailed studies of colour preferences conducted attest to this (Guilford, 1959; Granger, 1955a,b; Helson & Lansford, 1970, for example; see: Norman & Scott, 1952; Valentine, 1962; Ball, 1965; and Kreitler & Kreitler, 1972, for reviews).

In recent years however, the study of colour has been rather neglected. Colour has been relegated to a variable of minor importance, compared to the attention given collative properties of visual stimuli. One result of this is that collative properties are being studied in isolation from other visual properties with which they normally interact.

This is particularly noticeable in the study of complexity, for in this research almost all investigators using laboratory-designed stimuli present their stimuli in black and white. The Berlyne figures for example, always appear in black and white. Polygons similarly are presented as black figures on white backgrounds, the exceptions being the Thomas (1966) and Baltes and Wender (1971) studies where white polygons were presented on black backgrounds. When colour does appear in stimuli held to vary in collative properties, its effects are rarely measured, or they cannot be measured at all. For example, studies of complexity that have used coloured environmental scenes, sets of postage stamps, children's drawings, or nonrepresentational art (Wohlwill, 1975b; Hutt et al, 1976) do not allow for measurement of colour's aesthetic-affective effects. Stimuli such as these contain many interacting colours, which appear as an integral part of the visual configuration, but the effect of colour is too complicated to measure.

In some of Berlyne's studies colour is introduced as an independent variable, but it is clear from the emphasis in his work that the interest is not in colour *per se*. In two such studies (Berlyne & Boudewijns, 1971; Berlyne, 1972b) colour was used as a means of manipulating complexity (see also Strain, 1968). Colour was one of four properties by which the separate figures comprising a stimulus pattern could be judged the same or different, that is, all the figures in a pattern were presented in the same colour or in one of two different colours. The effect of colour itself was not measured. In two other studies (Berlyne & Parham, 1968; Berlyne, 1970) two different colours were utilized to vary novelty. Subjects sat before a screen continuously evaluating an irregular shape which appeared over and over again in the same colour. Suddenly, the same shape (or a different shape, in another condition) appeared in a novel colour. Again, the affective impact of colour itself was not of interest.

Other studies seem to add colour to stimuli for no apparent reason. Dorfmann and McKenna (1966) and Smith and Dorfmann (1975) for example, employed a series of green and white checkerboard patterns which varied in complexity, but because the entire series of stimuli were in green and white, the effect of green was not measurable. Of the few studies which have attempted to measure the effect of colour in conjunction with other variables, experimental control has not been very systematic or rigorous, as will be shown.

It is therefore the intention in the following studies to test the effect of colour in a direct manner. This will be done by constructing two sets of polygons, one in colour, the other in black (on white backgrounds). Each set of 40 figures will duplicate the other in number of polygons, number of complexity levels, and number of polygons at each level. They will differ only with regard to whether they are coloured or not. Thus, colour will be introduced as a dichotomous within-subjects variable, with each shape occurring once in black and once in colour.

Any difference in response will be viewed as a function of this difference.

Effects of coloured polygons

The manipulation of colour as a dichotomous variable is intended for various reasons, but not, it should be noted, to test whether chromatic figures are preferred to their achromatic counterparts. Based on almost a century of research in colour aesthetics, this question can be viewed as having already been satisfactorily resolved. For it is well established that certain primary colours, saturated red, blue, or green for example, consistently receive higher preference (or pleasingness, or affective) values than black (Winch, 1909; Staples, 1931; Sivik, 1974; Plack & Shick, 1974). Additional evidence that black has a low affective value comes from studies employing semantic differential ratings, and mood-tone associations. Williams et al (1968, 1975) for example, found that black was given low ratings on scales loading on the Evaluative dimension and Wexner (1954) showed that black was clearly associated with negative, unpleasant mood-tones.(13) It is therefore unnecessary to test whether children prefer colour to black.

Instead, the variable of colour will be examined in the following ways. It is intended first, to test whether preferences for chromatic polygons varying in complexity are the same as preferences for achromatic polygons. Second, it is intended to test whether coloured shapes at varying levels of complexity are viewed longer than the same shapes in black. Finally, an attempt will be made to test the affective salience of colour in determining preferences relative to visual complexity and to symmetry.

Colour and Preference

As stated previously, studies investigating preferences for figures varying in complexity have relied upon black and white stimuli to establish preferences. It has therefore not yet been established whether such preference functions will be the same when stimuli appear in colour. There is no reason to hypothesize that the functions will be different however, if and only if all the figures comprising a set appear in the same colour.

Rank ordering a set of black polygons should produce results no different from rank ordering a set of red polygons, for in both tasks preferences depend entirely upon the shape of the stimuli. The effect of colour does not come into play. Should a set of polygons contain some figures in black and others in red, then the determinants of preference are quite different. Preference for complexity would be confounded by the difference in preference value between black and red. As will be shown below, it is exactly this kind of manipulation which will be employed to test for salience. However, for the purposes at hand, children's preferences for polygonal complexity are expected to be unaffected by the particular colour in which the set of polygons are presented.

Colour and Viewing Time

In Chapter One, Hutt's hypothesis that attention is the basis of preference in children was introduced. According to this, visual features which attract fixation determine what is pleasing. A prediction followed that stimuli which hold attention the longest will be the ones judged as preferred. An alternative hypothesis, that relative pleasingness will be a factor in determining visual attention was also introduced, and it is intended to test this hypothesis with the use of colour. The addition of colour to a polygonal stimulus will be viewed as an increase in its affective (preference, or pleasingness) value. If coloured figures are viewed longer than the same figures in black, then this will be regarded as evidence that relative pleasingness affects viewing behaviour.

The relationship between affective value and viewing time has seldom been studied in children, and it is undoubtedly a complicated one. Faw and Nunnally's experiment (1968), mentioned earlier, manipulated affect with different facial expressions. Nineteen male subjects aged 7 to 13 were exposed to black and white pictures of adult male and female faces, each adult having posed with a pleasant, a neutral, and a negative facial expression. Level of affect was found to have no effect at all on viewing times. The same subjects were also exposed to coloured sets of photographs of different persons - attractive female faces, average faces and physically marred faces. With these stimuli however, the negative ones dominated viewing times. Similar results for female subjects were also found by Faw and Nunnally in an extension of the study. 9 and 10 year old girls viewed sets of achromatic pictures representing animate objects and social scenes, selected on the basis of ratings to represent a dimension of pleasingness. Stimuli were ranked in six steps of pleasingness, and ranged from a picture of a man's face with an amputated jaw to a picture of a mother holding her child. Again, subjects fixated on the more negative stimuli. More recently, Hutt <u>et al</u> (1976) also produced evidence that 5 and 7 year olds viewed unpleasant pictures longer than neutrally rated pictures (abstract designs).

These studies offer a rather poorly controlled variation of affect, and it is difficult to see what it is in common that the different types of stimuli share. Even within each type of stimulus, viewing times will be determined by numerous interacting and uncontrolled variables. Certainly, relative pleasingness is not the only means of describing the independent variable. Meaningfulness, or familiarity, or surprisingness could just as well have been chosen as a description.

While it may be desirable to investigate viewing time as a function of more than two levels of pleasingness, the choice of stimuli widely divergent in subject matter is regrettable, for it results in a loss of control over the principal variable of interest, rendering the results inconclusive. Varying affect dichotomously on the other hand, with pleasant versus unpleasant colours, assures that information content and subject matter remain constant at both levels of the variable. Moreover, it allows for a test of whether the effect of pleasing colours on viewing times holds for all levels of an important dimension of form, or whether colour and complexity interact.

Specific studies of colour and viewing

Two studies have examined the effects which individual colours have on adult viewing times. They produced contradictory results. Brown and Lucas (1966) had subjects look at triangles and 9-sided figures in each of eight colours and concluded that colour was of little importance to viewing time. Sobol and Day (1967, cited in Berlyne, 1971) on the other hand, using four colours, found that red and blue 20-sided polygons were inspected longer than yellow and green ones. They concluded that individual colours were important to viewing time, in that subjects spent more time looking at figures in colours they later said they preferred.

It is unfortunate that these two studies should produce different results, as they are the only ones of their kind, and are of particular interest because the figural information content of the different coloured stimuli was held constant. It is possible that the colours selected were different in each study. The available stimuli specifications are scanty, making comparisons impossible. Berlyne described Sobol and Day's colours by name only, and Brown and Lucas presented only the identification number of the manufacturer's coloured sheets.

It is of interest that the one study which did present coloured objects to children and compared viewing times to the same stimuli in black, used colour as a measure of redundancy. Clapp and Eichorn (1965) presented twenty-four 5 year olds three varieties of a set of meaningful pictures (e.g. ink-bottle, mushrooms, rake and spade): black and white stick drawings, the same figures drawn in curved lines, and the same figures in colours. They argued that presenting the objects in colours - two colours were used - decreased the similarity between the parts of that object, thereby reducing its redundancy compared to the standard curved drawings. (Essentially the same reasoning is evident in the Berlyne and Boudewijns (1971) and Berlyne (1972b) studies in which same or different colours in a stimulus pattern were used as a measure of complexity.) Clapp and Eichorn argued similarly that eliminating curvature from the drawings also reduced redundancy, although they did not state whether coloured or stick drawings had the lower redundancy. In any event, only one manipulation of redundancy had any effect. Results showed that coloured stimuli were viewed the longest, and that there was no difference between the other two levels of redundancy.

While this study is technically one of redundancy, the marked response of the 5 year olds to coloured stimuli is pertinent to the present discussion. Several uncontrolled variables tend to cloud the findings however. First, although all depicted objects were meaningful to the children, it appears that some were more familiar than others. The authors pointed out that more common objects were viewed more frequently than less common ones. Second, some objects were depicted in unfamiliar colours (orange mushrooms, rust-coloured apple), a factor which introduces another element of novelty. The authors suggested in fact that results may not have been due to the effect of colour, but rather to a combination of familiar objects in unfamiliar contexts.

In the following experiments, the problem of the relative novelty-familiarity of stimuli is completely avoided by the use of randomly generated polygons. It is assumed that all stimuli will be equally unfamiliar, although there will obviously be differences in the ease with which subjects may associate to the shapes. Furthermore, the fact that none of the shapes will have been seen before is a control for potential effects of memory colour (Bruner et al, 1951; Bartelson, 1960). Because a polygon is unfamiliar, it can have no memory colour; it is rendered no more or no less familiar if it is presented in black, or in red, or blue, or green. An orange mushroom, or a rust-coloured apple on the other hand, adds a new dimension to the perception of the object, which may well augment viewing time.

The third and perhaps most important consideration has to do with Clapp and Eichorn's use of more than one colour in the set of stimuli. Because it was necessary to use at least two colours to reduce similarity between parts of a figure, it becomes apparent that those two colours will interact, thus creating yet another uncontrolled and potentially influential variable. Two colours interacting in a stimulus produce a decidedly different perceptual effect than a single colour. An additional gestalt is operative in the stimulus configuration, which may well be considered as additive to the appeal of that stimulus. This point is not intended as a criticism of Clapp and Eichorn's study, as their interest was not in colour per se, but rather in redundancy. Nevertheless, their results really only justify the conclusion that colours in combination raise viewing time when compared to the same objects depicted in black and white line drawings.

In relation to the present discussion, the authors' final comment about the effects of colour is of interest:

> ... it seems reasonable to interpret the marked effect of colour not as the result of a decrease in redundancy ..., but rather as a function of some other attentional, perhaps affective, variable.
>
> (p.385)

The manipulation of colour in the following experiments results from similar reasoning, namely, that the addition of colour will add an affectively appealing component to visual stimulation which is capable of influencing children's viewing behaviour. It remains to be seen however, whether unfamiliar material, presented in single colours, at different levels of complexity, to an older, representative group of school-age children, will produce results which support Clapp and Eichorn's interpretation.

Symmetry

Symmetry is the third stimulus property in which the polygons will vary. Often subsumed under the problem of balance, or proportion, or goodness of pattern, symmetry has always been regarded as an important property of visual art, and it has long been recognised that a pattern with symmetry or degrees of symmetry is visually pleasing.

Symmetry unifies; it adds regularity; it gives balance; it facilitates organization, and as Jodl maintained "the unification of a multiplicity is a fundamental law of the aesthetically effective" (1917; cited in Eysenck, 1942). The Gestalt psychologists regarded symmetry as a major factor contributing to the 'goodness' of a figure (Koffka, 1935; Hubbell, 1940; also Garner, 1970), and certainly the more recent work confirms the Gestalt view that the presence of symmetry in a visual pattern renders it more pleasing, higher in affective value (Day, 1968a; Moyles et al, 1965; Berlyne & Peckham, 1966; Eisenman, 1968; Paraskevopoulos, 1968; Szilagyi & Baird, 1977).

Symmetry and complexity

It is a frequent misunderstanding that symmetry implies simplicity. Barron and Welsh for example (1952; Barron, 1951/52, 1953, 1963) paired simplicity and symmetry against complexity and asymmetry, viewing them as bipolar points which defined the dimension of figures on the Barron-Welsh Art Scale. Not until 1965 (Moyles et al) did further analysis of these figures reveal that symmetry-asymmetry and complexity-simplicity could be separated as two stimulus dimensions whose significance could be evaluated independently. In the early writings of Eysenck (1942) there is also exhibited a tendency for simplicity and symmetry to be mentioned in the same breath. One reason for this may have been that the number of polygonal sides Eysenck experimented with was not increased beyond a certain point, to a level of complexity where it is perceptually obvious that the properties of symmetry and complexity are independent.

Berlyne (1971), more recently, has also tended not to be precise in his classification of the property of symmetry. On the one hand he views symmetry as a 'special problem' in aesthetics to be studied in relation to problems of balance and proportion. On the other hand, the use of symmetry in his own experimental figures, defined as regularity of arrangement, shows that he classes symmetry as a property which distinguishes the simple from the complex. Symmetrical Berlyne figures are classified as simple, asymmetrical ones as complex.

This equation of symmetry with simplicity is perhaps most obvious in the study by Hutt and McGrew (1969), who extended it to polygons. It will be remembered that these authors defined all symmetrical figures, regardless of number of sides, as simple, and all asymmetrical figures as complex. From this, it would follow that a 40-sided symmetrical polygon is less complex than a 5-sided asymmetrical polygon.

In the following experiments, symmetry and complexity are manipulated as two distinct variables. While symmetry, like complexity, may be thought of as a continuum (Zusne, 1971), it will be employed as a dichotomous variable, in the same manner as colour, with 'symmetry' and 'asymmetry' as the only two variants. The decision to dichotomize the symmetry variable was taken because of results from experimental investigations of non-aesthetic perceptual responses to symmetry in polygons. Zusne (1971) found that most individuals (adult subjects) had a poorly developed concept of symmetry, and that unless polygons were made perfectly symmetrical, the property of symmetry could easily be ignored. It follows that children would be even less likely to recognize degrees of symmetry.

Types of symmetry

The decision to represent symmetry as an all-or-nothing property is in line with the early work by Birkhoff (1933) and by Eysenck (1940, 1942), whose interests were in the contribution that symmetry made to the 'aesthetic measure' of polygons. According to these authors, Aesthetic Measure (M) involved the relationship between elements of Order (O) and elements of Complexity (C). While they disagreed as to the exact nature of the relationship (for Birkhoff, M = O/C, for Eysenck, M = O x C), both emphasized the importance of symmetry as a contributor to O, and they discussed the relative affective value of polygonal stimuli, all of which exhibited 100% reflective symmetry, and not degrees thereof.

As well as distinguishing the property of symmetry from that of complexity, Birkhoff also measured the extent to which polygons could exhibit more than one type of symmetry: bilateral, horizontal, diagonal, or radial. Birkhoff felt, like others who followed (Paraskevopoulos, 1968), that bilateral symmetry, also known as vertical symmetry, was the most important because it appears in the natural environment more frequently than other types, in the form of animals, human beings, trees, etc. For this reason, the polygons in the experiments which follow are constructed to by symmetrically reflective about the vertical axis.

Effects of polygonal symmetry

The importance of symmetry in polygons will be examined in the same manner as the property of colour. Preference for polygonal complexity will be tested when polygons at all levels of complexity are symmetrical. Symmetrical polygons will be compared with asymmetrical polygons to determine if viewing times are affected, and the relative salience of symmetry will be compared to that of complexity and colour as determinants of preference. In addition, it is also intended to test whether children prefer symmetry to asymmetry. It will be remembered that this aspect of colour was regarded as unnecessary to test, as the literature on colour preference shows no discord. The developmental literature on preference for symmetry however, is neither extensive nor free of conflicting results.

It is also hoped that the experiments including symmetry will throw further light on the age at which children become perceptually aware of symmetry. Adherents of the Gestalt school of perception held that there is an innate determination of the principles of sensory organization, that the laws of 'goodness of form' were somehow wired into the visual system. This view gained some support from the early work of Fantz (1961) who showed that infants preferred (looked longer at) schematic faces to scrambled faces. Koopman and Ames (1968) however, found no significant differences in looking times to schematic, scrambled, and symmetrical faces (stimuli of the latter type employing facial features arranged symmetrically around the vertical axis but in a nonfacial arrangement). Banta et al (1966) found that only a few $2\frac{1}{2}$ to 6 year olds differentially responded to the absence or presence of symmetry in complex three-dimensional objects. Munsinger and Kessen (1966b) also reported that young children (aged 6 and 7) ignore symmetry in polygonal symmetry, that they respond to symmetry and asymmetry in the same manner. Older children on the other hand (aged 10 and 11), when estimating number of sides on polygons and when categorizing polygons, were found to be more differentially sensitive to symmetry. Similar age differences in sensitivity to symmetry were reported by Paraskevopoulos (1968) who, working with preference and recall of symmetrical dot patterns, concluded that the structure necessary to decode symmetry begins to become effective (a) for double symmetry (horizontal and vertical) at age 6, (b) for bilateral symmetry at age 7, and (c) for horizontal symmetry at age 11. Against these findings, Daniels (1933), a student of Meier (1933), found that subjects from age 2½ preferred, and attempted to reproduce a symmetrical arrangement of blocks compared to an asymmetrical arrangement.

There is some doubt then, as to when symmetry becomes a perceptually salient feature of the environment. The following experiments will bear on this matter, as two different response measures will be used to test for its effects.

<u>Symmetry and Preference for Polygonal Complexity</u>

The study of children's preferences for randomly generated polygons differing in complexity has involved, with one exception (Munsinger & Kessen, 1966b, Study IV), subjects choosing from a set of black and white asymmetrical stimuli. Munsinger and Kessen however, presented a set of symmetrical polygons varying in eight steps from 6 to 40 sides to children aged 6 to 11, for paired-comparison judgments of preference. In contrast to their findings with asymmetrical polygons, analysis (based on the number of 'votes for' only the 6-, 10-, 20- and 40-sided shapes) showed "a roughly linear function relating preference for symmetrical shapes and their variability". In addition, the older the child, the stronger the preference for stimuli of high complexity.

No real explanation of this discrepancy was offered. The authors stated that with symmetrical shapes, stimulus variability was manipulated by varying the independence of elements (resulting in older children preferring high variability), whereas with asymmetrical shapes it was manipulated by the number of elements (resulting in older children having lower preferences for high variability). This statement does not satisfactorily explain the difference, for while symmetrical stimuli do have increased redundancy (less independence) compared to asymmetrical shapes, they still exhibit marked variability with changing numbers of sides. What is more likely to account for the difference is the methodological problems of the asymmetrical polygon studies, already discussed. Study IV (1966b) was methodologically superior to their earlier asymmetry studies, in that eight levels of complexity were each represented by six symmetrical stimuli.

It is suggested then, that Munsinger and Kessen's linear function relating preference to polygonal complexity represents the true state of affairs. There are certainly no a priori reasons to hypothesize that complexity preferences for symmetrical figures will be different from those for asymmetrical figures, if and only if the figures comprising a set are all symmetrical, or all asymmetrical. Just as rank ordering a set of black polygons is expected to produce the same preference function as ranking a set of red polygons, it is expected that ranking symmetrical polygons will result in a preference function which will not be statistically different from that for asymmetrical stimuli. In both tasks, preference will depend upon, and be determined by complexity (number of sides). The property of symmetry will not come into play; it is a constant in each member of the set.

The following experiments will test this prediction using a rank ordering task instead of paired comparisons, and thus resolve the problem brought to light by the Munsinger research.

Preference for Symmetry versus Asymmetry

While the literature on colour preference strongly suggests that coloured polygons will be better liked than non-coloured ones, such a clear state of affairs regarding preference for symmetry over asymmetry seems to hold only for adult subjects. The two studies which have examined this problem are not only poorly designed, but produced different results.

In the Hutt and McGrew study (1969), in which symmetry was defined as simplicity, asymmetry as complexity, 5, 8 and 11 year olds did not prefer either of the two types of polygons. Eisenman et al (1969) on the other hand, found that a similarly aged group of children did prefer symmetry to asymmetry in polygons.

In addition to criticisms already made about these two studies, the difference in findings may be attributable to the different techniques used to measure preference. Hutt and McGrew's subjects had to press one of two buttons, while subjects in the other study had to circle the three best liked of 12 figures on a sheet of paper.

It has already been noted that in the Eisenman study only 3 of the 12 polygons were symmetrical, thus making them more novel than the remaining nine asymmetrical shapes. Furthermore, these 3 stimuli were not generated randomly like the 9 asymmetrical ones, but rather, were selected from Birkhoff's shapes (1933), which are carefully designed figures, often varying in more than one type of symmetry, occurring more frequently in the environment than randomly generated shapes, and containing a different set of artistic properties than randomly constructed stimuli. Eisenman's finding that symmetry is preferred to asymmetry is therefore not surprising.

Nevertheless, on the basis of developmental studies that have used non-polygonal stimulus material (Daniels, 1933; Paraskevopoulos, 1968), there is reason to believe that Eisenman's conclusion will be supported. Moreover, since studies with adults demonstrate a preference for the presence of symmetry in visual stimulation, and since preference for asymmetry seems to occur only with artistically trained adults, and with subjects who are experienced with visual patterns (Barron & Welsh, 1952; Munsinger & Kessen, 1964), it is expected that young subjects in the following exoeriments will show a similar pattern of preference for symmetry.

What cannot be anticipated is whether preference for symmetry will interact with certain levels of complexity. The only study which did systematically present an equal number of symmetrical and asymmetrical polygons at different levels of complexity (Hutt & McGrew, 1969) did not of course produce data pertaining to this question. However, since there is no available information relating to preferences for symmetry in stimulus material of high complexity, and no evidence that symmetry interacts with low levels of complexity, there is no reason to suspect that the two variables will interact.

Symmetry and Viewing Time

A main point in the design of this research is to test the effect of stimulus variables in combination with each other in such a way that the effect of each variable is still measurable independently. One of the following experiments is designed to test for the first time the effect of symmetry on children's viewing time, not as an isolated stimuius property, but in interaction with stimulus complexity and colour. An example of a study in which this opportunity was missed is that by Hutt and McGrew (1969), where symmetry was confused with complexity, and the number of sides variable was neglected.

An example of a study in which symmetry was manipulated but in an imprecise fashion, was conducted by Banta and colleagues (Banta et al, 1966). These authors presented complex symmetrical and asymmetrical three-dimensional objects for children to inspect inside a box. These objects were regularly spaced in between trials of more simple, coloured, wooden block presentations, and the authors were interested in changes in looking time as a function of the novelty of items. Although some stimuli were symmetrical (e.g. a wooden plate with red, yellow and black concentric circles) while others were asymmetrical (e.g. a twisted coat hanger with coloured beads at irregular intervals) the effect of symmetry itself was not easily measurable, as the items differed in so many other ways. In fact, the results suggested that a number of uncontrolled variables were governing duration of viewing. Approximately half the subjects consistently viewed asymmetrical objects for the longest times, while a third responded in this way to the symmetrical objects.

The study of symmetry by Day (1968b) conducted with adult subjects was better controlled, in that it allowed examination of both the symmetry and the complexity variables, as well as any potential interaction between the two.

The following study of symmetry is modelled after that of Day. It is expected that the presence of reflective bilateral symmetry in polygonal shapes, like the presence of colour, will increase the affective value of those shapes, which will produce longer viewing times for symmetrical polygons than for asymmetrical polygons with equal numbers of sides. Such a result will be interpreted as further evidence that pleasing visual properties affect attention.

<u>Symmetry and subjective complexity</u>

A problem that arises with the use of symmetry is that its introduction in a polygon causes a reduction in the number of *independent* sides in that polygon. In terms of informational measures, symmetrical polygons are redundant because all the information in one half is repeated in the other half (see Attneave, 1954, 1955; Michels & Zusne, 1965). While the total number of sides remains constant, the number of independent sides is reduced by approximately half (n/2 - 1). Insofar as adult ratings of complexity are concerned, this results in a loss of subjectively perceived complexity. Studies of this type (Munsinger & Kessen, 1966b; Attneave, 1957; Day, 1968a) demonstrate that symmetrical polygons are rated less complex than asymmetrical polygons with equal numbers of sides. However, Attneave also showed that symmetrical polygons were judged more complex than asymmetrical shapes with the same number of independent sides. He estimated in fact that reflecting a shape symmetrically had the effect of increasing the number of independent sides by about 19% in terms of judged complexity. This is not a percentage which easily lends itself to incorporation in a design.

Thus, while sets of symmetrical and asymmetrical polygons can be equated in terms of objective complexity (number of sides), it is difficult to determine exactly how they differ in terms of subjective complexity. A 40-sided polygon for example, is perceived (by adults) as less complex than a 40-sided asymmetrical figure, but more complex than a 20-sided asymmetrical figure. Its subjective complexity is somewhere in between. Unfortunately, the problem of holding subjective complexity constant between sets of stimuli can only be acknowledged at present, and not resolved. An attempt could be made with adults to produce a subjective complexity scale against which both symmetrical and asymmetrical polygons could be plotted, but the nature of such a task is outside the scope of this thesis. As children are unable to reliably make complexity-simplicity judgments (Munsinger & Kessen, 1966a), it is felt that the total number of sides (covarying with perimeter) on polygons is the most suitable variable to use when comparing viewing times for the two types of stimuli.[14] This decision is in accordance with the study by Day (1968b).

Day's study, it will be remembered, involved nurses viewing the two types of polygons under four instructional sets. Day hypothesized that if looking time was primarily a function of information search, then symmetrical stimuli would be inspected for shorter lengths of time, because their information content was lower as measured by ratings of complexity (Day, 1968a). If, on the other hand, looking time was a measure of affect, it would be longer for symmetrical stimuli which are rated higher in affect according to judgments of pleasingness (also 1968a).

Looking times were shown to be longer for the asymmetrical shapes, but only for the 'interesting' and 'recognize' instructional groups. The 'pleasing' and 'as long as you care to' groups showed no differences. Day concluded that looking time was more a function of collative variability than affect value, but added that "looking time is not independent of the observer's affective evaluation of the situation". It is not known whether he was referring to results from the 'pleasing' group, from the 'care to' group, or both.

The study by Hutt and McGrew (1969) suggested that the effect of symmetry on viewing times is dependent upon the age of subjects. In the original publication (1969) the authors stated that "in general, viewing times decreased with age". A later published illustration of the data (Hutt, 1970) in which the five different types of complexity were considered separately, shows that the statement does not accurately reflect viewing times for the two types of polygon. Viewing times for symmetrical polygons did decrease with age, but increased slightly for asymmetrical polygons. The graph shows an interaction between age and symmetry. 5 year olds viewed symmetrical stimuli longer than asymmetrical stimuli, 8 year olds showed no differences, and 11 year olds spent more time looking at asymmetrical stimuli.

Because the authors did not take number of sides (from 5 to 20) into consideration, the data have some rather interesting implications. Because all symmetrical stimuli were regarded as simple, all asymmetrical stimuli as complex, the data taken as presented imply that young children looked longer at 5-sided symmetrical stimuli than they did at 20-sided asymmetrical stimuli, whereas older children spent more time viewing 5-sided asymmetrical polygons than they did 20-sided symmetrical stimuli. This state of affairs requires verification.

Nevertheless, an age effect for symmetrical stimuli was demonstrated. The graph shows that the younger the child, the longer the time spent viewing symmetry. If this finding is confirmed in the experiments to follow, and if, as expected, viewing time is affected by increased affective value of stimulation, it would follow that younger subjects will rate symmetrical polygons more pleasing than older subjects. It should be pointed out though that the effect of symmetry has never been examined in children at different levels of stimulus complexity, nor has it ever been included in highly complex polygons for subjects of young ages. It may be the case that viewing times for symmetry decrease with age only for stimuli at relatively low levels of complexity, i.e. below 20 sides.

Affective Salience

The proposed experiments on salience arose from consideration of a body of research into children's colour-form sorting behaviour, which began early in the century (Descourdres, 1914; Brian & Goodenough, 1929). More recent work in this area has added considerable refinement (Harris _et al_, 1970; Smiley, 1972; Fernandez, 1976).

The basic aim in this research is to study the developmental changes in the way children select either the dimension of form or colour to make a judgment of similarity about two stimuli. Typically, a subject will be confronted in a trial with three simple geometric stimuli, a green triangle and a red circle at the top of a page and a green circle at the bottom. His task is to select from the two stimuli at the top the one which is most like the one at the bottom. If one dimension is selected more frequently than the other, dimensional salience (or dimensional preference) is said to be operative. The child is classed accordingly as either colour- or form-dominant (colour- or form-salient).

The early work did indeed produce evidence of developmental changes. At early ages, it was discovered that colour was preferred over form in making matches. After about age 6, form-salience was found to express itself. Several studies have confirmed the switch from colour to form dominance (Corah, 1964, 1966; Corah and Godspinoff, 1966; Suchman and Trabasso, 1966a; Mitler and Harris, 1969; Harris et al, 1970; Brown and Campione, 1971; Katz, 1971, 1975), but others have failed to find differences in salience which could be attributable to age (Doehring, 1960; Kagan and Lemkin, 1961). The bulk of the evidence strongly suggests however, that the selection of form over colour increases with age, such that by the time a child is school-aged, form is most likely to be salient over colour, and over other dimensions.

The basic study of dimensional salience has expanded considerably. An early study by Kuhlman (1904) heralded numerous later investigations seeking to relate colour and form salience to personality type, principally among adult populations (Oeser, 1932; Lindberg, 1938; Eysenck, 1947; Pfister, 1950; Keehn, 1954; Kay et al, 1975). Keehn, who has related dimensional salience to colour and form responses on the Rorschach (1953), has also shown that in general, the many different methods employed to measure dimensional salience are not highly correlated with one another (1953, 1955).

Studies designed to explore different aspects of salience within a developmental framework have found that form is not necessarily the most salient dimension among non-Western children (Suchman, 1966; Serpell, 1969; Schmidt & Nzimande, 1970; Davidoff, 1972), and, that it is selected more frequently by girls than by boys (Lindberg, 1938; Honkavaara, 1958; Doehring, 1960; Kagan & Lemkin, 1961). Other developmental studies have related colour and form dominance to personality characteristics of impulsivity and reflectivity, respectively (Katz, 1971, 1972; Hartley, 1976), to socio-economic status (Seaman, 1974), to speed of learning (Suchman & Trabasso, 1966b; May & Fernandez, 1974), and to problem-solving behaviours (Seitz & Weir, 1971; Odom & Corbin, 1973). The study of salience has also been expanded to include tasks which involve a choice between more than two dimensions (Kagan & Lemkin, 1961; Suchman & Trabasso, 1966a; Borich, 1970; Odom & Guzman, 1972; Farnham-Diggory & Gregg, 1975).

Affective and cognitive salience

Curiously, developmental research in colour-form sorting has not been related to research in children's aesthetic preferences. While the term 'preference' is frequently employed in the former, it is a special kind of preference, and refers to the *usage* of one dimension over another to establish similarities. Because of the task involved, it is a more cognitive response, implying classification and categorization. Preference in the aesthetic literature reflects liking, and is more affective in nature.

Nevertheless, it is pertinent to question how important colour is to school-age children, who are generally regarded as form-dominant, as a determinant of their aesthetic preferences. How affectively salient is colour as a determinant of preference in tasks which involve a less intellective mode of response to multidimensional stimuli? To answer this question, it was decided to test the salience of colour relative to a major dimension of form, namely complexity, in a task involving affective, and not cognitive preferences.

The task proposed is intended to confront subjects with a conflict of affective choice between two visual properties, just as colour-form sorting involves a cognitive conflict of choice. Subjects will be presented with a series of stimuli varying in complexity, some of which will appear in colour, some in black. Conflict will be induced when preference for stimulus complexity competes with preference for colour. The extent to which colour overrides complexity in determining preference will be interpreted as a measure of its affective salience.

Testing for evidence of salience

From the point of view of design, it was decided to test for salience using the same rank-ordering task, under the same instruction conditions, as already outlined. That is to say, subjects will be presented with 10 polygons to rank order by liking. The possibly contaminating effects of colour novelty will be avoided by presenting half of these 10 in a single colour, the other half in black. The decision to use the rank-ordering task ensures then, that the effect of colour on preferences can be successfully compared with preference functions established under conditions when colour-complexity conflict is not involved. This is an important comparison to make. If the addition of colour is to be meaningfully measured, it must be measured in relation to a baseline of preference. That baseline is the normal preference function for polygonal complexity.

If the baseline preference function for complexity increases with number of sides, as it is expected to do, it follows that in general, a given level of stimulus complexity will be preferred to stimuli at lower levels. Certainly, the higher levels of stimulus complexity (24 to 40 sides) can be accorded higher preference values than the lower levels (4 to 20 sides). What the experiments on salience seek to discover is the change in baseline function when colour is added either to high, or to low levels of complexity.

Measuring salience

Following the measurement of viewing time, subjects will be required to rank order four sets of polygons. Two of these are intended to establish a baseline preference function. Each of the other two will contain half of the polygons in black, half in colour. One of these will have high complexity stimuli in colour, low complexity in black, while the other set is the reverse of this - low complexity colour, high complexity black. What will be of particular interest will be the conflict generated when low complexity stimuli are presented in colour, with high levels in black. This set is the more apt test of colour's affective salience.(15)

Under this condition, there are three possible outcomes to the rank order:

(1) The presence of colour will make no difference. Preferences will increase linearly with number of sides, as in the baseline function. Colour will therefore have no affective salience; it is not an important affective property of visual stimuli, since its presence is not sufficiently potent to alter an established pattern of preference. Visual complexity on the other hand, will have high affective salience. It stands out as the predominant stimulus property contributing to preference in multi-dimensional stimuli of this type.

(2) Colour will make a very significant difference. Preferences for the most simple, coloured polygons (4-sided) will be higher than the most

complex, non-coloured polygons (40-sided). Preferences will be highly determined by the property of colour, and colour can then be said to have high affective salience, while visual complexity will have very little salience relative to that of colour.

(3) Colour will make some difference. Preferences for low complexity coloured stimuli will be raised, and consequently lowered for high complexity stimuli. The baseline function will be altered, but only to an extent. Colour will therefore show itself to have a degree of affective salience, but one which is relative and limited, compared to that of visual complexity. Both visual properties will contribute to preference in multidimensional stimuli, but neither property is sufficiently salient to outweigh the other.

The third outcome is the most likely, and Fig. 2 illustrates the expected general change in preference from the baseline function when low complexity figures are presented in colour, high complexity in black. Note that the slope representing preferences for low complexity stimuli should still be parallel with baseline, and similarly, the slope representing preferences for 24- to 40-sided black figures should also remain parallel to baseline. Note also that a decrease in slope from the most complex, coloured stimulus (20-sided) to the least complex, non-coloured stimulus (24-sided) is predicted.

