ABSTRACT

INCONGRUITY: THE EFFECT OF
SYSTEMATICALLY ALTERED DRAWINGS
ON ADULTS' RATINGS OF INCONGRUITY,
UNFAMILIARITY, AND RELATED DIMENSIONS

By

Richard Robert Knight

Drive-reduction conceptions of motivation have failed to explain a variety of behaviors. Among these are orientation, exploration, manipulation, and play. The explanation of these behaviors, particularly exploration, has been the aim of a considerable body of research.

There have been some attempts to determine physiological concomitants of exploration, but the majority of research has examined the conditions of stimulation in which exploration is elicited. In general, these conditions are novelty, complexity, and incongruity. The least is known about incongruity. Various definitions and theoretical treatments of this term have hypothesized the existence of an expectation, whose disconfirmation results in changes in activation or arousal.

Because of the importance of previous experience implied by expectations, incongruity may be a useful variable in developmental studies of exploration, play, fear, and cognitive development, by explaining phenomena in these areas in terms of arousal processes. Lack of any systematic attempt to define incongruity has limited its usefulness, however. The aim of this research was to clarify the

meaning of incongruity; to define it in terms of specific alterations of specific figures.

Accordingly, ten drawings were made, five of living figures and five of nonliving figures. Each was altered in four ways: Missing part; Misplaced part; Wrong part; Misplaced and Wrong part. Each manipulation was performed on both the head and leg of the living figures, resulting in three classes of figures: Living, head manipulated; Living, leg manipulated; Nonliving. The resulting drawings were seventy in number, ten unaltered; sixty altered.

College students (N=240) rated the seventy drawings on six dimensions: Incongruity; Complexity; Interestingness; Pleasingness; Unfamiliarity; Conflictfulness. Each subject rated each drawing once on only one dimension.

The ratings were highly reliable and were not influenced by several potential confounding factors. Analyses of variance of the ratings showed that 'Manipulation' and 'Class of figure' influenced the ratings on all six scales. Their interaction influenced ratings on five scales. The manipulation rated most incongruous was 'Misplaced and Wrong part'; the least incongruous was 'Missing part'. 'Living figures with the head manipulated' were rated most incongruous, and 'Nonliving' the least incongruous. The most incongruous combination of 'Manipulation' and 'Class' was 'Living figures with head Misplaced and Wrong'; the least was 'Nonliving figures with a part Missing'. It was also noted that manipulations performed on the head resulted in particularly high ratings of incongruity.

Ratings on all scales except pleasingness correlated positively with each other. Pleasingness ratings correlated negatively with all others. This indicates that incongruity shares meaning with complexity, interestingness, unfamiliarity, conflictfulness, and displeasingness. Some evidence was presented that incongruous figures are more than simply novel; that in addition to novelty they have a component that results in judgments of incongruity. That component is some combination of specific alterations made on specific kinds of figures.

A differential effect of incongruity and unfamiliarity upon looking time was hypothesized. If incongruity and novelty are different dimensions of stimulation, then familiarisation would result in a greater decrease in looking time to less incongruous figures than to more incongruous figures.

Previous studies have used figures of only moderate incongruity. Inclusion of the broader range of incongruity in the presently-used figures would likely enhance the effect of incongruity on visual exploration and physiological processes associated with arousal, and thus help to explicate the process by which these effects are produced.

Suggestions for further research included the effect of incongruity on visual exploration, play, and the development of fear.

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# INTRODUCTION

The period from the late 1940s to the present has seen great changes in psychological conceptions of motivation. The single most important factor driving these changes has been the recognition that certain behaviors resist explanation by traditional motivational theories. These behaviors, called "ludic" behaviors (from the Latin ludus, meaning play or game), generally are classifiable as exploration and play. Their most damaging feature, as far as the drive-reduction theories of the 1930s and 40s were concerned, was that they served no obvious biological purpose and reduced no biological or learned drive. Animals played and explored most insistently precisely when biological drives had been satisfied. The drive-reduction theories' failure to explain these ludic behaviors was generic; that is, the theories, given their fundamental premises about the bases of behavior, were incapable of explaining how painful stimulation, changes in homeostatic conditions, or previously neutral stimuli associated with either of these, could account for the intensity and direction of ludic behavior.

The following review of literature examines a sample of research on exploratory behavior which figured in the abandonment of the traditional drive-reduction model. Exploratory behavior in human subjects has been an important part of this research, and has been dominated by Daniel E. Berlyne. This work has been largely concerned with the conditions of the stimulus situation in which visual exploration occurs. Another approach has been to obtain subjects' verbal evaluations of stimuli, relating those evaluations to duration of visual exploration. Many of the studies in which evaluations have been obtained have been introduced as studies of "preference" for various stimulus conditions. The concept of "preference," however, requires careful examination. Research on stimulus correlates with visual exploration and "preference," initiated by Berlyne's early work and using many of his stimulus materials, has later been extended to children, though with few implications for developmental theory.

The intent of this review is to demonstrate that, across a variety of species, across age and experience, and in many different experimental tasks, certain features of the environment are likely to elicit exploration, manipulation, and perhaps play. Such generality of findings suggests that these characteristics of the environment, interacting with ongoing processes in the individual, may be potentially powerful in explaining other kinds of behavior.

These qualities of the environment have been variously named, but can generally be referred to as complexity, novelty, and incongruity. Of the three (actually many; see discussion of Berlyne's "collative" variables, which follows), the least is known about incongruity, and the term has been carelessly used. An attempt will be made to come to a better understanding of what is meant by "incongruity," and how it is related to other variables.

The review of literature is limited in several ways. First, the dominant interest of the present research is in humans, and, although it is acknowledged that this research area is indebted to the study of nonhuman species, the more recent study of nonhuman exploratory, manipulatory, and play behaviors will not be reviewed. Second, the emphasis in the present research is on characteristics of external stimulation which elicit exploration and verbal evaluation. Studies of physiological correlates of these conditions and the responses which they evoke, are clearly of interest, but not of primary interest here. The present research is eclectic rather than particular in theoretical orientation. Third, and this is dictated by the available research using human subjects, only studies of visual exploration will be of present concern.

## DRIVE REDUCTION AND 'LUDIC' BEHAVIORS

Since a number of excellent surveys of this literature, largely based on nonhuman subjects, are available (Dember and Earl, 1957; Glanzer, 1958; Cofer, 1959; White, 1959; Berlyne, 1960, Chs. 5&6; Dember, 1961; Welker, 1961; Hunt, 1963; Butler, 1965, and Lester, 1967), still another comprehensive review will not be undertaken here. Rather, studies will be mentioned to illustrate the problems raised for drive-reduction theories, and to provide a context for discussion of subsequent studies of visual exploration in humans. These studies are presented chronologically, but they belong to two conceptual groups: the first has to do with learning under conditions in which none of the "normal" reinforcers seemed to be operating. Learning seemed to take place when the reward was simply the opportunity to explore or to manipulate. Second is a group of studies based on a logical extension of drive-reduction theory, that organisms sated in every possible way will have no drives to reduce and therefore will be quiescent. As Berlyne (1966 , p. 26) has said, this reasoning represents "a view that anybody who has had to handle a child 'with nothing to do' must have been tempted to question."

For many years, two investigations stood almost alone in the psychological literature. In 1925, Dashiell reported that sated rats would explore extensively in the maze that bears his name. In 1930, Nissen reported that rats would cross a shock grid to reach an area which contained novel objects. There being no other possible reinforcer for this behavior, Nissen posited an exploratory drive.

Pavlov (1927) observed the "orienting reflex" in his experimental dogs, and commented on the place of that reaction to sudden or new stimuli in a motivational scheme (V. also Razran, 1961).

In addition, observation of "unlearned" fears were made during this early period. Köhler (1927) and Valentine (1930) observed a variety of situations which aroused fear in chimpanzees and young children, and argued that there had been no opportunity for these fears to be learned. Reduction of some drive-state, the explanation for learning, did not help to explain the development of these fears.

During the late 1940s and early 1950s the study of exploratory behaviors was intensified. Harlow (1950) and Harlow, Harlow, and Meyer (1950) found that food- and water-satiated rhesus monkeys would disassemble complicated puzzles for no other apparent reward than to take the puzzle apart.

Berlyne (1950) reported that rats approached and sniffed at novel objects more than familiar ones, and that this exploration decreased with successive presentations but was reinstated by introduction of another novel object. Later (1955) he found similar results for complex versus simple stimuli, and (Berlyne and Slater, 1957) showed that rats choose a more complex or more spacious Y-maze arm.

Montgomery (1952, 1953) began a series of experiments showing that the alternation behavior of rats in a T-maze is not based on response inhibition, but rather on choice of the unfamiliar place. Glanzer (1953) independently performed a similar experiment with the same result.

Butler (1953) found that monkeys would learn a discrimination problem when the reward was the opportunity to look through a window at the laboratory area, and (1954), that the rate of lever pressing depended on what was available to look at, a changing scene resulting in a greater rate of pressing than an unchanging scene.

Another aspect of stimulation, change or variation, has a powerful influence on exploratory behavior. The now classic studies on stimulus deprivation (Bexton, Heron, and Scott, 1954; Heron, Doane, and Scott, 1956) have clearly shown that low levels of stimulation are not tolerated for long by well-paid human subjects, and that they will do virtually anything to gain stimulation, from pressing a button for stock-market reports to hallucinating auditory and visual experiences. The implication is clear. Not only present stimulation, but stimulation experienced and perhaps adapted to at some time in the past, are powerful determiners of present exploratory behavior.

Finally, the major part of this review, concerning visual exploration and evaluation of complexity, novelty, and incongruity, constitutes clear evidence that some human behaviors are motivated by factors other than drive-reduction alone.

The above research shows that the drive-reduction theories were incomplete at best. This body of research between 1925 and the mid 1950s occurred in a changing Zeitgeist, but in the years 1949-1951 the climate changed in significant ways. As White (1959) has suggested, drive-reduction theory had been in trouble for some time, and its problems appear to have come to the fore during these years. Donald Hebb's Organization of Behavior appeared in 1949, with his well-grounded call for a serious consideration of the behavioral and physiological manifestations of attention and its influence on perception and learning. Moruzzi and Magoun's work on the brainstem reticular formation also appeared in 1949, and dealt the reflex arc, and by implication the drive-reduction model, its final blow. Finally, during this same period of time Lorenz (1950) and Tinbergen (1951) were arguing for a biological, evolutionary analysis of unlearned behaviors, thus diverting attention from and creating alternatives to the notion that motivation and resultant behavior could be explained by learning alone.

In an address given in 1951, Harlow (1953) concluded that the drive-reduction concept of motivation as it had been applied to learning theory was grossly inadequate in all but the very simplest of cases.

> We do not mean to imply that drive state and drive-state reduction are unrelated to learning; we wish merely to emphasize that they are relatively unimportant variables. Our primary quarrel with drive-reduction theory is that it tends to focus more and more attention on problems of less and less importance" (p. 27).

Harlow's call for the disavowal of drive-reduction, together with his plea for the study of stimulus properites influencing motivation undoubtedly had a seminal influence on conceptions of motivation, when taken in the context of Hebb, Moruzzi and Magoun, and the ethologists.

The final recognition of the existence of these pervasive 'ludic' behaviors coupled with drive-reduction theory's inadequate explanation of them has led a number of investigators to seek other explanations. These have centered around the "intrinsic" motivating properties of the behaviors themselves, of internal states such as conflict, arousal, or adaptation level, or of certain properties of external stimulation.

Leuba (1955) suggested that an optimal level of stimulation exists, which the organism strives to maintain. The question of what is optimal, however, is still open. Hebb (1955) suggested an optimum level of arousal, and Leuba's formulation can be interpreted in those terms. McClelland, Atkinson, Clark, and Lowell (1953) proposed an optimal discrepancy between the stimulus input of the moment and an adaptation level. Hunt (1963, 1965) similarly has posited an optimum of discrepancy between the stimulus input and some internal standard based on genetic factors and previous experience. Berlyne (1960, 1963b) has posited an optimal level of "arousal potential," the interaction between certain characteristics of stimuli and the momentary organismic state. Maddi (1961) has suggested an optimum of variation in stimulation, and Munsinger and Kessen (1964, 1965) have suggested an optimum of uncertainty. All of these interpretations involve an optimum (adaptation level, standard, "normal" level) of something involving change. The only major way in which they differ is the label by which change is specified. There are few other differences among them, and a choice of one rather than another would be largely idiosyncratic.

The events considered to have the potential to motivate organisms have been significantly broadened. However, it is unparsimonious to have one strong theory explaining consummatory behaviors and another set of theories to explain other behaviors. Berlyne (1960, 1963b) has attempted to integrate the theories, but more work, especially of a physiological nature, remains to be done.