Because this proposed research is exploratory, the actual means by which affective salience can be adjudged to the property of colour has no precedent. While it is possible to show statistically that the addition of colour to stimuli of low complexity significantly changes baseline preferences, the decision as to how much change is necessary before colour can be said to be affectively salient remains arbitrary. This is unlike colour-form sorting research in which salience (or preference) can be established more definitively, by counting the number

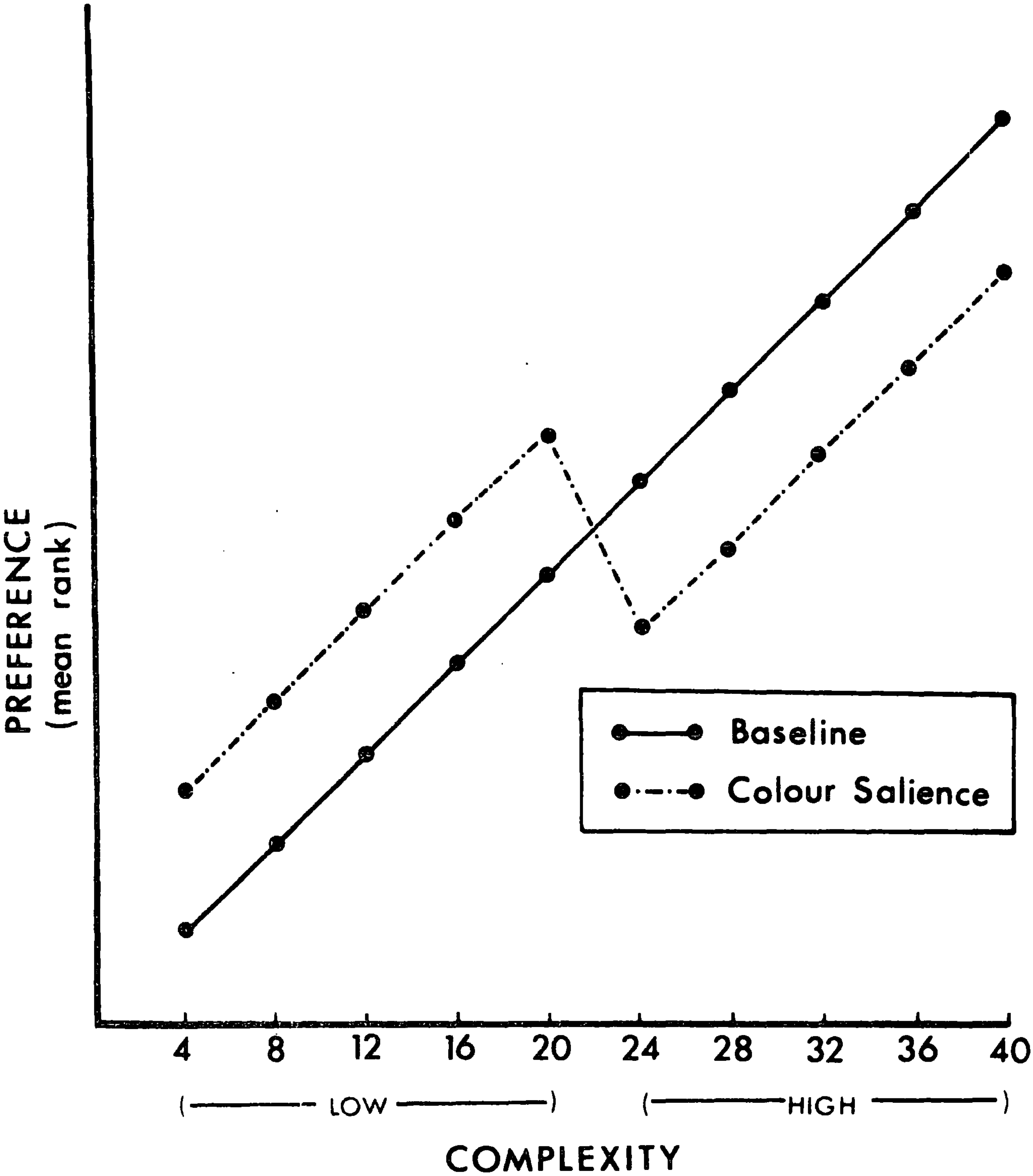


Fig. 2. Predicted effect on preference of affective salience of colour relative to predicted baseline complexity preferences.

of times a given dimension is utilized to match stimuli. The same criterion cannot be applied here, however. Should the data reveal that the most simple shape in colour is preferred to the most complex shape in black (outcome 2), then the decision as to whether colour is salient is made much easier. Such a result would attribute an extraordinary degree of salience to colour as a property contributing to preference in multidimensional stimuli, but it is felt that this outcome is most unlikely.

Salience and age

What is expected in the experiment to follow is that the salience of colour can only be adjudged in a relative sense, and, that there will be an upper limit to which the addition of colour will increase the affective value of a stimulus. For two reasons, one can posit that this limit will depend upon the age of the subjects.

The first reason derives from colour-form sorting investigations. Research shows that younger children are more likely to be colour-salient (cognitively speaking) than form-salient, or expressed differently, it shows that form salience in younger children (circa age 6 to 7) is not as strongly established as it is in older children. It is reasonable to assume then, that colour will also have a higher affective salience at young ages. The upper limit to which colour increases the appeal of a low complexity stimulus should therefore be higher in young children, than in older children.

The second reason why relative salience is expected to be age-dependent derives from the preference for complexity research. The literature shows that the effect of polygonal complexity on preference is more pronounced in older children than it is in younger children. The older the subject the more definitely is the complex preferred to the simple. The slope of the function relating older children's preference to number of sides is steeper (see Thomas, 1966, for example). It is to be expected then, that for older children colour will not have the same salience at low levels as it does with younger children, who do not respond to complexity in the same manner. Young children's preferences are not as well defined; their preference functions are less steep. They should therefore find colour in combination with low stimulus complexity a more appealing additive.(16)

The affective salience of symmetry

In the first experiment on affective salience (Chapter Three), the salience of colour relative to visual complexity will be examined. In a following experiment (Chapter Four), a similar examination of symmetry is intended. Subjects will rank order ten stimuli, consisting of five low complexity, symmetrical polygons and five high complexity, asymmetrical polygons. It is expected that the pleasing property of symmetry will, like that of colour, induce a conflict between preference for symmetry and preference for complexity. The extent to which the low complexity, symmetrical figures are 'more' preferred than high complexity, asymmetrical figures will be viewed as evidence of the affective salience of symmetry. The same three possible outcomes of rank ordering can be predicted, but symmetry, like colour, is expected to be salient only in a relative manner (as depicted in Fig. 2).

Once the relative salience of symmetry has been established in Chapter Four, it can be compared to that of colour in Chapter Three. Should one of the two properties increase the preference value of low complexity stimuli to a greater extent than the other, then that property can be adjudged as having a higher (or more) affective salience.

This line of thought will be extended and thoroughly tested in Chapter Five. An experiment is designed to test the competing, interacting effects of all three independent variables - complexity, colour and symmetry. By manipulating the component properties in tridimensional stimuli, such that subjects must choose between stimuli, all of which are pleasing but for different reasons, evidence of the controlling or salient properties determining preference will be forthcoming. Ultimately, it is hoped that a hierarchy of affective salience for different visual properties can be established.

CHAPTER THREE

THE EFFECT OF VISUAL COMPLEXITY AND COLOUR ON VIEWING TIMES AND PREFERENCE

CHAPTER THREE

The experimental work is reported in this and the following two chapters. This chapter reports two experiments which deal with both dependent variables, viewing time and preference, and with two of the three independent variables, visual complexity and colour. Chapter Four reports two similar experiments which investigate complexity and symmetry. The final chapter reports an experiment in which preference judgments only are solicited. All three independent variables will be manipulated in Chapter Five.

* * *

In this chapter there are two experiments, but presentation is in three parts. In Part One, the experiment on viewing time as a function of visual complexity and colour is presented, while Part Two reports the experiment on preference which includes the study of affective salience. In Part Three, which is not a separate experiment, the relationship between the two dependent measures is examined.

Each Part will commence with a brief re-statement of the specific hypotheses in question. There will be a discussion of results at the end of each chapter.

PART ONE

Viewing Time : Complexity and Colour

There are two hypotheses tested in Part One. These are that viewing times will increase with polygonal complexity, and that viewing times will be longer for chromatic stimuli than they will be for achromatic stimuli. No interaction between complexity and colour is expected. It is also expected that the age x complexity interaction will be significant (as suggested in Thomas, 1966), such that the slope of the function relating number of sides to viewing times will increase in steepness as age increases.

Subjects

Seventy-two subjects (36 male) with normal colour vision took part in the experiment. All subjects attended the same school, Tudhoe Colliery Primary School in Tudhoe, County Durham, and represented the entire age range of primary school pupils attending that school. Subjects were selected randomly from the school population from class lists provided. There were 12 subjects in each of six age groups (age 6 to 11) with an age range from 6 years, 1 month (6.1) to 11.4. The mean age within each group was 6.4, 7.4, 8.7, 9.6, 10.7 and 11.3.

The socio-economic-cultural background of the children can best be described as 'rural working class'. Parents were employed locally, primarily in factories, with some in farming and in the mining industry. Tudhoe (pop. 1500), once a separate colliery village, had grown such that it is now part of a larger town, Spennymoor. Most children lived within walking distance of the school.

Statistics on intelligence were not available, but according to the headmaster the range of IQ in the school was 'very representative' of the national population. The children were taught in an open-style classroom setting, without fixed seating arrangements. The curriculum included mathematics, english, physical education, and religious education as basic subjects.

Art lessons were frequent at the school, consisting of several prescribed exercises, balanced by considerable free time for drawing, but no formal art training was offered. All subjects tested knew the basic colour names, and were familiar with the simple, basic shapes (triangle, rectangle, etc.). All subjects had at least been exposed to the concept of symmetry (making symmetrical ink blots, for example), and had heard the word 'symmetrical' used by members of staff. At no time had subjects ever officially visited an art gallery. Moreover, as neither Tudhoe nor Spennymoor had art galleries, it is reasonable to assume that the only intentional exposure to artistic products among these subjects would have occurred in the home.

It should also be noted that the school population was quite accustomed to university researchers and student teachers, who regularly visited the school.

Apparatus

The apparatus described below was designed to satisfy several requirements. These are:

- that each stimulus be seen as a 'real picture', physically portable, and viewable in close proximity to the child (compared to slide projections for example, where stimuli are seen as distant projections on a screen);
- that direct manual action on the part of the child bring each stimulus into view, without the distractions of button-pressing or of visible electronic 'gadgetry';
- that viewing be made as comfortable and as relaxed as possible,

and that it take place in a familiar ('unlaboratory-like') room where level of illumination is held constant;

- that each child be tested individually;
- that subjects would not know they were being tested;
- that subjects would not become bored with the procedure.

The viewing time apparatus consisted of two main pieces - a large wooden screen with a 'window' in the centre, and a stimulus background board placed behind the screen.

The screen was rectangular in shape (4' long, $2\frac{1}{2}$' tall) and was made sufficiently large so as to occupy most of a subject's visual field when sitting in front of it. When placed on a flat surface, the screen sloped slightly away from the subject at an angle of 80°. It was supported in this position by support wings on each side which extended away from the screen at an angle of 30°. The support wings extended 11" at the bottom and 6" at the top. In the centre of the screen was an 8" square window, framed by a 1" border. The window could be opened and closed by sliding a panel from one side to the other. A small round peg extending from the middle of the right hand side of the panel allowed the subject to easily operate the sliding panel. The panel itself was mounted on runners behind the screen and disappeared from sight when the window was open, except for the peg which remained visible in a groove in the left hand side of the window frame. Plate 1 shows a frontal view of the screen with a child operating the window panel.

A microswitch was fixed to the back of the screen and was connected to an electronic Timer Counter, model SC3 (Advance Instruments). This was triggered by the end of the panel when the window was open, and switched off as the panel was moved to close the window. Viewing time (in centiseconds) was thus measured from the time the stimulus was in

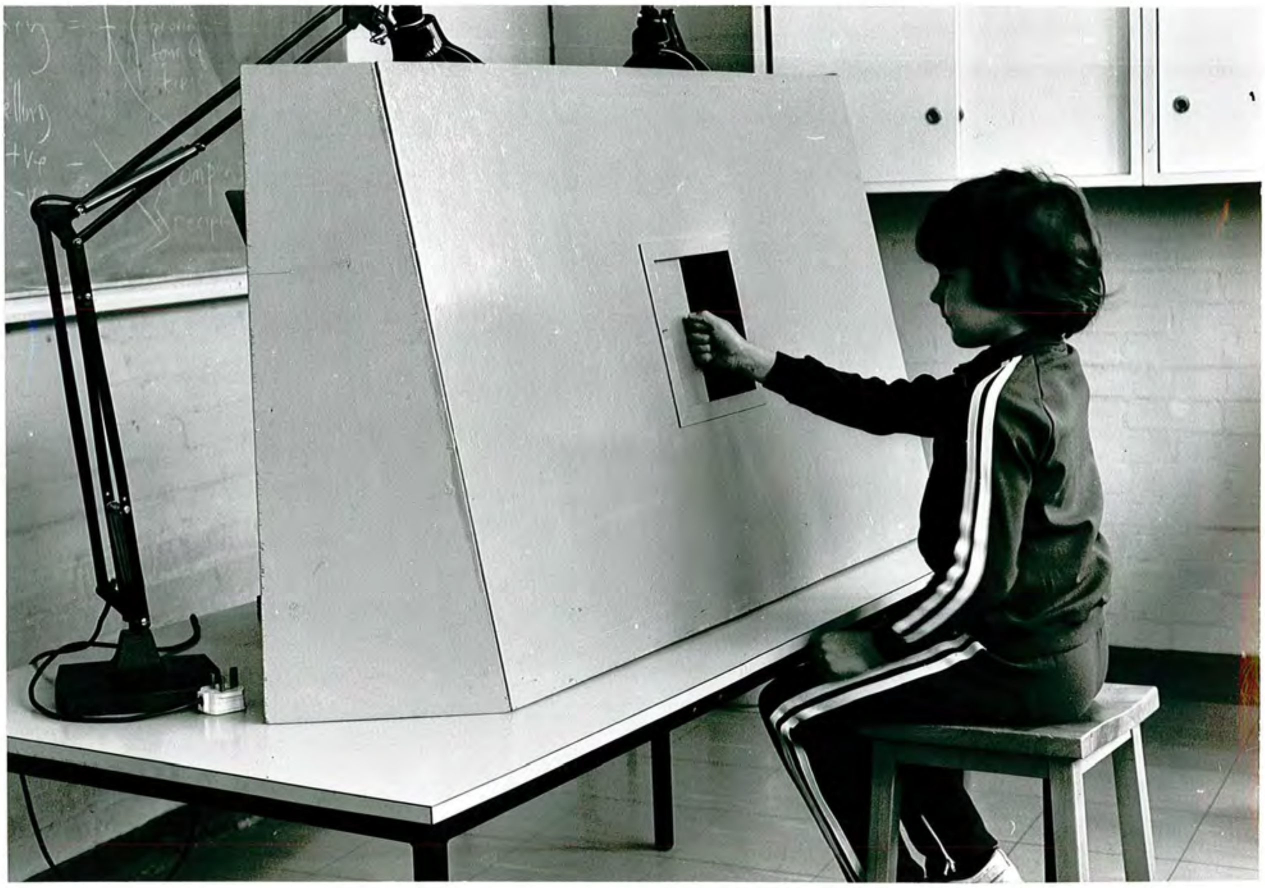


Plate 1. View of the apparatus with child operating the panel in the window.

full view, to the time when the subject started to close the window.

Behind the screen was a rectangular, wooden stimulus background board (34" long, 21" high), which was smaller in area than the screen, but of the same shape. A 10" long grooved ledge was fixed to the front of this board, and was positioned such that it supported the stimulus in the centre of the background immediately behind the window. Two aluminium 'blinkers' were fixed to the background board, one on either side of the stimulus. Their purpose was to assist in channeling the subject's vision onto the stimulus. These projected outwards from the board at an angle of 120°, and increased in height from 12" to 19", thus giving the appearance of receding perspective. (The actual 'vanishing point' was $4\frac{1}{2}$" behind the centre of the stimulus.) The distance between the vertical edges of the mounted stimulus and the point at which the blinkers projected from the background board was 1". The distance between the horizontal edges of the stimulus and the top and bottom of the background was $5\frac{1}{2}$".

The entire background board rested upon a $4\frac{1}{2}$" high solid, wooden box of equal length (34"), which could be firmly clamped to a table. The background board was secured to this box by hinges only at the back however (the experimenter's side). This was to facilitate stimulus removal and replacement. When the screen panel was closed, the experimenter could pull the background board toward him, remove the stimulus from its ledge, replace it with another, reposition the background board ensuring that the new stimulus appeared in the same place as the previous one. The support box rose perpendicularly from the table, but the background board resting upon it sloped away from the subject at an angle of 15° (as the screen did). This was necessary to prevent the stimulus from falling forward when in position.

Illumination was provided by two flexible-arm, desk lamps (tungsten filament, 60 watt each) positioned between the screen and background board on either side of the stimulus, out of sight of the subject. Colour temperature measurement of these light sources gave readings of 2900° Kelvin, thus showing them to approximate C.I.E. standard Illuminant 'A'. The approximate luminance of the stimulus background board was 2.5 foot-lamberts (measurements taken at points near the outer edges of the mounted stimulus).

The background board stood 1' behind the screen. Both pieces of apparatus were placed on a long table in front of which was a comfortable stool. When the subject was seated, the mounted stimulus visible through the screen subtended a visual angle of between 20° and 25°. When the window was closed, the only piece of apparatus visible was the screen. All leads, stimuli, scoring sheets, as well as the experimenter were out of sight. The screen, its sliding panel, and the background board were painted neutral grey, in a semi-gloss finish (approximating N5 in Munsell notation).

Testing was conducted in a corner of the school staff room during teaching hours, during which time the room was empty and quiet. At the far end of the room, behind the subject and facing the experimenter, a tall mirror was placed. This allowed the experimenter to visually monitor the subject at all times the window was open.

The Ishihara Colour Vision test (1969 edition, 38 plates) was used to screen subjects for colour vision. Plates were presented near an outside window (facing north) so that they were illuminated by natural daylight. They were presented approximately 2' away from the subject, with the plane of the plates at right angles to the subject's line of vision. Alternate double-pages were used. Double digit plates were used with older subjects, single digit plates with younger subjects. The winding lines (plates 26 to 37) were used with some of the very young subjects who had difficulty reading digits.

Construction of Stimuli

Forty different polygonal shapes were used. These ranged from 4 to 40 sides and represented 10 levels of complexity. Each increase in complexity was defined by an increment of 4 sides. All polygons were constructed according to Attneave and Arnoult's Method 1 (1956), with modifications.

In order to ensure that as many stimuli as possible were equated for association value, 4 each of the 4-, 8-, 12-, 16-, and 24-sided shapes were selected from Vanderplas and Garvin's stimuli (generated by Method 1) on the basis that they had equal association value. As their study did not include any 20-sided shapes or any stimuli with more than 24 sides, the remaining stimuli (20-, 28-, 32-, 36-, and 40-sided) were constructed according to the prescribed method.

The Vanderplas and Garvin stimuli were first photographed and increased in size to fit a 10" square background. They were then measured for perimeter and area. Perimeter was found to increase by approximately 4" (10cm.) for each incremental increase in complexity. Area was also found to vary considerably, but unlike perimeter, did not show a consistent relation to number of sides. Owing to the importance of these two parameters, adjustments were made such that perimeter would covary with number of sides, and area would be held constant. The increase in perimeter selected was 4" ($\pm \frac{1}{2}$), as this was the increment which resulted 'naturally' from random generation. The constant area selected was 15 sq. in. ($\pm$ 1 inch) as this value was the mean of all shapes.

These three factors - number of sides, covarying perimeter, and constant area - were then used as the baseline for generation of new stimuli. Basically, Attneave and Arnoult's Method 1 involves the following steps:

(a) for each level of complexity the appropriate number of coordinate points were selected from a computer-generated list of random numbers, and plotted on a transparent paper which overlay a 20 X 20 grid;

(b) the most peripheral points were connected, forming a convex polygon, whose sides are numbered - the remaining, internal points were randomly assigned numbers;

(c) a table of random numbers and letters was then used to determine which internal point was connected to which side - the order of selecting internal coordinate points was also determined randomly, and each internal point was connected to one of the external sides;

(d) if a point was to be connected to a given side and a previously constructed internal angle crossed the path between the point and that side, the point was then connected to the side of the angle closest to it;

(e) if three or more points lay on a straight line, the point(s) in the middle section of the line were randomly replotted - this ensured that all polygons had the correct number of sides they should have.

The completed polygons were then measured for area and perimeter. Like the Vanderplas and Garvin polygons, perimeter increased in rough proportion to number of sides, but area varied without relation to sidedness. The polygons were then adjusted, if necessary, according to the criteria described previously. All adjustments, both to the Vanderplas and Garvin stimuli, and to the newly constructed ones, were executed carefully so that the basic features of the randomly determined shapes were minimally altered. Most stimuli needed only minor adjustments.

The resulting set of 40 shapes ranged in sides from 4 to 40, and in perimeter from 18" (45cm.) to 54" (135cm.), with increments of 4 sides and 4" (10cm.), respectively. These were photographed from the transparencies and printed on thick paper. Each shape was then cut away from its background on the photographic paper.

The next step involved cutting out the shapes from sheets of coloured Pantone Letrafilm Colour/Film Overlay, a thin but strong, non-elastic material with gummed backing, made by Letraset. Two complete sets of 40 polygons each were cut out from these Pantone sheets, one in black (Pantone Opaque Black-A), and one in colour. Primary red, green, and blue were selected to represent the variable of Colour, because of their high affective value. The specific hues (Pantone Red-206A, Pantone Green-340A, and Pantone Blue-293A) were chosen on the basis of consultation with the Pantone manufacturers, who advised that they were the standard, popular examples of those three hues.

Colorimetric analysis of the stimuli was done with a Lovibond Flexible Optic Tintometer, Mark III,[17] and the instrument readings were converted into C.I.E. units. Dominant wavelength, brightness %, and saturation % were also calculated. Results are presented in Table II.

Colour Stimulus	C.I.E. Units X	Y	Dominant Wavelength	Brightness %	Saturation %
Pantone Red-206A	.542	.301	660	11.5	49
Pantone Green-340A	.198	.402	500	20.8	48
Pantone Blue-293A	.162	.126	473	7.8	66
Pantone Black			-	1.9	-
Pantone Grey 422-A*			-	37.1	-

TABLE II. Colorimetric specifications of the stimuli
(*used in 2nd experiment)
All stimuli were in matte finish.

Of the 40 polygons comprising the Colour set, 14 were cut in red, 13 in blue, and 13 in green. Each level of complexity, represented by 4 stimuli, had at least one shape in each colour. Apart from that consideration, colours were randomly assigned to stimuli. The Pantone cut-outs were then mounted on 10'' square white cards, 1.0 mm. thick. The orientation of each polygon in relation to its square background was determined randomly. Once orientation was established, each figure was positioned so that the distance between the horizontal edges of the card and the highest and lowest extending polygonal points was equal. The same procedure was applied for the distance between the vertical edges and the points extending farthest to the right and left. (It should be noted that this criterion of equidistance does not necessarily imply that the centre of gravity of the polygon will overlay the exact midpoint of the square card.) Once the Pantone shape was stuck to its white background, the side which would become, and would remain the 'top' of the card was randomly determined.

The steps involved in mounting the two sets of polygons were the same for each set. Thus, each member of a set was identical to its counterpart in shape, area (A), perimeter (P), P^2/A, orientation, position, and top-bottom axis, and was different only in colour. The resulting 80 stimulus cards were each given an identity and orientation code on the back.

The stimuli had the appearance of being painted. From a distance of 1 to $1\frac{1}{2}$ feet, the depth of the Pantone was imperceptible.

Fig. 3 shows the 10 red polygons used in this study, one at each level of complexity.

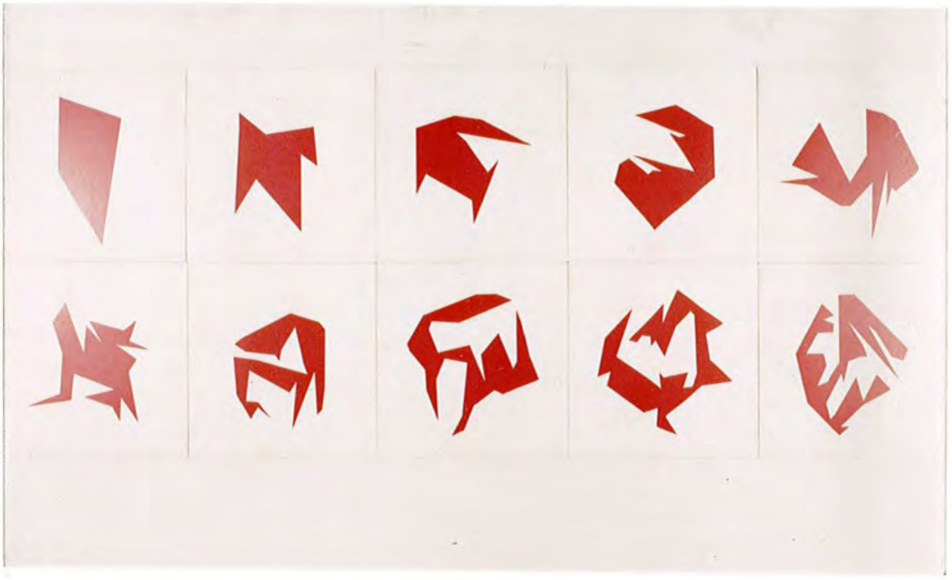


Fig. 3. Examples of asymmetrical polygons used in this study

Design

Division of subjects into groups for viewing was determined by the design of the experiment on preference (Part Two). In Part Two each subject was to rank order the same 40 stimuli (in 4 sets of 10) as had previously been presented singly for free viewing. However, as there were three colours involved (red, green and blue). colour had to be evenly balanced between these sets. This resulted in the formation of six different stimulus combinations, each containing 40 stimuli. Six subject groups were therefore also necessary for viewing to ensure that each subject was presented with the same 40 stimuli in both parts of the experiment.

It should be noted that the six groups were not treated differently, and differed only insofar as each received a different selection of polygons. The particular combination of these stimuli satisfied two criteria: 1) the three colours were evenly distributed in the sets presented for preference judgments, and 2) each level of complexity was represented by its coloured and noncoloured members an equal number of times in the free viewing and in the preference parts of the experiment.

Subjects were divided into six groups (n = 12). Age and Sex, the between-subject variables, were balanced by having 2 children (1 male) from the 6 age levels in each group. Each group was randomly assigned to one of the six stimulus combinations. All subjects viewed 40 differently shaped stimuli, half in black, and half in colour, and were exposed to all 10 levels of complexity, represented by two coloured and two noncoloured stimuli at each level. Colour and Complexity were therefore the within-subject variables.

Stimuli were presented one at a time in two blocks of 20. A different random order of presentation was used for each group. Each of the 72 subjects viewed the 40 stimuli in a different order, i.e. 12 possible variations of each group's random order were used (reversing it, halving it and then reversal etc.).

Procedure

Subjects were first made to feel comfortable on the stool facing the apparatus at a distance of 1 to $1\frac{1}{2}$' from the screen. They were then shown how to open and close the window, with the experimenter first demonstrating the operation of the panel and then requesting the subject to do the same. A sample stimulus was in view through the window on the stimulus background board. Familiarization continued with the same stimulus in view until the experimenter judged the subject could smoothly operate the panel. Also emphasized at this stage was the importance of sliding "the door as far as it will go" so that the subject could "see all the picture" through the window. This was important so that the microswitch would be triggered.

The experimenter then asked the subject if he would like to "look at some new pictures". All subjects indicated positively. The instructions given were as follows:

> All right, now listen carefully what to do. When you open this door you will see a new picture through the window. You may look at the picture for as long as you want ... When you want to see a new picture, just close the door. When you hear me say 'ready', you may open the door again, and you will see the new picture through the window. You may look at that picture for as long as you want ... and when you want to see another picture, just close the door again. We will look at the pictures through the window until you have seen all of them. (The number of stimuli was not revealed to subjects who enquired.)
> One thing is very important, (David). When the window is open, keep your eyes on the picture. Do not look around when the window is open. If you are tired of looking at a picture, just close the door, and I will show you a new picture to look at. But when the door is open, keep your eyes only on the picture.
> Please do not touch the pictures. Just look at them.

The experimenter then left the subject, and seated himself behind the stimulus viewing board. The instructions were terminated with "Do you know what to do now?" Queries were answered by repeating part of the instructions. Presenting the stimuli was preceded with a final statement: "All right, let us start ... Ready." Instructions did not include any reference to subjects making comments about the stimuli. They were neither encouraged to do so, nor discouraged from doing so. All comments were recorded.

Eight practice polygons were presented first, which sampled the full range of complexity. This number was necessary to reduce the novelty value of the apparatus, to allow sufficient time for the subject to familiarize himself with the procedure, and to allow the experimenter to monitor the subject's operation of the apparatus in the mirror. Instructions were repeated during the practice trials if deemed necessary. Subjects were not informed that they were practice trials however.

These stimuli were then followed without interruption by the first block of 20 experimental trials. Intertrial intervals were approximately 10 seconds. After the first block of trials, a rest period of one or two minutes followed, during which time the experimenter reappeared from behind the screen and talked with the subject. Following this, subjects were asked if they would like to see some more pictures. (Only one subject was unwilling to view the second block of trials.) The main points in the instructions were again repeated and the second block of 20 trials was presented. During testing, subjects were monitored at all times with the mirror. If they were seen to be fidgety, the basic instructions were repeated during an intertrial interval when the window was closed. Ten females and six males were observed to look completely away from the screen when a stimulus was in view. Viewing times for these trials were not scored, and instead, the stimulus in question was re-presented at the end of the block in 180° reversed position.

At the end of 40 trials, subjects were tested for colour vision. The data from those found to be colour defective (6 boys) were not scored and those subjects were replaced by colour-normal subjects. No explanation was given to subjects as to the purpose of the experiment. Testing took between 20 and 45 minutes.

Results

2,880 viewing scores (72 subjects x 40 stimuli) were recorded. The mean total time spent viewing all stimuli was 10 min. 40 secs. The mean viewing time for a single stimulus was 16.0 secs. Viewing times for a single stimulus ranged from 2.17 secs. to 1 min. 25.33 secs.

A preliminary analysis of variance of viewing times for the three different colours (red, blue, green) showed no significant differences between them. Subjects viewed two coloured and two non-coloured stimuli at each level of complexity, and viewing times for these pairs were combined. The data for adjacent pairs of complexity levels were also combined. This left a total of 720 time scores for analysis. In addition, the six age groups were analyzed as three (6 and 7 year olds, 8 and 9 years, and 10 and 11 years, hereafter referred to as 6/7s, 8/9s and 10/11s).

These data were then submitted to a 3(Age) X 2(Sex) X 2(Colour) X 5(Complexity) between-within analysis of variance with repeated measures on the Colour and Complexity variables (see Appendix la).

The main effect of Complexity was highly significant ($F(4,264) = 22.26$, $p<.000001$). In Fig. 4, which shows the relation of viewing to complexity, it can be seen that viewing times increased with complexity, and that the effect was most pronounced at low levels of complexity, as is apparent by the general curvilinear form of the function.

The main effect of Colour was also highly significant ($F(1,66) = 17.76$,

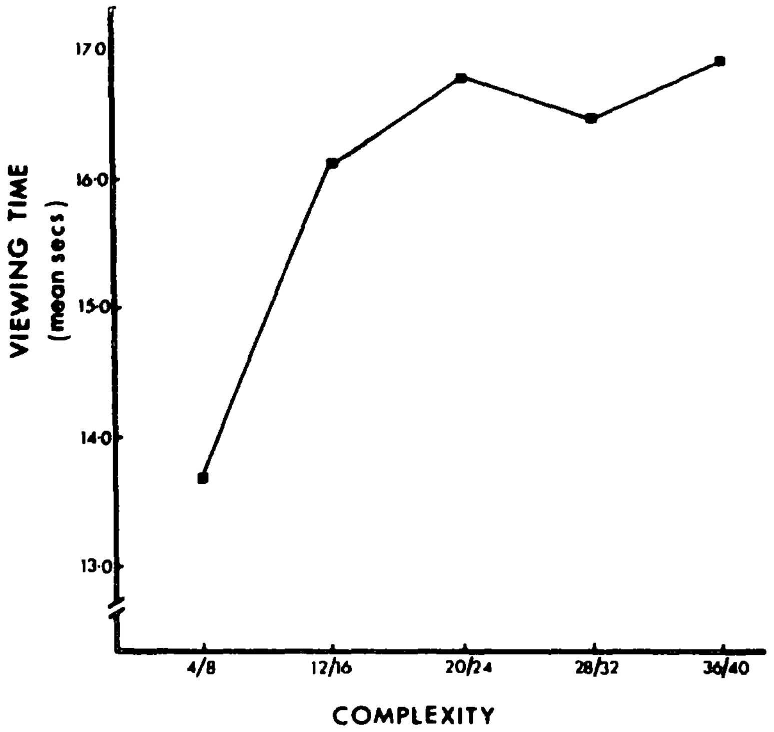


Fig. 4. Duration of viewing time as a function of polygonal complexity (mean viewing time for a single stimulus).

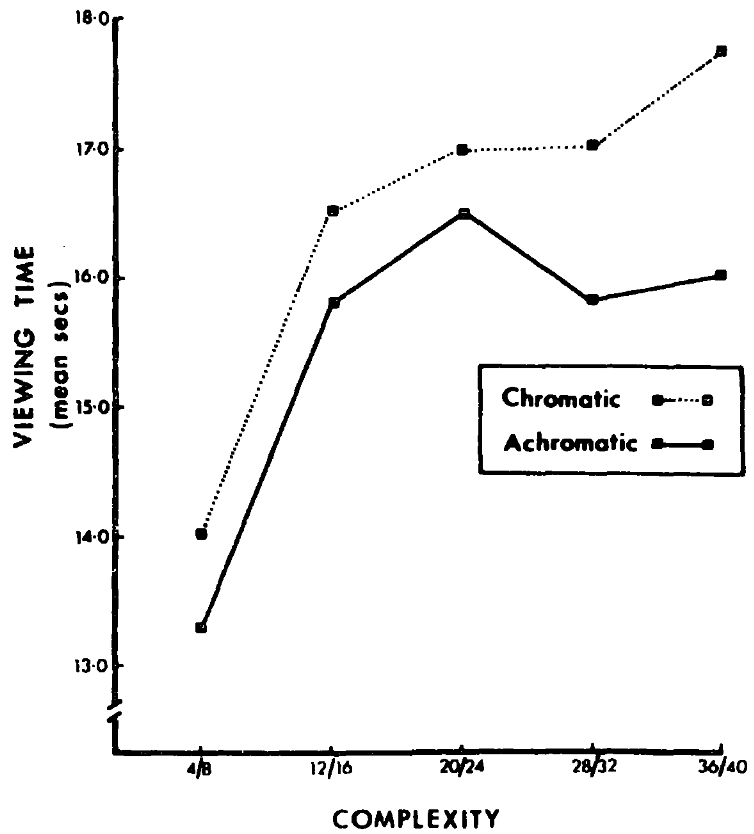


Fig. 5. The effect of colour on duration of viewing time (mean viewing time for a single stimulus).

p<.00025). Mean time spent viewing achromatic stimuli was 15.50, and for chromatic stimuli was 16.49 secs. The addition of colour then, represents an average increase in viewing time of 6.4%. As can be seen in Fig. 5, coloured stimuli at all levels of complexity were viewed longer than the same shapes in black. The functions depicted suggest that the effect of colour is most pronounced at high levels of complexity, however the Colour X Complexity interaction was not significant (p>.28).

The main effect of Age approached, but did not reach significance (p>.075). In general, as Fig. 6 suggests, time spent viewing stimuli increased as subjects' ages increased. At all levels of complexity, older subjects viewed polygons longer than younger subjects.

Fig. 6 also illustrates that age affected the response to complexity. Only the oldest of the three age groups (10/11s) shows a continuing increase in viewing with increased complexity. The 8 and 9 year olds (8/9s) on the other hand, responded to complexity only up to middle levels, at which point the function asymptotes. Increases in stimulus complexity beyond that point did not result in any change in viewing pattern. The youngest group (6/7s) in turn showed a different response pattern, with viewing times increasing at the low end of the complexity dimension, and then decreasing as complexity increases. After 16 sides, the more sides a polygon had, the less time was spent viewing it. Interest in the most complex figures was almost as low as that directed towards very simple figures. These differences were verified statistically with a significant Complexity X Age interaction ($F(8,264) = 4.30$, $p<.0002$).

The main effect of the second between-subjects variable, Sex, and all interactions with Sex were not significant. All other interactions involving Colour, Complexity, and Age were not significant.

Subsequent trend analysis on the effect of Complexity for the

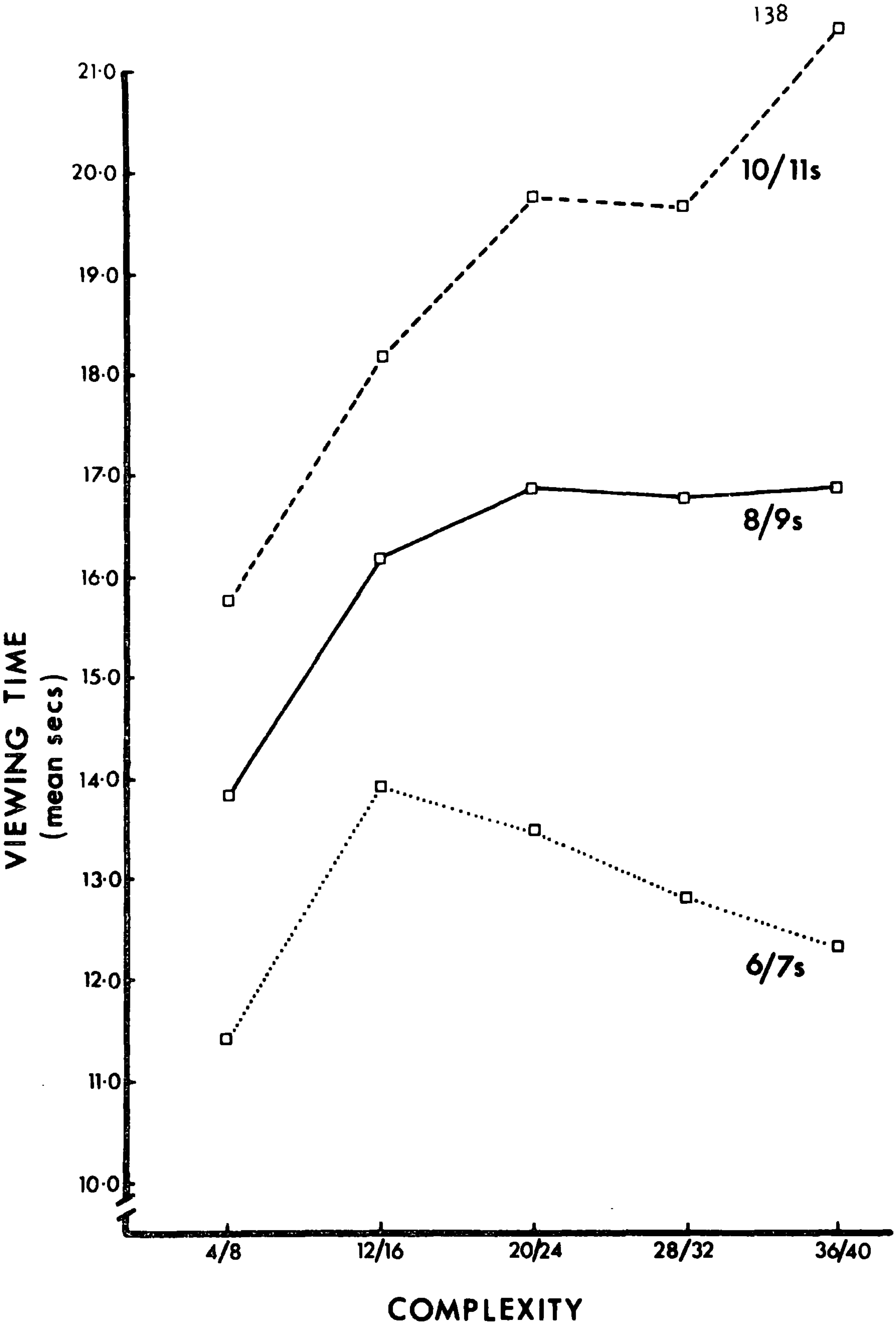


Fig. 6. Viewing time as a function of complexity for the three age groups (mean viewing time for a single stimulus).

whole group showed that 89% of the variation could be accounted for by linear and quadratic components (64% and 25%, respectively). Both trends were significant ($F_{lin}(1,264 = 67.67$, $p<.001$; $F_{quad}(1,264 = 26.14$, $p<.001$). A cubic component, also significant, accounted for the remainder of the variance ($F(1,264) = 10.62$, $p<.01$).