## 'COLLATIVE' VARIABLES: THE RESEARCH OF BERLYNE

Discussion of exploratory and evaluative reactions of human beings to various qualities of their environment must start with the work of D. E. Berlyne. All other investigators cited in this present review refer to Berlyne, and many of the stimulus materials used by them are based on Berlyne's stimuli, first used in 1957.

In the context of the study of exploratory behavior just reviewed, Berlyne (1960) called for a reconsideration of the drive-reduction model's utility. He reports, however, that by the time he finished Conflict, Arousal, and Curiosity (1960), he was convinced that a modified form of the drive-reduction model was the best means to explain both consummatory behaviors and hitherto unexplained exploratory behaviors.

In order to retain the drive-reduction theory, Berlyne found it necessary to posit two further drives: a curiosity drive explaining diversive exploratory behaviors, that is, behaviors aimed at no specific stimulus, and a boredom drive, elicited under conditions of low or unvarying stimulation, and reduced by the arousal generated by exploration, involving kinesthetic feedback and a changing stimulus field. The curiosity drive is more complex to analyze. Berlyne suggests that objects with "collative" properties (novelty, complexity, uncertainty, incongruity, ambiguity, surprisingness) elicit conflict, arousal, and curiosity. Berlyne calls these relational aspects of the stimulus situation "collative variables" because,

> in order to evaluate them, it is necessary to examine the similarities and differences, compatibilities and incompatibilities between elements--between a present

> stimulus and stimuli that have been experienced previously (novelty and change), between an element of a pattern and other elements that accompany it (complexity), between simultaneously aroused responses (conflict), between stimuli and expectations (surprisingness), or between simultaneously aroused expectations (uncertainty)" (1960, p. 44).

Curiosity, a drive state, is accompanied by a general arousal and elicits exploration. Exploration reduces the arousal by reducing the curiosity (the object is somehow assimilated or recognized). Berlyne calls the increase and subsequent decrease in arousal to the optimal level the "arousal jag," and maintains that the exploratory behavior is reinforced by the decrease in curiosity and arousal. It is in this sense that reduction of the curiosity drive is reinforcing. Only in his most recent major paper (1967) has Berlyne acknowledged that the increase in curiosity and arousal is a necessary concomitant of this arousal jag, and the effects of the decrease and increase in arousal have not, as yet, been separated. Perhaps the reinforcement of exploratory behavior is drive induction, or induction followed by reduction, or simply arousal change, and not drive reduction alone. After all, the organism behaves in such a way as to put itself in new situations as was shown earlier; it is more parsimonious to assume that a change in arousal is reinforcing.

Berlyne's treatment of exploratory behavior can be criticized on a number of other grounds. First, he has not attempted to quantify the collative variables, despite the fact that his theory is specific in predicting greater "attractiveness" of stimuli having greater amounts (up to some point) of the collative variables. Second, Cantor (1963) has pointed out that Berlyne predicts that stimuli which produce moderate conflict will be approached and investigated. Berlyne does not explain why these conflict-inducing stimuli are not instead avoided. Third, the collative properties are circularly defined: their presence is indicated by responses (orientation, approach, investigation, manipulation) which are theorized to be the result of arousal changes generated by the collative properties themselves. Related to this is the lack of any definition of the responses independent of the stimulus situations presumed to bring them about.

Last is a problem by no means unique to Berlyne, brought about by the naming of specific drives. In Berlyne's case, this consists of postulating two drives (curiosity and boredom) to account for exploratory behavior. Brown (1961) has noted that "drive" must be defined independently of the situation which it is assumed to cause, and which it is used to explain. "Thus the presence of a drive to explore is sometimes inferred from, and at the same time used to explain, behavior of moving from one place to another, especially if there is no other apparent reason for the movement" (Brown, 1961, p. 334). Such a circular line of reasoning is of questionable value as an explanation of behavior, regardless of how difficult the behavior is to explain. Hunt(1965) also comments on several unfortunate explanations for unexplained behavior:

> The first consists in the naming of drives to account for each of such varied activities as play, exploration, manipulation, and curiosity; in the naming of such needs as those for stimulation and variation; and in the naming of such urges as those for contact and locomotion. Such naming of drives, needs, and urges seems to revisit the instinct-naming of McDougall (1908). After our soul-searching excursion into theoretical methodology in the thirties and forties, we should know better. Insofar as the drives, needs, and urges named are accepted as explanations of the activities, they are theoretically unfortunate" (Hunt, 1965, p. 196).

Of more specific interest is Berlyne's (1957) first report of the use of a series of stimuli varying in complexity and incongruity, to study perceptual curiosity and visual exploration. In their final form (Berlyne, 1963a) they constitute nine different categories, each having two or more pairs of patterns. Each pair is made up of a less irregular pattern (LI) and a more irregular pattern (MI). According to Berlyne, all of the LI figures elicit little conflict and are highly redundant, whereas the MI figures elicit conflict (via competing responses), are ambiguous, and evoke uncertainty, the result being the arousal of a curiosity drive and subsequent exploration to reduce that drive. The nine categories are: A. Irregularity of arrangement; B. Amount of material; C. Heterogeneity of elements; D. Irregularity of material; E. Incongruity; F. Incongruous juxtaposition; XA. Number of independent units; XB. Asymmetry, and XC. Random redistribution.

The collative variables, at least as represented in these stimuli, have been shown to influence:

1) duration of exploration (Berlyne, 1957, 1958a, b; Berlyne and Lewis, 1963; Berlyne and Lawrence, 1964; Clapp and Eichorn, 1965; Day, 1965; Minton, 1963; Smock and Holt, 1962)

2) choice of stimulus to be viewed again (Berlyne, 1963a; Berlyne and Lewis, 1963; Day, 1965; Hoats, Miller, and Spitz, 1963)

3) verbal ratings (Berlyne, 1963a; Berlyne and Lawrence, 1964; Berlyne and Peckham, 1966; Berlyne, Ogilvie, and Parham, 1968; Day, 1965, 1966)

4) paired-associate learning (Berlyne, Borsa, Craw, Gelman, and Mandell, 1965)

5) the incidence and content of children's questions (Berlyne and Frommer, 1966)

6) incidence and amplitude of the galvanic skin response (Berlyne, Craw, Salapatek, and Lewis, 1963)

7) duration of EEG desynchronization (Berlyne and Borsa, 1968; Berlyne and McDonnell, 1965).

Clearly, a great deal of attention by experimenter and subject alike has been paid to these stimuli. For the purposes of the present discussion it will be most meaningful to consider three dimensions of stimulation as represented in these and similar stimuli, namely, complexity, novelty, and incongruity.

These variables are not difficult to define if one can be satisfied temporarily with limited definitions. Physical complexity has been defined by Attneave (1957) in terms of characteristics of the perimeter, angles, and number of elements. It is probably unwise, however, to assume that subjective complexity varies in a one-to-one manner with physical complexity. Few psychophysical relations are so simple. Day (1967) reported a monotonically increasing, though not one-to-one relation between objective complexity (number of turns) and judged complexity. Also, Johnson (1968) reported that familiarization did not affect looking time equally to three levels of complexity: The objectively most complex polygons (31 turns) resulted in a greater decrease in looking time with familiarization than did the least complex polygons (8 turns), indicating that objective and subjective complexity differ. A functional, subjective definition of complexity depends not only on stimulus characteristics and method of measurement, but also on the subject's past experience, leading us to expect both individual differences and strong developmental differences in subjective complexity.

Novelty is more difficult to appraise, because complete histories of human subjects are never available. However, if the experimental treatment is preceded by familiarization with some stimuli, short-term, relative novelty is readily defined. Novelty will be defined in this way in the studies to be reviewed here.

The "incongruity" variable is not so easily defined. The figures used by Berlyne, and modifications used by others, are clearly novel in a long-term sense. However, Berlyne and others often imply that incongruity is something more than novelty per se. Inspection of the figures (described in Appendix A) reveals that they are without exception familiar objects that have been altered in some way. One's expectation or prediction of the identity of the figure based on one part may be unfounded.

A word of caution is in order. The term "incongruity" is a poor definition of stimulus characteristics, because it implies internal processes that are assumed to be aroused by the stimuli, and therefore is circular. Ideally, the definition of stimulus conditions should be in terms of the characteristics of the stimuli alone, especially when those stimuli are assumed to affect in some lawful way a series of organismic processes. A better term for these figures would be "altered" stimuli, and they will be described in that way here.

We now turn to discussion of the various effects of complexity, novelty, and incongruity. These are discussed separately for clarity of exposition, but it will become clear that they are strongly related.

COMPLEXITY

A number of experiments using nonhuman subjects provide evidence that a stimulus' complexity has motivating properties. Among the experiments already cited, Dashiell (1925), Nissen (1930), Butler (1954), and Berlyne (1955) can be interpreted to mean that exploration is elicited under conditions of greater stimulus complexity. It is important to note, however, that complexity, novelty, and simply change are not independently defined and manipulated in these and other studies and the observed exploration could result from manipulation of any of these variables.

Dember, Earl, and Paradise (1957) have shown that the rat's exploration is influenced by the complexity of its surroundings. Rats which initially chose the less-complex loop of a figure eight maze (horizontal stripes) chose the more complex loop on subsequent days (vertical stripes). One might also suggest that the more complex pattern was chosen as it lost novelty.

The most abundant evidence for the motivating effects of complexity comes from studies of visual exploration and verbal evaluations, to which we now turn. Because a number of potentially important age differences have been obtained in these studies, the results for college students and children will be discussed separately.

The effect of complexity upon visual exploration

College students:

Berlyne (1957) devised a series of stimuli with which to determine the properties of visual stimulation which influence investigation. College students pressed a lever which exposed a figure in a tachistoscope for 0.14 second. They were told that they could look at each figure until they had seen enough of it, and that they would be asked no questions about the figures. The subjects took part in four experiments: experiments 1 and 3 were concerned with incongruity and surprisingness, and will be discussed later; experiments 2 and 4 were manipulations of complexity. In all cases, figures with more complexity (absolute or relative uncertainty) elicited significantly more lever presses than did less complex figures. Berlyne (1960, p. 162) notes that subjects reported that they pressed the lever until they had identified the figure, then stopped. Apparently the identified figures aroused, in Berlyne's terms, little curiosity. A common problem in studies using tachistoscopic presentation is that it is not clear why the subject exposes the figure several times. This may be a subtle effect of the instructions to the subject and the fact that he is in an experiment. He may look at the figures more in order to identify them, as Berlyne implies. Lastly, and this would seem to be what Berlyne is interested in, the subject may look at the figure several times <u>after</u> identifying it because of some quality which arouses him with the result that he explores it. Tachistoscopic presentation does not allow separation of these potential factors. An experiment is needed to determine whether subjects continue to look at stimuli having collative properites <u>after</u> they have identified them. Berlyne's experiment was replicated in all essentials by Minton (1963).

Berlyne may have recognized these methodological problems, because in a subsequent experiment (1958a) he examined the influence of the collative variables on orientation (selective attention), not investigation, and enlarged his pool of stimulus figures. College students were presented the pairs of figures for ten seconds per pair, and the duration of eye fixation to each member was recorded. Over all categories, the more complex figures were fixated for a significantly greater proportion of the ten-second period than were the less complex figures. In order to rule out the possibility that ten seconds was not enough time to identify the figures, Berlyne (1958b) replicated the experiment with a two-minute viewing time per pair. The same results were obtained. Thus, recognition or identification may not be a factor in the greater proportion of time spent looking at the more complex figures. Unfortunately, Berlyne did not instruct his subjects to report when they recognized the patterns.

Another change in method took place in a 1963 study (Berlyne, 1963a). In this case, college students were shown the two members of the pair in succession, then allowed to choose one to look at again. When exposures were short (0.5 - 1 second), more "more irregular" (MI) choices were made. However, at longer exposures (3 - 4 seconds), the subjects made more LI choices. In view of the ratings which also were obtained (the MI figures were more interesting but the LI figures were more pleasing), it would appear that the interestingness of a figure is related to choice at short exposures. At long exposures, however, the choice of which to look at again is a function of how pleasing the figure is. Perhaps the motivating property of interestingness decays rather rapidly as time passes, while that of pleasingness rises more slowly but is longer-lasting. Day (1967) has shown such a relation for four- to 160-sided polygons, but in terms of number of sides, not exposure time. Berlyne's results are potentially confounded however, because the ratings were made only at a three-second exposure time. In order to completely relate "choice to look at again" with interestingness and pleasingness, the ratings must also be made at the short exposure time.