Further analysis was directed towards examining the Complexity X Age interaction. Data from each age group were analyzed separately (see Appendix 1b) in three one-way, repeated measures, analyses of variance, with repeated measures on Complexity (N = 24, K = 5, each analysis). Complexity was significant in each age group ($F_{10/11}(4,92) = 17.39$, $p<.001$; $F_{8/9}(4,92) = 7.65$, $p<.001$; $F_{6/7}(4,92) = 4.51$, $p<.01$). Trend analyses showed that for the oldest group, only the linear component was significant ($F(1,92) = 63.00$, $p<.001$) and accounted for 89.3% of the variance. Variation among the 8/9s was accounted for by two components, linear and quadratic. Both were significant ($F_{lin}(1,92) = 19.17$, $p<.001$; $F_{quad}(1,92) = 9.94$, $p<.01$) and together explained 94.5% of the variance in that age group, 62% and 32.5% respectively. Variation in response to complexity among the youngest subjects was mostly explained (72%) by a significant quadratic trend ($F(1,92) = 12.9$, $p<.001$). A cubic component, also significant ($F(1,92) = 4.61$, $p<.05$) accounted for a further 26% of the variation.

PART TWO

Preference and Salience : Complexity and Colour

The hypotheses tested in Part Two relate to verbally expressed preferences. The first hypothesis predicts that children's preferences for polygons will increase as number of sides increases. Preference for polygonal complexity is also expected to increase as age increases. Subjects will be presented with two sets of 10 polygons to rank order, one in black, the other in a single colour. No differences are expected in the rank orders resulting from these sets, as the variables of colour and complexity are not competing with one another.

The second hypothesis deals with the affective salience of colour relative to the preference-determining properties of visual complexity. Subjects will be presented with two further sets of 10 polygons, each containing half the figures in black, half in a colour. It is expected that the presence of colour at specific levels of complexity will have sufficient affective salience to alter the baseline preference for complexity function. Specifically, a low complexity colour - high complexity black set is expected to induce conflict between preference for colour and preference for high levels of complexity. The resulting preference values of low complexity figures are expected to increase, while those of high complexity figures should decrease. The function resulting from the low complexity black - high complexity colour set is expected to show increased preference values for high complexity figures and decreased values for low complexity figures, compared to baseline. In addition, colour is expected to be more salient with younger children than with older children.

Subjects

The same 72 subjects described in Part One were tested for preferences in Part Two. Time between viewing the stimuli singly and preference testing was approximately five weeks for each subject.

Apparatus

No special apparatus was needed to test preference. Stimuli were presented on a table, 5' long, 2½' wide, which was covered with a grey blanket. Stimuli were presented in two rows along the length of the table. The table was positioned so that subjects were free to walk along its length to inspect stimuli. Illumination was provided by the same two light sources described in Part One.

Design

Each subject was to be presented with the entire range of 40 different polygons in four sets of 10 - the same 40 as had previously been viewed singly. Each of the four sets contained one polygon at the 10 levels of complexity. Two of these sets (Sets A and B) were intended to establish baseline preferences for polygonal complexity, while the other two (Sets C and D) were designed to test for affective salience.

As the design of the experiment is somewhat complicated by counterbalancing, Table III illustrates one example of the composition of the four sets. In Set A all the polygons are black, in Set B they are all in a single colour, either red, or blue, or green. In Set C, the five low complexity figures (4 to 20 sides) are in colour, the five high complexity figures (24 to 40 sides) in black. Set D is the reverse of this, with low complexity figures in black, high complexity figures in colour.

For any one subject, the composition of the three sets which included colour (Sets B, C, and D) was arranged so that each set was

SET	LEVEL OF COMPLEXITY (number of sides)									
	LOW					HIGH				
	4	8	12	16	20	24	28	32	36	40
A. Achromatic (all levels of complexity)	black	black	black	black	black	black	black	black	black	black
B. Chromatic (all levels of complexity)	red	red	red	red	red	red	red	red	red	red
C. Low complexity chromatic, high complexity achromatic	blue	blue	blue	blue	blue	black	black	black	black	black
D. Low complexity achromatic, high complexity chromatic	black	black	black	black	black	green	green	green	green	green

TABLE III. An example of arrangement of colours within the four sets presented to one of the six groups of subjects for rank ordering.

presented with a different colour. As Table III illustrates, a subject would see 10 red polygons in Set B, 5 blue and 5 black polygons in Set C, and 5 green and 5 black in Set D. Another subject would be presented with 10 green stimuli to rank in Set B, 5 red and 5 black in Set C, and 5 blue and 5 black in Set D. Thus, while the total number of coloured stimuli presented to each subject (20) was equal to the total number of black stimuli presented (20) across the 4 sets, there was uneven distribution of the 3 colours for any one subject. Counterbalancing the three colours between subjects was therefore necessitated.

The first stage in counterbalancing involved ensuring that each of the 3 colours was represented an equal number of times in Set B. A third (n = 24) of the subjects thus ranked 10 red polygons in Set B, a third ranked blue, and a third green. The second stage ensured that the remaining two colours were distributed equally to the low and to the high complexity figures in Sets C and D, respectively. For example, of the 24 subjects who were presented with 10 red polygons in Set B, half of these (n = 12) were presented with 5 blue low complexity polygons in Set C, and 5 green high complexity polygons in Set D (see Table III). The other half were presented with green and black in Set C, and with blue and black in Set D.

The two stages of counterbalancing prescribed the formation of 6 groups of subjects. Each group had 2 subjects in each of the 6 age groups, 1 male and 1 female. As was explained in Part One, these groups were not treated differently, and differed only insofar as each received a different 4 sets of polygons to rank.

Procedure

Subjects were returned individually to the testing room and were told that they were going to look at pictures again. They were asked to stand in front of the table, whereon one of the four sets was already in position, arranged in 2 rows of 5. Subjects were asked to look at each one of the ten pictures carefully, and were encouraged to walk along the front of the table to get a good view of each one.

When the experimenter was satisfied that all stimuli had been examined (younger subjects were asked to count them), a subject was asked to state which picture he liked best. It was emphasized that there was no hurry, that he could take as much time as he liked. The stimulus indicated was then removed from the table and held by the experimenter, out of sight of the subject. The remaining nine were then shifted to fill up the place the most preferred stimulus had occupied.

The subject was then told "there are now nine pictures left. Which one of these nine do you like best; take your time. There is no hurry." After the subject indicated the next most preferred, it was also removed and the remaining eight were rearranged. This procedure was repeated until a rank order was established for that set. Instructions and advice not to hurry were repeated intermittently throughout the procedure.

Subjects were then told they were going to see some more pictures. A second set was presented and subjects were encouraged to look at each stimulus as it was positioned on the table. Instructions and procedure for rank ordering were repeated for the second set as above. The third and fourth sets were presented in the same manner.

In the original presentation of a set, the 10 stimuli were presented randomly but arranged symmetrically on the table in two rows, and were placed 1 inch apart from each other. Each subject saw a different random order of stimuli within each set. The order of sets was randomly determined for each subject.

After each preference was made, the remaining stimuli were rearranged into a symmetrical pattern. This was done to ensure that before the next choice was made, stimuli were in close proximity to each other, and were evenly spatially distributed in the middle of the table. A stimulus was never accentuated by leaving it on its own, thereby eliminating any positional response biases among subjects of this age. In addition, the extra time taken by this part of the procedure allowed more time for subjects to scan the remaining stimuli as they were being repositioned on the table. For each set of stimuli, the post-choice rearrangement was continued until only two stimuli remained.

For half the subjects the experimenter stood to the right and slightly behind the subject as preferences were being made; for the other half the experimenter stood to the left and behind. Ranking the four sets took approximately 20 minutes.

Results

The data were ordinal in nature. Sums and means of ranks were computed separately for each of the four sets. Sets A and B were examined first.

(1) Baseline Preferences for Complexity (Sets A and B)

Rank orders were examined in two ways: i) to compare preferences between Sets A and B, and ii) to evaluate the effect of complexity on both sets together.

i) Sets A and B compared

To determine a baseline preference for complexity function, it was necessary first to establish whether there were differences between the responses to black polygons (Set A) and the responses to single coloured polygons (Set B). Preliminary analysis established that there were no differences between ranking red, blue, or green sets of polygons. Preferences in the two sets, depicted by mean rank as a function of level of complexity, are illustrated in Fig. 7. It can be seen that the two functions are very similar. They overlap considerably, while increasing linearly.

There is no suitable technique however, to statistically compare the two functions, as they represent two sets of nonparametric, ordinal data. Ranks were therefore converted into a form suitable for analysis as follows.

Each of the 72 subjects was assigned two rank order correlation coefficients. The objective, true order of polygonal complexity was utilized as a standard against which subjective, observed rankings were correlated. For the objective order, the 40-sided figure was ranked 1st, the 36-sided figure 2nd, the 32-sided 3rd, and so on, with the 4-sided figure ranked 10th. Each subject's observed rank order in Set A was then correlated (tau correlations) with the objective order, and the resulting correlation coefficient was considered as a score. That score represented the amount of agreement between an individual's rank order and the true rank order. A perfect positive correlation thus had a score of +1.0, a perfect negative correlation -1.0. Although the latter never occurred, it would mean that an individual liked the 4-sided figure best, the 8-sided figure next best, and the 40-sided figure least of all.

The same computations were carried out for all subjects' rankings in Set B. There were therefore two scores per subject. The sum of 1.0 was added to all scores to avoid negative numbers, and these data were then submitted to a 3(Age) X 2(Sex) X 2(Set) between-within analysis of variance, with repeated measures on Set (see Appendix 2a).

The main effect of Set did not approach significance at all ($p>.56$), and none of the interactions involving Set were significant. There were therefore no differences between the overall preference functions

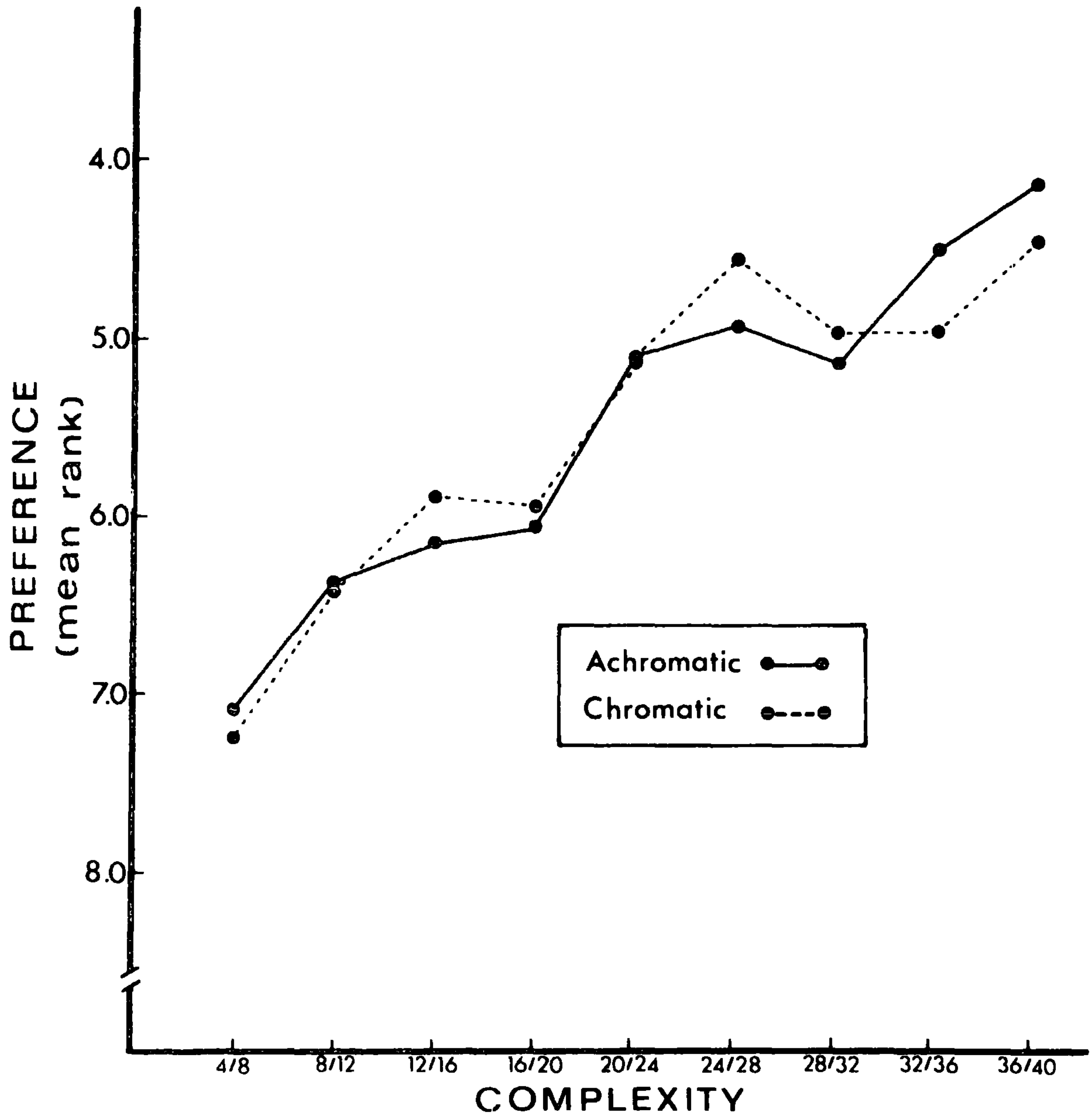


Fig. 7. Preference as a function of complexity for achromatic (Set A) and chromatic (Set B) polygons.

of the two sets (mean tau, Set A = +0.335; Set B = +0.311), and the data from each could be combined accordingly to establish a baseline of preference for complexity (hereafter referred to as A/B, or Sets A/B).

The main effect of Age was highly significant ($F(2,66) = 13.43$, $p<.0001$). Fig. 8 shows the differences between the three age groups, with mean rank plotted as a function of complexity. As illustrated, the differences lie mainly between the functions of the older groups, where preferences increase as complexity increases, and that of the younger group, which is quite flat relative to complexity. Expressed in terms of scores assigned to subjects, the two older groups show much higher rank order correlations with the true order of complexity than does the younger group. Mean rank order correlation coefficients for the three age groups are -0.006 for the 6/7s, +0.410 for the 8/9s and +0.564 for the 10/11s.

There was no overall effect attributable to Sex ($p>.69$), however an unexpected Age X Sex interaction which bordered on significance ($F(2,66) = 3.09$, $p<.0501$) merited attention. Inspection of the data revealed that a difference between sexes was present only in the youngest age group. The mean rank order correlation for 6/7 girls was positive (+0.170), but for 6/7 boys it was negative (-0.181). This difference was found to be significant ($F_{sex}(1,22) = 5.85$, $p<.02$) in a separate analysis of variance applied to the data from that age group (see Appendix 2b). To confirm that a sex difference was not present in the older groups, their scores were also analyzed separately. Neither group showed a sex difference.

In Fig. 9 sex differences among the 6/7s can be seen more explicitly. Girls show an increasing preference for visual complexity which approximates the trend in older subjects, while boys demonstrate a decidedly different pattern of preference. They prefer simple figures to complex ones.

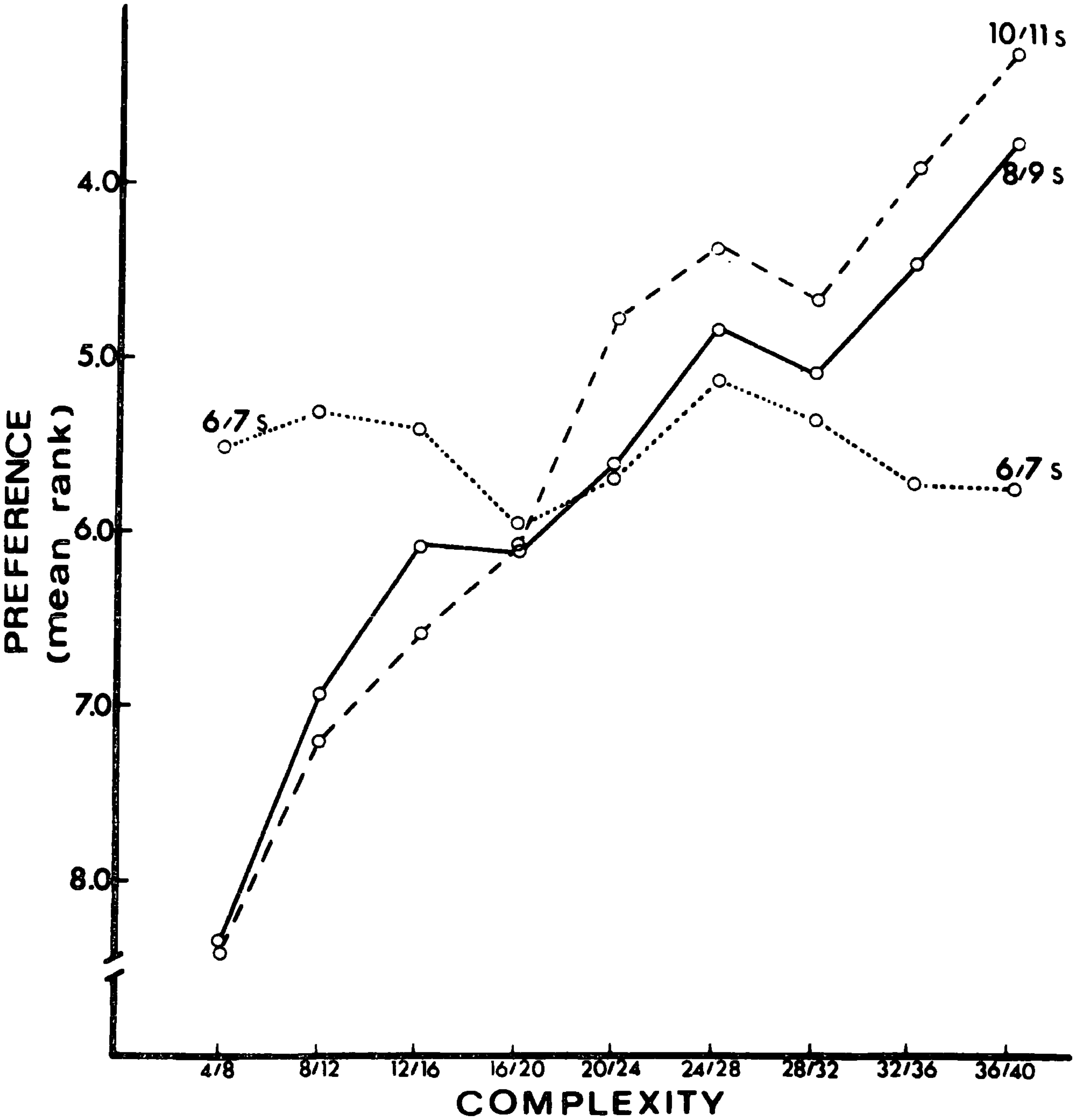


Fig. 8. Preference as a function of complexity for the three age groups (Sets A/B).

Fig. 9. The effect of sex on preference for complexity among the 6/7s (Sets A/B).

Compared to older subjects however, neither sex really shows strong preferences when the actual amount of increase or decrease on the ordinate is considered.

ii) The effect of complexity on Sets A/B

Analysis in section i) demonstrates that data from the two sets of figures can be combined to form a baseline preference for complexity function, but it does not reveal anything about the main effect of complexity on preference. To this end, the data from Sets A and B were combined and analyzed in their original form as ordinal data. Ranks from adjacent complexity levels were also combined, as was done with viewing timescores. Data for analysis were thus in nonparametric form, and represented five levels of complexity.

A Friedman analysis of variance was applied, which resulted in a highly significant effect of complexity for the whole group ($\chi_r^2 = 53.30$, $p<.001$). Subsequent nonparametric trend analysis (Ferguson, 1965) applied to the sums of ranks for adjacent complexity levels, showed that the increase was significantly monotonic ($z = 8.12$, $p<.001$). This monotonicity can easily be adjudged from the depiction of group data for Sets A and B (see Fig. 7).

Previous analysis (section i) showed that the strength of the correlation between subjective and objective orderings of complexity increased with age. This suggests an interaction between age and complexity. However, as nonparametric data cannot be analyzed for interactions, each age group was analyzed separately. Results of three Friedman analyses of variance confirmed the presence of an interaction. Complexity significantly affected preferences in the two older groups only ($\chi_{r\,8/9}^2 = 32.58$, $p<.001$; $\chi_{r\,10/11}^2 = 51.11$, $p<.001$). Trend analyses showed significant monotonically increasing trends in both groups (8/9 : $z = 6.10$, $p<.001$; 10/11 : $z = 8.14$, $p<.001$). Quadratic trends were not significant. In the youngest group, complexity had no effect at all on preference ($p > .95$).

When the youngest group was further subdivided into its component males and females ($n = 12$) and examined, the effect of complexity on preference was present in both sexes but did not reach significance. In both sexes however, there were significant monotonic trends ($z_{male} = 2.74$, $p < .01$; $z_{fem} = 2.37$, $p < .05$), but they were different from one another. Young males showed a significant monotonically decreasing pattern of preference, while 6/7 girls showed a monotonically increasing preference pattern in relation to visual complexity. These results provide support for the group Age X Sex interaction reported in section i), as well as confirm the Sex effect reported from the additional analysis of the youngest group.

One final test of complexity was applied to the data. It involved comparing median ranks from the low range of complexity (4- to 20-sided) with median ranks from the high levels of complexity (24- to 40-sided). Two medians were computed for each subject based on sums of ranks at each of the five complexity levels in the two sets (A/B). A Wilcoxon matched-pairs signed-rank test was applied to the 72 pairs of medians and showed that they were significantly lower (i.e. the figures ranked higher, more preferred) in the high complexity range of figures than in the low complexity range of figures ($z = -4.33$, $p < .00003$). The reason for this comparison will be made clear later.

(2) The Salience of Colour (Sets C and D)

In analyzing the salience of colour, Sets C and D were examined separately in sections 2a) and 2b), respectively.

2a) Set C : Low Complexity Chromatic - High Complexity Achromatic

Fig. 10 shows the preference function derived from Set C rankings. Baseline preferences (Sets A/B) are also illustrated for comparative

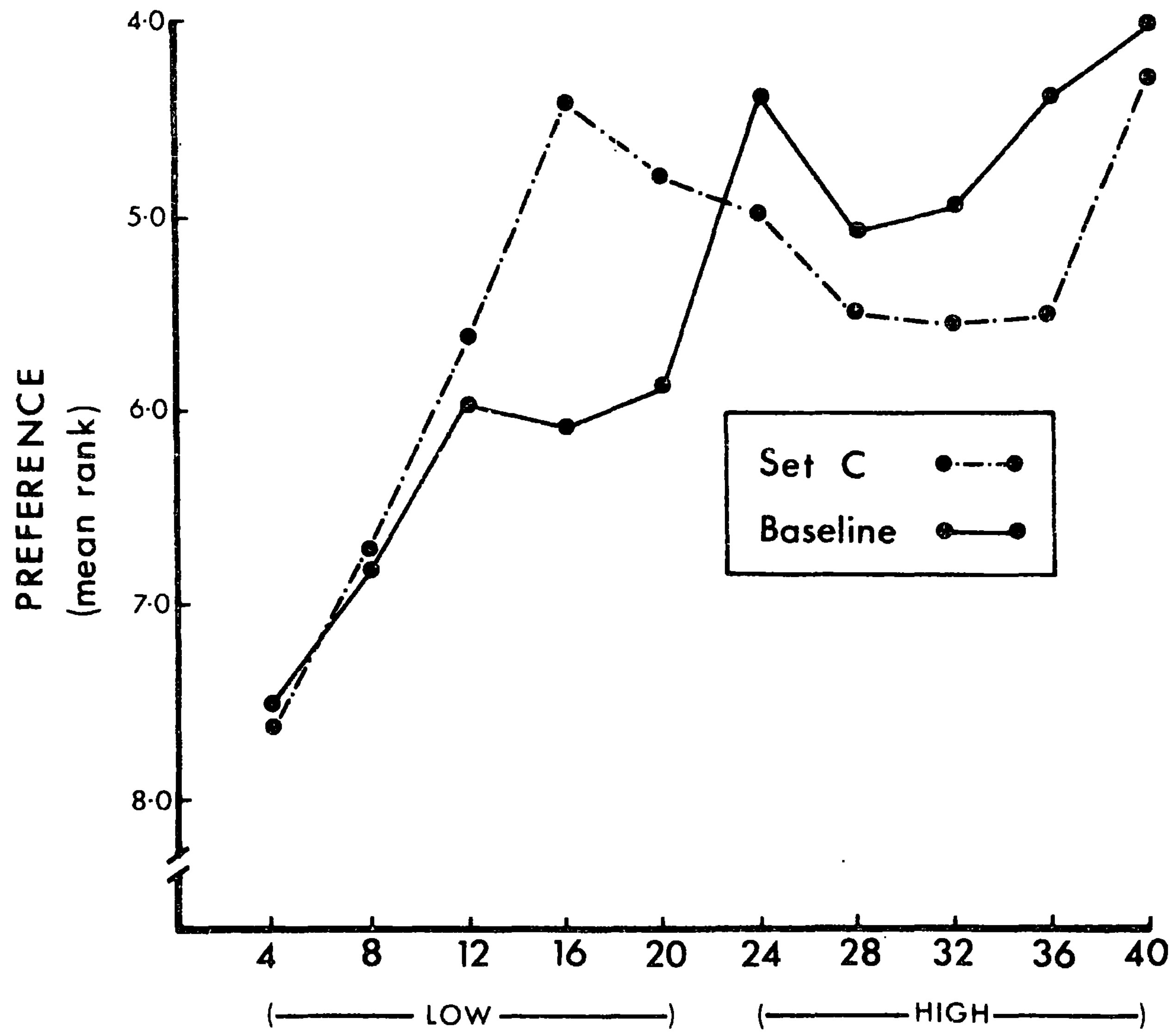


Fig. 10. The affective salience of colour relative to complexity: preferences in Set C compared to baseline (Sets A/B) preferences (Set C - Low Complexity Chromatic/High Complexity Achromatic).

purposes. Several features of the graphs come to attention. First, the addition of colour to low level complexity stimuli (4 to 20 sides) has the effect of increasing the relative preference value of those figures compared to baseline preferences. This increased liking, reflected by changes in mean ranks which are not distributed independently across levels of complexity, naturally occurs at the expense of the high complexity stimuli (24 to 40 sides) which are less preferred than in baseline.

Second, the salience of colour is particularly noticeable in the 12- to 20-sided range of complexity. Mean ranks are equal to, or lower (i.e. the figures are more preferred) than almost the full range of high complexity figures, the 40-sided figures being the only exception.

Third, the predicted change in the slope from the most complex chromatic stimuli (20-sided) to the least complex achromatic stimuli (24-sided) is quite apparent. It is of interest to compare the observed preferences in Fig. 10 with the predicted function in Fig. 2 (Chapter Two).

The data depicted in Fig. 10 then, suggest that subjects' rankings of complexity in Set C show less agreement with the objective rank order of complexity than is present in the baseline function. To test this, an analysis of variance based on correlation coefficients as scores was employed. One set of coefficients was derived by computing each subject's mean rank order from combined (summed) preferences in Sets A and B, and correlating this baseline rank order with the true rank order. The second set was derived by correlating each subject's rank order in Set C with the true rank order. It is expected that scores in Set C will be lower than in baseline. Derived scores were submitted to a 3(Age) X 2(Sex) X 2(Set) between-within analysis of variance, with repeated measures on Set (see Appendix 2c).

Results revealed a highly significant effect attributable to the within-subjects variable, Set ($F(1,66) = 14.70$, $p<.0005$). Correlations between Set C ranks and the objective order (mean tau = +0.181) were significantly lower than they were between baseline ranks and the objective order (mean tau = +0.329). This difference was not found at all ages however, for the Set X Age interaction was significant ($F(2,66) = 3.71$, $p<.03$). Inspection of the data showed that a difference between baseline and Set C rank orders was evident in the two older groups, but not the youngest group.

Analysis of between-subject variables showed that Age was significant ($F(2,66) = 10.15$, $p<.0003$), but that Sex was not ($p>.8$). With regard to age, the older the subject, the higher the correlation between his observed and the objective rank order of complexity (for both baseline and Set C preferences combined). The mean rank order correlations for the three groups were -0.03 for the 6/7s, +0.327 for the 8/9s, and +0.468 for the 10/11s. Age X Sex was also a significant source of variance ($F(2,66) = 3.16$, $p<.047$). Among the 6/7s, correlations between observed and objective rank orders were lower in males than in females, while among older subjects, males had higher correlations.

In addition to testing the overall difference in response to complexity between Set C and baseline, the salience of colour was further examined by comparisons of medians. Each subject's median rank of low complexity coloured stimuli (4- to 20-sided) in Set C was computed and compared to his baseline median rank from the same range of complexity. The prediction is that median ranks in the former set will be lower (the figures more preferred) than in the latter. A Wilcoxon matched-pairs signed-rank test was applied to the 72 pairs of ranks, resulting in a z value of -2.28 ($p<.011$).

The same test was also applied to medians from high complexity figures. Median ranks from the 24- to 40-sided range of figures in

Set C were computed and then compared to baseline high complexity medians, however, in this case the prediction is that the former should be higher (less preferred) than baseline. Results supported the prediction with a z value of -2.72 ($p<.003$).

Wilcoxon tests comparing median ranks were also applied to test the salience of colour at different ages. For the two older groups (n = 24 each), median ranks from the five chromatic, low complexity figures in Set C were significantly lower than baseline medians ($T_{8/9}=24.0, p<.005$; $T_{10/11} = 50.5$, $p<.025$). And conversely, median ranks from the high complexity range of figures in Set C were significantly higher than baseline ($T_{8/9} = 41.5$, $p<.025$; $T_{10/11}=27.0, p<.005$). There were no significant differences between medians in either the low or the high range of figures among the 6/7s.

A final test of the salience of colour involved a comparison between low and high levels of complexity within Set C itself. It will be remembered (section 1.ii) that the difference between baseline medians in the high complexity range and medians in the low complexity range was highly significant ($p<.00003$). A similar analysis was applied to the 72 pairs of median ranks in Set C to determine whether the presence of colour at low levels of complexity altered this pattern of preference. Results of a Wilcoxon test showed that medians representing preferences for high complexity figures were still significantly different, i.e. lower, ($z = -2.15$) from medians representing preferences for low level complexity figures, but that the difference was less pronounced ($p<.02$).

2b) <u>Set D : Low Complexity Achromatic - High Complexity Chromatic</u>

Data from Set D were treated in the same manner as Set C. Fig. 11 illustrates group preferences for figures in Set D which can be compared with the baseline preference function. Low complexity, achromatic figures received somewhat higher mean ranks in Set D, while high complexity chromatic figures are in general ranked lower than in baseline. The effect

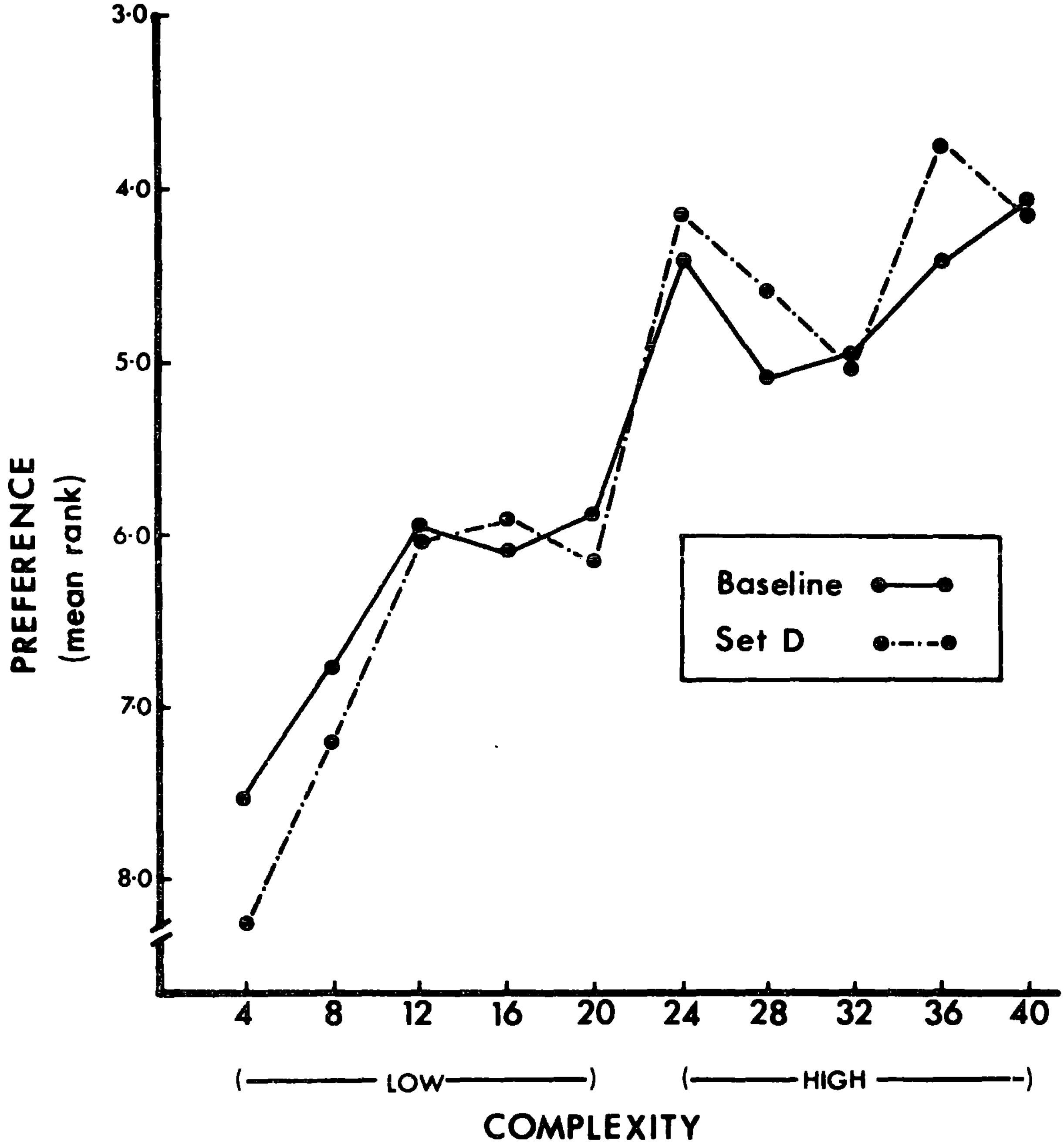


Fig. 11. The affective salience of colour relative to complexity: preferences in Set D compared to baseline (Sets A/B) preferences (Set D - Low Complexity Achromatic/High Complexity Chromatic).

of colour in combination with preferred shapes is not as striking however, as it is when in combination with non-preferred shapes (compare Fig. 11 with Fig. 10).

Statistical analysis provides confirmation of this. Correlations between observed and objective rank orders of complexity were computed for each subject in Set D (mean tau = +0.364) and were compared to correlations representing baseline preferences (mean tau = +0.329) in a 3(Age) X 2(Sex) X 2(Set) between-within analysis of variance, with repeated measures on Set (see Appendix 2d). The difference between Sets was not significant ($p>.5$). Set interacted significantly with Age, however ($F(2,66) = 5.81$, $p<.005$). Inspection of the data revealed that differences between baseline and Set D rank ordering of complexity were more pronounced in the youngest group than in the older groups. This interaction will be further examined below.

Analysis of between-subject variables showed that Age was significant ($F(2,66) = 7.57$, $p<.002$), but that Sex was not ($p>.98$). Regarding age, the older the subject, the more highly correlated to the objective order of complexity were the observed rankings of complexity in both sets. Mean rank order correlations for the three groups were +0.10 for the 6/7s, +0.410 for the 8/9s, and +0.529 for the 10/11s.