Berlyne and Lawrence (1964) allowed subjects to control their own exploration of the stimuli, and the length of time between the subjects' button-presses (which actuated the slide changer) was recorded. The previous results were replicated with this changed procedure. An attempt was also made to determine whether these stimuli changed the subjects' arousal state, as indicated by galvanic skin response, heart-rate change, or finger blood volume. There were no changes in any of these measures, either over three presentations of the same pattern or betweeen more- versus less-complex patterns.

Berlyne, Craw, Salapatek, and Lewis (1963) repeated the GSR part of the Berlyne and Lawrence experiment, but with three-second exposures. There was a higher incidence of GSRs to the more complex or incongruous patterns than to the LI members of the pairs, but only when the subjects were "extrinsically motivated." (Subjects were instructed, "You will have to recognize these later.") Berlyne and McDonnell (1965) used EEG desynchronization as the measure of arousal, and found longer desynchronization to MI patterns than to LI patterns.

Berlyne and Lewis (1963) allowed subjects to control their duration of exposure, and also used the choice task used by Berlyne (1963a). Three groups of subjects underwent conditions which were meant to induce higher arousal: shock expectation; memory test expectation, and white noise. A control group received the standard instructions. GSR changes indicated that the instructions did affect the subjects' arousal state. The effect of heightened arousal was to increase the duration of exploring all patterns, and to increase the number of LI choices to be seen again. Over all groups, and over all categories but one, the duration of exposure was greater to MI patterns than to LI patterns. Thus, the heightened arousal tends to reduce the probability of choosing a more complex or incongruous pattern, but activates behavior such that any figures are looked at longer.

Day (1966) suggests that there is an optimum level of complexity as reflected in looking-time scores. While the X series patterns were explored longer than the Non-X patterns, the MI patterns in the X series were explored less than the LI patterns in that series. No attempt has been made to quantify the complexity of these stimuli, however, so Day's conclusion is based on his own judgment of the relative complexity of these figures.

Four studies have used stimuli different from Berlyne's (photographs of landscapes and objects, and randomly-generated polygons). Leckart (1966), Faw and Nunnally (1967), Johnson (1968), and Willis and Dornbush (1968) have all found that college students look longer at (or choose more frequently) more complex patterns than less complex ones.

In summary, the complexity of a visual array is clearly related to the time a person looks at it, and to the choice of a pattern to be seen again. In general, more complex patterns are looked at longer and chosen more frequently than are less complex patterns, although there is a hint that some optimum of complexity may exist. With regard to arousal mechanisms, Berlyne, et al. (1963) and Hunt

(1965) have commented that complexity and other collative variables seem to have a greater effect on exploration than on physiological processes.

Children:

The research on infants' responses to complexity is in a state of flux. Until recently it was dominated by poor methods, and it is still related to studies concerned with responses to faces or face-like figures. It may be the influence of this latter that often results in an unsystematic selection of stimuli, some intuitively more complex than others. Cantor (1963) presents an excellent critical review, now outdated however, of the responses of infants and children to complexity and novelty.

Berlyne (1958c), Fantz (1958) and Spears (1962) all presented pairs of patterns to infants of ages up to nine months. They recorded either the pattern which was fixated first (Berlyne) or the proportion of time each was fixated (Fantz and Spears). It appears that patterns of greatest complexity were fixated first or longer. These were a checkerboard pattern, a computer-generated pattern of random dots, and a bull's-eye.

These results were questioned by Hershenson (1964), who analyzed motion pictures of infants' eye fixations, a more precise technique than those used by Berlyne, Fantz, or Spears. He found that two- to four-day-old infants fixated most on a 2 X 2 checkerboard, versus 4 X 4 or 12 X 12 patterns. Contrariwise, an inverted-U relation between looking time and complexity was obtained by Hershenson, Munsinger, and Kessen (1965), who presented randomly-generated polygons of 5 - 20 turns to new-born infants. The results of these two studies may not be comparable, because checkerboards may represent a different level of complexity than do randomly-generated polygons. In fact, the physical measures of complexity would seem to be different for the two kinds of stimuli, the checkerboards involving internal change, and the polygons involving change at the border.

The relation between age and visual responses to complexity was made clearer by Brennan, Ames, and Moore (1966). These investigators found, as did Hershenson, that 3-week old infants fixated longest at a 2X2 checkerboard. Fourteen-week-old infants, however, looked longest at a 24X24 pattern, and 8-week-old infants fixated an 8X8 pattern the longest. Thus, there appears to be a direct relation between age and "preference" (indexed by visual fixation time) for complexity. This direct relation has been confirmed by Munsinger and Weir (1967) using children 9 to 41 months of age.

In summary, it may be speculated that complexity and looking-time are related by a curvilinear function (inverted-U), and that this function varies monotonically with age, at least during infancy.

Since the research on preschool and elementary school children appears to have been initiated by Berlyne's research with adults, his stimuli or variations on them are often used. Unfortunately, while there is some continuity across stimuli, there is little similarity in the methods used to determine how long children explore various visual arrays.

Smock and Holt (1962) allowed first grade children to press a button, which projected a figure for 250 milliseconds. The number of presses to each figure was recorded. As in Berlyne's studies, the stimulus slides were designed in pairs, one member 'more complex' (by unknown criteria) than the other. Despite a poor analysis of the data, it is clear that the children gave more responses to the 'more complex' figures. There was also a sex interaction: girls responded more to heterogeneity of dispersion, and boys responded more to greater amount of contour.

Cantor, Cantor, and Ditrichs (1963) presented six triads of stimulus figures to preschool children, the members of each triad varying in complexity according to some unspecified, intuitive definition. The subjects sat before three boxes, each one containing one member of the triad. By pressing his forehead against a switch on the box, the subject turned on a clock timer and a light in the box which illuminated the figure. Each triad was presented for 60 seconds, during which time the child could view any of the three figures for as long as he desired. More time was spent viewing the high-complex figures than the medium- or low-complex figures.

Thomas (1966a) introduced another technique. The child's head is positioned on a chin rest, and movement of the head to the left or right actuates switches which turn on projectors behind two viewing screens. Thus when the left projector is actuated, one can be fairly certain that the child is looking at the left screen and not somewhere else. In an extensive study (1966b), Thomas used this device to present all possible pairs of 3-, 6-, 10-, 20-, and 40-turn randomly-generated polygons to children of ages 6, 7, 8, 9, and 12 years. The duration that each figure of the pair was illuminated was recorded, but the time data were not used, and "the stimulus displayed the longest was taken as the preferred stimulus." Thomas does not explain the basis for that decision, whether on raw scores or on proportion of total time. Treating the data in this way, Thomas obtained the equivalent of paired-comparison judgments, which were scaled. Over all age groups, scaled scores increased with increasing complexity.

Other studies (May, 1963; Pielstick and Woodruff, 1964; Faw and Nunnally, 1968a; Johnson, 1968; Willis and Dornbush, 1968) illustrate the continuing variety of stimuli and responses. Moreover, they all lead to the same conclusion: that children (preschool through sixth-grade) choose to look at more complex patterns, and look at them longer than less complex patterns.

The evidence is not so simple as the above studies would seem to indicate, however. Lore (1965) used five- and six-year-old children from middle- and lower-class homes, and allowed them to control the length of exposure of the slides by means of a lever. The 20 stimuli comprised four categories: incongruity, asymmetry, complexity, and number of turns. The complexity stimuli were modifications of those used by Cantor et al. (1963). No subjects looked longer at complex than at simple figures, or at figures having a greater number of turns. Only the middle-class children showed longer viewing times to asymmetric versus symmetric figures. These results were replicated in all respects by a 'reduction of hand activity' measure in a second experiment. At least for these stimuli, complexity had little effect on children's viewing time.

This is not the only such finding, however. Hoats, Miller, and Spitz (1963) have reported similar negative results, but their scanty analysis of the data and failure to apply any significance tests make the results very difficult to interpret. The instructions may have contributed to this. "You can look at the picture you choose for as long as you like" might have been interpreted by the children in terms of pleasingness, and Berlyne (1963a) showed that the less irregular patterns were rated (by adults) as more pleasing.

Clapp and Eichorn (1965) have also failed to obtain differential visual exploration of complex versus not-complex figures, with four- to five-year-old children. The stimulus patterns were taken from Berlyne (1957 ), along with another series of meaningful objects. Tachistoscopic presentation was used, with the variation that the child did not press the button, but told the experimenter when to stop pressing and change to another slide. With neither the geometric figures nor the meaningful figures did the children respond at other than a chance level to the more complex stimuli. These results are difficult to interpret, also. Having the child tell the experimenter when to stop may have introduced a social factor into the experiment. There are, after all, few times when a young child is asked to tell a strange adult when to stop doing something.

In summary, greater complexity usually results in longer visual exploration, depending on the stimuli and methods used, and the age of the children. The results are not as clear as those obtained with adults. Clearly, a systematic developmental study, using well-defined stimuli and both choice and duration-of-exploration tasks remains to be done.

The effect of complexity upon ratings and "preferences"

The research cited in this section is concerned with verbal evaluative responses to stimulus complexity. Increased exploration of more complex situations may be explainable in terms of the subject's evaluations of the stimuli, although it is just as likely that exploration and evaluation are merely two reflections of a common underlying process, changes in which bring about changes in both exploration and evaluation. That is, some figures may be looked at longer because (or while) the subject finds them "likable" or pleasant or interesting. Other figures may be looked at less because (or while) the person finds them uninteresting or unpleasant or "unlikable." In terms of arousal processes, these ratings might be considered to be the verbalizable emotional concomitants of arousal changes brought about by certain stimulus conditions. In a sense, they represent somewhat crude estimates of what is happening to a person who encounters complexity. Though certainly cruder than direct measurement of physiological processes, they are much easier to obtain.

Berlyne's figures have been used in only a small number of the studies of preferences for varying degrees of complexity (Berlyne, 1963a; Berlyne and Lawrence, 1964; Berlyne and Peckham, 1966; Berlyne, Ogilvie, and Parham, 1968; Day, 1966). Berlyne and Lawrence found that college-age subjects expressed a preference for the less-irregular figures over all categories. Berlyne (1963a) made this preference clearer, showing that more-irregular patterns were rated more interesting, but less-irregular patterns were rated more pleasing. Berlyne and Peckham used all stimulus categories except "Incongruity" and "Incongruous juxtaposition" and related pleasingness ratings to the Semantic Differential. They found a bimodal distribution relating either 'evaluative' or 'potency' dimensions to complexity, and a curvilinear (inverted-U) relation between 'activity' and complexity. These functions depend, however, on the experimaters' subjective ordering of the stimulus figures as increasing in complexity. There is no other information to support such an ordering.

Day (1966) asked his adult subjects which of the X and Non-X series figures they liked. He found an increasing proportion of "like" ratings with increasing complexity (to the extent once again, that degrees of complexity can be intuitively determined from Berlyne's figures), though the rating scores seemed to reach an asymptote at the high level of complexity.

Finally, Berlyne, Ogilivie, and Parham (1968) applied a multi-dimensional scaling technique to ratings of the complexity, interestingness, and pleasingness of 16 of the figures. They found significant correlations between ratings of complexity and interestingness (+.54), between complexity and pleasingness (+.41), and between interestingness and pleasingness (+.23). This suggests that interestingness and pleasingness are related to (and may be part of what we mean by) complexity, though they are not strongly related to each other.

The problem of obtaining some physical measurements of complexity is evident in Berlyne's figures, and was overcome by Munsinger and Kessen (1964) and Munsinger, Kessen and Kessen (1964), through the use of randomly shaped polygons of various number of sides (Attneave and Arnoult, 1956). In these stimuli, complexity is defined in terms of the number of independent turns or sides. Adults (Munsinger and Kessen, 1964) and children of ages 6 through 15 years (Munsinger, et al., 1964) were shown all possible pairs of 12 stimuli, which varied in number of sides from 3 to 40. Up to age 9 or 10, the relation between complexity and stated preference was monotonic, the most complex stimuli were the most preferred.

This is the same relation as has been obtained using visual exploration as the response. After age 9 or 10, the relation becomes curvilinear, the highest preference occurring to stimuli of intermediate complexity, around 10 turns. Additionally, the 10-turn stimuli were highly preferred by all subjects.

These studies prompted Thomas (1966b) to replicate, with some improvements. Specifically, Thomas suggested that the unique results obtained with the 10-turn stimuli might be due to stimulus sampling error. To test this he constructed 4 stimuli at each of 5 complexity levels (3 through 40 turns). Subjects of ages 7 through 19 years were presented with all pairs of complexity levels and were asked to choose which figure of the pair they liked best. Thomas found a monotonic relation between preference and complexity until age 15 or 16, after which an intermediate level of complexity was preferred. The different ages obtained by Munsinger, et al. and by Thomas, at which the shift in preference from most to intermediate complexity takes place cannot be reconciled at this time. This age difference requires further investigation. Finally, Thomas did not find any outstanding convergence of preferences across all ages for the 10-sided figures, as Munsinger and Kessen had found.

Stenson (1966) correlated adults' judgments of the complexity of random forms with 24 different physical measurements of complexity, and factor analysed the resulting matrix of intercorrelations. Four measures accounted for most of the variance in the ratings: number of turns, length of perimeter, ratio of perimeter squared to area, and variance of internal angles. Thus there is some correspondence between (arbitrary and complicated) physical measures of complexity and subjective measures.

Finally, Day (1967) presented all possible pairs of random polygons of 4 to 160 sides to adult subjects, and obtained judgments of complexity, pleasingness and interestingness. While subjective complexity increased monotonically as the number of sides increased, interestingness ratings slowly reached an asymptote. Pleasingness ratings rose more quickly, reaching a maximum at between 20 and 40 sides, and then fell steadily. Thus, at a high number of sides (100-160) the patterns were rated interesting but not pleasing. At a low number of sides (4-20) the patterns were judged pleasing but only slightly interesting. This result is clearly related to Berlyne's (1963a) finding, that more-irregular figures were rated more interesting, but less-irregular and less complex patterns were rated more pleasing.

Clearly, a variety of judgments of figures change as the physical complexity and to some extent, the subjective complexity changes. Just as clearly, complexity appears to have similar effects on both verbal evaluations and looking time. The work of Berlyne and of Thomas indicates that these ratings and preferences are related to the duration of time that adults and children explore those patterns.

NOVELTY

A wide variety of experiments with non-human subjects have implicated novelty as a motivating factor, so many that the relation between novelty and exploration hardly requires substantiation. Dashiell (1925), Nissen (1930), Berlyne (1950), Montgomery (1952, 1953), and Glanzer (1953b) all provide abundant evidence that novelty influences 'ludic' behaviors.

Denny and Leckart (1965) have shown that rats avoid the side of an E maze to which they had been forced and rewarded. Even when the free-choice trials were given one trial per day, avoidance of the previously forced and rewarded side still occurred after seven days. Furthermore, food was available at the previously forced and rewarded side during the free-choice trials. When the rat's behavior is viewed as approach to the unfamiliar side the effect seems more powerful, because the hungry rat is avoiding food. The authors conclude, "The traditional notions of reinforcement are challenged because learning occurred without the presence of an identifiable reinforcer, directly in the face of food reinforcement for the opposite response." (p. 232)

There have been observations of both withdrawal and approach in a novel situation (Berlyne, 1950; Melzack, 1954; Welker, 1956 a, b, 1961; Mason, 1965). Welker presented chimpanzees with novel moving toys. The first response was fear and withdrawal, later followed by alternating approach and withdrawal, and eventually leading to manipulation and subsequent habituation. Such observations are not uncommon in children. Mason (1965) has reviewed his own work with chimpanzees, which shows that play behavior is most likely to occur in conditons of moderate novelty. Unfortunately, Mason's judgment of the relative novelty of situations is largely subjective. Still, this research and Welker's is the only real response to Beach's (1945) plea for a concerted study of the nature and function of play. The outstanding conclusion to be drawn from Beach's review of attempts to explain play is that chaos abounds when a behavior is found for which there is no manifest biological purpose. Beach pointed out that the existing "theories" of play were circular and non-explanatory. These theories resulted when a class of behavior was examined to which a need-drive formulation patently did not fit. But, and this is the most telling point in Beach's paper, there was little to fall back on when the drive-reduction model failed.

The relation between novelty and fear is amply supported by Gordon Bronson (1968a, b) in his recent reviews, and also by Berlyne (1960, Ch. 5) and Hunt (1963). That novelty and fear are related is reflected in Bronson's (perhaps unfortunate) definition of fear as a response to visual novelty, and Mowrer's (1960) analysis of exploratory behavior as determined by fear.

Although sporadic and often crude observations of fear in human infants had been made in the 1930s (V. Bronson, 1968a), the work of Köhler (1927), Valentine (1930), Hebb and Riesen (1943) and Hebb (1946) were especially important. There is reason to suspect, however, that novelty was not the only cause of the observed fear, so this work will be discussed in the section on "incongruity."

The effect of novelty upon visual exploration

College students:

Novelty, at least as defined in terms of familiarization trials, has not been greatly studied in adults. Many of the stimuli used by Berlyne and others to study other collative variables are novel in a long-term or absolute sense, but the term "novelty" could and should be used more precisely. It is of some interest that there are considerably more studies of the effect of novelty on children than on adults.

Berlyne (1958a) presented pairs of stimuli side-by-side to college students. Over 7 trials the pattern on one side did not change, while a different pattern on each trial was shown on the other side. Subjects looked significantly longer at the side where the novel or varying stimuli appeared than at the side where the same figure appeared on each trial.

Leckart (1966), in the study referred to previously, manipulated familiarity, giving different groups of subjects 0, 10, or 20 seconds of familiarization to each pattern. After a delay of either 0 or 48 hours (which had no effect), the subject looked at the same patterns again for as long as he desired. There was a decrease in looking time with increasing familiarization, implying that greater novelty resulted in longer visual exploration.

Johnson (1968) found that both adults' and children's looking time decreased over 45 familiarization trials, but that the decrease was not the same for high-, medium-, or low-complexity stimuli.

Children:

A variety of children's responses to novelty have been studied, and the literature is both recent and extensive, enough so that the review by Cantor in 1963 is very much out of date. This literature will not be reviewed here in its entirety. However, the experimenter's notion of the ubiquity of novelty in the young child's world is worthy of some attention. The influence of novelty on children's choice of toys has been clearly shown by Harris (1965, 1967a, 1967b), Endsley (1967), and Mendel (1965). Green (1964) has shown the distracting effect of a novel stimulus in a discrimination learning task, and Ellis and Arnoult (1965) have shown that children tracing a T shape alternate less than chance when the situation changes from trial to trial.

In a similar study, Harris and Granskog (1968) found just the opposite result, the more the situation varied from trial to trial the more likely were the children's maze-tracing responses to be more variable.

The results of May's (1963) study, already discussed in the section on complexity, could also be interpreted to mean that the children chose the more novel and complex 8- and 12-rectangle cards, after familiarization with the cards bearing five rectangles.

In two studies, Cantor and Cantor (1964a, b) have shown that kindergarten children look longer at novel than at familiar figures, regardless of the delay between familiarization and self-controlled visual exploration. This result holds whether the figures are from the Welsh Figure Preference Test, or are cartoon drawings from a children's toy (Kenner Give-a-Show).

Leckart, Briggs, and Kirk (1968) showed four- and five-year-old children pairs of pictures taken from children's books. For 20 trials the picture on one side did not change but the picture on the other side changed on each trial, similar to Berlyne (1958a). When asked which side "they would enjoy looking at most," the novel side was chosen most frequently, and this novel choice increased over trials, and increased more for girls than for boys. Similar results have been reported by Lewis, Goldberg, and Rausch (1967), though a sex difference was not found.

In summary, novelty even in this restricted operational sense, exerts a strong influence on the exploratory behavior of children and adults alike. The strongest support for this conclusion comes from Harris (1965). Children not only chose the novel toy overwhelmingly in excess of chance expectation, but chose the novel toy when it meant giving up two familiar toys, even when the novel toy was broken.

## The effect of novelty upon ratings and "preferences"

Subjective novelty has been little studied. The only investigation is an extensive one by Berlyne and Parham (1968), in which adult subjects rated the novelty of colored random shapes under eight conditions of successive presentation. Berlyne and Parham found that a stimulus X is rated less novel:

1) when X was experienced recently
2) on the second presentation of X
3) when the subject was familiar with all the stimuli
4) with repeated presentations.

The stimulus was rated more novel:

1) with the number of repetitions of another stimulus Y before X
2) with the number of ways X differed from Y.

They found no evidence that novelty varies with the time since the last presentation of X, with the number of prior presentations of X, or with the number of kinds of stimuli preceding the first presentation of X. These last are surprising findings, and, as the authors note, should be investigated further.

The only study in which novelty was manipulated and ratings on some dimension obtained is that of Cantor (1968). Figures from the Welsh Figure Preference Test were shown to fifth- and sixth-grade children. Ten figures were presented in familiarization trials, then the children rated those ten and ten others which they had not seen on a 10-centimeter scale, from "strongly dislike" to "strongly like." The unfamiliarized stimuli received higher ratings. Cantor interprets this to mean that children look at novel stimuli longer than familiar stimuli because they like them more, not because they contain more information, as Berlyne argues. Neither Cantor nor Berlyne suggest that both "liking" and information content may determine exploration, and Cantor fails to ask what is the basis for the preference for the novel figures. It is possible, of course, that children like these figures because they contain more information.

## INCONGRUITY

In contrast to complexity and novelty, relatively little can be learned about incongruity from previous studies of nonhuman animals. The only study using rats as subjects is that of Haywood and Wachs (1967), and the results of this study are not clear in many ways. Their definition of incongruity as 'not experiencing shock where shock was experienced before' is likely a better definition of surprise. They did find that rats who received shock or "shock incongruity" chose a novel versus familiar endbox at a chance level, while control rats chose the novel endbox on 25 of 32 trials. Haywood and Wachs interpret these data in terms of Hebb's theory, that there is some optimal level of arousal, and that situations that are highly arousing (beyond the optimum in this case), such as shock or white noise, will result in fewer choices of novel stimuli.

### Development of fear in chimpanzees and children

The research discussed in this section is important because it represents the earliest discussion of incongruity as a motivational factor, and because it provides descriptions of situations that might be called "incongruous," and represents a crude operational definition of the term.

The findings of Hebb and Riesen (1943) and Hebb (1946) are now classic, largely because they showed that fear in young chimpanzees could not be explained by conditioning, which Watson (1920, 1924) maintained was the means by which all but the most rudimentary, unlearned fears (to loud noises and loss of support) were developed. In the 1943 study, Hebb and Riesen observed that chimpanzees do not show fear of strangers until about four months of age, under carefully controlled laboratory conditions in which the animals' histories were known and any association of a stranger with a noxious event could be ruled out. Hebb (1946) later showed that laboratory-reared chimpanzees showed withdrawal and fear responses to such stimuli as the sculpted head of a chimpanzee with the body missing, an anesthetized infant chimpanzee, a painted human eye and eyebrow from a mannequin, or the experimenter in the familiar animal caretaker's coat. Because Hebb knew the histories of his animals he could rule out learning as an explanation for these fear responses. He hypothesized,

> that fear occurs when an object is seen which is like familiar objects in enough respects to arouse habitual processes of perception, but in other respects arouses incompatible processes" (1946, p. 268).

Observations similar to Hebb's had been made a number of years earlier by Köhler (1927) and Valentine (1930). Köhler observed that his chimpanzees showed extreme fear to primitive stuffed toys, "...caricatures of oxen and asses [with which the chimpanzees were familiar], though most drolly unnatural" (1927, p. 320).

> One day I entered their room with one of these toys under my arm. Their reaction times can be very short; in a moment a black cluster, consisting of the whole group of chimpanzees, hung suspended from the farthest corner of the wire-roofing, each individual trying to thrust the others aside and bury his deep head [sic] in among them" (p. 321).

The chimpanzees also showed fear when Köhler approached them wearing a demon mask.

Köhler uses these observations to argue against the proposition that experience (presumably learning) is necessary for the development of fear, because the chimpanzees had never encountered any of these things before, and yet he notes:

> It is too facile an explanation of these reactions to assume that everything new and unknown appears terrible to these creatures. Any geometrical figure of wood found standing or lying about, though it represents something quite new to them, rouses no such convulsions of terror, even though in the first moment it is rather cautiously examined. New things are not necessarily frightful to a chimpanzee, any more than to a human child; certain impressive qualities are requisite to produce this special effect" (pp. 321-322).

Köhler suggests that these impressive qualities are surprise and the unknown.