While analysis of variance showed no overall difference between sets, the presence of colour at high levels of complexity in Set D did affect median ranks. A Wilcoxon test comparing the magnitude of the difference between high complexity medians in Set D and those in baseline showed that the former were significantly lower ($z = -2.06$, $p<.02$). A difference was also found between medians from the low complexity range of figures ($z = -1.69$, $p<.05$). In this comparison, Set D median ranks were higher, i.e., less preferred.

Finally, the data were examined to throw light on the Set X Age interaction reported above. As stated, this interaction reflected differences between sets which were present in the 6/7s, but not the older groups. These differences in turn, were discovered to be more pronounced among 6/7 males than among females. Fig. 12 shows two preference functions for 6/7 males. One represents baseline preferences and shows that males at this age prefer simple figures to complex ones. The other depicts preferences in Set D, and shows that simple figures are not preferred to complex ones when the latter are presented in colour.

A one-way, repeated measures analysis of variance ($n = 12$) applied to correlation coefficients representing preferences in the two sets showed that the difference was significant ($F(1,11) = 7.57$, $p<.03$). In addition, a Wilcoxon test comparing high complexity medians in baseline and in Set D showed that the difference between them was significant ($T = 5$, $p<.01$). There was no significant difference between low complexity medians in the two sets (see Appendix 2e).

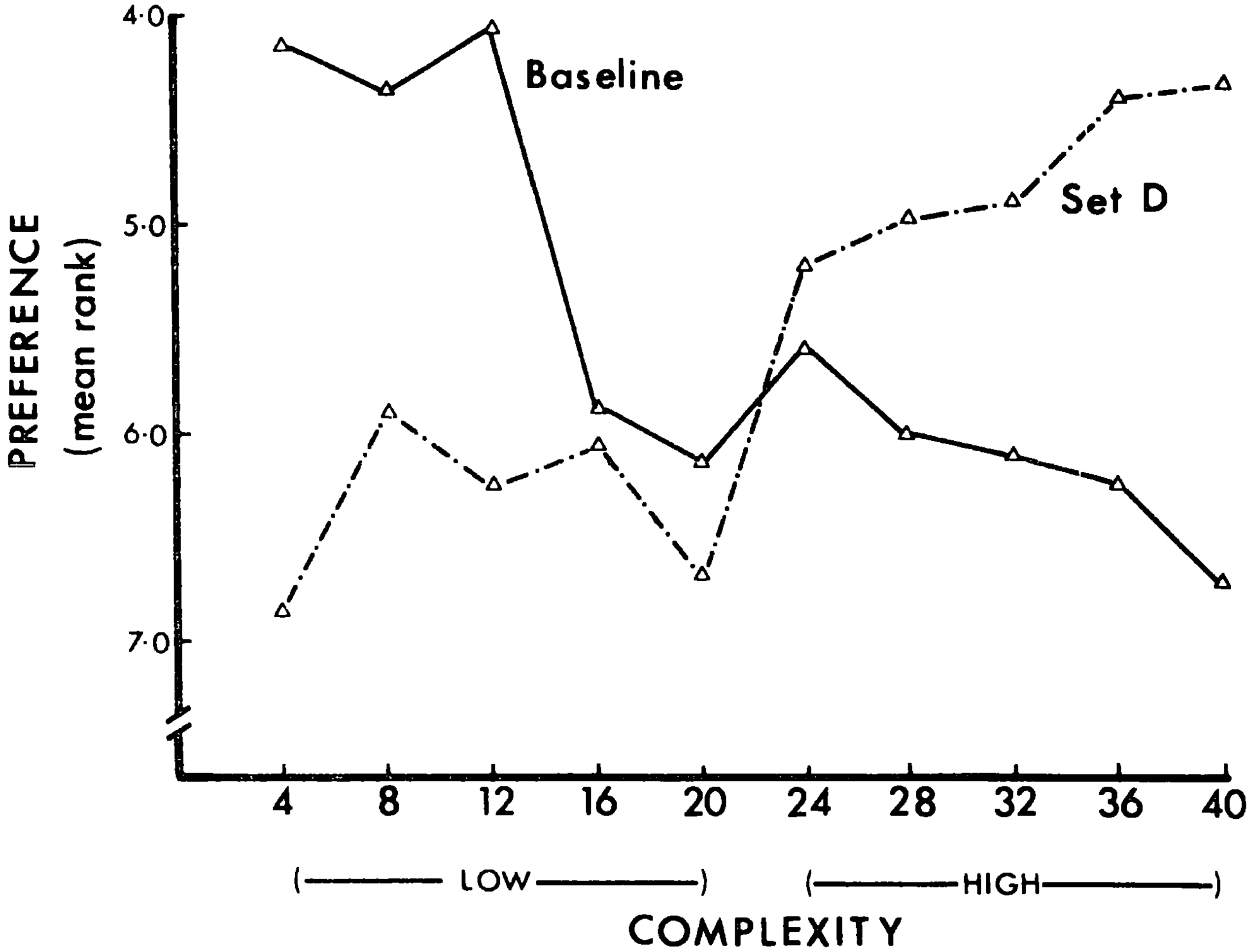


Fig. 12. The affective salience of colour for 6/7 males: preferences in Set D compared to baseline (Sets A/B) preferences (Set D - Low Complexity Achromatic/High Complexity Chromatic).

PART THREE

Relationship between Viewing Time and Preference

The hypothesis tested in Part Three is that the two response measures, viewing time and preference, do not differ from one another as a function of visual complexity. An isomorphic relation is expected between the two measures.

Hutt's hypothesis that differences between measures will be more pronounced in older subjects than in younger subjects will also be examined.

Results

To compare viewing time (Part One) with preference (Part Two: Sets A/B), data from the former were ranked and thus converted into ordinal form. For each subject, the total time spent viewing at each level of complexity (the sum of four stimuli) was first computed. The level of complexity receiving the longest total viewing time was given the rank of 1, the second longest the rank of 2, and so on, for all ten levels.

Group data are presented in Fig. 13. As can be seen, the two measures show some agreement with one another. Both functions increase with increasing complexity, trends which have already been analyzed as significantly monotonic (or linear) for both measures. There is a difference at the upper levels of complexity, where viewing time reaches an asymptote while preference continues to increase. This difference in turn has already been reported in the analysis of viewing times where a significant quadratic trend was found. No such bitonic trend was present among preferences.

The two response measures were compared for differences by analysis of variance. Correlation coefficients were computed between each subject's rank-ordered viewing times and the true order of complexity.

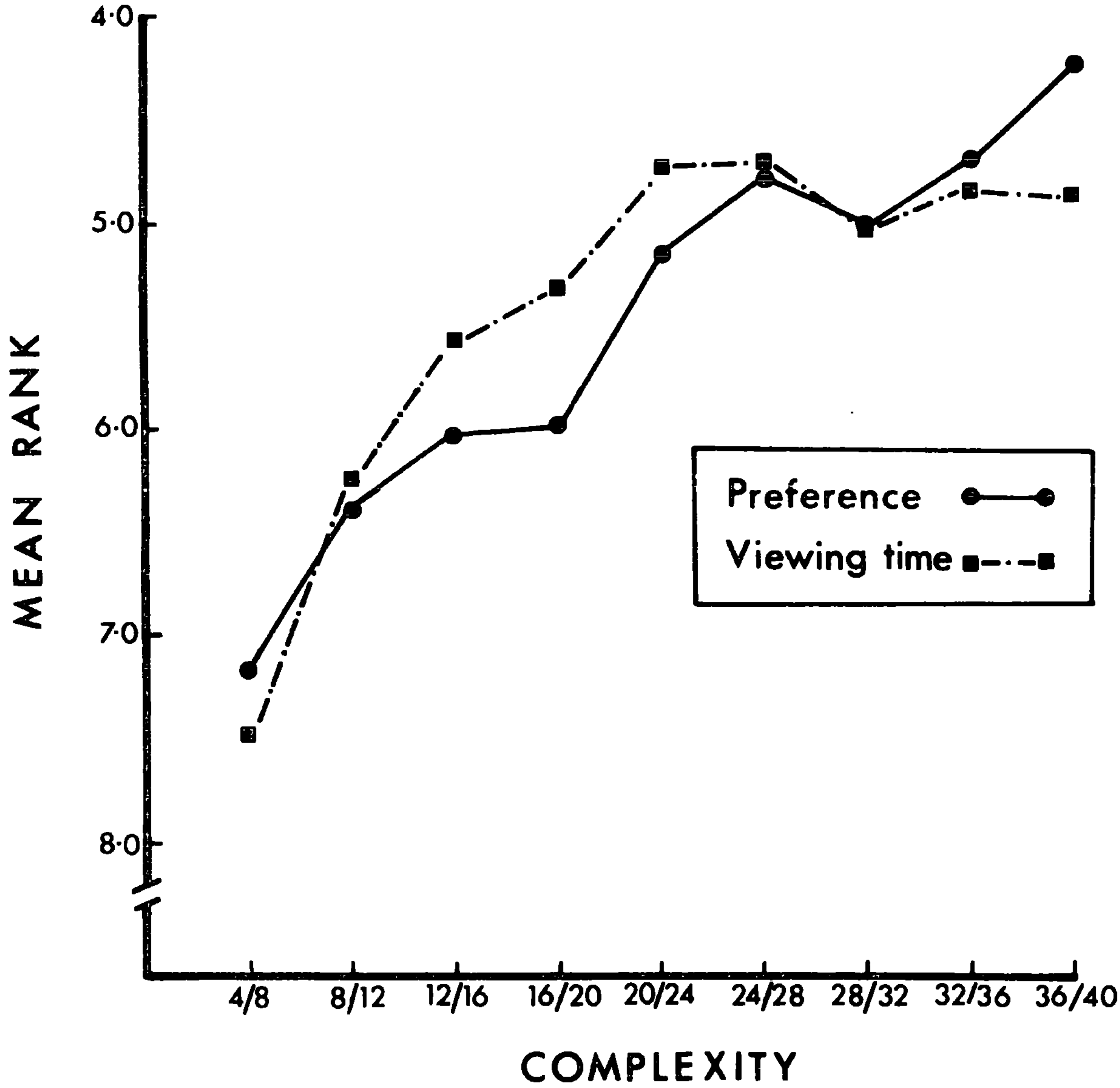


Fig. 13. The relationship between preference (Sets A/B) and viewing time as functions of complexity.

These scores were then compared to correlation coefficients already computed for baseline preferences in a 2(Response) X 3(Age) X 2(Sex) between-within analysis of variance, with repeated measures on the Response variaole (see Appendix 3) .

Results showed that the difference between response measures was not significant ($p > .13$). The mean rank order correlation for viewing time was +0.230, for baseline preferences it was +0.329. The only significant source of variance was Age ($F(2,66) = 25.13$, $p < .0001$). No interactions were significant.

Although the Response X Age interaction was not significant, it is of interest in view of the contradiction between Hutt's predictions and the opposing trend in the literature, to see the relationship between measures as a function of age. Sets of rank ordered data for the two response types are illustrated for the three age groups in Fig. 14a, b, and c. As preferences for 6/7 males and females show an inclination to differ, two preference functions are depicted in Fig. 14c. These figures suggest that the relationship between measures is closer as age increases.

Discussion

I. Visual Complexity

The experiment just reported is the first time a representative sample of children of primary school age has been visually presented with a wide range of stimulus complexity in which the polygons representing that dimension have been carefully constructed to vary in sidedness, and in perimeter, without variations in area. Under these conditions, visual complexity has been shown to have very definite effects on two different response measures.

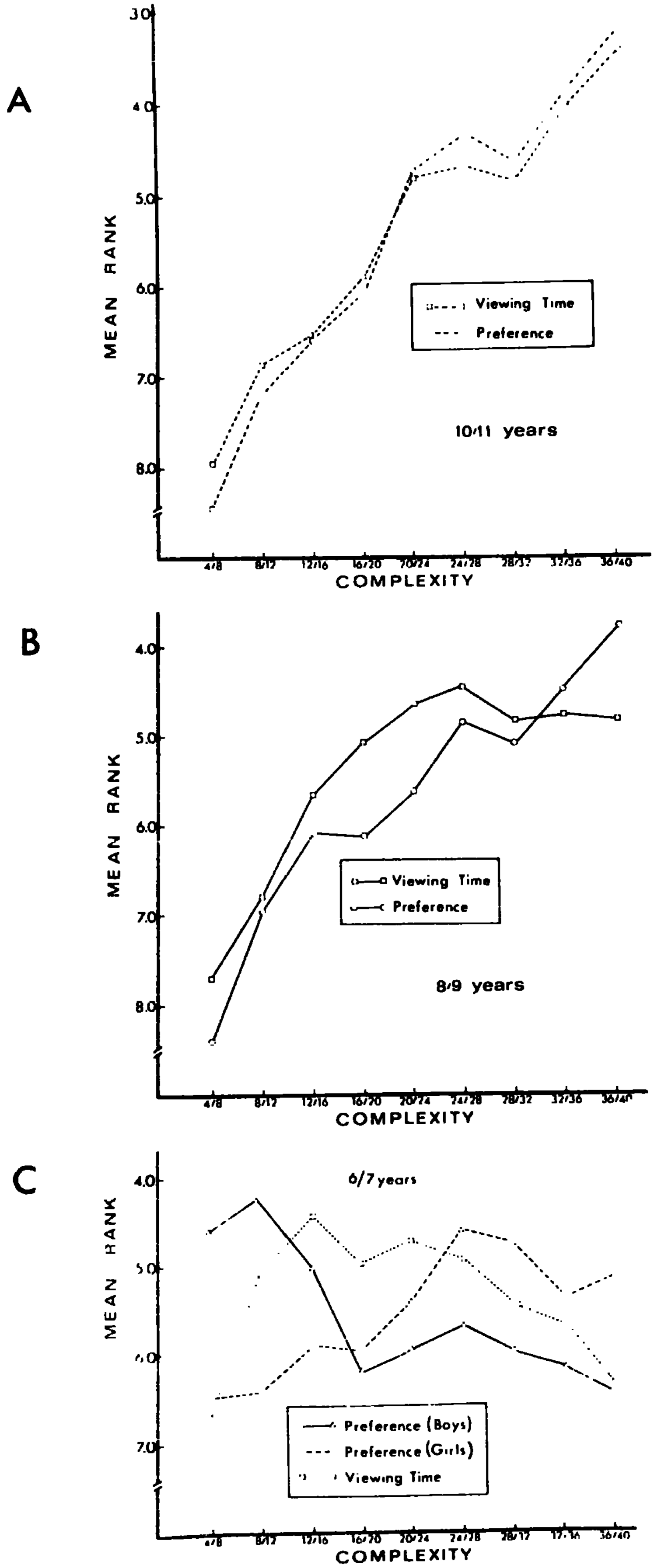


Fig. 14. The relationship between preference and viewing time for the three age groups.

<u>Complexity and viewing</u>

Polygonal complexity has a pronounced effect on children's duration of viewing. The general pattern found indicates that the more complex a stimulus is, the more time a child is willing to spend viewing it. This supports previous findings (Thomas, 1966; Munsinger & Weir, 1967; Kaess & Weir, 1968) all of which showed similar results. In particular, these findings support Thomas' temple bar press study, as he tested similar aged children. This is the first evidence though, that increased viewing times result from increases in complexity when the stimuli are presented singly, and viewed on their own merit, as opposed to paired-comparison presentation.

There is also the first statistical evidence of an Age X Complexity interaction. Previous studies of this kind have been designed such that examination of this interaction was not possible. Inspection of Thomas' graphs reveals that as age increases, so does the steepness of the slope relating viewing times to complexity. The present study provides the necessary support for this trend. Only the oldest group showed steadily increasing viewing times. The 8/9s showed definite increases from low to middle levels of complexity, but beyond that a plateau was reached. The youngest group on the other hand, showed a clear inverted U-shaped pattern of viewing, with a quadratic component accounting for 72% of the variance. This latter result curiously contradicts Thomas, who stated that 6 year olds showed a monotonic increase. No statistical analysis was provided to confirm this statement, however. Some suggestion of the strength of the reported monotonic trend was given by analysis which showed there to be no statistical difference between any of the five pairs of complexity levels (at the .05 level, and with a two-tailed prediction). Thus, even with a monotonic trend apparent, it described a relatively weak preference for complexity function. A further peculiarity is that

Thomas reported monotonicity for 6 year olds, but not for 7 and 8 year olds. The findings in this study are more consistent with regard to the age variable. As age increases, the functions change from inverted-U to curvilinear-quadratic, to linear.

Other comparisons between the studies are difficult for methodological reasons. Thomas used a paired-comparison method of presentation, and presented no stimuli between 20 and 40 sides. In this study, the sampling of complexity was improved, and interestingly, it is approximately at the 20-sided level of complexity that viewing time functions for the two youngest age groups begin to change.

Complexity and preference

The complexity of a polygonal stimulus has also been shown to have a definite effect on how much that stimulus is liked. In general, the more complex it was, the more it was preferred. These results provide no support at all for Munsinger and Kessen's paired-comparison studies which reported an age-invariant preference for 10-sided figures (Munsinger & Kessen, 1964, 1966a); however, as was pointed out, these authors sacrificed adequate representation of each complexity level in order to sample a fuller range of complexity. The present study does confirm a later paired-comparison study by Munsinger (1966) which included good polygonal representation at each complexity level and which reported monotonically increasing preferences.

Comparing the present results to studies which did not employ paired-comparison designs, the significant monotonically increasing preferences in the 8/9s and 10/11s confirm Baltes and Wender's (1971) study which group-tested 9 to 15 year olds who rated polygons on 9-point scales. And they provide partial support to Aitken and Hutt's (1974) study in which a younger group of children (5 to 8) rank ordered sets of polygons. These authors found monotonically increasing preferences in the 7 and 8 year olds, and in some of the 5 and 6 year olds. A majority of subjects in the latter group showed U-shaped preference functions (both the monotonic decreasing and bitonic components were significant). The remainder approximated the trend in the older subjects. The present study also produced differences among the younger subjects, but in addition, it showed that the difference could be explained by the sex of subjects. The trend in young males' preferences was monotonically decreasing, while in females it was increasing. Aitken and Hutt did not specify whether their differences were similarly based, and this finding will require some further study. The following experiment on symmetry will shed further light on this matter.

A rather curious omission in the Aitken and Hutt study was the failure to analyze the main effect of the complexity variable itself. They reported only the results of trend analysis (Ferguson's nonparametric trend analysis, 1965, the same as used in this analysis) which showed significant monotonically increasing trends were predominant. Analysis of U-shaped preferences in their 5 and 6 year old subgroup showed both significant monotonic (decreasing) and bitonic components. At face value, these trends would suggest that polygonal complexity had a significant effect on preference. But that is not necessarily the case. In the present study, both a Friedman nonparametric analysis of variance (which tests for complexity) and a trend analysis were employed. Both tests produced significant results in the two oldest groups of subjects, however in the subsequent analysis of 6/7 males and females, only the trends were significant. Complexity itself had no effect. While this is a surprising finding, it does mean that caution must be exercised in interpreting results based only on trend analysis. In view of this, the following conclusions are in order: levels of stimulus complexity do indeed produce a systematic pattern of preference among 6/7s, albeit in different directions for males and females, but stimulus complexity itself does not have a particularly strong influence on the preferences of children at this age.

* * *

One further finding relating to children's preferences for complexity has now been made explicit, and that is that preferences for coloured stimuli are no different from preferences for black stimuli. Formerly, all evidence was based on achromatic stimulation. This finding holds for stimuli presented in red, in blue, and in green; it holds for all levels of polygonal complexity; and it holds for children of all ages tested.

II. <u>Colour</u>

The experiment on viewing time reported above has demonstrated for the first time that an affective stimulus property which does not affect information content, can have a definite influence on children's viewing times. At all levels of complexity, for children of all ages, the presence of red, or blue, or green significantly increased the duration of viewing time compared to identically shaped stimuli presented in black. The data show that the actual increase in viewing time caused by the presence of colour is in the order of 6 to 7%.

This result is viewed as a test of the 'complementary hypothesis' to Hutt's, namely, that affectively pleasing properties of stimulation will sustain prolonged visual fixation. This interpretation is supported by unsolicited comments recorded during viewing. Many of the comments upon seeing coloured shapes indicated that colour was experienced as pleasurable (for example, "Oh! I like that one.", "Now that's a nice shape (or picture)", "There's a good colour.").

It was also noted that coloured shapes elicited more associations than did the black shapes. There was a greater tendency for subjects to claim they could 'see shapes' and 'see things' in the coloured stimuli.

On the basis of these comments, one can conjecture that number of associations generated was greater for coloured stimuli, or that perceived meaningfulness was increased by the presence of colour. However, the extent to which a presumed association-facilitating aspect of colour is a source of pleasure or a cause of longer visual investigation remains an entertaining question. The present study does not allow for elaboration on these matters.

Two methodological points should be noted in interpreting the effects of colour on viewing time. First, colour was manipulated in the experimental design as a within-subject variable, that is, every subject was exposed to both levels of the colour variable. Each subject viewed 20 chromatic and 20 achromatic polygons, evenly distributed throughout the dimension of complexity. But, each subject did not view a given shape twice, i.e. once in colour, once in black. The coloured stimuli that each subject viewed were different shapes than the non-coloured stimuli. Thus, the results do not allow for a statement that for any one subject a single coloured shape will sustain longer viewing times than the same shape in black. To test this, intricate counterbalancing would be in order, for on the second appearance of a given polygon, an element of familiarity would introduce itself.

The second point is a more important one, and has to do with the possible effects of novelty-familiarity already operative in the present design. Out of 40 stimuli viewed by each subject, one half was black, and 1/6 each were in red, blue, and green. Thus, while the total number of coloured and non-coloured stimuli were equal, stimuli which appeared in any of the three colours could be said to be more novel. Rabinowitz and Robe (1968) have reported evidence that children do respond to colour novelty. Subjects pressed buttons which activated different coloured lights more frequently than buttons which activated lights of the same colour.

In general, developmental research which has dealt with the effects of novelty on exploratory behaviour, including duration of viewing, has demonstrated that the more novel a stimulus is, the more visual investigation it will attract and sustain (Smock & Holt, 1962; Cantor & Cantor, 1964, 1966; Faw & Nunnally, 1968; Faw & Pien, 1971; Hutt, 1975; Eson et al, 1977), with only a few conflicting findings on this point (Freeman, 1972; Sluckin et al, 1973). In view of the present manipulation of colour, it is possible that increased viewing times for coloured stimuli were a function of the relative novelty of these stimuli, and not due to the presence of colour itself. In the experiment which follows this one, the design will be altered to eliminate such a possibility. A second 'achromatic colour', grey,(18) will be employed in the construction of stimuli, and one of the three colours used in this experiment will no longer be used. Thus there will be two achromatic variants, and two chromatic variants, with an equal number of stimuli in each category. Stimuli which appear in all four 'colours' then, can be adjudged as having equal novelty. It is expected that the effect of colour in this experiment will be confirmed, however.

III. Salience

The study of salience produced some very interesting results. From the baseline preference for complexity function (established in Sets A and B), the results clearly show that sidedness is the predominant variable influencing preferential choice. However, when stimuli are presented which include an alternative visual property upon which to make a choice, it is equally clear that colour is a potent alternative.

In Set C, with colour added to stimuli of low complexity, which are normally accorded relatively low preference values, the pattern of preferences expressed towards those stimuli was significantly altered.

Colour raised the relative preference of all those stimuli, at the expense of high complexity stimuli remaining in black. The presence of colour then, decidedly reduced the influence of visual complexity as a determinant of preference, and to that extent colour has considerable affective salience as a determinant of preference. This showed itself to be particularly the case when colour was presented in combination with middle levels of complexity.

The salience of colour also expressed itself in Set D, but to a much lesser extent. Colour in combination with preferred (upper) levels of complexity produced some minor changes in the Set D function compared to baseline, but the differences were not sufficient to reach significance when the two functions were compared to the same objective ordering of complexity. There were significant differences though, when sets of median ranks from both high and low levels of complexity were compared. It is to be noted that the z scores and corresponding probabilities arising from comparisons of medians are much lower than those resulting from the same comparisons in Set C. This is not surprising, for in Set D there is no competition between complexity and colour. Both high levels of complexity and the presence of colour have appealing affective values which conjoin to produce high preference values.

The most intriguing evidence demonstrating salience of colour results from analysis of 6/7 male preferences in Set D. This was the only subgroup to show monotonically decreasing preferences for complexity, indicating that simple figures were preferred to complex ones. Yet, when high complexity figures appeared in colour, the pattern of preference shifted radically. Fig. 12 indicates the extent of this change. The full range of coloured figures was better liked than the more simple figures in black, with analysis showing that the difference was significant. It would appear that colour has particularly strong affective salience for this group. This finding correlates well with developmental research in colour-form sorting that has reported males to be more colour-salient than females (Lindberg, 1938; Kagan & Lemkin, 1961).

The picture is not entirely straightforward though, for one would expect the pattern of baseline complexity preferences evidenced in Sets A and B to express itself within the high and the low ranges of complexity in Set D. This is not the case, as Fig. 12 illustrates. Whereas preference for 24- to 40-sided figures decreases in baseline, it increases within the same range in Set D. This is difficult to explain; some complex interaction between the combination of colour and high levels of complexity must be taking place. More data than are presently available are needed to clarify this point.

Age and salience

Finally, the question of age is considered. It will be remembered that colour was hypothesized to be more affectively salient with young children than with older children, for the reason that the former are more likely to be classified (cognitively) as colour-salient in sorting tasks. This experiment provides only partial support for the hypothesis. Data from Set D show that 6/7 males were highly susceptible to the influence of colour as a determinant of their preferences. Preference for simple forms was outweighed by preference for colour. Colour salience was evidenced by the change in average correlation coefficients between the observed and the objective rank orders of complexity, from -0.250 in baseline, to +0.220 in Set D. Certainly, young males showed the strongest positive reaction to colour.

However, this finding must be tempered by the fact that colour is not a particularly salient aesthetic property for girls of this age. Their preferences for more complex stimulation showed only minor shifts when simple forms were paired with colour. Average rank order correlation coefficients changed from +0.190 in baseline to +0.10 in Set C. In fact, contrary to the hypothesis, 6/7 girls showed less response to colour than did older subjects (8/9s: tau = +0.420 in baseline, to +0.230 in Set C; 10/11s: tau = +0.595 in baseline, to +0.340 in Set C).

Data relating to an age effect on colour salience are extremely difficult to interpret, and must be considered in relation to other factors. First, there is the fact that younger children in general have much less well developed preferences for complexity than older children. Complexity did not have a significant effect on preferences among the 6/7s. Second, it is the case that young males prefer the simple to the complex (though not statistically), while young females show a pattern of preference which approximates older subjects. To that extent young females' preferences are more developed, or more mature, a finding which supports other developmental studies in which female subjects (across a wide age range) prefer more complex stimulation (Kagan & Lewis, 1965; Eisenman, 1967b, 1967c, 1968; Caron & Caron, 1969; Turner & Arkes, 1975). A third factor to be considered is that stimuli of whatever complexity, which are already preferred, are not judged all that more favourably when they appear in colour. This shows itself generally in Set D rankings by older subjects, and specifically in Set C rankings, among 6/7 males.

A fourth finding which makes it difficult to interpret the effect of age on salience is the two Set X Age interactions. Concerning Set C and baseline, the overall effect of Set was significant, i.e. baseline coefficients were higher than those derived from Set C. Inspection of the derived data shows that this difference was l e s s pronounced among younger subjects, hence the Set C X Age interaction. Concerning Set D and baseline, the overall effect of Set was not significant, i.e. baseline coefficients were not different from Set D coefficients. Inspection of these scores shows that among young subjects, the differences were more pronounced, hence the Set D X Age interaction. In both cases, it is the youngest subjects who contribute to the interaction.

Nevertheless, in spite of the complexities of the data, the following interpretation of age and colour salience is offered. The affective salience of colour (relative to visual complexity) is dependent upon how well established is preference for complex stimulation, which in turn is age dependent. Among subjects who exhibit the most developed preferences for complex over simple figures, colour is likely to be only moderately salient. Its affective impact is influential, but it is not a sufficiently powerful visual property to outweigh preferences based on variations in form. These subjects are also most likely to be form-salient, cognitively speaking. Among subjects who clearly do not show established preferences for complex stimulation (6/7 males), the affective impact of colour is likely to be highly influential. Young males who have the least developed preference for complexity, also show a later development from (cognitive) colour- to form-salience than girls do (Doehring, 1960, for example). They are the only ones to exhibit this reaction to colour. Young females at this age appear to be in a transition stage with regard to colour, and to complexity. They do not exhibit marked response patterns in either baseline, or Set C, or Set D. It appears to be the case that for these subjects, preference for stimulus complexity is completely balanced by preference for colour.

This interpretation is of course based only upon a test of the salience of colour. It will be of interest in the following experiment to determine if symmetry produces similar effects.

IV. Preference and Viewing Time

Evidence is available that the two dependent measures, preference and duration of viewing time, are positively, but not wholly related to one another. When group data from the latter were ranked and compared to ranks established from preference judgments, the resulting two functions did overlap to an extent (see Fig. 13). Thus, the chromatic and achromatic polygons which sustained the longest viewing times were for the most part accorded the highest preference rankings. This finding provides some general support for Hutt who predicted an isomorphic relationship between the two measures, or as she stated 'children will like better what they attend to more'. However, the differences between the two functions evidenced at the upper levels of complexity must be compared to the similarities at the lower levels of complexity. To re-phrase Hutt's statement, the data demonstrate instead that 'children will dislike most what they attend to least'.

There is no support at all though for Hutt's other prediction that the measures will become more independent of one another as age increases. The contrary is more accurate, in view of the trends evidenced in Fig. 14a, b and c. It is the oldest group of subjects who showed the closest relationship between measures, while the youngest group showed least evidence of a positive relationship. The greater difference between measures among young subjects, though it did not result from the overall analysis of variance (i.e. no significant Response X Age interaction), is readily apparent from the earlier analyses in Parts One and Two. Complexity had a significant effect on viewing time in all three age groups, but only affected preference in the two oldest groups.

Trend analyses provide further evidence of greater differences between measures at young ages. A quadratic component accounted for most of the variance in viewing times among the 6/7s, while monotonic trends were found in male and female preference functions at that age. For the 8/9s, linear and quadratic trends were both present in the viewing time function, while only the former was found among preferences. And among the 10/11s, a linear and only a linear component accounted for the variance in both functions.

* * *

The following experiment will examine both preference and viewing time as a function of stimuli which vary in an additional visual parameter, vertically reflective symmetry. With this third property producing increased stimulus variation, the relationship between measures and the effect of age on that relationship will be tested even more thoroughly.

CHAPTER FOUR

THE EFFECTS OF VISUAL COMPLEXITY AND SYMMETRY ON VIEWING TIMES AND PREFERENCE

CHAPTER FOUR

This chapter reports experiments which investigate the third independent variable - visual symmetry. As in the previous chapter, the experimental work is presented in three parts: Part One deals with viewing time, Part Two with preference and salience, and Part Three shows the relationship between the two response measures.

PART ONE

Viewing Time : Symmetry, Complexity, and Colour

The main hypothesis tested in Part One is that symmetrical figures, because of their higher affective value, will sustain subjects' viewing times longer than asymmetrical figures with the same number of sides. No interaction between complexity and symmetry is expected.

It is also expected that viewing times will increase with complexity and with colour, as they were shown to do in Chapter Three, Part One. Additionally, the previously evidenced Age X Complexity interaction is again predicted, with older subjects showing greater increases in viewing time with complexity than younger subjects.

Subjects

Sixty subjects (30 male) with normal colour vision were selected from Tudhoe Colliery Primary School to take part in the experiment. These were selected randomly from the school population with the stipulation that they had not served as subjects in the previous experiment.(19) There were 20 subjects (10 male) in each of three age groups (6/7s, 8/9s, 10/11s) with an age range from 6.0 to 11.3. The mean age within each group was 6.11, 9.1 and 10.7.

Apparatus

The apparatus to measure viewing time was the same as that described in Chapter Three.

Construction of Stimuli

As in the previous experiment, 40 different polygonal shapes were used, ranging from 4 to 40 sides, and representing 10 levels of complexity with 4 examples at each level. Half the polygons were symmetrical, with two examples at each level of complexity. Symmetrical shapes were constructed by the following operations:

(a) Twenty original stimuli from the previous experiment, 2 at each complexity level, were selected for conversion into symmetrical polygons. The remaining 20 stimuli were retained for use in this experiment.

(b) With each polygon a point of intersection between two sides was randomly selected. This point was then connected to a second point of intersection which was separated from the first by half the total number of sides. The line between these points thus formed the axis of reflection. One of the two 'halves' was then selected to be reflected symmetrically about this axis.[20]

(c) Each polygon was measured for area and perimeter and if necessary, adjusted to the pattern of variation already described for asymmetrical stimuli. Area was held at 15 sq. in. ($\pm$ 1.0 sq.in.) and perimeter increased 4" for each 4-sided increment in complexity.

The resulting 20 symmetrical shapes were then photographed and printed on thick paper. The next step involved cutting out the shapes from sheets of Pantone. Two stimuli were made from each symmetrical polygon, one achromatic, the other chromatic, as in the previous experiment. In this study however, instead of using three different chromatic representatives (red, blue, green) and one achromatic representative (black), two examples were selected to represent each level of the Colour variable. Chromatic stimuli were represented by red and blue, achromatic by black and grey. No green stimuli were used. The reason for this modification has already been explained - to avoid any possible effects of novelty by having equal numbers of different coloured stimuli.

In this study then, one-quarter each of the symmetrical stimuli were constructed in red, blue, black, and grey. Asymmetric polygons retained from the previous study were also changed accordingly, i.e. one half of the 20 black shapes were re-cut in grey. The grey chosen from the Pantone selection (Pantone Grey-422A) closely approximated Munsell N5/ on the Munsell neutral value scale.

Symmetrical shapes were cut from Pantone sheets and mounted in the centre of 10 inch square white cards, with symmetry reflected about the vertical axis. The 'top' of each stimulus was randomly determined. Fig. 15 shows the ten blue symmetrical polygons used in this study, one at each level of complexity.

As in the previous experiment, there were 80 stimuli altogether (40 symmetrical). Half of these were chromatic, the other half achromatic. Each level of complexity was represented by 8 stimuli, 4 symmetrical and 4 asymmetrical. Fig. 16a and b shows an example of the 8 stimuli at the 20-sided level of complexity.

The asymmetric stimuli retained from the previous experiments, including the newly-cut grey ones, were all rotated 180° for presentation. In terms of physical parameters, they thus retained their original characteristics, while in terms of appearance, they functioned as a new set of stimuli.

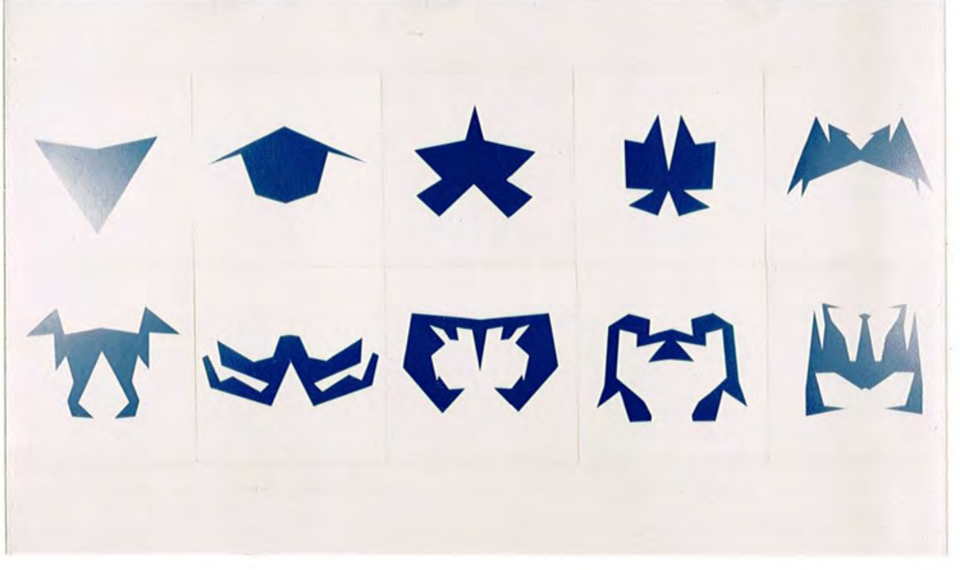


Fig. 15. Examples of symmetrical polygons used in this study.

a) Symmetrical polygons

b) Asymmetrical polygons

Fig. 16. An example of the variation in appearance of stimuli at one level of complexity (20-sided).

Design

The 80 stimuli were divided into two sets, with each set containing the 40 different shapes. Colour and symmetry were balanced between sets as follows:

(1) half the stimuli in each set were symmetrical, half asymmetrical; there were two symmetrical and two asymmetrical polygons at each level of complexity;

(2) half the stimuli in each set were in colour (red and blue), half were achromatic (black and grey); there were two chromatic and two achromatic polygons at each level of complexity;

(3) at each level of complexity, one of the symmetrical polygons was chromatic, the other achromatic; the same was done for asymmetrical stimuli;

(4) the four colours (red, blue, black, grey) were evenly divided between sets, so that each set had 10 polygons in each of the colours; within a set, the four colours were evenly distributed between symmetrical and asymmetrical polygons, i.e. each set had five red symmetric polygons, five red asymmetric polygons, five black symmetric polygons, five black asymmetric polygons, and so on.

Subjects were randomly assigned to view one of the two sets, with the stipulation that each set be viewed by an equal number of males and females, and by an equal number of subjects in each of the three age groups.

Stimuli were presented one at a time, in two blocks of 20. A different order of presentation was used for each subject.