Valentine (1930) took Watson to task for oversimplifying the development of fear, and suggested that general fears or predispositions to emotional arousal were based on maturation. He observed that his daughter (age 12 months) showed fear of her brother in a cat costume, and (age 14 months) when her brother put a paper bag over his head. Further observations, between 17 and 29 months of age, revealed fear to: her father crawling toward her on hands and feet, "monkey-wise", with head down; a doll whose head opened backwards; a nearly decapitated doll, and the doll's eyes joined by a wire. Valentine refers to these events as "uncanny", in the sense of strangeness associated with the very familiar. He concludes:

> Even assuming that the fear of animals is always due to some chance association with loud noises or withdrawal of support or to suggestion, we can scarcely imagine that such weird combinations -- that of a boy with a paper bag on his head or a boy dressed as a black cat -- can become fearsome by association. These and other examples in the records of careful observers, of fear of uncanny strange things, make it certain, as it seems to me, that we must assume an innate tendency to fear under certain conditions. Not that there is a specific definite fixed innate fear of, say, all furry animals; what the facts suggest to my mind is that there is, first, a general tendency to fear the very strange, especially when closely associated with the familiar" (p. 409).

Although Köhler and Valentine did not have control over the histories of their subjects as Hebb did, there is striking similarity in the events that aroused fear both in chimpanzees and in young children. In each case the object or situation is familiar, but has been changed in some way. It is not clear whether the change is from familiar to unfamiliar, or familiar to 'familiar-but-changed', or perhaps 'familiar-but-unfamiliar'. Hebb interpreted his findings not in terms of novelty alone, but rather in terms of "the familiar in an unfamiliar guise." Hebb's theory, later elaborated (1949) held that while the fear of novelty may be unlearned, a certain amount of experience is necessary to encode the familiar before an organism can identify a pattern as novel.

"The familiar in an unfamiliar guise" is perhaps as good a definition as any for the variable which Berlyne and others have referred to as "incongruity." As will be shown in the sections to follow, incongruity results in visual exploration in humans, both children and adults, and there are only Valentine's suggestive observations of his own child as evidence of fear or withdrawal. As has been shown, incongruity presented to nonhuman animals at a variety of ages results in withdrawal and fear, and approach or exploratory responses have not been observed. Such a clear dichotomy is not common, and represents an interesting problem in itself.

The effect of incongruity upon visual exploration

College students:

At this juncture, it is well to call attention again to the point made earlier, that "incongruity" or "incongruous" are poor terms to use to describe stimulus characteristics. "Incongruity" seems to refer to the presumed competing responses aroused by these figures, rather than to the characteristics of the figures themselves. Henceforth in this discussion, stimulus figures which have been called "incongruous" or "congruous" will be labeled "altered" or "unaltered." "Incongruity" may well be a useful term, but not when applied to stimulus characteristics.

With only three exceptions (Bruner and Postman, 1949; Connolly, 1969; Nunnally, Faw, and Bashford, 1969), the stimuli and methods used to investigate incongruity as a motivating variable have been those used by Berlyne. The stimulus figures that have been used and referred to as "incongruous" are described in Appendix A.

Bruner and Postman's investigation was prompted not by questions about exploratory behavior, but rather by questions about the nature of perceptual organization when expectations were not confirmed. They altered six playing cards such that the color was reversed, e.g., a black four of hearts. College students were presented 1, 2, 3, or 4 of these cards along with normal cards in a tachistoscope, and recognition thresholds were determined. The thresholds for altered cards were significantly higher than for normal cards, and decreased depending on how many altered cards had been seen previously. Also, the number of prerecognition responses that were compromises ("brown spades," "purple," "rusty black") was greater to the altered cards. Bruner and Postman interpret these compromises as resistance to stimulation that fails to confirm the observer's expectations, that is, is unexpected or incongruous. The increased recognition thresholds, they maintain, are the result of this resistance.

The existence of any compromise reactions has been questioned by Kempen, Hermans, Klinkum, Brand, and VerHaaren (1969). They suggest that the results obtained by Bruner and Postman may have been due to the red paint used to alter the playing cards, a darker, less yellow shade of red than on normal cards. Kempen et al. suggest that the 'incongruity' is not only the red-black inversion, but also the unusual (for playing cards) red color. They had playing cards made with the red-black inversion, but in the usual colors, and replicated the Bruner-Postman experiment exactly. Their results agreed considerably with Bruner and Postman's, with one exception. They found no compromise reactions, although they do not report how their subjects were encouraged to verbalize what they were seeing in the tachistoscope.

It is not clear why the recognition thresholds are higher. The recognition threshold method has been amply and justly criticized (V. Dember, 1960; Eriksen, 1960), because it is not clear that the subject reports at the same moment that he recognizes. He may recognize the figure, but not report it, perhaps thinking "I couldn't have seen that," or "I can't say that to him (or her)" (the experimenter). Thus the longer durations required for correct recognition of the altered figures may be the result of a conceptual conflict rather than of perceptual processes alone. There is clearly a possibility that higher order, more complex processes than perception alone may influence the results of such experiments. In addition, the results are potentially confounded with the social relation that exists between subject and experimenter.

The studies by Berlyne which are germane to this discussion also have involved novelty or complexity, so they have been discussed in previous sections. When responses to altered and unaltered figures are compared, altered figures

1) are viewed more frequently in a tachistoscope (Berlyne, 1957 ; Minton, 1963)

2) are chosen more frequently to be seen again (Berlyne, 1963a)

3) are fixated for a greater proportion of a 10-second or 2-minute period (Berlyne, 1958a, b)

4) are explored for a longer period of time (Berlyne and Lewis, 1963; Berlyne and Lawrence, 1964)

5) result in greater incidence and amplitude of GSR (Berlyne, et al., 1963) and longer EEG desynchronization (Berlyne and McDonnell, 1965).

Adult males fixate longer on some of Berlyne's altered figures than at the unaltered versions (Faw and Nunnally, 1967), and adult females look longer at 'more incongruous' figures than at 'less incongruous' ones (Nunnally, Faw, and Bashford, 1969). However, the latter finding is not without question and will be discussed more fully in the section on "'preference' for incongruity."

Clearly, adults respond differently to familiar figures that have been altered than to their unaltered counterparts. No study has failed to obtain these results.

Children:

Much of the research to be reviewed here has examined novelty, complexity, and incongruity in the same experiment, and so has been discussed in previous sections.

The studies which show that altered figures are explored longer are those of Smock and Holt (1962), Lore (1965), Clapp and Eichorn (1965), Faw and Nunnally (1968a), Connolly (1969), Dodd and Lewis (1969), and Nunnally, Faw, and Bashford (1969). In the case of the Smock-Holt and Clapp-Eichorn studies, the altered figures were part of Berlyne's "animals" and "birds" series. Thus these positive results are based on only four figures: a bird with three heads; a bird with the lower body of an elephant; a dog with an elephant's head, and a camel with a lion's head. Smock and Holt found a strong sex interaction, the boys showing a larger difference score than the girls between the altered and the unaltered figures. Clapp and Eichorn found no such sex difference.

Lore (1965) presents results which largely support those above. Similar to the results for complexity, only the middle-class children responded significantly more to the altered than to the unaltered figures. It is possible that the effect was masked in the lower-class children by the elaborate apparatus, being "finger printed" for the GSR measure, and by the attention of the experimenter. Attempts to determine social-class differences in reactions to figures such as these will have to be more carefully controlled, to the extent that machinery, explicit instructions, and an adult's avid attention can be expected to have differential effects on children from different social classes.

Faw and Nunnally (1968a) presented pairs of altered figures to seven- to 13-year-old boys, and measured the proportion of time that each figure was fixated. Two pairs of stimuli were taken from Berlyne's "Incongruous juxtaposition" category, and two other pairs were made up by the authors. The altered figures were fixated significantly more (58.7%) of the total time that either figure was fixated. In experiment II, an attempt was made to scale "novelty" (the authors' description of their stimuli) by designing other altered figures. The stimulus pairs were presented as before to 33 nine- and ten-year-old girls, and fixations were recorded. After the fixation trials the subjects were asked to rank the stimuli on the basis of their <u>familiarity</u>. The two sets of figures are shown in Appendix A. A monotonic increasing relation obtained between the scaled fixation score and the mean rank assigned to the figure. That is, altered figures rated as less familiar were fixated a greater percentage of the time. This result has been replicated twice (Faw and Nunnally, 1968b; Nunnally, Faw, and Bashford, 1969).

Dodd and Lewis (1969) assessed the reactions of 60 two-year-old children to altered and unaltered figures. The figures were photographs of: a man; the same man standing on both sides of himself, resulting in three identical men; a man with three heads, and a man with an upside-down head. A variety of measures of attention were made: fixation time; direction of first fixation; number of vocalizations; arm movements; pointing; smiling; changes in heart rate. In general, the children pointed more, moved their arms more, and looked first and longer at altered figures than at the unaltered figure.

In a well designed and executed experiment, Connolly (1969) has shown that kindergarten, second-grade, and fourth-grade children look longer at, and show longer and more intense changes in facial expression to altered drawings of animals than to unaltered drawings. These results were independent of age. All of the figures were presented as a picture book, and E recorded the interval between page-turns. This is a particularly powerful technique to use with children because it rules out the possibility that the children are not responding to the stimulus figures, but to the operation of the tachistoscope (Clapp and Eichorn) or slide projector (Smock and Holt). It should be pointed out, however, that Murray and Brown (1967), using adults, and Faw and Nunnally (1968b), using children, have found no difference in looking time at altered figures between the typical laboratory setting and a less formal "waiting room" setting, in which the subjects leafed through a booklet containing the figures.

Only one study shows no difference in exploration of altered versus unaltered figures (Hoats, Miller, and Spitz, 1963). Certain data analysis problems of this study have already been discussed. In view of these problems, the results are difficult to interpret.

In summary, the results would seem to indicate that infants, preschool, and elementary school children, like adults, look at altered figures more than at their unaltered counterparts. The results do not show when in the child's growth and experience such differences in responding begin to take place, though in Connolly's study there were no age differences. This is a matter of some interest from a developmental standpoint, especially for the development of cognitive processes, as Charlesworth (1969) has pointed out.

The effect of incongruity upon ratings and "preferences"

Few attempts have been made to obtain subjects' evaluations of altered familiar figures. As noted previously, Berlyne and Lawrence (1964) found that adults preferred the unaltered forms to their altered versions, and Berlyne (1963a) found that the altered figures were rated more interesting but the unaltered figures were rated more pleasing. When considered in light of Day's (1967) results, this finding would suggest that looking time is more a function of interestingness than pleasingness, whereas the opposite may be the case for verbal evaluations. It also might mean that altered figures are more complex than unaltered figures.

The work of Nunnally and Faw at Vanderbilt University (Faw and Nunnally, 1968a, b; Nunnally, Faw, and Bashford, 1969)is highly germane to this discussion. This work attempts to relate ratings of altered figures to looking time as measured by photography of eye fixations. The altered figures are described in Appendix A.

The three studies by these investigators are similar in many respects, and only the latter will be examined in detail. The hypothesis under investigation was concerned with the shape of the function relating level of incongruity to looking time. Following the reasoning of Berlyne and others, one would predict a curvilinear relation, on the argument that incongruity elicits conflict and arousal for which individuals seek some optimum level. Nunnally, Faw, and Bashford suggest an alternative explanation, that longer looking time at altered figures is the result of a greater number of competing interpretations of those figures, and that a person looks until the interpretations are resolved. This suggests a monotonic (increasing) relation between level of incongruity and looking time.

The authors designed four sets of one unaltered and three altered figures each, so that each set would represent four distinct levels of incongruity. Twenty-seven female college students and 54 third- and fourth-grade boys were shown all possible pairs of figures within each set, a total of 24 pairs. Each pair was shown for 30 seconds and Ss' eye fixations were photographed. After all pairs were presented, the subjects ranked the four figures in each set from most familiar (1) to most unusual (4).

The movie frames were analyzed, and eye fixations scored as Left, Right, ar Center. The percentage of time for Left and Right fixations was calculated, with the "Center" category disregarded. A "mean % viewing time" score was thus computed for each figure, for each of the three 10-second periods of the 30-second exposure.

For both adults and children, significant F-ratios were obtained for "levels of incongruity" and the "levels of incongruity X time intervals" interaction. A monotonic relation between viewing time and level of incongruity occurred during the first and second 10-second periods for the adults, and only during the first 10-second period for the children. The results seem to show fairly clearly that the more "unusual" an altered figure is ranked the greater time a person will look at that figure.

There are several reasons, however, to consider the above interpretation tentatively. The first concerns the "incongruous" figures and their evaluation by the subjects. Examination of the description of the figures (Appendix A) reveals a considerable haphazardness in the design of these figures. It would be helpful if the authors would spell out the intuitive basis on which the figures were drawn. Why were these figures chosen to be altered in these ways? More importantly, the subjects were asked to rank the figures, not on a dimension of "incongruity," but in terms of their unfamiliarity. The two terms may not be synonymous, that is, incongruity may in fact be something other than or in addition to novelty, as much of the literature seems to suggest. But this is a moot point. The figures were not, in fact, ranked on the basis of their familiarity. They were ranked from most familiar to most unusual, not most unfamiliar. Do "unusual" and "unfamiliar" have the same meaning for both female college students and third- and fourth-grade boys? If they do not mean the same, then no clear conclusions can be drawn from the rankings, and about their relation to viewing time.

It is likely, therefore, that the research is mistitled. It is concerned with "Effects of degrees of incongruity on visual fixations in children and adults" only according to the authors' unstated criteria for incongruity. The subjects were not asked about incongruity, however, so it is more likely concerned with the effects of familiarity-unusualness on fixations in children and adults.

The second reason why Nunnally et al.'s interpretation must remain tentative is the manner in which the viewing time was scored. As was mentioned previously, Center fixations were discarded. To use the authors' example, "if of the total 30-second viewing period, the more incongruous stimulus was looked at for 15 sec., while the less incongruous stimulus was looked at for 10 sec., then the percentage scores for these pictures would be 60% and 40% respectively." Note that they are not 50% and 33.3%. This perhaps mistakenly assumes that "center" looks are meaningless. It would be worthwhile to see the results analyzed with the "center" fixations included, because the percentage of "center" looks may vary considerably from pair to pair.

The third source of concern is based on the statistical analysis. The research was based on an hypothesis about the nature of the relation between level of incongruity and looking time, monotonic versus curvilinear. Such an hypothesis would seem to require a trend analysis, at least some consideration of nonlinear components of variance. Yet the reported analyses of variance involve only linear components. No F-Ratios are reported for quadratic or cubic components.

Finally, the subjects differed in both age and sex. While the literature on visual exploration would lead us to expect few sex differences, the developmental literature is replete with sex X age interactions, for example, developmental changes in "field-dependence" (Witkin, 1960).

Thus, the results of this research are highly suggestive, but inconclusive.

In sum, however, verbal evaluations of the complexity and familiarity of stimulus figures made to vary in their complexity, novelty and "incongruity" would seem to be related to visual exploration of these figures in an exploration or choice task. As noted previously, the meaning of those ratings and preferences in terms of the physiological effects of various parameters of stimulation is a matter for further investigation.

Definitions and theoretical treatments of incongruity

The term "incongruity" has not been of major importance in any theory of motivation, or attention, or development. The term has most frequently been used in conjunction with the terms "novelty" and "complexity", and has represented, in effect, an acknowledgment that novelty and complexity are not the only non-homeostatic, non-drive-reducing determiners of motivation and attention. When an attempt is made to explain exploratory, investigatory, and play behaviors, the first stimulus determiners invoked are novelty and complexity. Given such a situation, it is not surprising that incongruity has remained poorly defined and imperfectly integrated into any theoretical formulation.

The three terms, novelty, complexity, and incongruity have a common base, however, in the role of experience in establishing the levels of these stimulus dimensions which result in different motivational and attentional states. Novelty and incongruity are explicitly based on experience; complexity is less so. Furthermore, the three have in common the concept of anticipation or expectation. Expectation is used in two senses: either as a cognitive event based on past experience with concepts and classes of objects, or as a learned (habitual) response to some specific situation. In either case, some disruption of the usual response to that situation is experienced or evidenced.

While Berlyne (1960) has been prominent in the use of the term incongruity, its definition and place in theory have been discussed also by Hebb (1949), Piaget (1952), Bruner and Postman (1949), Maddi (1961), and Nunnally, Faw, and Bashford (1969). Each of these will be taken up briefly, but it must be emphasized that treatments of this stimulus dimension have been uniformly speculative, rational in approach. There has been no empirical treatment of "incongruity."

Berlyne (1960) regarded incongruity as one of a number of stimulus variables ("collative" variables) which generate arousal and curiosity through conflict. The drive state curiosity is reduced through exploration. Berlyne defined incongruity as existing

> when a stimulus induces an expectation which turns out to be disappointed by the accompanying stimuli.
>
> Incongruity requires not only a combination of stimuli that is novel but a combination differing from, yet having components in common with, one that the organism has learned to treat as more likely.
>
> We can think of incongruity if we insist, as a special case of surprise, since the incongruous pattern contradicts expectations aroused by the whole mass of past experience" (pp. 24-25).

Thus, in Berlyne's terms, incongruous figures are of necessity novel, but something has been added such that the result is incongruity. This is a temporal distinction: novelty is the result of "successive" expectations and incongruity is aroused by "simultaneous" expectations. This "simultaneous-successive" distinction is more explicit in his discussion of incongruity and surprise. In both cases the distinction is notably weak. No two events in the same sense modality are ever simultaneous in terms of the operation of the nervous system. The eyes, in addition, are in constant motion changing the point of fixation. All events are functionally successive. It is very difficult and arbitrary to decide when two events occur in such close succession that they can be considered simultaneous.

Hebb (1946, 1949) treated incongruity on two levels, neurological and observational. The neurological explanation is in terms of disruption of established 'associations' of neurons, with resultant emotional behavior, arousal, and exploration. Specifically, through perceptual experience mediated by eye movements and selective attention, neurons become functionally associated with each other (their thresholds for firing are reduced). These functional 'structures', which Hebb referred to as cell assemblies, can be combined with each other and with motor processes to result in still more complex functional 'structures' called phase sequences. A stimulus situation which results in partial firing of a cell assembly, but which contains an element or elements not normally there (not 'expected' by the succeeding neurons in the chain) disrupts the organized activity of the cell assembly. This disruption then leads to exploratory activity. A stimulus situation giving rise to such disruption would be called incongruous. Thus, incongruity is here defined in terms of disorganized activity of hypothetical neural structures. This is a difficult proposition to test. The cell assemblies and phase sequences remain hypothetical, and, as Hebb points out, are extremely difficult to identify, due to their experientially-based complexity.

Hebb's (1946) observations, along with those of Köhler (1927) and Valentine (1930), provide a variety of descriptions of familiar situations or stimuli that had been changed, and provoked fear responses. Unfortunately, there is little commonality among the situations that Hebb, Köhler, and Valentine describe. The head (as distinct from the rest of the body) seems to be involved in many of them, but by no means all. In general the situations were familiar, but with some elements changed. In terms of frequency, many of the elements of the situation were highly frequent. Some, however, were infrequent, either in an absolute sense, or in the context of the frequent elements. This may be an important distinction. If the changed elements are infrequent in an absolute sense, the situation may, in fact, be novel. Incongruity may be the case when the changed elements are infrequent <u>in the context</u> of the high frequency elements. This may be what Hebb alluded to with "the familiar in an unfamiliar guise."

There is reason for caution, however. Fear was the reaction observed by Hebb, Köhler, and Valentine. Approach and exploration are the responses of children and adults to incongruity, as shown by the literature reviewed in the preceding sections. The generality of Hebb's, Köhler's, and Valentine's observations therefore may be questionable.

Piaget (1952, pp. 68, 276) has noted that the most effective elicitor of attention and exploration in infants is a moderate alteration of some familiar stimulus. This could be taken to mean incongruity, though Piaget does not use the term. His treatment of stimulus characteristics that influence exploration and investigation is in terms of novelty. It should be noted that Hebb's and Piaget's discussions of novelty-incongruity are similar: both point to the importance of prior experience to establish standards by which to determine whether a situation is familiar or unfamiliar.

Novelty (and perhaps incongruity) are important in Piaget's theory of cognitive development. The child's tendency to orient toward, approach, and explore novel objects is a major source of cognitive development (<u>V</u>. Flavell, 1963), because it leads to a constantly enlarging and reorganizing store of representations of stimulus characteristics and the child's responses to them. As a result of this exploration, the child's cognitive structure is expanded and reorganized, thus directing his behavior differently. He therefore encounters other new objects which result in further reorganization, thus making different behaviors possible, and so on. This source of cognitive development is seen most dramatically in play, which Piaget (1962) regards as the means by which the child exposes himself to, and thus gains more cognitive representations of, a wide range of objects and their characteristics.

This treatment of cognitive change as generated by novelty has been enlarged by Charlesworth (1969) to include surprise. Charlesworth distinguishes between novelty and surprise, however, on a number of grounds, and points out that surprise, as a potent determiner of attention, may be an important source of cognitive development.

Bruner and Postman (1949) and Bruner (1951) have explicitly defined incongruity in terms of expectancy. Perceivers, they maintain, bring with them to any situation a general readiness to respond selectively, an expectancy or hypothesis. Stimulus information is compared with the existing hypothesis, and the hypothesis is confirmed or not. In the latter case the hypothesis is changed according to personal, idiosyncratic factors, and according to experience. New information is sought out by which to test the modified hypothesis. Incongruity exists "when perceptual expectancies fail of confirmation" (Bruner and Postman, 1949, p. 208). In this sense, incongruity is the outcome of a comparison, and the outcome could be influenced by <u>any</u> stimulus conditions failing to confirm the hypotheses. Thus, incongruity is not a dimension of stimulation but a state of the perceiver that has motivating properties, such that: 1) the hypothesis is changed; 2) contradictory information is not attended to ("defended against"), or 3) further information is sought to reduce the mismatch between hypothesis and information. According to this formulation of incongruity, the terms 'novelty', 'change', 'surprise', and 'incongruity' (as a dimension of stimulation) would all be synonymous, because they all could result in defeated expectations.

Maddi (1961) deals more directly with incongruity as a stimulus variable. "An incongruous stimulus contains elements which are perceived as incompatible with each other on the basis of prior experience with these elements" (p. 256). The definition resembles Berlyne's (1960). In both, expectations are thought to be aroused, but are disconfirmed. The result is a change in arousal or activation (though Berlyne prefers arousal to be mediated through conflict), which leads to exploration. Berlyne seems to refer to the stimulus as a whole arousing an expectation which is disconfirmed by some part or parts, whereas Maddi refers not to the whole stimulus but to incompatibilities among its parts. Maddi continues:

> Novelty, complexity, incongruity, and surprisingness can be fairly well defined in the abstract, but when an attempt is made to vary one of them while holding the others constant, the distinctions become blurred. The more complex, incongruous, and surprising a stimulus is, the more likely it is to be novel. The more incongruous a stimulus is, the more likely it is to be complex" (1961, p. 267).

The final treatment of incongruity to be considered is by Nunnally, Faw, and Bashford (1969). In this investigation, incongruity was not explicitly defined. An empirical definition might possibly be obtained by examination of the kinds of alterations made on the stimulus figures, but cannot, because (as previously noted) the design of the figures was haphazard. The authors speculate, however, on the mechanism by which incongruity affects visual exploration. They hypothesize that,

> effects on looking behavior are because of the competing possible interpretations of the incongruous figure rather than because of conflict-induced states of arousal. The incongruous figure will tend to dominate visual orienting behavior until the conflicting interpretations are resolved" (p. 361).

If 'interpretation' can be taken to mean 'expectation', then this explanation is similar to those preceding. It is not clear that this is the case, however. This seems to refer to a multiplicity of meanings, in a sense conceptual complexity, with the implication that a great number of 'part-meanings' makes more difficult (and therefore more time consuming) an association of meaning to the figure as a whole.

It is clear that incongruity has received little more than speculative definition. There has been no empirical treatment of the term other than the observations of Köhler, Valentine, and Hebb. While there is considerable variability in the specifics of definition, all reflect the importance of prior experience, and most refer to alteration of arousal or activation state by this and other related variables.

## SUMMARY OF RESEARCH ON VISUAL EXPLORATION AND "PREFERENCES"

It seems clear that novelty, complexity, and incongruity, all variously defined, are aspects of the subject-environment relationship which have the power to effect shifts in attention and prolonged visual exploration, which are paralleled by changes in various evaluations. However, if one considers the age of the subject the result is less clear, especially with respect to the influence of complexity.

One of the strengths of this research is that, despite different definitions of the variables, despite different stimuli meant to depict such variables, and despite the variety of measures of exploration that have been used, the major results still obtain: that situations that are novel, complex, or incongruous are explored longer than are familiar, less complex, or "congruous" situations.

This research has a major weakness also. These results may be peculiar to the stimuli that have been used, and not generalizable to other stimulus situations. This is a serious criticism and is especially applicable to the incongruity dimension. Berlyne and others following him have taken a simple intuitive approach to incongruity. There is nothing wrong with an intuitively-based operational definition, at least in the early stages of scientific work, but to regard incongruity as a phenomenon as simple as its crude definition may be a serious mistake.

This problem of defining stimulus characteristics of "incongruity" is paralleled by the difficulty in defining the response, that is, "preference" in many of the studies already reviewed.