Procedure

The general procedure for presenting stimuli for viewing was the same as that described in the previous study. The only difference was that symmetrical polygons were included in the practice trials. No subjects were unwilling to view the second block of 20 polygons.

During the running of this experiment four females were observed in the mirror to look away from the screen while a stimulus was in view. Viewing times for those trials were not scored, and the stimulus in question was re-presented at the end of the block in a 180° reversed position.

Six boys were found to be colour defective at the end of the session, and were replaced by colour normal subjects.

Results

2,400 viewing scores (60 subjects x 40 stimuli) were recorded. The mean total time spent viewing stimuli was 10 mins. 32 secs. Mean viewing time for a single stimulus was 15.8 secs.,with a range from 2.17 secs. to 1 min. 0.17 secs.

Two preliminary analyses of variance showed that there were no significant differences between viewing red and blue polygons, or between viewing black and grey polygons. Scores for the two chromatic and for the two achromatic stimuli were therefore combined. Scores for adjacent complexity levels were also combined, leaving 20 viewing times per subject for analysis. These data were then submitted to a 3(Age) X 2(Sex) X 5(Complexity) X 2(Symmetry) X 2(Colour) between-within analysis of variance with repeated measures on Complexity, Symmetry and Colour (see Appendix 4a).

The main effects of Complexity and of Colour were both significant ($F_{comp}(4,216) = 26.90$, $p<.000001$; $F_{col}(1,54) = 37.15$, $p<.00001$). These results are illustrated in Fig. 17, which shows that viewing times increase as complexity increases, and that chromatic stimuli at all levels of complexity are viewed longer than achromatic stimuli. The Figure also shows that there is no interaction between the two variables.

Symmetry had no effect at all on viewing times ($p>.84$) as Fig. 18

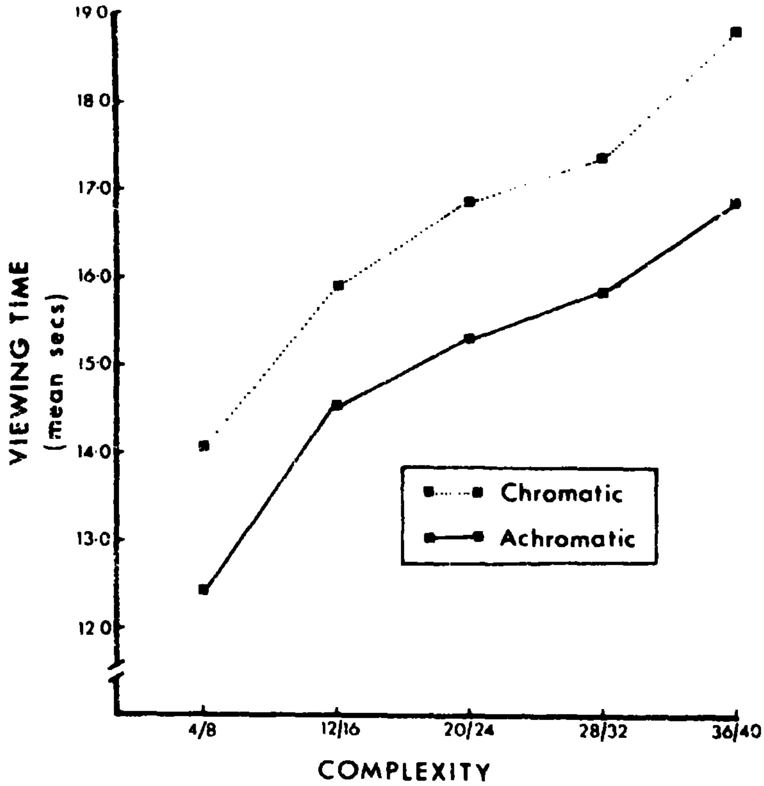


Fig. 17. The effect of complexity and colour on duration of viewing time (mean viewing time for a single stimulus).

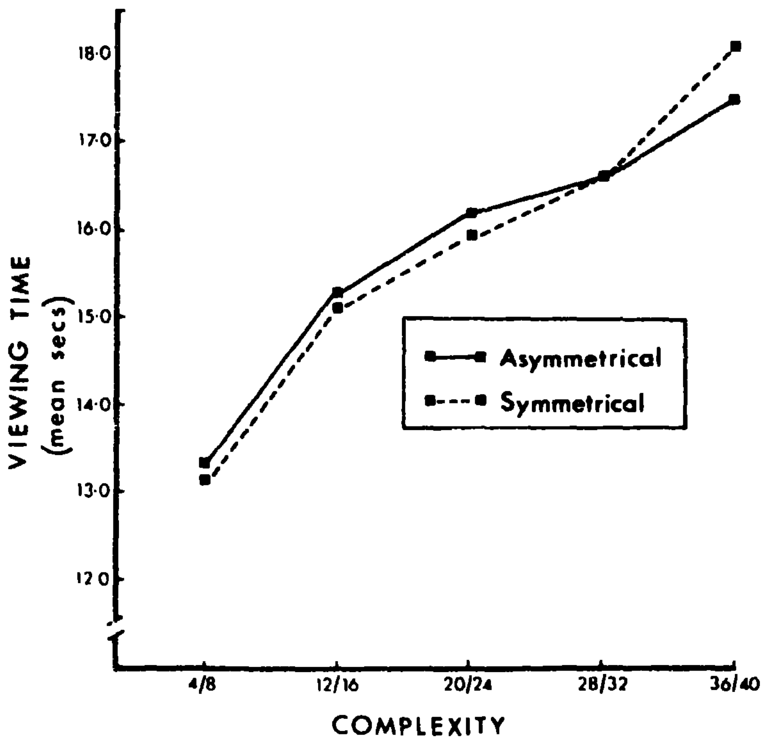


Fig. 18. The effect of symmetry on duration of viewing time (mean viewing time for a single stimulus).

illustrates. The mean time spent viewing symmetrical polygons was 15.82 secs., asymmetrical polygons 15.78 secs. No interaction between symmetry and any other variable was significant.

Only one of the two between-subject variables, Age, was a significant source of variance ($F(2,54) = 4.81$, $p<.012$), while Sex was not. The older the subject the longer the time spent viewing. There was also a significant Age X Complexity interaction ($F(8,216) = 4.52$, $p<.0002$), which is shown in Fig. 19. It can be seen that while there are some differences between the 8/9s and the 10/11s, the main source of the interaction is the difference between the two older groups and the 6/7s, whose viewing time function is basically flat. The only other significant interaction was Complexity X Colour X Sex ($F(4,216)= 2.85$, $p<.03$).

The main effect of complexity was further examined for trends. Only the linear component, which accounted for almost all of the variance (97%), was significant ($F(1,216)= 104.7$, $p<.000001$).

The effect of complexity at different ages was further examined by applying three separate, one-way, repeated-measures analyses of variance ($N = 20$, $K = 5$ in each analysis) to viewing times in the three age groups (see Appendix 4b). Complexity affected viewing times in the two older groups ($F_{8/9}(4,76) = 11.27$, $p<.001$; $F_{10/11}(4,76) = 18.75$, $p<.001$), but had no effect on the youngest age group ($p>.25$). Subsequent trend analyses showed that linear trends only were significant in the two older groups ($F_{8/9}(1,76) = 40.96$, $p<.0001$: $F_{10/11}(1,76) = 71.38$, $p<.0001$) and that they accounted for 91% and 95% of the variance attributable to complexity, respectively.

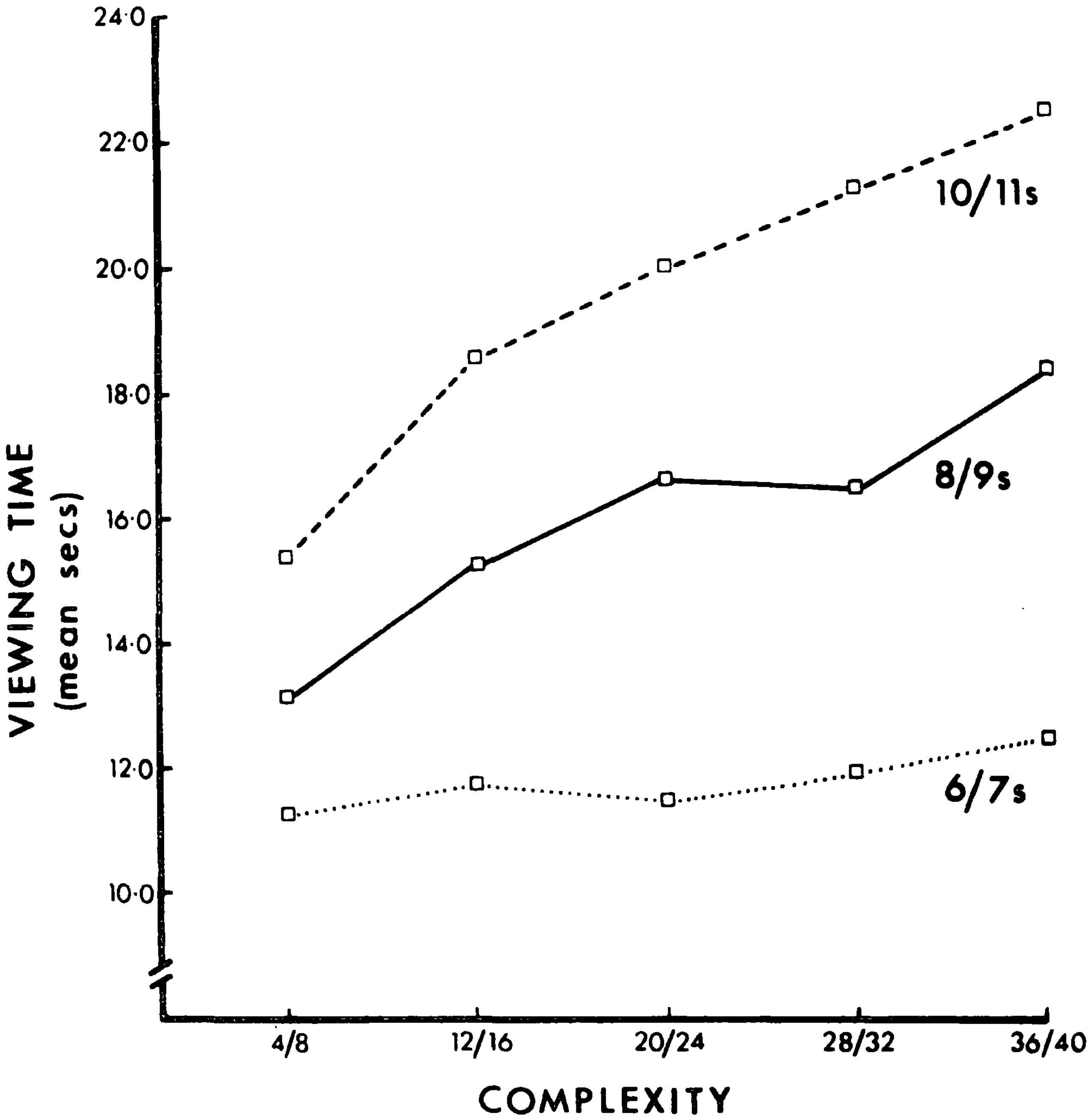


Fig. 19. Viewing time as a function of complexity for the three age groups (mean viewing time for a single stimulus).

PART TWO

Preference and Salience : Symmetry

The hypotheses tested in Part Two relate to verbally expressed preferences. The first hypothesis is not directly related to symmetry but rather is a test of preference for complexity when all stimuli are symmetrical in appearance. Subjects will be presented with ten symmetrical polygons to rank order. It is expected that preference will increase with complexity and will be unaffected by the presence of symmetry at all levels. It is expected that the preference function resulting will not be different from the baseline function with asymmetrical polygons.

A second hypothesis predicts that symmetrical polygons will be preferred to asymmetrical polygons at all levels of complexity. Subjects will be presented with two sets of stimuli to rank order, one containing five low complexity figures (4- to 20-sided) with symmetry and five low complexity asymmetrical figures, the other containing five high complexity (24- to 40-sided) symmetrical figures and five high complexity asymmetrical figures. It is not expected that preference for symmetry will interact with complexity.

The final hypothesis tests the salience of symmetry relative to visual complexity. Subjects will be presented with a set of polygons which induce conflict between preference for symmetry and preference for complexity. Half the stimuli will be at low levels of complexity and will be symmetrical, the other half will be at high levels and will be asymmetrical. It is expected that the affective salience of symmetry will function like that of colour, namely by increasing the relative preference value of low complexity figures compared to baseline at the expense of high complexity figures.

Subjects

The same 60 subjects described in Part One were tested for preferences in Part Two. Time between viewing stimuli and preference testing was approximately six weeks for each subject.

Apparatus

No special apparatus was constructed to test preferences. The table on which stimuli were presented and the sources of illumination were the same as described in the previous chapter.

Design

All subjects were given 40 stimuli to rank order, presented in four sets of 10.

One set (Set E) was designed to test preference for complexity when all stimuli were symmetrical. Set E contained one polygon at each level of complexity.

Two sets (Sets F and G) were designed to test preference for symmetry over asymmetry, at the low and at the high ranges of the complexity continuum, respectively. Set F contained one symmetrical and one asymmetrical polygon at each of the five lower levels of complexity (4-, 8-, 12-, 16-, and 20-sided). Set G contained one symmetrical and one asymmetrical polygon at each of the five levels of complexity (24-, 28-, 32-, 36-, and 40-sided).

The fourth set (Set H) was designed to test the salience of symmetry relative to complexity, and contained five low complexity symmetrical polygons and five high complexity asymmetrical polygons. (This set is similar in design to Set C which tested the salience of colour.)

Regarding the selection of polygons to comprise sets, it is to be remembered that there are a total of 40 symmetrical stimuli - two different symmetrical shapes at each level of complexity - with each stimulus having a chromatic and an achromatic variant. Stimuli in

Set E for example, could therefore be presented in one of four coloured variants, since each level of complexity was represented by four stimuli, one in each of the four colours. It was decided however, to further extend the variation in appearance of stimuli in Set E by reversing 180° one of each of the 20 pairs of symmetrical shapes. Ten chromatic (blue) and ten achromatic (black) polygons were reversed, thus making 40 different symmetrical stimuli available for inclusion in Set E.

Colour was not varied within sets, that is, subjects were never presented with a set of stimuli which contained chromatic and achromatic polygons. Colour was evenly distributed between sets though, according to two criteria. First, each set appeared an equal number of times in one of the four colours. This necessitated the division of subjects into four groups of 15 subjects each. All groups rank ordered the four sets of stimuli, and each set was presented to the four groups in a different colour. Groups had five subjects in each of the three age groups; two groups had seven males and eight females, two groups had seven females and eight males.

The second criterion ensured that subjects did not have to rank order more than one set in the same colour. The four sets presented to each group were therefore in four different colours. An example of the arrangement of colours and stimuli within sets which was presented to one of the groups is shown in Table IV.[(21)]

Procedure

Presenting stimuli for preference judgments proceeded in the same manner as described in the last chapter. The order of presenting the four sets to subjects was determined randomly, and each subject saw a different random order of stimuli presented within a set. After each preference was made, remaining stimuli were rearranged into a symmetrical pattern on the table, as described before.

SET	LEVEL OF COMPLEXITY (number of sides)									
	LOW					HIGH				
	4	8	12	16	20	24	28	32	36	40
E. All symmetrical	blue*	blue*	blue*	blue*	blue*	blue	blue	blue	blue	blue
F. Low complexity symmetrical, low complexity asymmetrical	red red	red red	red red	red red	red red					
G. High complexity symmetrical, high complexity asymmetrical						black black	black black	black black	black black	black black
H. Low complexity symmetrical, high complexity asymmetrical	grey*	grey*	grey*	grey*	grey*	grey	grey	grey	grey	grey

*denotes stimuli which are identical in physical characteristics at respective levels of complexity, but different in colour; stimuli marked * in Set E were reversed 180° to produce a different appearance.

TABLE IV. An example of arrangement of colour and symmetry within the four sets presented to one of the four groups of subjects for rank ordering.

Ranking the four sets took approximately 20 minutes per subject.

Results

All data in Part Two were ordinal in nature. Sums and means of ranks were computed separately for each of the four sets of polygons. Set E was examined first.

(1) Preferences for Symmetrical Polygons (Set E)

Group preferences (N = 60) for symmetrical polygons varying in complexity are depicted in Fig. 20. They are illustrated by mean rank as a function of complexity, with adjacent complexity levels combined. For comparative purposes, the baseline preference function for asymmetrical polygons (A/B) is also presented. It can be seen that the two functions are very similar. The only difference is that preference for symmetrical polygons increases in a more linear manner with increasing complexity than does preference for asymmetrical polygons.

Preference functions for the three age groups are shown in Fig. 21. The two older groups of subjects both show linearly increasing preferences, while the function reflecting preferences among 6/7s is slightly U-shaped. Compared to older subjects however, the 6/7s do not show a really marked pattern of response to complexity.

Statistical analysis examined two questions: i) is the effect of complexity significant, and ii) is the preference function the same as that derived from asymmetrical stimuli?

(i) The effect of complexity

A Friedman nonparametric analysis of variance was applied to the sum of ranks from combined complexity levels (k = 5). Results showed a highly significant effect of complexity for the whole group ($\chi_r^2 = 42.67$, df = 4, $p<.001$). Subsequent trend analysis showed that the effect was significantly monotonic ($z = 7.46$, $p<.00003$), as Fig. 20 suggests. The

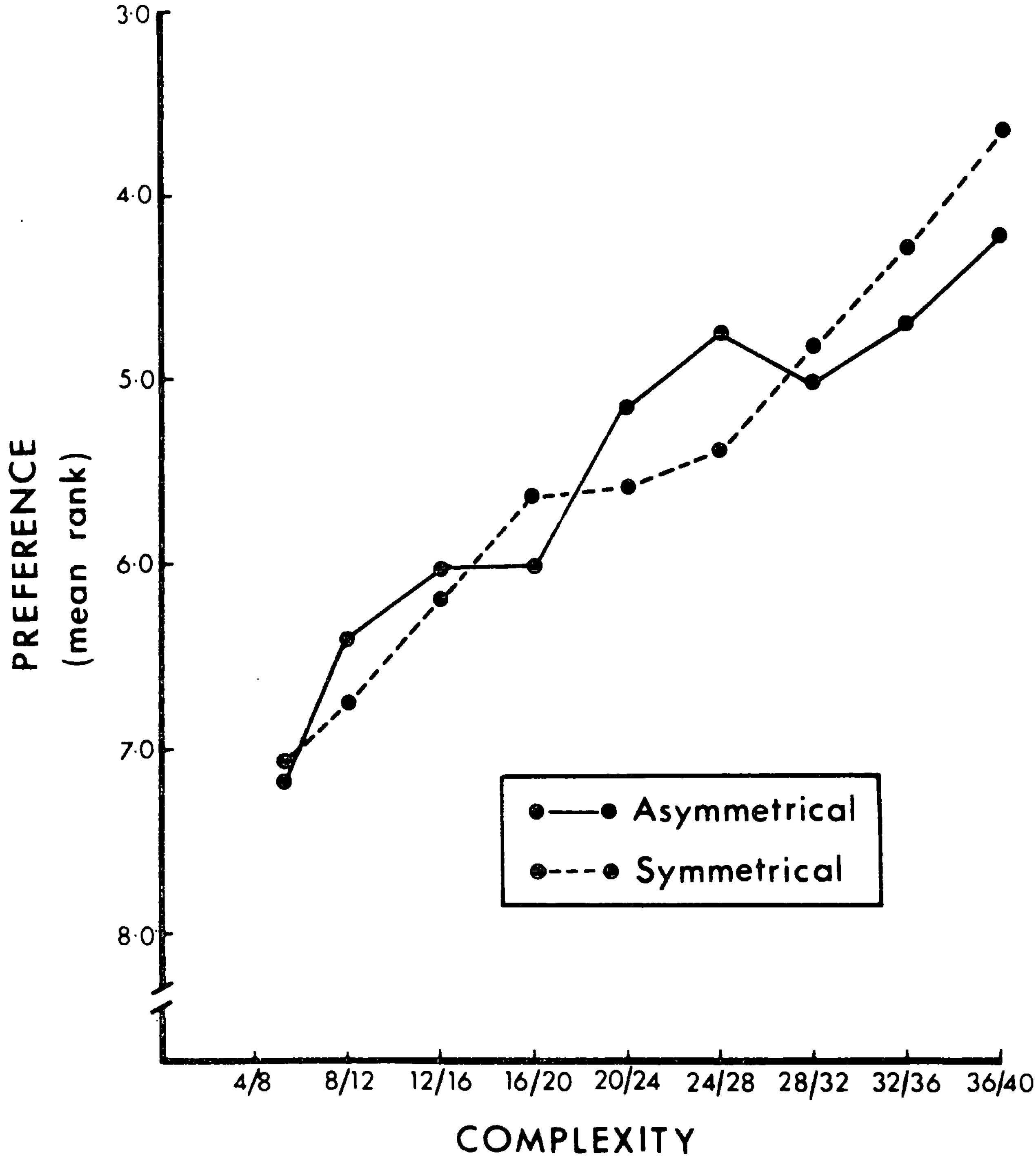


Fig. 20. Preference as a function of complexity for symmetrical (Set E) and asymmetrical (Sets A/B) polygons.

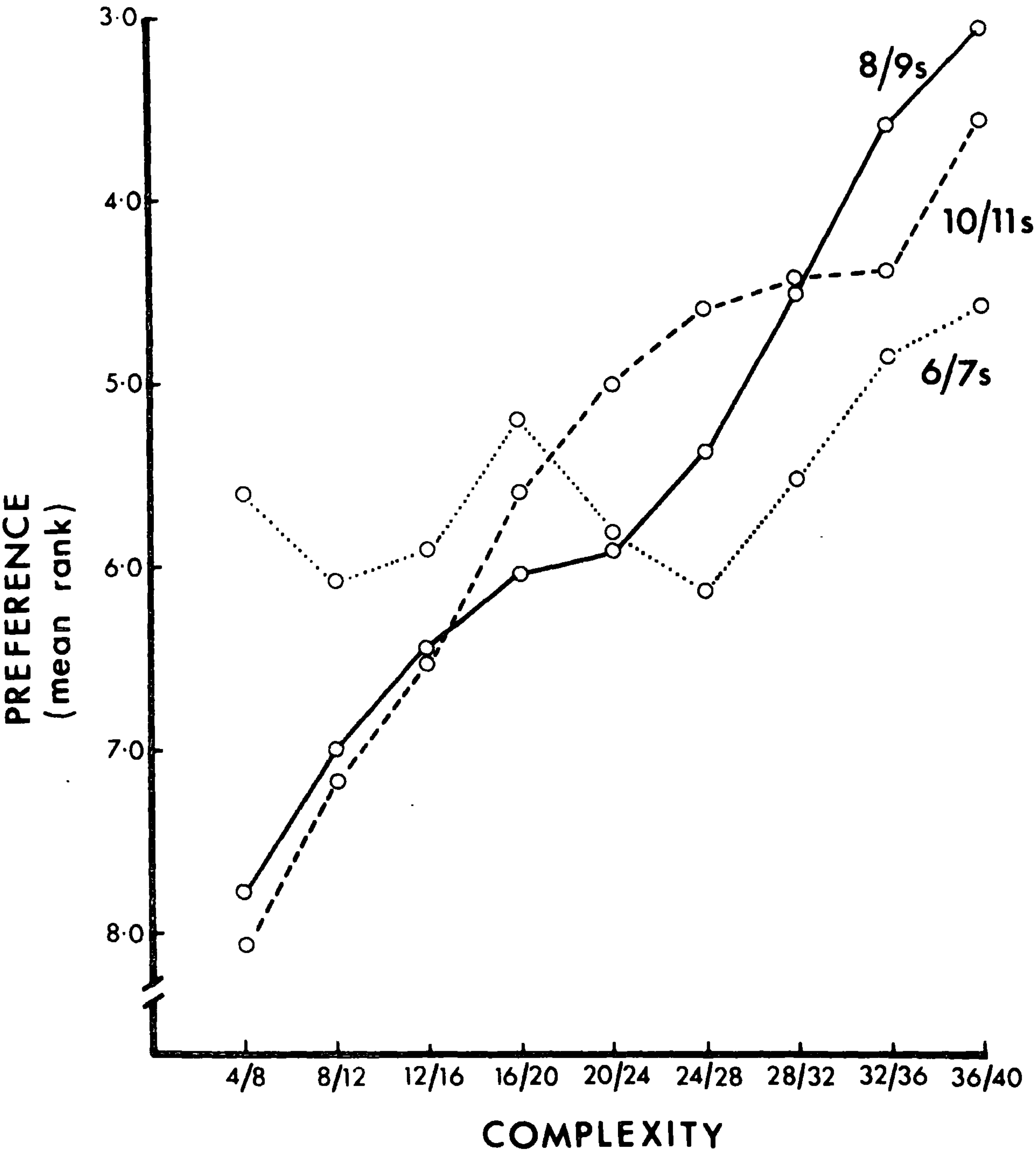


Fig. 21. Preference as a function of complexity for the three age groups (Set E).

bitonic component was not significant (p>.30).

Mean ranks for each age group were also examined with three separate Friedman analyses of variance. Polygonal complexity significantly affected preferences in the 8/9s and 10/11s (χ_r^2 = 32.18, p<.001; χ_r^2 = 25.17, p<.001, respectively), and trend analysis showed that the increase in preference was significantly monotonic in both cases (z = 6.38, p<.001; z = 5.63, p<.001, respectively). Complexity had no effect on preference in the 6/7s (p>.50), although trend analysis revealed a significant bitonic component (z = 1.67, p<.045). These trends can readily be appreciated from the depiction of age group data in Fig. 21.

One final test was applied to measure the effect of complexity. Each subject's median rank of the five low complexity stimuli and median rank of the five high complexity stimuli were compared with a Wilcoxon test. As expected, high complexity medians were significantly lower (z = -4.30, p<.00003), i.e. they were preferred. The reason for this comparison will be explained later.

(ii) Comparison with asymmetrical stimuli

To compare preferences for symmetrical stimuli with preferences for asymmetrical stimuli, data from the former were converted into rank order correlations (tau). Each subject's ranking of the 10 levels of complexity was correlated with the objective order of complexity by the method already described. The mean rank order correlation for symmetrical stimuli (N = 60) was +0.363, for asymmetrical stimuli (N = 72) was +0.329.

Correlation coefficients from the two groups were than analyzed in a 2(Set) X 3(Age) X 2(Sex) between-group analysis of variance which took into account the uneven cell frequencies (see Appendix 5a). Results showed that the effect of Set did not approach significance (p>.66), that is to say, there is a high probability that preferences for the two types of stimuli are not different from each other. Age was highly significant ($F(2,120) = 17.13$, $p<.00001$) and an Age X Sex interaction was also significant ($F(2,120) = 4.28$, $p<.015$). The Sex variable itself had no effect ($p>.63$). All other interactions were insignificant.

The Age X Sex interaction was given further attention because in the previous experiment the same interaction had bordered on significance ($p<.0501$). The data in this study however showed very little difference in preference between 6/7 males and females. Preferences in both sexes, though not marked, were similar and were generally U-shaped. To determine whether in fact an interaction existed with symmetrical stimuli, an additional 3(Age) X 2(Sex) between-group analysis of variance was applied to the 60 rank order correlations from this study (see Appendix 5b). Results showed the effect of Age was significant ($F(2,54) = 6.54$, $p<.003$). As Fig. 21 suggests, rank orders in the two older groups (mean tau = +0.495, both groups) were more highly correlated with the objective rank order of complexity than they were in the 6/7s (mean tau = +0.085). The other variable, Sex, had no effect on preference ($p>.80$) and the Age X Sex interaction did not reach significance ($p>.14$).

(2) Preference for Symmetry at Low (Set F) and at High (Set G) Complexity

Group preferences for symmetrical and asymmetrical polygons at low (Set F) and at high (Set G) levels of complexity are depicted in Figs. 22 and 23. Preferences are illustrated in both figures by mean ranks as a function of complexity.

Fig. 22 shows that symmetrical stimuli are preferred to asymmetrical stimuli at all five levels of low stimulus complexity. It can also be seen that the two functions are roughly equidistant from one another, although preference for symmetry is more pronounced at the upper levels

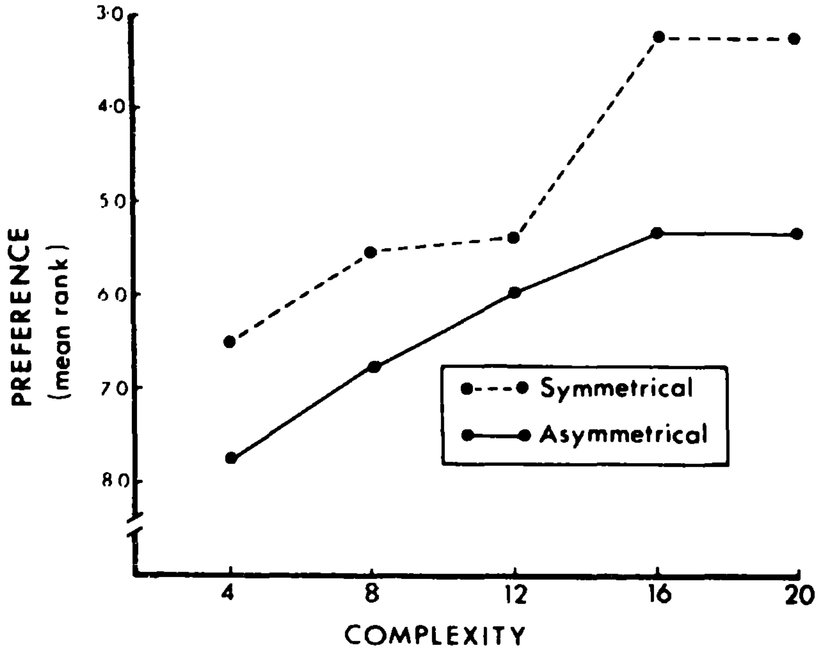


Fig. 22. Preference for symmetry at low levels of complexity (Set F).

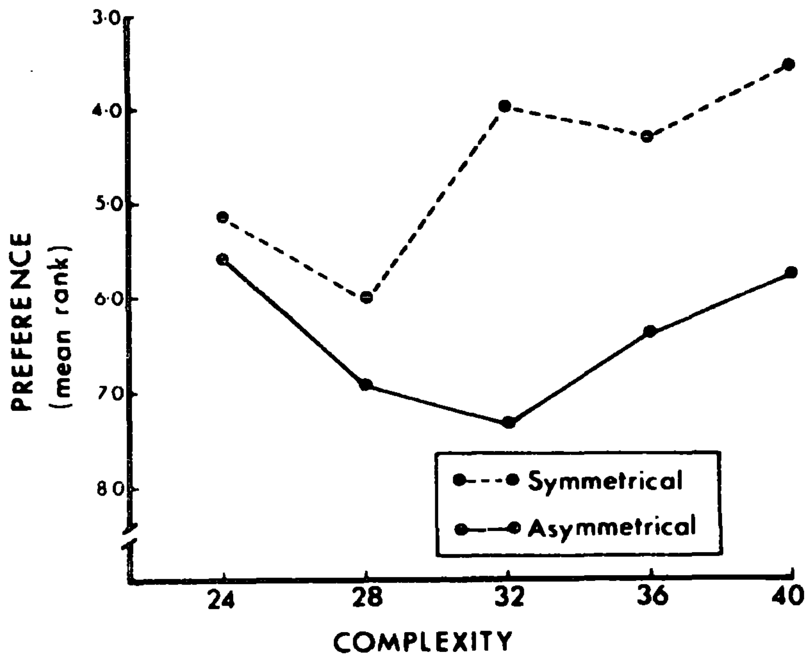


Fig. 23. Preference for symmetry at high levels of complexity (Set G).

of this range. Fig. 22 illustrates further that preferences for both types of stimuli increase with increasing complexity, and, that the two functions are predominantly linear in appearance.

Fig. 23 shows that symmetrical stimuli are also preferred to asymmetrical stimuli at all five levels of high complexity. Unlike low complexity preferences however, the two functions are not equidistant from one another. Preference for symmetry is much weaker at low levels of this complexity range than it is at high levels. Finally, it can be seen that while the level of complexity is affecting preferences for the two types of stimuli, both functions are decidedly nonmonotonic in appearance.

The main question (i, below) to which statistical analysis is addressed is whether preference for symmetry is significant in each set. A secondary question (ii) is concerned with whether such preferences are consistent across all levels of complexity, that is, whether there is an interaction between preference and level of complexity. Subsidiary analyses (iii) are suggested by the shapes of the preference functions in the two sets, and are aimed at evaluating the effect on preference of the complexity variable itself - is there a preference for complexity effect in the two different and limited ranges of complexity, and is it monotonic or nonmonotonic in nature?

(i) Preference for symmetry

To answer the first question, the median ranks of the five symmetrical figures and of the five asymmetrical figures were computed for each subject, in both Sets F and G. Differences between medians within sets were then compared with Wilcoxon tests. Results showed significant differences in both sets. Low complexity symmetrical figures (Set F) were preferred to low complexity asymmetrical figures ($z = -4.19$, $p<.00005$), and, high complexity symmetrical figures (Set G) were preferred to asymmetrical figures ($z = -4.58$, $p<.00005$).

Wilcoxon tests were also applied to differences between median ranks of subjects in each of the three age groups. All comparisons resulted in significant differences. Symmetry was preferred to asymmetry at low levels of complexity by the 6/7s ($z = -2.37$, $p<.009$), by the 8/9s ($z = -2.24$, $p<.013$), and by the 10/11s ($z = -2.65$, $p<.004$). Symmetry was also preferred to asymmetry at high levels of complexity by the 6/7s ($z = -3.02$, $p<.002$), by the 8/9s ($z = -2.05$, $p<.021$), and by the 10/11s ($z = -2.93$, $p<.002$).

(ii) The preference-complexity interaction

To answer the second question concerning the interaction between preference for symmetry and complexity, the total number of subjects who preferred symmetry to asymmetry was computed for each of the five levels of complexity in Set F. The data were thus in nominal form, and consisted of five frequencies of subjects. An interaction would be present if there were significant differences between these frequencies.

These data were evaluated with a Cochran Q test. The resulting Q value revealed that the difference was significant at the .05 level ($Q = 10.81$, $df = 4$). As mean rank orders in Fig. 22 suggest, more subjects preferred symmetry at the 16- and 20-sided levels of complexity than they did at the 4- and 8-sided levels. At the middle point of the complexity range (12-sided) preference for symmetry over asymmetry is weakest.

As this was an unexpected finding, preference patterns were examined in each age group. The raw data showed that 8 and 9 year olds preferred equally the 12-sided symmetrical and asymmetrical figures (mean rank = 5.65). Other age groups did not show any obvious interactions at this level of complexity or at any other levels. The three age groups were than analyzed separately with Cochran Q tests, and the results supported this. For the 6/7s, $Q = 3.03$ ($p>.50$), for the 8/9s, $Q = 12.13$ ($p<.02$), and for the 10/11s, Q = 8.00 ($p>.05$).

Similar analysis was applied to the frequencies of subjects who preferred symmetry to asymmetry in Set G. Again, analysis of group frequencies resulted in a significant Q value (Q = 13.93, df = 4, $p<.01$). As Fig. 23 illustrates, the overall group preference for symmetry is most striking at the middle value (32-sided) in the high complexity range, and is least evident at low levels (24- and 28-sided). Inspection of individual age trends showed that this particular interaction was pronounced among the 10/11s, but was not as apparent among the two younger groups of subjects. Separate Cochran Q tests supported this. For the 6/7s, Q = 4.59 ($p>.30$), for the 8/9s, Q = 2.86 ($p>.50$), and for the 10/11s, Q = 15.59 ($p<.01$).

(iii) The effect of complexity

The final question, concerning the effect of complexity on preference in the two ranges of complexity, was examined by Friedman analyses of variance. Data for the analysis were mean ranks computed for each subject at each of the five levels of complexity within a set. These means were derived from each subject's two ranks at that level of complexity - one ranking of a symmetrical figure, the other of an asymmetrical figure. The analysis then, was concerned only with the effect of visual complexity on preference, and not with symmetry or asymmetry.

Analyses of group data showed that complexity significantly affected preferences in both sets (Set F: χ_r^2 = 40.74, df = 4, $p<.001$; Set G: χ_r^2 = 19.13, df = 4, $p<.001$). Subsequent trend analysis revealed that the function relating complexity to preference at low levels of complexity was best described as decidedly monotonic (z = 7.061, $p<.00003$). A bitonic component did not approach significance. Trend analysis applied to ranks at high levels of complexity (Set G) showed that the function relating preferences to complexity was both monotonic ($z = 2.037$, $p < .02$) and bitonic ($z = 2.37$, $p < .008$) in nature.

The effect of complexity and the presence of trends can be adjudged from the mean ranks depicted and already described in Figs. 22 and 23.

(3) The Salience of Symmetry (Set H)

Data relating to the salience of symmetry were treated similarly to data relating to the salience of colour (Set C - last chapter).

In Fig. 24 the preference function derived from Set H is depicted with the baseline preference for complexity function (last chapter). The most notable feature of the graphs is that with symmetry present at low levels of complexity, the mean preference value of all low complexity figures increases compared to baseline. Consequently, the relative preferences of all high complexity stimuli in Set H are lower than baseline preferences.

The second feature to be noted in Fig. 24 is the predicted decrease in preference from the most complex symmetrical stimuli in Set H to the least complex asymmetrical stimuli. (Compare observed preferences in Fig. 24 with the predicted function in Fig. 2.)