## THE CONCEPT OF PREFERENCE

A word is in order concerning the use of the term "preference." A number of investigators have asked subjects whether they preferred or "liked best" a stimulus figure. Others have measured the duration that a figure was explored and inferred that it was preferred if it was explored longer than other figures. Either procedure alone is of questionable utility because different "preferences" may be obtained with the two methods.

Kaess and Weir (1968) present evidence that the method of measurement influenced the degree of preference for figures differing in complexity. They presented pairs of randomly-generated polygons to 54 29- to 66-month-old children and obtained, on successive days and in counterbalanced order, 1) stated preference, i.e., which member of the pair they "liked best," and 2) looking time, the figure looked at longer being scored as preferred. The relations between the complexity of the figures and each of the two measures differed considerably. Stated preference showed little change as number of turns increased from 5 to 40, but looking time increased monotonically. At the complexity level of 5 turns, the scaled score was higher for stated preference than for looking time, but at 40 turns the reverse was true. Age was not a contributing factor.

The authors are appropriately tentative about stated preferences obtained from three- to five-year-olds, but present some evidence (split-half reliabilities from .45 to .65) that the children were not responding randomly. Comparison of the evaluation and looking time methods is not quite so clear as Kaess and Weir's study would indicate, however, because age is also a factor. Thomas (1966b) found no difference in results between the two measures, using six- to 12-year-old children. Berlyne and Lawrence (1964) used adult subjects and found a negative correlation between evaluation and looking time.

It is difficult to say which of the stimuli in Kaess and Weir's study were "preferred," because the "preference" depended on the method of measuring it. The confusing results already summarized in the section on "preference" for complexity may be explainable in terms of these different response measures. Experimenters have been understandably reluctant to ask young children which figures they liked best, and so "preference" has been based on looking time. Contrariwise, older children have been counted on to understand instructions and give trustworthy verbal responses, and their judgments of "preference" have tended to be based on such verbal evaluations. Thus, age differences in "preference" have clearly been confounded with mode of response.

There are further objections to the indiscriminate use of the term "preference." Knowing that a figure is preferred over other figures (however measured) tells little about the subject's response to that figure. A more meaningful question is, What is the underlying basis for the longer looking time and verbal evaluation? or, What are more specific responses that the subject makes to the stimuli? There seems to be an encouraging trend in this literature away from global "preference" or "liking" ratings toward more specific questions, for example, how interesting or pleasing the stimuli are, although these questions too are difficult to interpret.

Furthermore, investigators interested in "preference" have virtually ignored organismic variables as a source of explanation of choice behavior, in favor of explanation in terms of stimulus characteristics. The only such organismic variable to receive any consideration has been age, and as was remarked above, age has been confounded with method of response. The possibility for systematic individual variations in responsiveness and quality of response exists, whether or not we choose to use the term 'personality'. Individual differences in style of perception and cognition have been explored to some advantage by Witkin (1960; Witkin, et al., 1954) and by Kagan, Moss, and Sigel (1963). There is no reason why such a research approach could not help explicate the concept of preference.

There is one further danger. That is the error of reification, that the name arbitrarily assigned to a class of behavior comes to be regarded as a thing, a process or structure within the organism. To say that a subject prefers one thing to another is to describe his behavior. To say that he (therefore) has a preference is to impute to him some unknown, perhaps unnecessary, and perhaps overly simplistic process or entity. Such an inference is unparsimonious and easily leads to circular reasoning.

An analogy with the concept of instinct is compelling. Schnierla (1966) maintained that "'innateness' is nothing more than a poor hypothesis as to alleged types of ontogenetic origins" (p. 287). To say that a behavior is instinctive is to describe it according to some criteria, primarily, species-specificity and independence of learning. "Instinctive" is a description in the same sense that "preferred" describes choice behavior, either verbal or visual. However, Schnierla points out that it has been relatively easy to slip from "instinctive" to "instinct," implying that there exists some entity intervening between genetic mechanisms and behavior. In like fachion, a slip from "preferred" to "preference" may be just as easy and just as potentially misleading. Unexplained behaviors must be described nevertheless, and "instinctive" and "preferred" or "preference behavior" are perfectly adequate labels, but they are only descriptive, not explanatory.

THE PROBLEM

A number of problems have been raised in this review. The current research focuses on a basic question: What does "incongruity" mean? That is, what kinds of figures, altered in what kinds of ways, are called "incongruous?", and how do "incongruity" ratings relate to other possible ways of evaluating these same figures?

As Appendix A shows, no systematic operations have been performed on figures that are called "incongruous," or by others (Smock and Holt, 1962; Faw and Nunnally, 1967, 1968a, b; Nunnally, Faw, and Bashford, 1969), simply "novel." In fact, the only commonality among the figures is that they are all altered forms of meaningful figures, the alteration often being one of substitution of various parts. In research of this type, in which subjects are exposed to various qualities of stimulation and in which the experimenter is called upon to devise stimuli which in fact depict those variables, interpretation of the results depends intimately on the stimulus figures and the response measure used. It behooves the investigator to show that the effects of the manipulated stimulus variables are not specific to the stimuli used, and that the stimuli are a sample of all stimuli that would depict those variables.

The aim of this research is essentially a clarification of the meaning of "incongruity" in terms of: the manipulations or operations performed on stimuli that yield "incongruity," and verbal evaluations on a number of other dimensions which can be expected to be related to "incongruity." Only after such an initial step to understand "incongruity" can this complex aspect of stimulation be used in a meaningful way to investigate other complex classes of behavior.

# METHOD

## Subjects

The subjects were 240 college students (147 female, 93 male) enrolled in the introductory and child psychology courses at Michigan State University during the summer term, 1969. The mean age of the group was 20.7 years. Table 1 lists the number of subjects, male and female, in each group and in each order of presentation.

## Stimulus figures

The stimulus figures chosen in earlier studies to represent "incongruity" are diverse and unsystematically sampled, and they may not be representative of a general factor "incongruity," assuming for the moment that such a factor exists. The stimuli described in Appendix A are based on each previous experimenter's intuitive ideas about incongruity. There is nothing wrong with an intuitive approach, but evidence suggests that it is time to become more specific about what is meant by "incongruity."

To this end the author has listed in Appendix B a variety of factors which may be thought to make an object or a two-object situation incongruous. For simplicity's sake, the factors are listed singly rather than in combinations or multiple interactions. This conceptualization, like previous unstated ones, is rational and intuitive, but also more systematic and comprehensive. It is by no means exhaustive, yet it serves to illustrate that the concept of incongruity is potentially far more complex than the figures used to date would indicate. We note too in comparing Appendices A and B

Table 1. Subjects

| Group | Order | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Order 1 | | | Order 2 | | | | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| Incongruity | 10 | 10 | 20 | 4 | 16 | 20 | 14 | 26 | 40 |
| Complexity | 10 | 10 | 20 | 5 | 15 | 20 | 15 | 25 | 40 |
| Interestingness | 10 | 10 | 20 | 6 | 14 | 20 | 16 | 24 | 40 |
| Pleasingness | 11 | 9 | 20 | 4 | 16 | 20 | 15 | 25 | 40 |
| Unfamiliarity | 10 | 10 | 20 | 7 | 13 | 20 | 17 | 23 | 40 |
| Conflictfulness | 12 | 8 | 20 | 4 | 16 | 20 | 16 | 24 | 40 |
| Total | 63 | 57 | 120 | 30 | 90 | 120 | 93 | 147 | 240 |

that the majority of incongruous figures used in past studies have involved only one operation, "wrong part."

This outline, besides exposing the conceptual complexity of incongruity, allows the construction of a series of stimulus figures which vary in specified ways. The figures used in this research are described in Appendix C. Two major factors were involved in the construction of these figures: Class of object (Living versus Non-living) and Manipulations performed on body part. The latter is comprised of: 1) Missing part; 2) Misplaced part; 3) Wrong part; 4) Misplaced and Wrong part. Another potentially important variable is the part manipulated (head or leg). In figures used in previous studies, either has been manipulated. Therefore, in the current study all manipulations were made on both head and leg of the living figures. Such was not possible for the nonliving figures, since these figures, while having parts similar to legs, have nothing like heads. Thus, the Class factor has three values: 1) Living figures with Head manipulated; 2) Living figures with Leg manipulated, and 3) Nonliving figures with part manipulated.

With considerable effort these diverse figures in Appendix C were made as much alike as their differences would allow. For instance, with the exception of the man, ape, and umbrella, the figures are oriented toward the right, either full-right (car, bicycle, and elephant) or approximately half-right, to allow all legs to be seen (dog, eagle, table, and chair). In all cases, the leg (or wheel) missing is in the right half of the drawing. When misplaced, the leg (or wheel) is moved left, toward the back of the figure. When a part is wrong, in both the living and nonliving figures, it is made the size of the correct part (the ape's head on the elephant, the eagle's leg on the man, the chair seat on the car). When the head of the living figure is misplaced, it is moved down the body, whether that be gravitationally down (man, ape), or left (elephant, dog, eagle). Finally, the limb manipulated always implied disequilibrium, a loss or change of support.

A number of potentially important factors were varied randomly or left uncontrolled in these figures. One is the angle of view of the figure; face front; profile, or half front. To make clear that a part was missing or misplaced and not merely obscured or a function of the perspective of the figure, it was necessary to vary the perspective. Eye contact is related to perspective and is especially important for the human figure, but is also potentially effective in the other living figures. Another factor is whether the entire part is missing, misplaced, or wrong, or whether only part of the part is manipulated. Another is the symmetry of the figure. Yet another is whether any action is portrayed. Finally, the proportional size of the "wrong" parts could contribute to a figure's judged incongruity. For instance, when an ape's head is put on an elephant's body, should the head be the size of an ape's head or an elephant's?

These factors could be controlled, of course. Eye contact could be controlled by constructing four basic drawings: 1) man standing face front, facing front; 2) man standing face front, but looking to the side (head in profile); 3) man standing in profile, but looking face front; 4) man standing in profile and looking straight ahead (head in profile). Each of the four manipulations then could be performed on the heads of each of the above four figures. Each manipulation (with the exception of "missing") would be performed in two ways: with the manipulated head in profile, that is, looking away from the observer; and, with the manipulated head face front, looking at the observer. Similar controls could be exerted on other variables, though to allow generalization over figures and to keep the task reasonably short, such control was not exerted in the present study.

The 70 figures listed in Appendix C were drawn in india ink on 9 X 12 inch layout paper. The unaltered versions of the figures were drawn first, and as many of the altered versions as possible were then drawn by tracing the unaltered versions. The 70 figures were drawn approximately the same size and have some inner detail, though they are basically outline drawings.

The pen-and-ink drawings were photographed on Kodachrome X film and processed as slides. Because the lighting conditions were not optimal, the projected slides had a definite yellow-brown tint. The slides were not true black on white, though they were uniform in this fault.

The 60 slides of altered figures plus the 10 slides of unaltered figures were randomly ordered and placed in Kodak Carousel slide trays, alternating with black cardboard to darken the screen between exposures. The 10 unaltered figures were included in order to get estimates of their own incongruity, unfamiliarity, or conflictfulness as a base against which to interpret the ratings of the altered figures. It is possible that including the unaltered figures with the altered figures influenced the ratings of the altered figures, but this was not considered to be a serious problem, since the differences between various classes of figures are unlikely to have been affected, and it is these differences in ratings, not their absolute values, that are important.

Two orders of presentation were used. Order 1 was generated according to the following: The series of 70 exposures was partitioned into ten 7-digit sequences. From each of these sequences a number 1 through 7 was randomly chosen, and one of the ten randomly ordered unaltered figures was assigned to that position in the series. Thus, an unaltered figure appeared in every seven exposures, although any two were not allowed to occur in succession. The remaining 60 positions were filled by the altered figures, which were randomly assigned with the following restrictions: 1) no two alterations of the same basic figure (e.g., man) were presented in succession; 2) no manipulation was presented twice in succession, and 3) no more than three Living or three Nonliving figures were presented in succession. Order 2 was the reverse of order 1.

Rating scales

The dimensions used in the rating scales were

1) incongruity

2) complexity

3) interestingness

4) pleasingness

5) unfamiliarity

6) conflictfulness.