To test whether symmetry was sufficiently salient to alter baseline preferences, the data were analyzed by the same method used to test the salience of colour. Rank order correlations between each subject's observed rank order and the objective rank order were computed. These scores were then compared to coefficients representing baseline preferences in a 2(Groups) X 3(Age) X 2(Sex) between-subjects analysis of variance, which took into account the uneven cell frequencies (see Appendix 5c). It is predicted that correlations in Set H (mean tau = +0.129) will be lower than baseline correlations (mean baseline tau = +0.329).

Results supported the prediction with a significant effect of

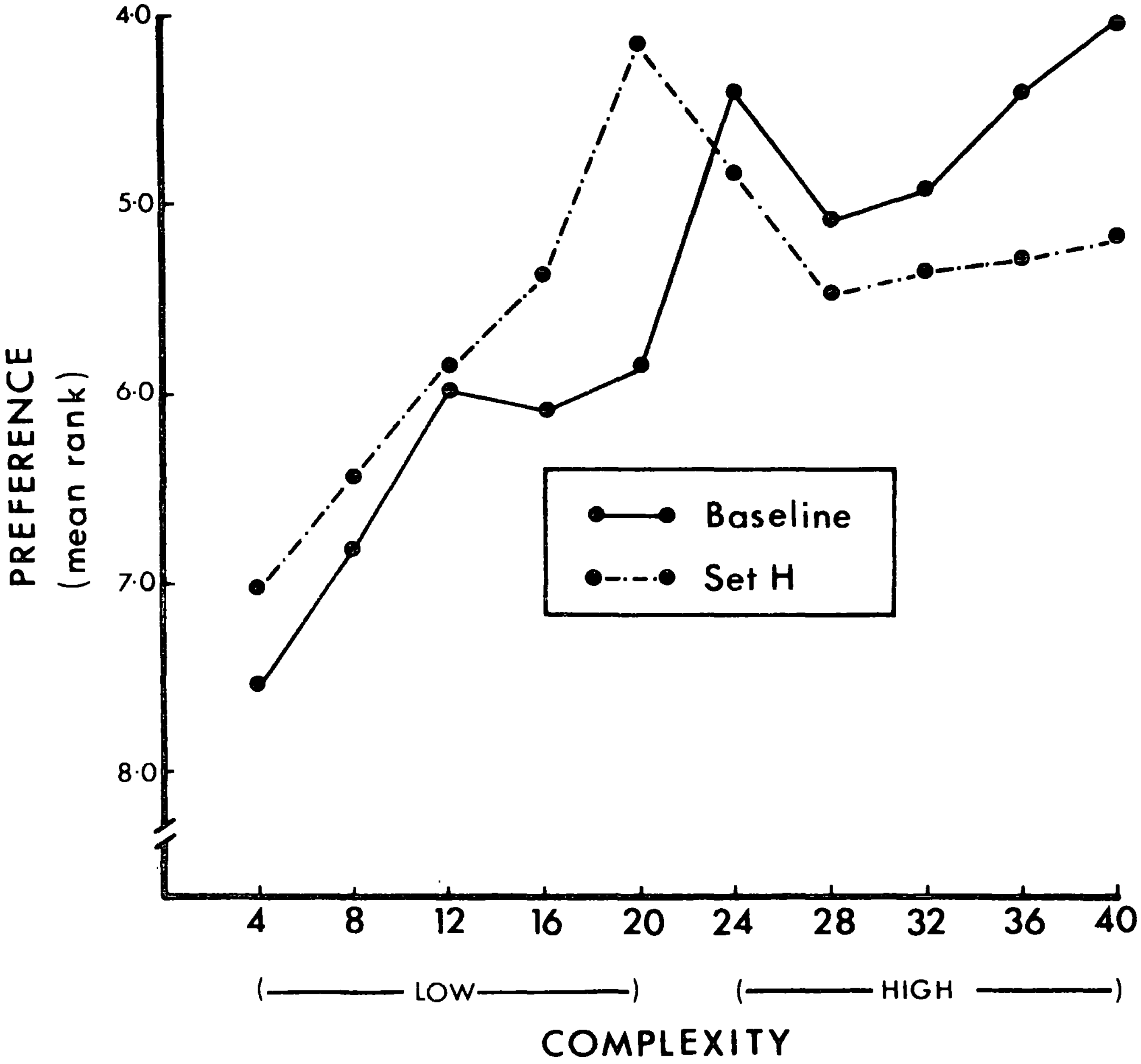


Fig. 24. The affective salience of symmetry relative to complexity: preferences in Set H compared to baseline (Sets A/B) preferences (Set H - Low Complexity Symmetrical/High Complexity Asymmetrical).

Groups ($F(1,120) = 5.95$, $p<.016$). Age was highly significant ($F(2,120) = 14.65$, $p<.00001$); sex showed no effect ($p>.70$). The only significant interaction was Age X Sex ($F(2,120) = 3.85$, $p<.024$).

Further analysis involved comparing subjects' preferences in Set H with their preferences in Set E. (It will be remembered that preferences for symmetrical polygons have already been shown to be no different from preferences for asymmetrical polygons.) Comparisons took two forms.

First, correlation coefficients derived from the two sets were compared in a 2(Set) X 3(Age) X 2(Sex) between-within analysis of variance, with repeated measures on Set (see Appendix 5d). Results showed a highly significant effect attributable to the within-subjects variable, Set ($F(1,54) = 23.05$, $p<.00001$). Rank order correlations in Set E were significantly higher than those in Set H. Age was significant ($F(2,54) = 6.37$, $p<.003$), Sex was not ($p>.90$). No interactions were significant.

Second, comparisons between medians in Sets E and H were executed. Each subject's median rank of low complexity symmetrical figures (4 to 20 sides) in Set H was computed and compared to his median rank from the same range of complexity in Set E. The prediction is that Set H medians will be lower (i.e. the figures will be more preferred) than Set E medians. A Wilcoxon matched-pairs signed-rank test was then applied to the 60 pairs of medians, resulting in a z value of -2.56 ($p<.0052$).

The same statistic was applied to median ranks from high complexity stimuli (24 to 40 sides) in the two sets, however with this comparison it is predicted that median ranks in Set H will be higher than in Set E. Results of the Wilcoxon test supported this prediction with a z value of -2.97 ($p<.0015$).

The final test for the salience of symmetry consisted of comparing median ranks within Set H itself. Each subject's median rank from the five low complexity symmetrical figures was compared with a Wilcoxon test to his median rank from the five high complexity figures. It will be remembered that the same analysis applied to medians from the two ranges of complexity in the baseline (Sets A/B) and in Set E (this study) showed significant differences ($p<.00003$, and $p<.00003$, respectively), i.e. high complexity figures were preferred in both cases. Results of this analysis on Set H medians showed that the differences in preference between the two ranges of complexity were not significant ($p<.06$).

PART THREE

Relationship between Viewing Time and Preference

The hypothesis tested in Part Three is that the two response measures, viewing time and preference, do not significantly differ from one another as a function of symmetrical stimuli varying in complexity.

Results

To compare viewing time (Part One) with preference (Part Two, Set E) data from the former pertaining to s y m m e t r i c a l s t i m u l i o n l y were ranked, and thus converted into ordinal form. Each subject's total time spent viewing the two symmetrical stimuli at each level of complexity was first computed. The level of complexity receiving the longest total viewing time was given the rank of 1, the second longest the rank of 2, and so on, for all 10 levels of complexity.

Group preferences and ranked viewing times for symmetrical stimuli are plotted together in Fig. 25. It is quite apparent that the two functions are closely related. Both increase linearly from low to high levels of complexity.

The two response functions were compared for differences by an analysis of variance. Correlation coefficients were computed between each subject's rank ordered viewing times for symmetrical stimuli and the objective order of complexity. These scores were then compared to correlation coefficients already computed from preference data in a 2(Response) X 3(Age) X 2(Sex) between-within analysis of variance, with repeated measures on the Response variable (see Appendix 6). Results showed that there were no significant differences between the two measures ($p>.56$). The mean rank order correlation for viewing was +0.330, for preference +0.363. Age was the only significant effect

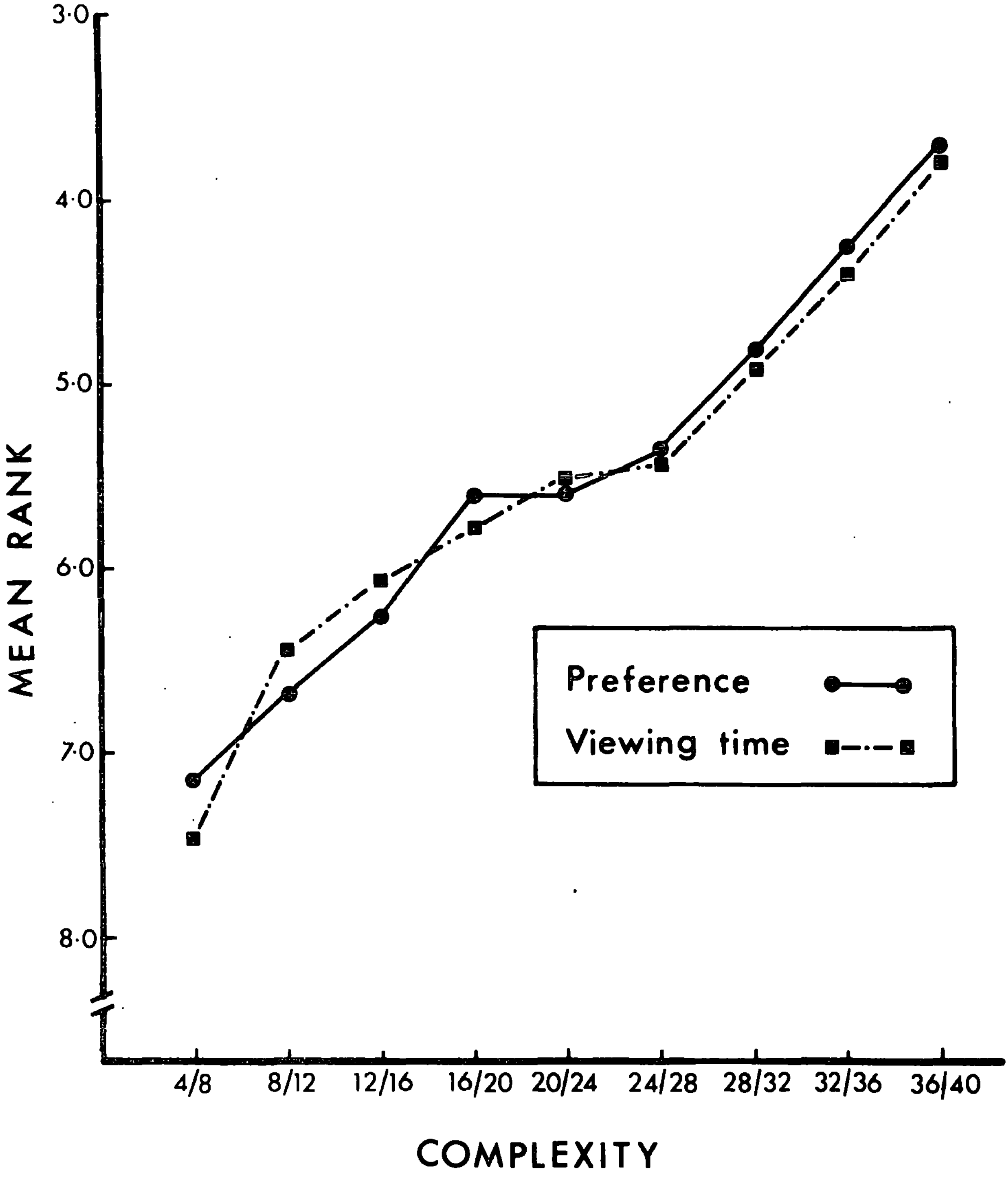


Fig. 25. The relationship between preference (Set E) and viewing time (symmetrical polygons) as functions of complexity.

($F(2,54) = 8.56$, $p<.0007$). All interactions were not significant.

Although the Response X Age interaction was not significant, it is of interest to adjudge the relationship between the two measures for the three age groups by comparing functions depicted in Figs. 19 and 21. These figures will be referred to in the discussion.

Discussion

I. Symmetry

Symmetry and viewing time.

The presence of a third variable parameter in polygons produced some rather unexpected results. First to be considered is the specific effect of symmetry on duration of viewing time. The data show clearly that the main effect of symmetry had no effect at all on duration of viewing, nor did it interact with any other variable. Thus there is no support for the Age X Symmetry interaction reported by Hutt and McGrew (1969). In fact, the difference between viewing symmetrical and asymmetrical figures with equal numbers of sides was negligible at all levels of complexity, and at all ages.

While this is the first time data pertaining to this problem in children havebeen reported, these results do confirm what Day (1968b) found with adults, using similar instructions. Nevertheless, the results are contra hypothesi, and they demonstrate an important distinction between colour and symmetry. They do not support the complementary hypothesis which holds that the presence of symmetry, like colour, will increase viewing times because of increased affective value. Moreover, it cannot be argued that symmetry does not increase affective value, as the data in Part Two show (see below).

Why should this be the case? One interpretation is that the results do not present an accurate picture because of the method in which complexity is scaled. The two sets of polygons were equated for total number of sides, yet symmetrical polygons have fewer independent sides (n/2 - 1). Thus a 40-sided polygon can be viewed as approximately equivalent to a 21-sided asymmetrical polygon in terms of number of independent sides. If the data are rearranged in this manner, symmetrical polygons do sustain longer viewing times.

This is not a particularly satisfactory explanation however, for reasons stated in Chapter Two. While it is the case that symmetrical polygons are rated less complex than asymmetrical polygons with equal numbers of sides, it is equally the case that they are not rated half as complex. The subjective complexity of a 20-sided symmetrical polygon lies somewhere in between the subjective complexity of a 20-sided and a 40-sided asymmetrical polygon. Attneave (1957) estimated that reflecting a shape symmetrically had the effect of increasing the number of sides by about 19%, a percentage which cannot easily be utilized in scaling. Moreover, there is no evidence that children respond primarily to number of independent sides, and not to the total number of sides.

Another interpretation which is related to the problem of scaling is that the presumed decrease in complexity with symmetrical polygons is balanced by the increase in their affective value. In other words, whatever reduction in viewing time is caused by lower information content (measured by number of independent sides) is simultaneously compensated for by the increased affective value of the symmetrical stimuli. These two variables, decreased complexity and increased affectivity, can be hypothesized to produce opposing effects on duration of viewing, effects which counterbalance each other. The result is that symmetrical stimuli sustain the same viewing times as asymmetrical stimuli.

Looking at the viewing time functions for the two types of polygons presented in Fig. 18, this interpretation has a certain appeal. The two functions do indeed overlap. What detracts from the interpretation however, is the remarkably consistent lack of difference between the two functions throughout the entire dimension of complexity. It would be unusual, to say the least, for increased affect and decreased complexity to counterbalance each other so exactly at all levels of stimulus complexity. This interpretation must therefore be viewed as somewhat improbable.

Finally, it is worth noting that although symmetry did not affect duration of viewing, it did produce changes in the pattern of viewing evidenced with the asymmetric stimuli. Consider the results of 6 to 9 year olds in the previous experiment (see Fig. 6). Both these age groups showed significant quadratic trends, when the stimuli presented for free viewing varied in only two properties, complexity and colour. The 8/9s reached a plateau at middle levels of complexity, while the 6/7s showed decreases in viewing times after middle complexity. In the present experiment, both these quadratic trends disappeared. Viewing times increased monotonically for the older group, while for the younger group, they remained relatively unchanged across all levels of complexity.

Why do these changes occur? Are they directly attributable to symmetry? The reason suggested is that the presence of this third polygonal variable considerably extended the range of appearance in these stimuli from what it was in the previous experiment. The entire set of polygons was perceived as more interesting. Symmetry, it is felt, introduced an important element of organization which had its strongest influence on visual exploration at high levels of complexity.

The data from the previous experiment show that increases in number of randomly arranged sides was not a sufficiently strong source of variation by itself to produce continued increases in viewing times for all age groups, even when combined with variations in colour. The

8/9s' pattern of viewing these figures suggests that beyond a certain point of figural complexity, further increases were monotonous, or boring. Certainly the effect of increased numbers of sides had a neutral effect on duration of viewing. For 6/7s, it had a negative effect. Viewing times decreased.

However, with the introduction of a third pictorial element, the whole pattern of exploring visual complexity changed. Increases in viewing times occurred not only with high complexity symmetrical figures, but also with similarly complex, asymmetrical figures. And it is because of increased viewing directed towards asymmetrical figures that the variable of symmetry does not appear to have a significant effect on duration of viewing.

Unsolicited comments suggest that the presence of symmetry was perceived by children of all ages fairly immediately. It is believed that the property of symmetry, once experienced, became a reference point which influenced the perception of all stimuli. It is to be expected that once a given polygon was perceived as asymmetrical, a subject would look for ways in which it did incorporate a degree of symmetry. There would be an attempt to impose organization, to resolve the random asymmetry. Asymmetrical stimuli at high levels of complexity obviously offer more alternatives than do simple shapes. Thus, one can refer to a 'set' for possible symmetry which was operating during the inspection of all asymmetrical polygons.

When a child sees a new polygon, he perceives it as being symmetrical ("It's the same on both sides"), or not. Stimuli experienced as not having symmetry though, are appreciated as such. In the former experiment this was not possible. None of the stimuli incorporated symmetry, they gave no hint of balance, and it is unlikely that subjects would look for it. However, in the present experiment symmetry encouraged successive interstimuli comparisons, comparisons which at high levels of complexity took more time.

To conclude then, the dichotomous variable of symmetry-asymmetry did not have the effect on duration of viewing it was expected to have. A possible rescaling of the dimension of visual complexity suggests that symmetrical polygons were in fact viewed longer, however such rescaling is problematic and awkward. An alternative but related interpretation is that two characteristics of symmetry, increased affect and reduced information content or subjective complexity, simultaneously produced opposing effects on duration of viewing. This explanation, although an appealing one, is improbable because of the exact balance of these opposing characteristics throughout the entire dimension of stimulus complexity. And finally, it is suggested that symmetry produced a broadened experience of stimulus multidimensionality, such that subjects were induced to make more interstimuli comparisons, and especially to look for degrees of organization in asymmetric stimuli. To that extent, symmetry produced an increased responsivity to the entire dimension of visual complexity, particularly to those levels of complexity which offered more alternatives to imposing organization.

Symmetry and preference

The effects of symmetry on the other dependent variable, preference, are conclusive and more easily interpretable. Results from Sets F and G show that symmetrical polygons were preferred to asymmetrical polygons at all levels of complexity. Discounting the Eisenman study (Eisenman et al, 1969) with its many faults, this is the first report of a clear preference for polygonal symmetry in children, which thus gives general support to Paraskevopoulos' finding (1968) of a similar preference for symmetry in dot patterns in children. Moreover, the present results hold for children of all ages, and for sets of stimuli presented in all four colours.

There is evidence that preference for symmetry is more pronounced in the upper ranges of complexity (Set G), than in the lower levels (Set F). With the exception of 28-sided symmetrical figures, mean ranks of all symmetrical figures in Set G were lower than those of all asymmetrical figures. In Set F however, only the two most complex symmetrical figures were preferred to the full range of asymmetrical shapes (see Figs. 22 and 23).

This pattern suggests that when symmetry is viewed as an aesthetic device which adds order to disorder, balance to randomness, its affective appeal is greatest among stimuli which require the most organization, i.e. the more complex ones. The greater the stimulus complexity, the higher the evaluation of a figural characteristic which imposes order on that complexity. The addition of symmetry to very simple figures on the other hand, does not have such a strong effect, since these figures do not require as much effort at organization and assimilation.

In each set, there is also evidence that preference for symmetry interacts with specific levels of polygonal complexity. The 8/9s for example, ranked as equal the 12-sided symmetrical and asymmetrical figures, whereas in Set G, the 10/11s exhibited much stronger preferences for symmetry among 32-sided polygons than at other levels of complexity. The reasons for these interactions are not clear. Not only is the nature of the interactions different in the two ranges of complexity, but the two age groups contributing to the interactions are also different. The only similarity is that each interaction occurred at the midpoint of its respective complexity range. The lack of any real pattern suggests however, that they are artifacts due to idiosyncracies of individual polygons, which are perceived as more or less pleasing within restricted ranges of complexity by some age groups and not by others. Verification of this point will await the following experiment, where similar sets of polygons will be presented for preference judgments.

II. Visual Complexity

Complexity and viewing

Like the previous experiment the main variable of polygonal complexity had a significant effect on duration of time spent viewing, in that the more sides symmetrical and asymmetrical polygons had, the longer was the time spent viewing them. Furthermore, as already explained in the previous section, the response to upper levels of complexity was even more pronounced because of the presence of symmetry. There were no quadratic trends for viewing times in any age group, and 97% of the total group variance was accounted for by a linear trend.

The Age X Complexity interaction was again a significant source of variance, however in this experiment, it is due to the difference between the two older groups and the youngest group. The former show strong linear trends, while the function for the 6/7s rises only minimally with increasing complexity.

The unexpected Complexity X Colour X Sex interaction is not readily interpretable.

Complexity and preference

The results in Part Two (Set E) show that symmetry makes little difference to the general pattern of preference for complexity established in the previous experiment. And they confirm the findings of Munsinger and Kessen (1966b, Study IV) where similar aged subjects showed increasing preferences for symmetrical polygons varying in complexity, using a paired-comparison task. Moreover, they give credence to the explanation of why Munsinger and colleagues found differences in complexity preferences between symmetrical and asymmetrical polygons, namely, that their research investigating the latter suffered from methodological weaknesses.

In the present study, agreement between the two functions is particularly the case with the two older groups who showed the same monotonically increasing pattern of preference for symmetrical polygons as they did for asymmetrical polygons. Results for the 6/7s brought out similarities as well as differences between the two studies. With males and females considered together, visual complexity did not have any effect on preference for symmetrical polygons. This confirms the findings for asymmetrical polygons. A difference between the two types of stimuli emerged with regard to the sex variable. In this experiment both males and females exhibited similar, slightly U-shaped functions, whereas with asymmetrical stimuli males and females showed different patterns of preference. The change was more pronounced in males.

Again, the data represent another case where the presence of symmetry is responsible for changing the pattern of response to complexity. When young males are confronted with a set of asymmetrical stimuli which offer no possibility of imposing order, they choose the least complicated shapes. Yet when presented with a set that incorporates an obvious element of order throughout the range of shapes, their responses to complex stimuli are more favourable. It is to be noted though, that for both types of stimuli, preference for simple shapes remains relatively high among males at this age.

One point is worth repeating at this stage, which is that visual complexity does not really influence preferences at this age. The differences between males and females that resulted with asymmetrical stimuli and not with symmetrical stimuli were differences in trends only. The overall effect of complexity on preferences in both groups of children, male or female, was not significant. A pattern of undeveloped responsivity to complexity at this age then, is a constant in the two experiments, which is represented by the low correlation coefficients of the 6/7s that produced the Age effect in both experiments.

A rather curious effect of complexity showed itself in Sets F and G, where subjects were presented with restricted ranges of complexity. Analysis of group preferences showed that complexity significantly effected preferences in each set, but also that the pattern of preference was different in the two sets. At high levels of complexity, the trend was U-shaped; both the monotonic and the bitonic trends were significant. At low levels of complexity, the more complex figures were preferred; the trend was highly monotonic. These data suggest then, that preference for specific levels of stimulus complexity is dependent upon what range of complexity is presented for inspection in the first place. In the high complexity range, the simplest figures were accorded higher preference values relative to other figures in that range than they received when presented in the full range of complexity.

This is a problem which has received almost no attention in the experimental literature. Walker (1970) produced evidence that adult complexity judgments of complexity were influenced by the range of complexity presented, and Steck and Machotka (1975) found that adult preferences for musical compositions varying in complexity showed a similar dependence upon the range presented. They claim that preferences are in fact totally determined by range, and that therefore all preferences for complexity must be thought of as relative and not absolute. The present study is the first to suggest that a similar dependence may be operating in young subjects, and thus establishes the need to investigate the problem of range effects more thoroughly.

III. Colour

The data on viewing times as a function of colour confirm what had been found previously, namely that chromatic polygons at all levels of complexity were viewed longer than achromatic polygons, by children of all ages. The presence of colour caused an average increase in viewing of 11%, which compares favourably with 6.4% in the previous experiment.

Moreover, the modification designed to eliminate the potential effects of colour-novelty did not alter the results.

IV. Salience

The affective salience of symmetry was tested in Set H, which effectively produced competition between preference for symmetry and preference for complexity. Results showed that symmetry in combination with low levels of polygonal complexity significantly increased the relative preference values of all those stimuli, at the expense of high complexity asymmetrical stimuli. Subjects' rank orders in Set H were significantly different from baseline, and were different from their preference for complexity functions established in Set E. Further evidence of the salience of symmetry was established in comparisons between Sets E and H, based on subjects' median ranks in the two complexity ranges. Thus, when a set of stimuli varying in complexity is presented which includes an alternative visual property upon which to make a choice, it is the case that symmetry, like colour, is a potent alternative.

The results brought out differences between symmetry and colour, however. The relative salience of symmetry was not only apparent at all ages, but its effects were also the same at all ages, i.e., there was no Set X Age interaction in either the Set H and E comparison or in the Set H and baseline comparison. Thus, another important distinction between the properties of symmetry and colour has been found in that only the affective salience of the latter is age-dependent. The salience of symmetry is constant across ages, and it does not appear to depend upon how well established preference for complexity is.

The Age variable itself, although not bearing on the problem of salience, was significant in both of the above comparisons. This adds further confirmation to previous findings that young subjects do not respond preferentially to variations in complexity as do older subjects. An interesting Age X Sex interaction resulted from the analysis of baseline and Set H correlation coefficients. There is good evidence however, which reveals that this interaction is present only in baseline preferences (6/7 males versus females, previously discussed) and not in Set H preferences, for the interaction did not occur when Set H and Set E rank orders were compared using the same method of analysis. Moreover, when correlation coefficients from Set E were compared to baseline coefficients, the Age X Sex interaction was significant, but when Set E preferences were analyzed on their own, the interaction was not present. Thus, a sex difference among young subjects results only in preference for polygons which do not contain symmetry.

V. <u>Preference and Viewing Time</u>

The comparison of preference ranks and ranked durations of viewing confirmed the findings in the previous experiment that the two measures show a positive relationship to one another, a result which provides further general support for Hutt's prediction of an isomorphic relationship between the two. In this experiment preferences and duration of viewing showed even closer agreement with one another than in the previous experiment. Probabilities of a difference between them are .56 and .13 respectively, for the two experiments. The reason for this is the lack of any sex difference among the 6/7s in preference for symmetrical stimuli, which resulted in a closer correspondence between the two measures at this age.

As in the previous experiment the relationship established gives no support at all to Hutt's argument that the two measures will be more independent as age increases. The Response X Age interaction was not significant. Moreover, comparing the results of trend analyses shows that the measures are more closely related among older subjects, as was evident in the previous experiment. Significant monotonic trends were present in the preference functions of 8/9s and 10/11s, and significant linear trends accounted for almost all of the variance of viewing times for these two age groups. Among the 6/7s however, a bitonic (U-shaped) trend described preference functions, while viewing times showed no trends. These trends suggest then, that Hutt's prediction of an age-dependent relationship between measures will require considerable revision.

VI. Additional Considerations

Results from the two experiments on preferences show that the properties of colour and symmetry both have a significant degree of salience relative to visual complexity. The question arises: which of the two is the more salient?

Specific hypotheses bearing on this question are difficult to delineate on the basis of results already reported. At this stage there is no direct evidence to suggest that one is more salient than the other. The reason for this is quite apparent in that manipulations of the two variables have been intentionally designed so they do *not* interact with one another.

There is indirect evidence however, which suggests that symmetry is a more salient determinant of preference than colour is. This evidence is as follows: in the first experiment (Sets A and B) it was established by comparisons of medians that low complexity figures were significantly less preferred than high complexity figures. Also in the first experiment (Set C), it was shown that the presence of colour at low levels of complexity significantly increased the mean rank of those stimuli such that the overall preference function in Set C was statistically different from baseline ($p<.0005$). However, low complexity, chromatic stimuli were still significantly less preferred than high complexity, achromatic stimuli ($p<.016$). In the second experiment (Set H), a similar result was reported for the property of symmetry. At low levels of figural complexity, the presence of symmetry sufficiently raised preference values of 4- to 20-sided polygons such that the overall preference function in Set H was different from baseline ($p<.016$). But, low complexity, symmetrical stimuli were not significantly less preferred than high complexity, asymmetrical stimuli ($p>.06$). There was no difference in median ranks between the high and the low complexity figures.

What this suggests then, is that while both properties have salience relative to visual complexity, symmetry appears to exert a more powerful influence on preference than colour does. Moreover, the affective salience of symmetry is constant at all ages. The salience of colour is not. And so, on the basis of indirect evidence, it is predicted that the visual appeal of symmetry will be more salient than that of colour. This prediction will be tested in the following experiment.

CHAPTER FIVE

THE AFFECTIVE SALIENCE OF COLOUR AND SYMMETRY

CHAPTER FIVE

The final experimental chapter deals entirely with preference. An experiment is reported which investigates the competing effects of colour and symmetry, as they interact at different levels on the stimulus complexity dimension.

Following procedures already established, subjects in this study will also be presented with four sets of polygons to rank order by preference. As before, these sets are designed to introduce the dichotomous variables - colour and symmetry - into specific ranges of visual complexity, that is at either low or at high levels of complexity. Composition of stimuli within these sets is more complex however, in that both variables will be manipulated simultaneously. In former experiments, colour and symmetry were not allowed to interact.

The first two sets will be composed of polygons in either the low (4 - 20 sides) or the high (24 - 40 sides) ranges of stimulus complexity. It has already been established (Sets F and G) that symmetry is preferred to asymmetry throughout the range of complexity. In this study, the asymmetric figures will be presented with additional visual appeal, i.e. they will be in colour. Each level of complexity within these two sets will be represented by a chromatic, asymmetric polygon, and by an achromatic, symmetric polygon.

Should symmetrical figures still be preferred, then there is evidence that symmetry is a more powerful determinant of preference than is colour. Should there be no difference between the two functions, then there is evidence suggesting that the two properties have equal affective appeal. On the other hand, if the coloured, asymmetrical figures are better liked than symmetrical figures in the two ranges of complexity, then there is evidence that the presence of colour in multidimensional figures exerts a stronger influence on preference than symmetry does.

The remaining two sets of polygons in this study each present stimuli which sample the full range of visual complexity (4 to 40 sides). In the third set, colour at low levels of complexity is contrasted with symmetry at high levels, while the fourth set is the reverse of this, contrasting symmetry at low levels with colour at high levels. The salience of colour relative to visual complexity has already been demonstrated (Set C), and the third set in this study is designed to test whether colour still has this effect on preference when the high complexity figures are symmetrical. The composition of stimuli in the fourth set is similarly designed. It has already been shown that symmetry, like colour, also has salience relative to visual complexity (Set H), and the purpose of the fourth set is to test whether symmetry has the same salience when the complex figures are presented in colour.

On the basis of the indirect evidence discussed in the previous chapter, symmetry is expected to have higher salience than colour in terms of its affective appeal.

Subjects

Sixty subjects (30 male) with normal colour vision were selected from Tudhoe Colliery Primary School to take part in the experiment.[22] There were 20 subjects (10 male) in each of three age groups (6/7s, 8/9s, and 10/11s) with an age range of 6.2 to 11.5 years. Mean ages for each age group were 6.8, 8.11, and 10.7 years.

Apparatus

No new apparatus was needed. Preferences were tested on the same table under the same illumination previously described.

Description of Stimuli

New stimuli were not required for this study, and so existing ones were utilized. Forty different polygons were employed, representing 10 levels of complexity. At each level there were two symmetrical, achromatic (1 black and 1 grey) polygons and two asymmetrical, chromatic (1 red and 1 blue) polygons. Thus, half the stimuli were symmetrical, half asymmetrical; half were chromatic, half achromatic.

It will be noted that no chromatic, symmetric and no achromatic, asymmetric stimuli were employed. This is because of the general intent of the study, namely, to produce a conflict between the two variables of colour and symmetry. Polygons containing both properties were therefore not required.

Design

The study involved presenting subjects with four sets of ten polygons (Sets J, K, L and M) which would force a choice between colour and symmetry. In each of these sets, five stimuli were symmetrical and achromatic, while five were asymmetrical and chromatic. Visual complexity was also varied within sets.

The first two sets in this study, Sets J and K, are an extension of the design of Sets F and G in the previous study. It will be remembered that in Sets F and G subjects were exposed to a confined range of visual complexity - to low complexity (4 to 20 sides) in Set F, and to high complexity (24 to 40 sides) in Set G. At each of the five levels of complexity within a set, one stimulus was symmetrical, one was asymmetrical, but all stimuli in a set were presented in the same 'colour' (either red, or blue, or black, or grey). In this study the asymmetrical members of Sets J and K appear in colour (red or blue), while the symmetrical members remain achromatic (black or grey). Set J then consists of 10 low complexity figures, while Set K contains 10 high complexity figures.

The third set (Set L) is an extension of Set C from the first study. It will be recalled that Set C consisted of five low complexity, chromatic figures and five high complexity, achromatic figures. All figures were asymmetrical. In Set L, the five high complexity, achromatic figures will be symmetrical. Set L then, presents colour at low levels of complexity, symmetry at high levels.

The final set (Set M) is an extension of Set H in the second study, which it will be remembered contained five low complexity, symmetrical figures and five high complexity, asymmetrical figures. In Set M the high complexity figures will appear in colour. Set M, then, presents symmetry at low levels of complexity, colour at high levels.

Stimuli in Sets J and K represent the low and the high ranges of complexity, respectively, while stimuli in Sets L and M represent the full 10-level range of visual complexity.

Arrangement of the two chromatic stimulus variants (red, blue) and the two achromatic variants (black, grey) within sets was done as follows: the four possible combinations of chromatic with achromatic stimuli (red and black, red and grey, blue and black, blue and grey) were distributed so that each set was presented once in each of these four combinations. This necessitated division of subjects into four groups of 15 subjects each, with five subjects at each age level in each group. A second criterion for arranging colours ensured that subjects did not have to rank order more than one set in the same chromatic-achromatic combination.

An example of the arrangement of colours and of stimuli within sets which was presented to one of the groups is shown in Table V.

SET	LEVEL OF COMPLEXITY (number of sides)									
	LOW					HIGH				
	4	8	12	16	20	24	28	32	36	40
J. Low complexity symmetrical Low complexity asymmetrical	grey blue	grey blue	grey blue	grey blue	grey blue					
K. High complexity symmetrical High complexity asymmetrical						black red	black red	black red	black red	black red
L. Low complexity asymmetrical, high complexity symmetrical	red	red	red	red	red	grey	grey	grey	grey	grey
M. Low complexity symmetrical, high complexity asymmetrical	black	black	black	black	black	blue	blue	blue	blue	blue

TABLE V. An example of arrangement of colour and symmetry within the four sets presented to one of the four groups of subjects for rank ordering.

Procedure

Subjects were first randomly assigned to groups. The four sets were presented to subjects in a random order, and each subject saw a different random arrangement of stimuli within a set.

Preferences were solicited by the same procedure described earlier. After each preference was made, remaining stimuli were rearranged into a symmetrical pattern on the table, as described before.

Ranking the four sets took approximately 20 minutes.

Results

Sums and means of ranks were computed separately for each of the four sets of polygons. Sets J (Low Complexity, Symmetrical, Achromatic / Low Complexity, Asymmetrical, Chromatic) and K (High Complexity, Symmetrical, Achromatic / High Complexity, Asymmetrical, Chromatic) were analyzed first.

(1) Sets J and K

Group preferences for low complexity figures (Set J) and for high complexity figures (Set K) are depicted in Figs. 26 and 27, respectively. In both figures, preferences are illustrated by mean rank as a function of level of complexity.

Fig. 26 shows that polygons with symmetry are preferred to polygons in colour at all five levels of low complexity. It can be seen that symmetry appears to be more preferred at some levels of complexity than at others. At the 4-sided level, the difference between mean ranks is negligible, but as complexity increases preference for symmetry over colour becomes more pronounced. It can be seen further that preferences for both types of stimuli are inverted U-shaped within this range of complexity.

Fig. 27 shows that polygons with symmetry are also preferred to

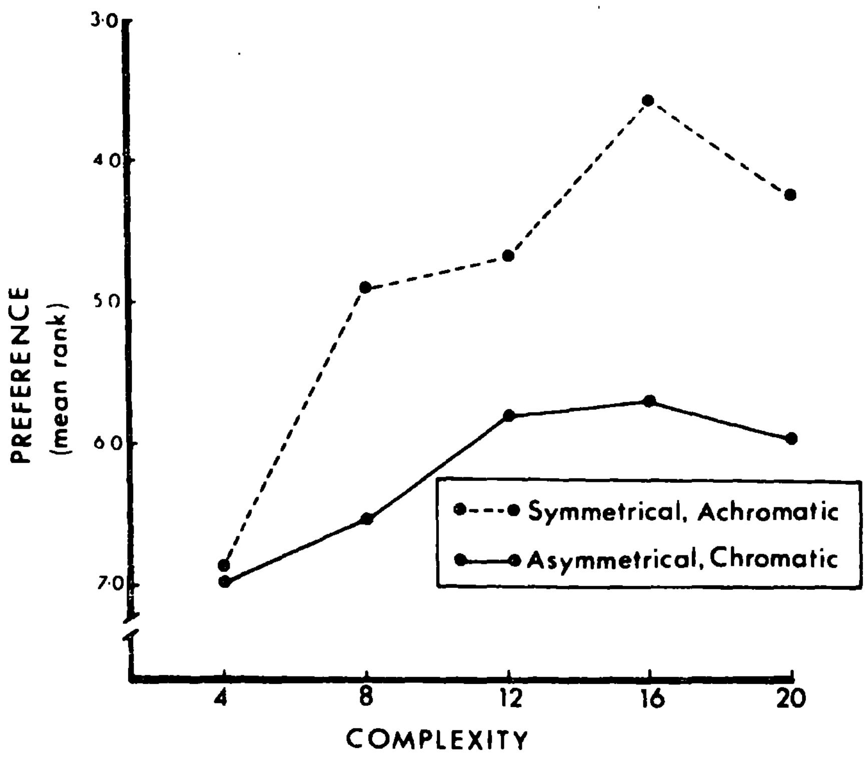


Fig. 26. Preference for symmetry compared to preference for colour at low levels of complexity (Set J).

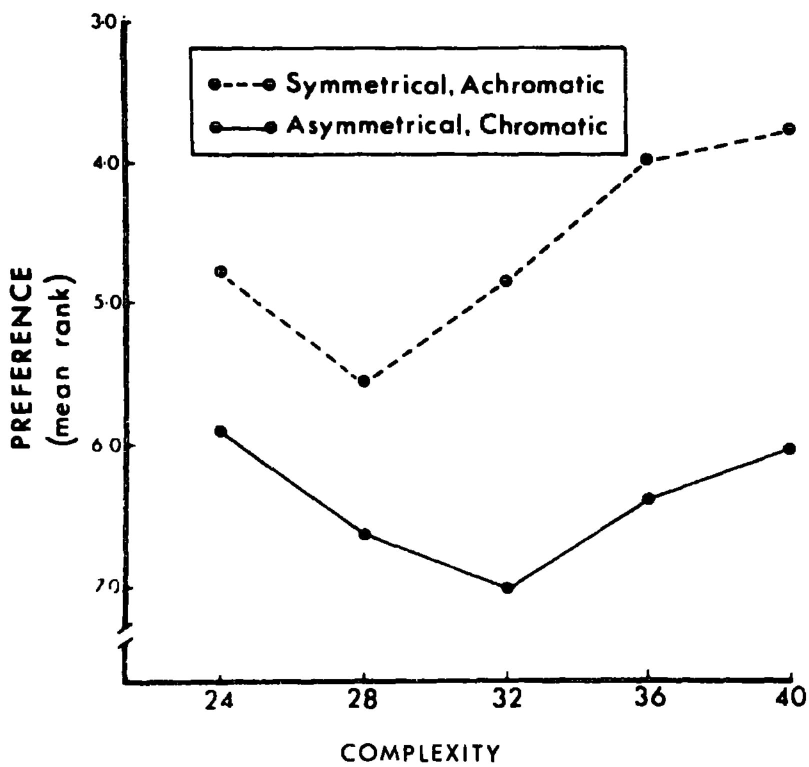


Fig. 27. Preference for symmetry compared to preference for colour at high levels of complexity (Set K).

polygons in colour at all five levels of high complexity. It can be seen that within this range of visual complexity, preference for symmetry over colour is more clearcut, although there is still a tendency for symmetry to be less preferred at the low end of the range. Finally, Fig. 27 illustrates that both preference functions are U-shaped.

As in the previous experiment, the main question (i, below) to which statistical analysis is addressed is whether preference for symmetry is significant in each set. Secondary analysis (ii) involves evaluating possible interactions between preference and complexity. Subsidiary analyses (iii) are concerned with the effect on preference of the complexity variable itself.

(i) Preference for symmetry

To answer the first question, two medians were computed for each subject in each set, one from the ranks of the five achromatic, symmetrical figures, the other from the ranks of the five chromatic, asymmetrical figures. Differences between medians were compared with Wilcoxon tests. The analyses showed that low complexity figures with symmetry were significantly preferred to low complexity figures in colour (Set J: $z = -4.46$, $p<.00003$), and, that high complexity figures with symmetry were significantly preferred to high complexity figures in colour (Set K: $z= -5.25$, $p<.00003$).

Separate Wilcoxon tests of differences between median ranks were also applied to the data from each age group. For the 6/7s, median ranks of figures with symmetry were significantly lower in Set J ($z = -3.53$, $p<.0002$) and in Set K ($z = -3.34$, $p<.0005$); for the 8/9s, medians were also significantly lower in both sets (Set J: $z = -2.82$, $p<.002$; Set K: $z = -2.69$, $p<.002$); for the 10/11s, figures containing symmetry were preferred to those in colour only at high levels of complexity (Set K: $z = -3.08$, $p<.001$). The difference between medians at low levels of complexity did not reach significance ($z = -1.44$, $p>.07$) for the older subjects.

(ii) The preference-complexity interaction

To answer the second question concerning an interaction between preference for figures with symmetry and level of complexity, the total number of subjects who preferred symmetrical figures to chromatic figures was computed for each of the five levels of low complexity in Set J. These frequencies were evaluated with a Cochran Q test. The resulting Q value showed there to be no differences between the frequencies ($Q = 3.23$, $df = 4$, $p>.50$). Further evaluations of each age group showed similarly that there were no interactions between preference and complexity level ($Q_{6/7} = 4.42$, $p>.30$; $Q_{8/9} = 2.13$, $p>.70$; $Q_{10/11} = 3.29$, $p>.50$).

The same analysis for interactions was applied to the data in Set K. No significant differences in frequencies were found. For the overall group analysis, $Q = 3.03$ ($df = 4$, $p>.50$). For the 6/7s, $Q = 4.78$ ($p>.30$), for the 8/9s, $Q = 2.33$ ($p>.50$), and for the 10/11s, $Q = 5.33$ ($p>.20$).

(iii) The effect of complexity

Examination of the effect of complexity on preference was conducted by the same procedures described in the previous study (Sets F and G). The mean of each subject's two ranks (one ranking of an achromatic, symmetrical polygon, the other of a chromatic, asymmetrical polygon) at each level of complexity within a set was first computed, and these means were then submitted to a Friedman's analysis of variance. It should be remembered that this analysis is independent of whether stimuli are symmetric or asymmetric.

Results showed that the level of complexity significantly affected preferences in both sets (Set J: $\chi_r^2 = 24.34$, $df = 4$, $p<.001$; Set K: $\chi_r^2 = 16.22$, $df = 4$, $p<.001$). Subsequent trend analysis revealed that in both sets, the functions relating mean ranks to complexity level had significant monotonic and bitonic components. Within the 4- to 20-sided range of complexity, the monotonically increasing trend described the functions better ($z = 4.52$, $p<.00003$) than did the inverted U-shaped bitonic trend ($z = 2.16$, $p<.016$), while in the 24- to 40-sided range of complexity, the reverse was true. At high levels of complexity, a significant bitonic trend ($z = 3.07$, $p<.001$) fitted the U-shaped function better than did a monotonic trend ($z = 2.20$, $p<.014$).

The effect of complexity on preferences, and the trends describing those functions can be adjudged from the depiction of mean ranks in Figs. 26 and 27.

(2) <u>Set L: Low Complexity, Chromatic, Asymmetric versus High Complexity, Achromatic, Symmetric</u>

Mean ranks for the 10 levels of complexity in Set L are illustrated in Fig. 28. In addition, Fig. 28 also depicts the mean ranks derived from Set C (Study I), in which symmetry was not present at high complexity levels.

There are two notable features of these graphs. First, the presence of colour at low complexity levels does not raise preference values for those figures relative to high complexity figures, when the latter are symmetrical in appearance. None of the chromatic stimuli in Set L are preferred to the symmetrical stimuli. This is not the case in Set C where the salience of colour relative to high complexity is notable.

Second, the Set L function is linear in form, with preferences increasing as complexity increases. It appears that symmetry counterbalances the salience of colour, which results in a preference for complexity function that is similar in appearance to baseline. The mean rank order correlation coefficients (between the observed and the true rankings of complexity) for Set L and for baseline are both positive and

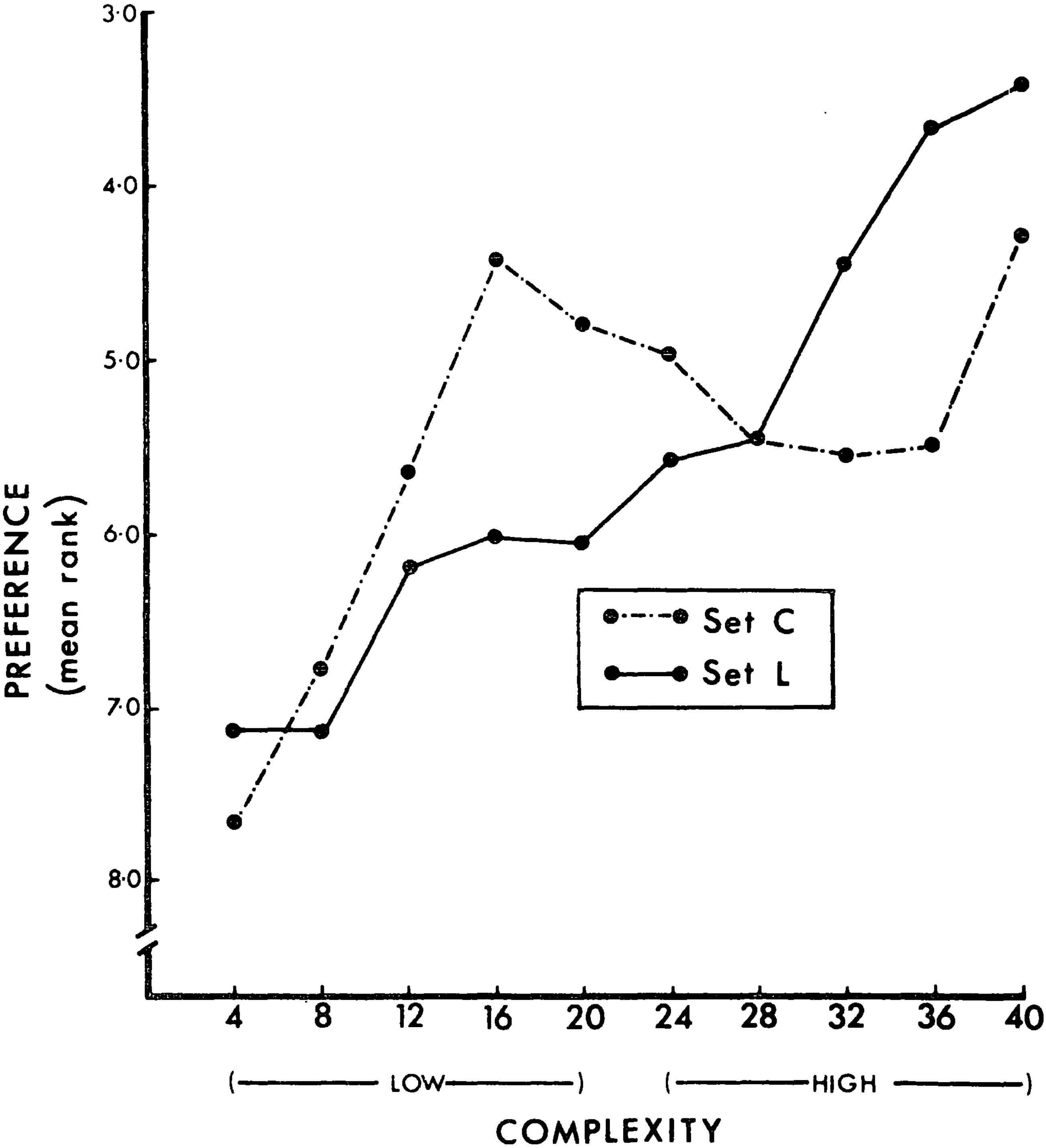


Fig. 28. The affective salience of colour relative to symmetry: preferences in Set L and Set C (Set L - Low Complexity, Chromatic, Asymmetrical/High Complexity, Achromatic, Symmetrical; Set C - Low Complexity, Chromatic, Asymmetrical/ High Complexity, Achromatic, Asymmetrical).

show the same degree of correlation (Set L = +0.331; baseline = +0.329).

Statistical analysis involved comparing Set L preferences with Set C preferences in three ways.

(i) Set L and Set C were first examined by comparing the analyses of median ranks within sets. In Set C, it will be remembered, a Wilcoxon test showed that median ranks of the high complexity range (24 to 40 sides) were lower (i.e. more preferred) than median ranks of the low complexity range (p<.016). The same analysis applied to medians from the two ranges of complexity in Set L produced the same result, but showed that the difference was more striking (z = -4.89, p<.00003).

(ii) Sets L and C were also compared by analyses of median ranks between sets. A Mann-Whitney U test showed that medians of the chromatic, low complexity range of stimuli were significantly higher (i.e. less preferred) in Set L than they were in Set C (z = -2.72, p<.003). A similar analysis of medians of the achromatic, high complexity range of figures in the two sets showed that medians were significantly lower in Set L than in Set C (z = -2.71, p<.003).

(iii) Finally, correlation coefficients representing the relationship between the observed and the objective rank order of complexity were computed for each subject in Set L. These were compared to coefficients already computed from Set C in a 2(Set) X 3(Age) X 2(Sex) between-groups analysis of variance (see Appendix 7a), which took into account uneven cell frequencies (Set L, N = 60; Set C, N = 72). It is expected that rank order correlations in Set L (mean tau = +0.331) will be higher than those in Set C (mean tau = +0.181). Results supported this with a significant difference between Sets (F(1,120) = 5.13, p<.024). Age was significant (F(2,120) = 7.67, p<.0009), and the interaction between Set, Age and Sex was also significant (F(2,120) = 3.81, p<.024). All other sources of variance were not significant.

(3) Set M: Low Complexity, Achromatic, Symmetric versus High Complexity, Chromatic, Asymmetric

Mean ranks for the 10 levels of complexity in Set M are illustrated in Fig. 29. In addition, Fig. 29 also shows mean ranks from Set H (Study II), which is similar to Set M in design, but did not include colour at high levels of complexity.

Several features of the functions are worth noting. First, the presence of symmetry at low levels of complexity in Set M increases the preference value of those figures relative to the more complex, chromatic figures. This is particularly noticeable at the 16- and 20-sided levels of complexity which are more preferred than the full range of complex, chromatic figures.

Second, the two functions show definite similarities in shape; they are roughly inverted U-shape in appearance with two turning points each. In both sets, preferences for symmetrical polygons increase sharply as number of sides increases, and then, at the point in the complexity continuum where further increases in number of sides are accompanied by a change from symmetry to asymmetry, preferences notably decrease. The two functions also show a second turning point. In the middle of the high complexity, asymmetric range of figures, preferences begin to increase again with increasing complexity.

A third feature to be noted is the difference between the two functions. Judging by mean ranks, symmetry appears to be even more salient in Set M than it is in Set H. Compared to the mean ranks of symmetrical stimuli in Set H, in Set M where simple symmetric figures are contrasted with stimuli that are not only more complex but also in colour, the effect of symmetry on preferences is more pronounced.

Statistical analysis of Set M and H preferences follows the format described in the previous section (Set L).

(i) Sets M and H were first examined by comparing the analyses of median

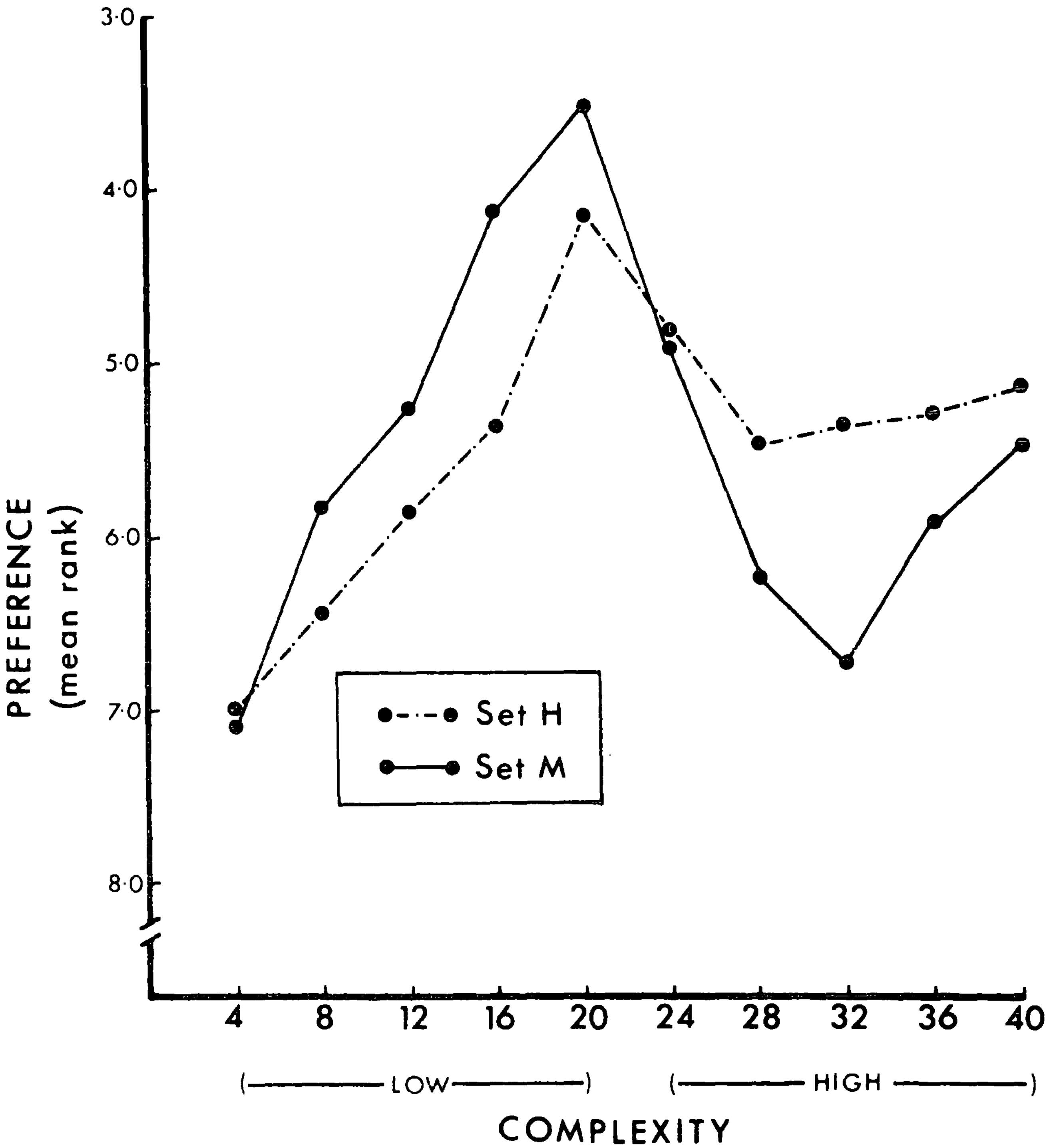


Fig. 29. The affective salience of symmetry relative to colour: preferences in Set M and Set H (Set M - Low Complexity, Achromatic, Symmetrical/High Complexity, Chromatic, Asymmetrical; Set H - Low Complexity, Symmetrical/High Complexity, Asymmetrical.

ranks within sets. In Set H, it will be remembered, a Wilcoxon test showed that median ranks of the high complexity, asymmetric range of stimuli were not significantly different from median ranks of the low complexity, symmetrical range of stimuli ($p<.06$). The same analysis applied to medians from the two ranges of complexity in Set M showed that there were differences ($z = -2.04$, $p<.021$). Low complexity medians were significantly lower than high complexity medians, i.e. the low complexity figures were m o r e preferred.

(ii) Sets M and H were also compared by analyses of median ranks between sets. A Mann-Whitney U test showed that median ranks of the 5 low complexity, achromatic, symmetrical stimuli in Set M were significantly lower (i.e. more preferred) than median ranks from the same type and range of stimuli in Set H ($z = -2.28$, $p<.012$). Similar analysis showed that medians from the high complexity range of figures were significantly higher in Set M than in Set H ($z = -2.49$, $p<.007$).

(iii) Finally, correlation coefficients representing the relationship between observed and objective rank orders of complexity were computed for each subject in Set M, and were compared to coefficients already computed from Set H. The mean rank order correlation (tau) for Set M was +0.002, and for Set H was +0.129. A 2(Set) X 3(Age) X 2(Sex) between-group analysis of variance (see Appendix 7b) was applied ($N = 60$, both groups), and results showed that overall differences in the ranking of complexity were not significant ($p>.11$). Age was the only significant source of variance ($F(2,108) = 3.99$, $p<.021$).

Discussion

Sets J and K

The results of ranking stimuli in Sets J and K demonstrate that the property of symmetry does indeed have a high affective salience. At all levels of complexity, symmetrical polygons were significantly preferred to chromatic, asymmetrical polygons. In the previous study (Sets F and G) preference for the property of symmetry was clearly established, and Sets J and K were designed to test the strength of that preference by including colour as an additional property to influence affective choice. It was expected that colour would make more appealing the asymmetrical stimuli and thereby produce competition between preference for colour and preference for symmetry. However, the results show clearly that subjects focussed on symmetry and not colour as the predominant property determining preference. Colour plainly does not have sufficient affective appeal to 'compete' with symmetry for preferences, and to that extent it has less affective salience.

This conclusion applies generally to all three age groups, as well as to both high and low ranges of stimulus complexity, with one exception. The difference between rankings of symmetrical and chromatic figures in Set J was not significant for the oldest group of subjects. Inspection of these preference functions shows that at this age subjects responded more to the dimension of complexity than they did to either symmetry or colour. Preferences for very simple figures were low, regardless of whether they were symmetrical or coloured. This result, although unexpected, does corroborate the repeated finding that the response to the dimension of stimulus complexity is highly age-dependent, in that the older the subject the more pronounced is the differential responsivity to complexity. Indeed, the more developed the response to stimulus complexity, indicated in older subjects by consistently low preferences of simple figures, the less susceptible are their preferences to alternative stimulus properties which would augment stimulus appeal at younger ages.

* * *

The number of subjects who preferred symmetry to colour was found to be consistent across all levels of complexity. All tests for interactions between preference and levels of complexity showed negative results. This supports the interpretation given their occurrence in the previous experiment, namely, that because there was no obvious pattern to the specific interactions, they were artifacts due to idiosyncratic responses by some of the subjects.

* * *

Finally, analysis showed again that visual complexity can effect preferences within confined ranges of complexity. Complexity was significant in both sets, as it was in the previous experiment, however the two younger groups showed changes in their response to complexity at low levels. Formerly, with just two variables interacting, the functions relating preference to complexity were almost wholly monotonic for all age groups. In this experiment, the functions for 6/7s and 8/9s are curvilinear, and the overall group function has a significant bitonic component. The presence of colour then, seems to reduce the effect of stimulus complexity among younger subjects. Older subjects, as already stated, do not show this effect. They continue to show a marked response to polygonal complexity that is independent of how many alternative stimulus properties are competing for preferential attention.

The effect of range on preferences for complexity becomes more difficult to interpret as the number of stimulus variations in addition to complexity increases. In the upper range of complexity, preferences are U-shaped in both Sets G and K, and the bitonic components in each are significant at a higher probability level than the monotonic components. In both sets, 24-sided figures received higher relative preference values than they would if presented within the full 10-level range of complexity. The effects of range are less obvious at lower levels of complexity however, as the general pattern of response is different in Sets F and J.

Set L

Rank orders of complexity established in Set L give convincing evidence that the property of colour has limited affective salience. In Set C the salience of colour relative to pleasing levels of visual complexity was demonstrated. The present experiment demonstrates that symmetry completely counterbalances that effect, such that the preference for complexity function is restored to its original baseline appearance. Analysis of rank orders showed that Set L preferences were significantly different from those in Set C. Comparisons of median ranks in the two sets provides further evidence that the presence of symmetry at high levels of complexity counteracts the salience of colour at low levels.

Analysis of correlation coefficients representing rank orders in Sets C and L resulted in a significant triple-order interaction between Set, Age, and Sex, which is difficult to interpret because none of the three possible two-way interactions were significant. Inspection of scores in the 12 subgroups concerned (3 ages, 2 sexes, and 2 sets) shows that again it is the young male subjects who contribute to the interaction. The difference between preference functions in the two sets is most pronounced among this subgroup. The mean rank order correlation in Set C was -0.164, while in Set L it was +0.445.

This must be viewed as further evidence that male subjects at this age have particularly undeveloped and unreliable patterns of preference for various visual properties. It appears to be the case that when confronted with an array of multidimensional stimuli, they tend to focus affective attention on one property to the exclusion of others. The choice of property is not predictable however, and varies according to the number and type of variables that interact in the set of stimuli. The present experiment suggests that symmetry is the salient property determining affective choice.

Set M

The results of Set M provide further evidence that symmetry is a more salient determinant of preference than colour. Symmetrical figures at low levels of complexity were accorded significantly higher preference values than asymmetrical figures of high complexity, even with the latter having the additional appeal of colour.

Analysis also revealed how complicated preferences can be when there are three stimulus variables interacting, for there is some evidence that the affective salience of symmetry was more pronounced when in competition with colour (Set M) than it was in Set H when colour was not varied. The analysis of median ranks in the two ranges of complexity in Set M showed that median ranks of simple, symmetrical figures were significantly lower than those in the high complexity range. This was not the case in Set H. Further analysis of the high and low complexity median ranks between sets suggested that symmetry increased the relative preference value of simple figures in Set M to a greater extent than was evidenced in Set H.

Why does symmetry seem to be more salient in Set M than in Set H? The most apparent answer is that subjects were keenly aware of the competition between properties in Set M. Symmetry and colour, juxtaposed as they were at either end of the complexity dimension, presented subjects with obvious affective conflict. And, to the extent that this conflict between liking high complexity figures in colour and liking simple figures with symmetry could not easily be resolved, it is suggested that subjects did resolve it by focussing affective attention on one property to the exclusion of others.

Similar decision-making processes may be said to be operative during subjects' initial inspections of all sets in this experiment, such that the more difficult the perceived choice between competing properties is, the greater the likelihood that one property will be selected as a basic determinant of preference. The property of symmetry is clearly the most salient cue that guides and determines such preference decisions for children at these ages.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

The experiments reported in this thesis can best be thought of as contributing to three problems of central importance to developmental experimental aesthetics. These problems are:

(1) how different measures of aesthetic behaviour relate to one another, and whether the relationship changes with age;

(2) how different aesthetic stimulus variables independently, and in interaction, affect measures of aesthetic responsivity;

(3) whether some aesthetic stimulus variables are more affectively salient than others in determining preferences.

The first two topics of study have already received some, though inadequate experimental attention, while the third is an entirely new approach to the field. Results bearing on these three topics will be summarized below.

(1) The Relationship between Preference and Viewing Time

Chapter One introduced two significant components of aesthetic behaviour - verbally expressed preference and the duration of viewing time. Both components it was shown represent different aspects of aesthetic behaviour, and both can be usefully employed with subjects at young ages.

It was argued that a better understanding of children's aesthetic behaviour is gained when more than one response is examined, and, that our understanding of any one aesthetic response is considerably increased when we study the relationship between responses. Hutt's hypothesis was then introduced, which held that attention (measured by viewing time) was the basis of children's preferences, with the specific prediction that amount of viewing should accord well with verbally expressed preferences.

However, a review of the literature revealed that research pertinent to this problem had failed to provide any firm support. Closer examination of eight studies that employed the two dependent measures revealed further that results were most contradictory when the stimuli presented varied in the collative property of complexity. A resolution of the different findings was suggested when the question of subjects' ages was considered. Young subjects (approximately 4 to 8) exhibited less agreement between measures than did older subjects. However, this discovery was found to contradict another hypothesis advanced by Hutt, which predicted that older subjects should show less correspondence between the two measures, as they have gained more evaluative experience, and should therefore not be as dependent upon the attention value of stimuli as should younger children.

Because of these discrepancies, it was decided to provide a much more thorough test of the relationship between the two measures than had been made previously, by presenting a carefully constructed set of polygons which would include variations in three important stimulus properties (complexity, colour and symmetry), and which would be basically unfamiliar to primary school children. Polygons were constructed to extend over a wide range of visual complexity, and to adequately represent each level of complexity.

Results of the first experiment demonstrated that preference and viewing time were positively, but not closely related aesthetic responses, when ordinal data representing each response were compared to the objective, standard order of visual complexity. This finding applied to chromatic as well as to achromatic polygons. Results of the second experiment confirmed this relationship, as well as extended the findings to apply to aesthetic stimuli that contained a third stimulus property, symmetry.

However, the results do not fully support Hutt's major prediction because of the effects of age on the relationship. Both analyses (Study I and II - Part Three) failed to find the Age X Response interaction predicted by Hutt. Trend analyses (Part One and Two) did reveal that there were differences between measures, but these were contrary to the direction predicted by Hutt. Preference and viewing time functions were described by quite different trends among the 6/7s, whereas as age increased, the two functions could be almost wholly described by linearly increasing trends. Hutt's prediction about the effect of age then, was clearly not supported.

Examining her hypothesis more closely, one sees that it is based on the fact that with age comes increasing evaluative experience. The present results do not really contradict this. They provide evidence that older children have more definite, more clearly established patterns of preference than do younger children.

Observations of subjects making their preferences showed that, when confronted with the arrays of multidimensional polygons, the older subjects knew with more certainty which stimulus designs they liked,[23] and which ones they disliked. Observations also revealed that the older subjects had a more developed concept of the serial nature of the task than did the younger subjects. They responded more quickly to the task demands, and tended not to wait for ranking instructions to be repeated when subsequent sets of stimuli were presented. In general, the data in this thesis demonstrate that older subjects preferred the more complex stimuli to the simple ones, whether they were in colour, in black, with symmetry or without. And the data also demonstrate that they were less likely to alter their affective evaluations when stimuli appeared with additional properties such as colour or symmetry (Sets A, B and E). To that extent, having 'increased evaluative experience' may be interpreted as having more developed, or better established, patterns of stimulus preference. But the fact that the highly preferred stimuli were also the ones which sustained longer viewing times should not be taken to mean that their preferences were based upon attention. It means only that the two response measures are more closely related in older subjects. Their affective evaluations of the polygons with symmetry demonstrate plainly that there is more to preference than attention value. While symmetrical stimuli did not sustain any longer viewing times, they were clearly preferred to asymmetrical stimuli (Sets F and G).

When considering the preferences of younger subjects, the results also support Hutt in suggesting a lack of evaluative experience. Patterns of preference are not well developed, and the relative likes and dislikes of polygonal complexity are particularly difficult to predict, for they fluctuate according to the combination of aesthetic properties interacting in stimulus arrays (Sets A, B and E). Moreover, the reason why preferences are less likely to be determined by the attention value of stimuli is that the latter in turn is also subject to considerable fluctuation for subjects at young ages. Viewing times in Study I (Part One - asymmetrical stimuli) showed a significant quadratic component with a maximum at the second level of complexity (k = 5), that is, after 12 or 16 sides, the more complex the polygon, the less it sustained viewing time. In the second study (Part One) though, where symmetry was introduced, the quadratic component disappeared. The looking time function was basically flat. This result suggests then, that symmetry caused the young subjects to completely alter their allocation of attention towards stimulus complexity, such that all stimuli, symmetrical and asymmetrical, simple or complex, sustained equal interest. The important point about this change however, is that it was not reflected in preferences (Set E). More complex polygons were in general given higher preference values than simple polygons.

In conclusion then, the results of these experiments demonstrate that Hutt's hypothesis about the relationship between duration of viewing and preference is not a particularly sound one. Generally speaking, the two measures correlate with one another but not in the manner predicted by Hutt.

These results also demonstrate that as subjects become older, they exhibit more pronounced likes and dislikes, and that they are not as prone to change their patterns of exploratory viewing. The findings suggest then, contrary to Hutt, that with increasing age the attention value of stimulation is more likely to be a significant determinant of preference, whereas at young ages, preference is less likely to depend upon the attention value, as neither liking nor the distribution of attention is particularly well developed.

The present findings do not permit a definitive statement that attention is the basis of preference. Even among older subjects who demonstrated greater consistency in the two responses, the results do not imply that one is the basis of the other. This is still a matter of conjecture. The most striking evidence that aesthetic preferences are based upon factors other than attention can be seen in the second experiment with the introduction of symmetry. The presence of symmetry in polygons made no difference at all to the duration of viewing times, and yet symmetrical polygons were clearly preferred to asymmetrical polygons at all levels of complexity, and by children of all ages.

(2) The Effects of Individual Stimulus Variables

The use of three aesthetic stimulus variables not only provided a more thorough test of the relationship between aesthetic responses, but it also allowed for examination of the independent effects that each variable had on each of the two response measures. The experiments reported can therefore be viewed as contributing to our understanding of viewing time as a function of stimulus complexity, as a function of colour, and as a function of symmetry. They also provided data relating to children's preferences for complexity and symmetry. (Preference as a function of colour, it will be remembered, was not tested.) The following sections summarize the findings related to the three stimulus variables.

Complexity

Visual complexity has been studied more frequently than any other collative property in the new experimental aesthetics, but as Chapter Two showed, its effects on affective responses are not always predictable. Moreover, it has generally been studied in isolation from other stimulus properties with which it normally interacts.

Complexity and preference

The present research (Studies I and II - Part Two), which improved upon the means of representing the dimension of complexity evidenced in the paired-comparison studies (Munsinger et al, 1964; Munsinger & Kessen, 1966; Thomas, 1966; Stevenson & Lynn, 1971; Kaess & Weir, 1968), and which avoided the methodological errors of other polygon-preference studies (Hutt & McGrew, 1969; Eisenman et al, 1969) confirmed the findings of Aitken and Hutt (1974), which were that primary school children like complex figures more than they do simple figures. Moreover, it was found that this response to complexity is highly dependent upon the subject's age (confirming Baltes & Wender, 1971). A true preference for polygonal complexity does not become manifest until age 8 or 9, although there is some evidence that females below that age develop 'more mature' preferences before males do (Study I, Part Two). Furthermore, there is also evidence that young children (6/7s) respond favourably to high complexity if the stimuli are more meaningful to them. This was evidenced in both 6/7 males and females when all stimuli were symmetrical (thereby confirming Munsinger & Kessen, 1966b). It is of interest that the symmetrical stimuli evoked more comments and associations than did the more unfamiliar, asymmetrical stimuli. Finally, there is evidence for the first time that preferences for stimulus complexity remain the same when figures are presented in colour as well as in black and white.

In addition to a dependence upon age, there is evidence that preference for complexity is dependent upon the range of complexity presented. In Set G, which was composed of high complexity stimuli only (24 to 40 sides), preferences were significantly bitonic (inverted U-shaped). The same pattern was evidenced in Set K. Range effects have really only been studied systematically with variations in musical complexity (Steck & Machotka, 1975). The present findings establish the need for similar studies of variations in visual form.

At face value, the data in Sets G and K support Berlyne's theoretical position that intermediate levels of complexity will be more preferred, but more importantly they demonstrate once again that preference for complexity is dependent upon the type of stimulus material that is presented to subjects. In Set G, stimuli differed in complexity and in symmetry, and in Set K in complexity, symmetry, and in colour. The results suggest that the response to complexity is dependent upon not only the range of complexity presented, but also upon the number, and type of additional stimulus variables with which it interacts. It appears to be the case then, that the main effect of complexity on preference is easily altered or reduced by the addition of other (interacting) stimulus variables. One can speculate that what is already evidenced in these studies is the first emergence of something like the ceiling effect of complexity O'Hare and Gordon (1977) posited as occurring in multidimensional artistic stimuli. If this is the case, one would hypothesize that the addition of further stimulus variation (curvature, or degrees of symmetry for example), would reduce even further the importance of complexity as a major determinant of preferences.

Certainly, the present results demonstrate that the more stimulus variables there are interacting with complexity, the more difficult it is to predict the effect of the complexity variable itself.

Complexity and viewing time

The previous research on polygon viewing (Thomas, 1966; Munsinger & Weir, 1967; Kaess & Weir, 1968; Faw & Nunnally, 1968; Hutt & McGrew, 1969) suggested numerous improvements in design were necessary. In particular, these studies used a small number of stimuli to represent a limited number of complexity levels. Additionally, all the previous work relied upon paired-comparison presentation to determine durations of viewing, and allowed a limited, maximum amount of time which subjects could direct toward pairs of stimuli. In short, the concept of 'free' viewing was in question. Finally, previous research had studied mainly pre-school children. The one study which tested school-aged children was Thomas' temple bar press study, which required confirmation under more relaxed viewing conditions.

Results of the present work (Studies I and II, Part One) have established that in general, the more complex a polygon is, the longer will be the time spent viewing it. These results hold for stimuli which were both asymmetrical and symmetrical, and both chromatic and achromatic. They did not hold however, for children of all ages. The Age X Complexity interaction was significant in both studies, which resulted from the response to high levels of polygonal complexity being more pronounced among older subjects than younger subjects. These interactions are the first empirical confirmation of the trends that were observable in the graphs from Thomas' study.

As already noted, the presence of symmetry made a difference to the duration of viewing complex stimuli in younger children. It was suggested that symmetry influenced the perception of all stimuli, asymmetrical and symmetrical, such that subjects spent more time searching for elements of organization in the figures. The whole pattern of exploring polygons, particularly the complex ones, was therefore different in the second study. Again, this is to be interpreted as evidence that the response to variations in visual complexity depends very much upon the combination of stimulus variables with which complexity interacts.

Finally, it is to be noted that complexity had no effect at all on viewing times for the 6/7s in Study II. Here again the data suggest that the response to polygonal complexity is determined by other interacting polygonal characteristics. However, these data also suggest that stimulus novelty may have outweighed stimulus complexity. It will be remembered that opening the window would produce a picture that could appear in one of many different stimulus-variable combinations. It could be either red or blue or black or grey, with symmetry or without, and at one of many levels of figural complexity. For children at young ages, these variations represent a considerable range of appearance. The data show that even the simple 4-sided figures were examined for as long as the 40-sided ones. It is possible then, that young children responded to all stimuli, regardless of stimulus complexity, as if they were 'equally novel'. An hypothesis arising from this interpretation would predict that if the stimuli were made to vary along a fourth dimension, that the same lack of response to stimulus complexity would result for the next oldest group of subjects, the 8/9s.

Colour

Almost all recent studies in aesthetics that have presented laboratory-designed stimuli to children have presented them in black and white. The few studies presenting coloured stimuli have used colour as a means of varying collative variables, such as stimulus novelty (Berlyne & Parham, 1970), or complexity (Strain, 1968), or redundancy

(Clapp & Eichorn, 1965). In general however, the importance of colour as a significant contributor to affective appeal has recently been neglected. This is particularly the case in the study of visual complexity.

For the present research, colour was introduced as a dichotomous variable, represented on the one hand by a set of polygons appearing in black and grey on a white background, and on the other hand by the same shaped set of polygons in red or blue or green.

The variable of colour was employed in various ways. It was argued that in general, our understanding of children's preferences for variations in complexity and for symmetry would be better grounded if they were shown to hold true when the stimulus material was presented in colour. Specific hypotheses were also advanced, which dealt with the effect of colour on viewing time, and, with the affective salience (see section 3 below) of colour relative to complexity and symmetry.

Colour and viewing time

The presence of colour in polygons was conceptualized as increasing the affective value of those polygons, without altering their information content. It was argued that increased affective value would lead to longer viewing times, a hypothesis which had not been systematically tested before. This hypothesis was put forward as one complementary to Hutt's, namely that the relative pleasingness or preference value is a determinant of attention. Specifically, it was hypothesized that coloured polygons would sustain longer durations of viewing than the exact same-shaped achromatic polygons.

Results of the first study (Part One) confirmed the hypothesis, with the data showing the increase in viewing caused by the presence of colour was in the order of 6-7%. This result held for polygons at all levels of complexity, and for children of all ages tested. It was noted though, that polygons in each of the three individual colours occurred only 1/3 as frequently as the black polygons, and that the results could have been due to the relative novelty of these colours. Stimuli in Study II were therefore constructed to remove this possibility (achromatic stimuli were represented by black and grey, chromatic by blue and red), and results confirmed the findings of the first study. It should be noted that although this is the first time the effect of single colours on children's viewing times has been studied, these data confirm what Clapp and Eichorn (1965) found with a group of 5 year olds, using pairs of colours in meaningful stimuli as a measure of redundancy.

The present findings are not only of interest to developmental aesthetics, but they also have obvious application to classroom learning situations. The use of colour in today's classroom is very evident indeed, and teachers are well aware of its usefulness, for example, in assisting discrimination learning. However, if the addition of colour alone can significantly increase the attentive span of primary school children, it makes good sense to present all illustrations which are aids to learning, in colour, and not in black and white.

Symmetry

Symmetry, another visual property of traditional interest to aesthetics, has also been neglected in recent research, particularly with young subjects.

In these experiments, symmetry, like colour, was introduced as a dichotomous variable, represented on the one hand by a set of bilaterally reflective symmetrical polygons, and on the other hand by a set of asymmetrical, randomly-generated polygons. Specific hypotheses were advanced which dealt with the effect of symmetry on both responses - preference and viewing time.

Symmetry and viewing time

It was reasoned that the presence of bilateral symmetry in a stimulus, like the presence of colour, would add an affectively appealing component which was capable of influencing children's viewing behaviour. Specifically, it was hypothesized that symmetrical polygons would sustain longer viewing times than asymmetrical polygons. Results (Study II, Part One) did not confirm this. In fact, the amount of time spent viewing symmetrical stimuli was remarkably similar to that spent viewing asymmetrical stimuli, for children of all ages, and for all levels of stimulus complexity. While these results confirm what Day (1968b) found with adult subjects, they give no support to Hutt & McGrew's (1969) finding that the effect of symmetry on viewing time was dependent upon age. These authors reported that 5 year olds viewed symmetrical polygons longer, while 11 year olds viewed asymmetrical polygons longer. They presented only a limited range of complexity however, (up to 20 sides) as well as presented their stimuli in pairs, and the results may not be comparable for those reasons.

The results demonstrate that symmetry and colour have quite different effects on children's attention. While both are clearly preferred properties of stimuli, only the former is capable of increasing viewing times. The differences are interesting for several reasons, but primarily because they establish how difficult it is to pinpoint the factors which determine preference and affective attention in children. In terms of Hutt's major hypothesis, it is evident that there is more to preference than the attention value of stimuli. And conversely, in terms of the hypothesis complementary to Hutt's, it is equally the case that preferred stimulus properties do not always increase attention.

It has already been noted that, while symmetry did not increase the duration of viewing, it did change the pattern of viewing complex polygons in Study II for younger subjects. These changes were interpreted as symmetry functioning as a reference point which affected the manner in which children explored the polygons. Once perceived as a potential polygon characteristic, all polygons were inspected for the presence of symmetry, and quite reasonably, the more complex polygons sustained greater periods of inspection. To that extent, the property of symmetry can be viewed as having increased the duration of attentive viewing.

Symmetry and preference

Contrary to expectation, the property of symmetry as a determinant of children's preferences has received very little attention. Paraskevopoulos (1968) showed that children prefer symmetry in dot patterns, Eisenman et al (1969) reported that children preferred Birkhoff shapes to random polygons, while Hutt and McGrew (1969) found that symmetry did not affect polygon preferences (as measured by exploratory choice). That the two polygon studies were poorly designed suggested that a more comprehensive study of children's preferences for symmetry was in order.

The results of these experiments were unequivocal. Symmetrical stimuli at all levels of complexity, in all four colours, were highly preferred to asymmetrical stimuli, by children of all ages tested.

The results from Set G (24 to 40 sides) were most interesting because they showed the property of symmetry was more preferred at upper levels of complexity than at lower levels (Set F). This was interpreted as being due to the very nature of symmetry's aesthetic appeal, i.e. its capacity to impose order on disorder, to give balance to randomness. It was suggested that the greater the perceived complexity of a stimulus, the more the need to impose order, and therefore the higher the evaluation of figures which demonstrate such organization.

(3) Affective Salience

The reported studies on affective salience were concerned entirely with children's preferences. Experiments were designed to determine the relative weight or influence that different stimulus properties have in determining preferences for multidimensional stimuli. They were conceived because in everyday aesthetic behaviour it is seldom the case that we are confronted with a set of aesthetic stimuli which differ from one another in only one respect. More often than not, stimuli differ in a number of ways. Some we appreciate because they appear in colour, others we like because they have symmetry. Others we judge appealing for their complexity. These different stimulus properties can be said to 'compete' with one another. They exert competing influences on our preferences, and the extent to which some have more potency or influence than others represents what I have called their affective salience.

If we think back to Fechner's original formulation of 'aesthetics from below', we realize how fundamental to aesthetics is the problem of affective salience. Fechner, quite correctly, viewed a finished, complex work of art as a combination of interacting stimulus properties. His intent was to establish how variations along single stimulus dimensions affected preferences. Eventually, he hoped, it would be possible to build up a more comprehensive picture of evaluative responses to complex works of art from a knowledge of the responses to its single, constituent properties. However, the history of experimental aesthetics shows that this has not been the case. Fechner's approach failed because not enough effort has been devoted to examining responses to stimuli which vary systematically along more than one dimension. The approach taken in this thesis rectifies this failing. Moreover, the stimuli chosen for study closely approximate examples of genuine art. The examples illustrated (see Fig. 1, p.13), may be described with the same number of stimulus dimensions employed in these experiments.

The initial experiments (Sets C, D and H) were designed such that subjects would experience a conflict of aesthetic choice, between preference for high complexity stimuli on the one hand, and preference for simple, but coloured (or symmetrical) stimuli on the other hand. It was argued that if the presence of colour (or symmetry) significantly raised the preference value of the normally non-preferred simple stimuli, at the expense of the normally preferred complex stimuli, then one could attribute a degree of affective salience to either colour or symmetry.

Quantitative measurement of affective salience arose from consideration of the research dealing with dimensional dominance, in which only one of two or more stimulus dimensions is selected to make a judgment of similarity between stimuli. In that literature, the 'cognitive' salience of a dimension can be determined by counting the number of times it was chosen, however in these experiments it was recognized that affective salience could only be determined relatively. Nevertheless, it was argued that the relative affective salience of colour and of symmetry would be exhibited if the resulting preference functions in Sets C, D and H were significantly different from the baseline preference for complexity function.

In the first experiment, colour was predicted to be more salient with young children, as they were more likely to be colour-salient (cognitively speaking). The results (Sets C and D) adequately demonstrated the salience of colour, that is, colour effectively competed with stimulus complexity, but the hypothesis relating to age was only partly confirmed. Colour was particularly salient with young boys (6/7s), but not with young girls of the same age. These data were interpreted to mean that the affective salience of colour depends upon how well established is preference for stimulus complexity. For subjects who have definite preferences for high levels of complexity (8/9s, 10/11s), colour will be only moderately salient. Among subjects who show a definite preference for simple shapes on the other hand (6/7 males), colour will be highly salient, and will function as a major determinant of preference. Young girls (6/7), it was argued, are in a transition stage in the development of preferences for complex stimuli. Evidence from the dimensional dominance research corroborates this interpretation, because it shows that young girls at this age develop form salience earlier than boys do, or, expressed differently, that colour is not as dominant a dimension for girls as it is for boys. A prediction following from this interpretation would hold that girls in the 4/5 age range (classified cognitively as colour-dominant) would exhibit the same marked response to colour as the boys tested in this study did.[24]

In the second experiment the affective salience of symmetry relative to visual complexity was tested. Results showed that the presence of symmetry in combination with stimuli of low complexity significantly increased the preference value of all those stimuli at the expense of high complexity asymmetrical stimuli (Set H). An important difference between colour and symmetry was shown in that the affective salience of the latter was constant at all ages. The salience of symmetry did not depend upon how well established was preference for complexity. This difference suggests that symmetry has greater affective salience than colour. In addition, comparison of the statistical results relating to the salience of colour and that of symmetry provided indirect evidence to the same effect, namely, that symmetry was a more potent determinant of preference than was colour.

The final experiment was designed to test this. Sets of stimuli were presented which effectively produced a competition between preference for symmetry and preference for colour. Results of all four sets

(Sets J to M) established conclusively that symmetry is a more affectively salient property of stimuli than colour is.

In terms of establishing a hierarchy of salience, these experiments affirm that symmetry overrides colour as a determinant of children's preferences. Moreover, the influence of both colour and symmetry has been demonstrated to be greater than stimulus complexity, but only to an extent. Stimulus complexity cannot be completely outweighed as a determinant of preference in multidimensional stimuli. High polygonal complexity still predominates, when competing with colour or with symmetry.

Concluding Comments

Several questions have been investigated in this thesis. On a general level, the present experiments document that young primary school children are capable of responding meaningfully to aesthetic stimuli. The subjects tested exhibited definite likes and dislikes for the visual figures presented to them for evaluation, and, they were willing to spend considerably different lengths of time passively viewing those figures. To that extent, the children were aesthetically sensitive to the variations in the visual properties constituting the stimuli.

Such sensitivity however, was found to be very much dependent upon the child's age. Younger subjects did not exhibit a systematic pattern of preference toward the dimension of stimulus complexity for example, as did the older subjects, nor did their duration of viewing the complex and simple stimuli show the same consistency as did that of the older children. To that extent, these experiments provide further information about the developmental, maturational changes in evaluative experience.

That the responses of the young children fluctuated according to the number and type of stimulus properties interacting in the polygons, makes it difficult to establish the nature of the relationship between preference and viewing. It is clear however, that Hutt's explanation of preference as depending upon the attention value of stimuli is not wholly satisfactory. It gains only limited empirical support from the results of this study. Not only are young children's preferences not closely related to their viewing times, which is contrary to her predictions, but the relationship between preference and viewing in older subjects is also not always as close as Hutt predicts.

Hutt maintains that children will like best what holds their attention most. A more accurate expression of the relationship is that children will dislike most what holds their attention least.

It is apparent that many factors will determine a child's visual preferences. Attention-value is just one of them. One of the most interesting and unexpected findings which relates to this point is the effect of symmetry on viewing time. Symmetry made no difference at all to viewing but was clearly a highly preferred property, for children of all ages. Children's preferences are thus seen to be based upon factors other than attention value.

The study of affective salience is I believe, of central importance to 'the new experimental developmental aesthetics'. Just as the cognitive studies of dimensional salience have investigated the hierarchy of dimensions involved in children's classification and similarity-judgment behaviour, so has the present work attempted to establish a hierarchy of preferential salience for properties determining an affective response. The extent to which both colour and symmetry can counterbalance, indeed outweigh the affective appeal of stimulus complexity has been demonstrated. These results have implications for the many preference-for-complexity studies cited earlier. They prove that complexity can have limited affective salience as a determinant of children's visual preferences, and they emphasize the impracticality of studying complexity to the exclusion of other important stimulus properties with which it normally interacts.

These experiments have also demonstrated convincingly that symmetry has much greater affective salience than colour for primary school children. While this is the first study of this phenomenon, these results extend, as well as agree with the research findings of cognitive saliences, in that a parameter of form (represented by symmetry) is more salient than colour.

To conclude, it is my belief that the study of aesthetic preferences must inevitably tackle in detail the problem of affective salience. When human beings examine works of art, it is conspicuous that some artistic properties have greater appeal than others. We must make further efforts to understand the nature of this differential appeal.

The experimental methods used in this study are a beginning. They have been employed to investigate young subjects who are unfamiliar with the art world, and who are just beginning to develop aesthetic sensitivities. And they have been utilized with just three of the basic visual ingredients of artistic works - complexity, colour and symmetry.

I would concur with many of the critics of the Fechnerian-Berlynian approach who point out that such methods may never allow an understanding of the intricate gestalts operating in an impressionist Monet, for example. However, I would argue just as strongly that there are many works of art, particularly in the modern schools, which permit an affective salience analysis of their constituent properties. By careful addition of further variables to the visual figures we present, the range of artistic stimuli that can be investigated in this manner can be considerably extended.

FOOTNOTES

(1) Daniel E. Berlyne's death last year is a significant loss to the experimental study of aesthetics.

(2) The opening sentences in the only two reviews of aesthetics which have been published in the Annual Review of Psychology illustrate this point. Pratt (1961) writes that "Aesthetics has no clearly defined boundaries or directions", while Child (1972) states that "Psychological esthetics, broadly defined, is so diverse that major progress in the 11 years since Pratt's review is hard to summarize briefly."

(3) The actual size of finished works of art is of course not always comparable to the size of stimuli presented in the laboratory. However, dimensions of all stimuli presented in this study were 10" x 10", which compare favourably with Kelly's "Study for a Sculpture" (9" x 9"), and with his "White on Green" (13" x 11"). Kelly's "Red White" is considerably larger (81" x 90 3/4"), and could only be approximated if laboratory stimuli were presented as slide projections on a screen, as they are in many studies (Smith & Dorfman, 1975, for example).

(4) Smith and Dorfman's stimuli, though published as black and white, were actually presented as green and white. They were selected for comparison with Malevich's painting as the published illustration of their stimuli was most suitable for photographic reproduction.

(5) In some respects Irwin's analysis of preference is limited because of his exclusive reliance upon hypothetical examples of the paired-comparison type. The inclusion of multiple choice, or rank ordering tasks as examples would have proven interesting extensions, but may well have presented irresolvable problems within the specifics of the argument. With more than two stimuli to discriminate between, or to rank order, the formulation of multiple outcomes is necessitated, which would presumably have to be weighted relative to one another in some manner.

(6) The concept of pleasure has not always been regarded as an integral factor in aesthetic behaviour. Bullough expressed his own views quite strongly on this point some years ago:

> To speak, therefore, of the 'pleasure value' of Art, and to introduce hedonism into aesthetic speculation, is even more irrelevant than to speak of moral hedonism in Ethics. Aesthetic hedonism is a compromise. It is the attempt to reconcile for public use utilitarian ends with aesthetic values. Hedonism, as a practical personal appeal, has no place in the distanced appeal of Art.
>
> (1912, p.118)

Certainly Bullough would argue with Berlyne's working assumption that certain works of art can be classified according to their 'hedonic value' (which includes pleasure, reward value, positive feedback, attractiveness, and positive incentive). Nor would Bullough agree with Metzger's thesis that "all art should give pleasure" (1965).

(7) Skinner also held that time spent viewing could be regarded as a measure of the reward value of a stimulus. He stated that

> A direct inventory may be made by allowing a subject to look at an assortment of pictures and recording the time he spends on each. The behavior of looking at a picture is reinforced by what is seen. Looking at one picture may be more strongly reinforced than looking at another, and the times will vary accordingly.
>
> (1953, p.74)

(8) The term 'verbal preference' can be slightly misleading. If a child merely points to a stimulus, in response to the instruction 'Which one do you like best?', the response is technically a non-verbal one; it is silent. However, in view of the fact that in a given experiment some subjects will express their preferences by pointing, while others will actually state 'I like that one' (or variants thereof), it is felt that the meaning of verbally expressed preferences is sufficiently clear to cover both types of responses.

(9) Interestingly, Bullough also held that "the more intense the aesthetic absorption, the less one 'likes', consciously, the experience".

(10) Another study by May and Hutt (1974), which also manipulated a collative variable, uncertainty, was similarly concluded with the same proposal. It is not included in Table I though, because the actual duration of viewing time was not recorded. Instead, preference was compared with the n u m b e r of times children pressed buttons to view different displays of lights varying in uncertainty.

(11) In chronological order, the 18 studies are: Smock and Holt (1962), May (1963), Cantor et al (1963), Hoats et al (1963), Pielstick and Woodruff (1964, 1968), Clapp and Eichorn (1965), Thomas (1966), Banta et al (1966), Munsinger and Weir (1967), Faw and Nunnally (1968), Kaess and Weir (1968), Faw (1969), Faw et al (1969), Hutt and McGrew (1969), Kreitler et al (1974), Wohlwill (1975a,b).

(12) The temple bar press was designed by Thomas, and is described as follows:

> For measuring the length of viewing in the individual method ... a special apparatus was constructed .... Briefly, the apparatus used as an instrumental response a temple bar press. The S, seated in a chair, rested his chin on a small pillow chin rest. On either side of his head, and close to his temples, were two movable vertical members. By rocking his head to one side and exerting a slight but continuous pressure on one of the movable members, the S could display for his viewing a stimulus on an 8 x 8 in. opal-glass screen about 3 ft. in front of him. Rocking his head to the other side caused a second stimulus to be displayed. The S was in effect controlling a 35 mm. projector in which a pair of stimuli had been placed for viewing. The length of time each stimulus was projected was recorded; that stimulus displayed the longest was taken as the preferred stimulus.
>
> (1966, p.845)

(13) Further evidence that black (and grey) are associated with negative affect on the Emotions Profile Index can be found in the work of Aaronson (1970). Oyama et al (1962) found similarly that black and grey were negatively evaluated on semantic differential scales with high loadings on the Evaluation factor (see also Adams and Osgood, 1973).

(14) A recent study by Chipman (Chipman and Mendelson, 1975) produced some interesting evidence that children can distinguish between pairs of checkerboard patterns varying in complexity, defined by amount of contour and by the presence of types of symmetrical arrangement of the black squares on the white background. Instead of asking for judgments of complexity, subjects judged which of the pair was 'simpler'. Chipman reports that even $4\frac{1}{2}$ to $5\frac{1}{2}$ year olds could detect and respond to changes in contour, but were not responsive to the structural properties of the patterns (symmetrical arrangements). Older children (7 to 8) responded to both amount of contour and to structure. The authors stated that "there appears to be no inherent difference between the child's and the adult's comprehension of the word 'simple' ".

(15) The high complexity colour, low complexity black set is included to deal with the possibility that simple stimuli are preferred to complex ones in the baseline. Presenting high complexity stimuli in colour then, would be a suitable test of colour's salience, since it is effectively doing the same thing as in the other set, namely, pairing colour with nonpreferred stimuli.

(16) Additional reasons for suggesting that colour ought to have higher affective salience at young ages can be found in developmental research in related areas. A study conducted by Machotka (1966) involved presenting paintings in groups of three to 6 to 12 year olds. Subjects were asked for their preferences as well as for the reasons for their choice. Analysis showed that 58% of the 6 year olds and 35% of the 7 and 8 year olds justified their preferences by mentioning colour. With increasing age, the use of colour as a criterion for preferring paintings decreased. Research on children's use of colour when responding to Rorschach ink blots is also interesting in relation to the affective salience of colour. Ames et al (1952) found that Rorschach responses scored for colour (C, CF and FC responses) were most frequent at age 7, not noticeably declined thereafter.

(17) It should be noted that all readings were taken under Illuminant 'C' viewing conditions, whereas stimuli were presented to subjects under viewing conditions approximating Illuminant 'A'. Photometric measurements of the red, green and blue stimuli, taken when properly mounted on the stimulus background board under the Illuminant 'A' source, gave luminances of 1.6, 1.9 and .8 foot lamberts, respectively. The luminance from the black stimuli was .57 foot lamberts. All stimuli were mounted on the same white background board which had a luminance of 6.3 foot lamberts.

(18) The colour grey is seldom presented in colour preference studies, and hence very little is known about its relative affective value. More often than not, grey is used as the neutral background against which other colours are placed for judgments. A study by Staples (1932) with infants relates closely to the present design, however. Staples

presented infants (below the age of 2) with pairs of coloured discs: red with grey, blue with grey, and green with grey. Her results showed that "each of the four colours was looked at for a greater number of seconds than the simultaneously presented and equally bright grey".

(19) All but four subjects had not been tested previously. The four who took part in the earlier experiment (6 months earlier) had to be included in this experiment because the school at that time had a shortage of eligible colour-normal pupils in the 10/11 year group.

(20) Dividing an asymmetrical polygon into two parts is not straightforward, particularly with complex polygons which contain internal angles. In certain instances the line connecting the two points created an additional side, or left a gap in the middle of the sectioned polygon. In such cases, a new point of intersection immediately to one side of the randomly determined point was selected and the operation repeated. Gaps which did remain between the two mirror-imaged halves were filled in. Generally, construction of symmetrical polygons resulted in an increase in area.

(21) The reader will note that low complexity, symmetrical figures (4 to 20 sides) appear three times for rank ordering - in Sets E, F and H. As there are only two different shapes at each level of complexity, and three sets in which five low complexity symmetrical shapes must appear, one set of five shapes had to be presented twice, albeit in a different colour. This was felt undesirable, as some subjects might recognize the shape of a stimulus on its second appearance. Note that this problem of recognizing repeated shapes has already been avoided in two of the four groups, because 10 blue and 10 black symmetrical stimuli (which include the five low complexity symmetrical polygons) were reversed 180^{o} in forming Set E. To avoid recognition in the other two groups, the five symmetrical stimuli concerned were also reversed 180^{o}, but in Set F. Of 60 subjects, six remarked that some of the figures 'looked like' stimuli they had seen previously.

(22) Owing to the small size of the school, not all subjects could be technically 'naive'. Twenty-two children (12 female) who had already taken part in a previous experiment, had to be selected for a second time. Sixteen of these had served in the first experiment (a year before this one), six in the second experiment (3 months previous). These six were the only ones to have had any exposure to symmetrical figures. No subjects were aware of the purpose of the experiment.

(23) That older children were observed to respond with more certainty when asked to rank order the polygons by liking may also mean that their concept of 'liking' was better developed than that of younger subjects. As Bolton points out in a discussion of the development of language

> It is evident that the child's ability to use words to refer to different aspects of his experience is dependent upon the development of cognitive skills connected with both the differentiation of subjective desires and feelings from external reality and with the comprehension of the intentions towards that external reality.
>
> (1977, p.56)

(24) This prediction was tested in a follow-up study to this one. Young girls preferred simple shapes to complex ones, when the range of complexity presented included polygons from 4 to 40 sides, but varied in 6 increments as opposed to 10. When these subjects were presented with their preferred shapes in black, their non-preferred shapes in a colour, their pattern of preference toward stimulus complexity changed significantly (like that of the 6/7 males in Set D). They preferred colour to simplicity.

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APPENDICES

The appendices contain summary tables for the analyses of variance. All significant main effects and interactions which appear in the text are included in the tables. Probabilities are only given for significant results, however. All values appearing in the tables have been rounded off to two decimal places, although the actual analyses were carried out to four decimal places.

Appendix 1, 2 and 3 present the summary tables for Parts One, Two and Three in Chapter Three, respectively. Appendix 4, 5 and 6 present the summary tables for Parts One, Two and Three in Chapter Four, respectively. Appendix 7 presents the summary tables for Chapter Five.

Appendix 1: Chapter Three, Part One

Viewing Times

1a. Viewing Times as a Function of Complexity and Colour

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Complexity = Cp, Colour = Cl

Source	df	SS	MS	F	Prob
Subj	71	97103984.09			
A	2	7311028.26	3655514.13	2.70	n.s.
S	1	71023.33	71023.33	<1	n.s.
A x S	2	478685.05	239342.53	<1	n.s.
Error	66	89243247.44	1352170.42		
Cp	4	1609720.74	402430.19	22.26	<.000001
Cp x A	8	622579.26	77822.41	4.30	<.0002
Cp x S	4	117782.39	29445.60	1.63	n.s.
Cp x A x S	8	233701.66	29212.71	1.61	n.s.
Error	264	4773040.35	18079.70		
Cl	1	279464.20	279464.20	17.76	<.00025
Cl x A	2	21496.32	10748.16	<1	n.s.
Cl x S	1	9716.70	9716.70	<1	n.s.
Cl x A x S	2	64707.27	32353.63	2.06	n.s.
Error	66	1038839.41	15739.99		
Cp x Cl	4	63732.92	15933.23	1.26	n.s.
Cp x Cl x A	8	156652.83	19581.60	1.55	n.s.
Cp x Cl x S	4	35248.72	8812.18	<1	n.s.
Cp x Cl x A x S	8	69576.08	8697.01	<1	n.s.
Error	264	3331173.05	12618.08		

Appendix 1 (cont'd)

1b. Viewing Times as a Function of Complexity for the Three Age Groups

Complexity = Cp

6/7s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	23	494271.00			
Cp	4	6042.11	1510.53	4.51	<.01
Error	92	30815.09	334.95		

8/9s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	23	292620.20			
Cp	4	10513.06	2628.27	7.65	<.001
Error	92	31601.34	343.49		

10/11s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	23	1009633.57			
Cp	4	28289.37	7072.34	17.39	<.001
Error	92	37425.10	406.79		

Appendix 2: Chapter Three, Part Two

Preferences

2a. Comparison of Complexity Preferences between Chromatic and Achromatic Stimuli

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Set = St

Source	df	SS	MS	F	Prob
Subj	71	307834.75			
A	2	83343.88	41671.94	13.43	<.0001
S	1	484.00	484.00	<1	n.s.
A x S	2	19183.88	9591.94	3.09	<.0501
Error	66	204823.00	3103.38		
St	1	205.44	205.44	<1	n.s.
St x A	2	2387.10	1193.55	2.03	n.s.
St x S	1	110.25	110.25	<1	n.s.
St x A x S	2	852.04	426.02	<1	n.s.
Error	66	38640.17	585.46		

2b. Sex Differences in Preference for Complexity among the 6/7s

Analysis of Variance Summary Table

Between-subject variables: Sex = S
Within-subject variables: Set = St

Source	df	SS	MS	F	Prob
Subj	23	70159.31			
S	1	14735.02	14735.02	5.85	<.02
Error	22	55424.29	2519.29		
St	1	1575.52	1575.52	1.89	n.s.
St x S	1	212.52	212.52	<1	n.s.
Error	22	18324.46	832.93		

Appendix 2 (cont'd)

2c. Comparison of Set C and Baseline Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Set = St

Source	df	SS	MS	F	Prob
Subj	71	289120.49			
A	2	63313.01	31656.51	10.15	<.0003
S	1	189.06	189.06	<1	n.s.
A x S	2	19695.54	9847.77	3.16	<.047
Error	66	205922.88	3120.04		
St	1	7906.17	7906.17	14.70	<.0005
St x A	2	3997.26	1998.63	3.71	<.03
St x S	1	437.51	437.51	<1	n.s.
St x A x S	2	1499.85	749.92	1.39	n.s.
Error	66	35504.71	537.95		

2d. Comparison of Set D and Baseline Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Set = St

Source	df	SS	MS	F	Prob
Subj	71	262422.64			
A	2	46957.18	23478.59	7.57	<.002
S	1	0.44	0.44	<1	n.s.
A x S	2	10873.60	5436.80	1.75	n.s.
Error	66	204591.42	3099.87		
St	1	434.03	434.03	<1	n.s.
St x A	2	9631.51	4815.76	5.81	<.005
St x S	1	1248.44	1248.44	1.51	n.s.
St x A x S	6	4192.76	2096.38	2.53	n.s.
Error	66	54663.25	828.23		

Appendix 2 (cont'd)

2e. Comparison of Set D and Baseline Preferences in 6/7 Males

Analysis of Variance Summary Table

Set = St

Source	df	SS	MS	F	Prob
Subj	11	14618.46			
St	1	13207.04	13207.04	7.57	<.03
Error	11	19196.46	1745.13		

Appendix 3: Chapter Three, Part Three

Comparison of Viewing Times and Preferences (asymmetrical stimuli)

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Response = R

Source	df	SS	MS	F	Prob
Subj	71	178211.94			
A	2	73204.63	36602.31	25.13	<.0001
S	1	22.56	22.56	<1	n.s.
A x S	2	8869.88	4434.94	3.04	n.s.
Error	66	96114.88	1456.29		
R	1	3570.06	3570.06	2.25	n.s.
R x A	2	1994.04	997.02	<1	n.s.
R x S	1	895.01	895.01	<1	n.s.
R x A x S	2	5716.68	2858.34	1.80	n.s.
Error	66	104834.71	1588.40		

Appendix 4: Chapter Four, Part One

Viewing Times

4a. Viewing Times as a Function of Complexity, Colour and Symmetry

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Complexity = Cp, Colour = Cl, Symmetry = Sm

Source	df	SS	MS	F	Prob
Subj	59	32111030.58			
A	2	4739421.79	2369710.89	4.81	<.012
S	1	215445.20	215445.20	<1	n.s.
A x S	2	577015.58	288507.79	<1	n.s.
Error	54	26579148.02	492206.44		
Cp	4	1083418.61	270854.65	26.90	<.000001
Cp x A	8	364297.72	45537.22	4.52	<.0002
Cp x S	4	41890.53	10472.63	1.04	n.s.
Cp x A x S	8	139162.03	17395.25	1.73	n.s.
Error	216	2175076.31	10069.80		
Cl	1	315219.67	315219.67	37.15	<.00001
Cl x A	2	1467.67	733.83	<1	n.s.
Cl x S	1	2422.52	2422.52	<1	n.s.
Cl x A x S	2	18607.18	9303.59	1.09	n.s.
Error	54	458197.72	8485.14		
Sm	1	402.52	402.52	<1	n.s.
Sm x A	2	5939.04	2969.52	<1	n.s.
Sm x S	1	33148.54	33148.54	2.96	n.s.
Sm x A x S	2	41237.57	20618.79	1.84	n.s.
Error	54	604070.48	11186.49		
Cp x Cl	4	8237.66	2059.42	<1	n.s.
Cp x Cl x A	8	33130.84	4141.36	<1	n.s.
Cp x Cl x S	4	71264.76	17816.19	2.85	<.03
Cp x Cl x A x S	8	43514.43	5439.30	<1	n.s.
Error	216	1347950.31	6240.51		
Cp x Sm	4	16444.46	4111.11	<1	n.s.
Cp x Sm x A	8	44675.32	5584.41	<1	n.s.
Cp x Sm x S	4	14537.99	3634.50	<1	n.s.
Cp x Sm x A x S	8	62328.39	7791.05	1.14	n.s.
Error	216	1480613.45	6854.69		

4a. (cont'd)

Cl x Sm	1	46.81	46.81	<1	n.s.
Cl x Sm x A	2	3706.12	1853.06	<1	n.s.
Cl x Sm x S	1	10579.14	10579.14	1.36	n.s.
Cl x Sm x A x S	2	4188.75	2094.38	<1	n.s.
Error	54	420994.54	7796.20		
Cp x Cl x Sm	4	49003.96	12250.99	1.56	n.s.
Cp x Cl x Sm x A	8	80822.71	10102.84	1.29	n.s.
Cp x Cl x Sm x S	4	11815.37	2953.84	<1	n.s.
Cp x Cl x Sm x A x S	8	50792.27	6349.03	<1	n.s.
Error	216	1692788.09	7836.98		

4b. Viewing Times as a Function of Complexity for the Three Age Groups

Complexity = Cp

6/7s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	19	87161.39			
Cp	4	1264.59	316.15	1.01	n.s.
Error	76	23803.61	313.21		

8/9s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	19	185528.96			
Cp	4	19181.16	4795.29	11.27	<.001
Error	76	32339.24	425.52		

10/11s: Analysis of Variance Summary Table

Source	df	SS	MS	F	Prob
Subj	19	824308.59			
Cp	4	38793.19	9698.30	18.75	<.001
Error	76	39300.41	517.11		

Appendix 5: Chapter Four, Part Two

Preferences

5a. Comparison of Complexity Preferences between Symmetrical and Asymmetrical Stimuli

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S, Set = St

Source	df	SS	MS	F	Prob
Subj	131	319124.90			
A	2	65570.18	32785.09	17.13	<.00001
S	1	441.33	441.33	<1	n.s.
St	1	378.33	378.33	<1	n.s.
A x S	2	16364.60	8182.30	4.28	<.015
A x St	2	2932.97	1466.48	<1	n.s.
S x St	1	145.09	145.09	<1	n.s.
A x S x St	2	3649.29	1824.64	<1	n.s.
Error	120	229643.10	1913.69		

5b. Age and Sex Differences in Preferences for Symmetrical Stimuli

Analysis of Variance Summary Table

Age = A, Sex = S

Source	df	SS	MS	F	Prob
Subj	59	1169.43			
A	2	214.94	107.47	6.54	<.003
S	1	0.37	.37	<1	n.s.
A x S	2	66.51	33.26	2.02	n.s.
Error	54	887.61	16.44		

Appendix 5 (cont'd)

5c. Comparison of Set H and Baseline Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S, Groups = G

Source	df	SS	MS	F	Prob
Subj	131	361661.80			
A	2	64363.05	32181.52	14.65	<.00001
S	1	156.80	156.80	<1	n.s.
G	1	13069.11	13069.11	5.95	<.016
A x S	2	16909.57	8454.79	3.85	<.024
A x G	2	2229.48	1114.74	<1	n.s.
S x G	1	421.53	421.53	<1	n.s.
A x S x G	2	983.66	491.83	<1	n.s.
Error	120	263528.60	2196.07		

5d. Comparison of Set H and Set E Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Set = St

Source	df	SS	MS	F	Prob
Subj	59	223871.67			
A	2	40818.20	20409.10	6.37	<.003
S	1	.20	.20	<1	n.s.
A x S	2	10069.27	5034.63	1.57	n.s.
Error	54	172984.00	3203.41		
St	1	16403.41	16403.41	23.05	<.00001
St x A	2	418.47	209.23	<1	n.s.
St x S	1	66.00	66.00	<1	n.s.
St x A x S	2	1288.87	644.43	<1	n.s.
Error	54	38423.75			

Appendix 6: Chapter Two, Part Three

Comparison of Viewing Times and Preferences (symmetrical stimuli)

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S
Within-subject variables: Response = R

Source	df	SS	MS	F	Prob
Subj	59	101547.10			
A	2	23182.82	11591.41	8.56	<.0007
S	1	.68	.68	<1	n.s.
A x S	2	5239.55	2619.78	1.93	n.s.
Error	54	73124.05	1354.15		
R	1	336.68	336.68	<1	n.s.
R x A	2	3092.45	1546.23	1.63	n.s.
R x S	1	60.21	60.21	<1	n.s.
R x A x S	2	2035.72	1017.86	1.07	n.s.
Error	54	51277.45	949.58		

Appendix 7: Chapter Three

Affective Salience of Colour and Symmetry

7a. Comparison of Set L and Set C Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S, Set = St

Source	df	SS	MS	F	Prob
Subj	131	223919.50			
A	2	22154.26	11077.13	7.67	<.0009
S	1	935.76	935.76	<1	n.s.
St	1	7415.55	7415.55	5.13	<.024
A x S	2	302.05	151.02	<1	n.s.
A x St	2	8150.89	4075.45	2.82	n.s.
S x St	1	564.40	564.40	<1	n.s.
A x S x St	2	11022.14	5511.07	3.81	<.024
Error	120	173374.50	1444.79		

7b. Comparison of Set M and Set H Preferences

Analysis of Variance Summary Table

Between-subject variables: Age = A, Sex = S, Set = St

Source	df	SS	MS	F	Prob
Subj	119	238629.60			
A	2	15182.07	7591.03	3.99	<.021
S	1	11.41	11.41	<1	n.s.
St	1	4876.88	4876.88	2.57	n.s.
A x S	2	2043.47	1021.73	<1	n.s.
A x St	2	8396.60	4198.30	2.21	n.s.
S x St	1	18.40	18.40	<1	n.s.
A x S x St	2	2792.07	1396.03	<1	n.s.
Error	108	205308.70	1901.00		