Incongruity is the variable of major interest, especially as respects its relations with the other five variables. As was suggested earlier, "incongruous" figures are also unfamiliar, and differential reactions to incongruity (longer looking times, "preference") in fact may be reactions to novelty (V. Smock and Holt, 1962; Faw and Nunnally, 1967, 1968a; Nunnally, Faw, and Bashford, 1969). A similar case has been made for complexity (Maddi, 1961; Cantor, 1963), to the extent that "incongruous" figures are also more complex than their "congruous" counterparts, and in view of the similarities of response to higher versus lower complexity and altered versus unaltered figures. The research of Berlyne (1963a; Berlyne, Ogilvie, and Parham, 1968), Cantor (1968), and, in particular, Day (1967) indicate that interestingness and pleasingness are related monotonically and curvilinearly, respectively, to complexity. Thus a consideration of complexity should include those variables. Finally, Berlyne (1957, 1960, 1963b) has named conflict as the major factor in any explanation of differential responding to various forms of stimulation. The notion of conflict, whether arising through competing responses or physiological processes, seems implicit in the theorizing of Festinger (1957), Hebb (1949, 1955), and Hunt (1965). It is reasonable to expect that these six concepts, represented by the six rating scales, will be interrelated.

Procedure

The subjects were given one of the six instruction-answer booklets in the classroom. The instructions, read aloud by the experimenter, were as follows:

> Please state your age and sex in the spaces provided on the answer sheet.
>
> This is an experiment to discover how you react to various aspects of pictures. A number of figures will be projected on the screen at the front of the room. After you have looked

> at each figure, please rate that figure by marking an X in one of the 7 spaces provided on the answer sheet.
>
> Just before each new figure appears, I'll say "Next picture" so be sure you are looking at the screen. You'll have 6 seconds to look. Then I'll turn the picture off, and you'll have 7 seconds to rate it on your answer sheet. There are 70 figures in all, so this will take approximately 17 minutes.
>
> There are a number of ways that you might react to each figure,...

After reading this far, E asked the subjects to continue reading on their own, "because there are several sets of instructions." The subjects were also advised that the person sitting next to them was unlikely to have the same instructions. The instructions for each of the six groups were:

1) Incongruity:

> There are a number of ways that you might react to each figure, but your particular task is to rate the figure on how incongruous it appears to you. Think of 'incongruous' as meaning that the parts don't seem to fit, or the figure doesn't seem to go along with your previous experience. If the figure appears to you to be very incongruous, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely incongruous, you should give it a rating of "1" or "2".
> The 7-point scale is:

| not at all or barely incongruous | | | moderately incongruous | | | very incongruous |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

2) Complexity:

> There are a number of ways that you might react to each figure, but your particular task is to rate the figure on how complex it appears to you. Think of 'complex' as meaning that the figure is complicated, made up of many parts, perhaps difficult to understand. If the figure appears to you to be very complex, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely complex, you should give it a rating of "1" or "2". The 7-point scale is:

| not at all or barely complex | | | moderately complex | | | very complex |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

3) Interestingness:

There are a number of ways that you might react to each figure, but your particular task is to rate the figure on how interesting it appears to you. Think of 'interesting' as meaning that the figure arouses your curiosity, attracts and holds your attention. If it appears to you to be very interesting, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely interesting, you should give it a rating of "1" or "2". The 7-point scale is:

| not at all or barely interesting | | | moderately interesting | | | very interesting |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

4) Pleasingness:

There are a number of ways that you might react to each figure, but your particular task is to rate the figure on how pleasing it appears to you. Think of 'pleasing' as meaning that the figure is satisfying, enjoyable, gives you a good feeling. If the figure appears to you to be very pleasing, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely pleasing, you should give it a rating of "1" or "2". The 7-point scale is:

| not at all or barely pleasing | | | moderately pleasing | | | very pleasing |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

5) Unfamiliarity:

There are a number of ways that you might react to each figure, but your particular task is to rate the figure on how unfamiliar it appears to you. Think of 'unfamiliar' as meaning that the figure is out of your experience, unknown, or strange. If the figure appears to you to be very unfamiliar, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely unfamiliar, you should give it a rating of "1" or "2". The 7-point scale is:

| not at all or barely unfamiliar | | | moderately unfamiliar | | | very unfamiliar |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

6) Conflictfulness:

There are a number of ways that you might react to each figure, but you particular task is to rate how much you feel some conflict about that figure. That is, you may feel that you want to get closer to the figure or look at it, but at the same time you want to move farther away from it or look away. Such a situation can be thought of as conflictful. If the figure appears to you to be very conflictful, you should give it a rating of "6" or "7". If it seems to you to be not at all, or just barely conflictful, you should give it a rating of "1" or "2". The 7-point scale is:

| not at all or barely conflictful | | | moderately conflictful | | | very conflictful |
|---|---|---|---|---|---|---|
| 1 ____ | 2 ____ | 3 ____ | 4 ____ | 5 ____ | 6 ____ | 7 ____ |

All sets of instructions concluded with:

Try to be thinking about how you would rate the figure while you're looking at it. Then, when the figure goes off, mark an X in the space on the answer sheet that best describes your reaction to that figure, in terms of how (incongruous, complex, interesting, pleasing, unfamiliar, conflictful) it is. There are no right or wrong answers; this research is concerned with your reaction to the figures.

Remember, mark an X in one of the spaces "1" through "7", whatever you think applies best.

When all of the figures have been shown, please make sure that you have marked your age and sex on the answer sheet.

The instructions "Think of 'incongruous', 'complex', 'interesting', 'pleasing', and 'unfamiliar' as meaning ... " were derived from content analysis in a previous pilot study, of 29 college students' most frequent responses to the instruction, "Write in one or two short sentences what this word means to you." The present instructions were elaborated, that is the terms were "defined" by several synonyms, for two reasons. First, the range of responses from the 29 students was large, suggesting that any particular person's interpretation of these terms was likely to be general and somewhat vague. The scales were expected to overlap, but the overlap should be attributable to common characteristics among the terms, not to misinterpretations of the terms. Essentially, then, the purpose was to reduce the variance within each of the six groups of subjects. Second, these 'definitions' were intended to allow the subjects to attend more to the figures as they were presented instead of thinking about the various meanings of the term by which they were to evaluate the figures.

The slides were exposed by a Kodak Carousel 750 projector located 22 feet from a projection screen. The projected image was 26 X 34 inches in dimension. Exposure time was measured by a hand-held stopwatch.

The 120 subjects given order 1 made their ratings during a single lecture class. Ratings obtained under order 2 were obtained in one large class and four smaller classes.

In summary, six groups of subjects (N = 40 per group; Order 1, n = 20; Order 2, n = 20) rated each of the 70 figures. Each subject rated each figure once on only one dimension.

The resulting factorial design for each scale is 2 X 3 X 4, with factors: Order (2); Class of figure (3: Nonliving (NL); Living-Head manipulated (L-H); Living-Leg manipulated (L-L)), and Manipulation performed on part (4: Missing (M); Misplaced (MP); Wrong (W); Misplaced and Wrong (MP&W)). Subjects were nested within order, with repeated measures within subjects. The basic datum for the analyses of variance was the mean score per subject for the five figures which made up each of the 12 C X M combinations. The ratings of the unaltered figures were not included in the analyses of variance.

## RESULTS

The answer sheets were checked for mistakes, and the ratings punched on IBM cards for computer analysis. A total of 290 sets of ratings were collected. Of these, 19 were unscorable, usually because of two ratings for one figure and resulting confusion later in the list. The number of unscorable answer sheets in each group was: Incongruity -- 3; Complexity -- 3; Interestingness -- 5; Pleasingness -- 0; Unfamiliarity -- 2; Conflictfulness -- 6. Of the remaining 271 scorable answer sheets, 31 were randomly discarded, so that 40 subjects would remain per group with roughly equal proportions of males and females in each group.

### LEVEL OF SIGNIFICANCE

In the analyses of variance and related analyses reported below, a large number of significance tests have been performed on the same data. Since it is difficult to specify the true alpha level under these conditions (V. Hays, 1963), type I error was minimized by letting alpha = .01. Differences significant at alpha levels greater than .01 should be interpreted cautiously.

### CONFOUNDING VARIABLES

The first step in the analysis was to determine whether the ratings were influenced by any of several potentially confounding variables. Those examined were: 1) inconsistency of the ratings, that is, whether the ratings were randomly distributed, either within or between scales; 2) a serial position effect across the 70 presentations, and 3) sex of the subject.

1 (a). Consistency of ratings within each scale. The aim of this analysis was to determine whether the subjects' ratings were sufficiently consistent (nonrandom) on each scale to make further analysis meaningful. Two-way analyses of variance were performed on the data of each of the six groups, and coefficients of reliability were calculated (Winer, 1962, pp. 126-128). They were: Incongruity, 0.94; Complexity, 0.91; Interestingness, 0.69; Pleasingness, 0.91; Unfamiliarity, 0.91; Conflictfulness, 0.86. According to this method the reliability of the ratings on each scale increases as the variance of the ratings between figures grows increasingly larger than the variance of the ratings within figures.

1 (b). Ratings compared across scales. The ratings were compared across all six scales. Nonrandomly disrtibuted ratings would indicate that the scales measured different things. At the least it would show that subjects were not all responding on the same (unknown) basis, that is, that the instructions had some effect.

Accordingly, a four-way analysis of variance (summarized in Table 2) was performed, with factors: Groups (6); Order (2); Manipulations (4), and Class of figure (3). The "Groups" factor represents the six rating scales. In this analysis of variance, as in all subsequent ones, appropriate degrees of freedom, expected values of mean squares, and error terms for F ratios were determined according to the rules outlined by Millman and Glass (1967).
The effect of Order, Manipulation, and Class will be examined in greater detail when each of the six scales is discussed separately. For the present, it is sufficient to note that the Group effect was

Table 2. Analysis of variance over all scales

| Source | df | MS | F | p |
|---|---|---|---|---|
| Group (G) | 5 | 754.887 | 58.12 | <.001 |
| Order (O) | 1 | 228.488 | 17.59 | <.001 |
| G X O | 5 | 55.766 | 4.29 | <.001 |
| Subjects within GXO (S:GXO) | 228 | 12.988 | | |
| Manipulation (M) | 3 | 101.775 | 231.05 | <.001 |
| G X M | 15 | 9.480 | 21.52 | <.001 |
| O X M | 3 | 3.572 | 8.11 | <.001 |
| G X O X M | 15 | 0.561 | 1.27 | >.10 (NS) |
| S X M: G X O | 684 | 0.440 | | |
| Class (C) | 2 | 135.190 | 141.45 | <.001 |
| G X C | 10 | 20.307 | 21.25 | <.001 |
| O X C | 2 | 1.004 | 1.05 | >.10 (NS) |
| G X O X C | 10 | 0.810 | < 1.00 | NS |
| S X C: G X O | 456 | 0.956 | | |
| M X C | 6 | 2.401 | 10.07 | <.001 |
| G X M X C | 30 | 1.566 | 6.57 | <.001 |
| O X M X C | 6 | 0.483 | 2.02 | >.05 (NS) |
| G X O X M X C | 30 | 0.856 | 3.59 | <.001 |
| S X M X C: G X O | 1368 | 0.238 | | |
| Total | 2879 | 3.246 | | |

significant (F=58.12, df=5, 228, $p<.001$), but interacted with Order, Manipulation, and Class. On the basis of the significant Group effect, it can be concluded that the different instructions had significantly different effects on the ratings.

2. <u>Serial position effect</u>. Before major analyses proceed, it must also be determined whether there was a serial position effect, that is, whether there were any systematic changes in the ratings as a function of figure position in the series of 70 presentations. For example, habituation, boredom, or systematic changes in context could have influenced the ratings.

To test for such an effect, an Order of presentation X Block analysis of variance was performed on the ratings on each scale independently. The blocked factor consisted of 5 levels: the mean rating given to the first group of 14 figures presented, through the mean for the fifth group of 14 figures. For each subject a mean was calculated of the ratings of the first 14 figures (whatever figures they were), for the second 14, and so on. These five means for each subject were the basic data in the analysis of variance. The five levels of the blocked factor were crossed with the two orders of presentation.

Six such analyses were performed, one for each scale, and are summarized in Table 3. Three scales showed significant ($p<.01$) differences among the five means: Incongruity (F=6.28, df=4, 152, $p<.001$); Interestingness (F=7.85, df=4, 152, $p<.001$), and Pleasingness (F=4.69, df=4, 152, $p<.005$). The means for these three scales, for each order of presentation and averaged over both orders, are presented in Table 4.

Table 3. Summary of serial position effect analyses of variance

| Effect | df | Scale | | | | | |
|---|---|---|---|---|---|---|---|
| | | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Order | 1,38 | 4.85* | | | | 24.68*** | 4.38* |
| Means | 4,152 | 6.28*** | 2.46* | 7.85*** | 4.69** | 2.99* | 2.66* |
| O X M | 4,152 | 3.37** | | 2.93* | 3.20* | 9.64*** | 2.39* |

Note.--Entries are F ratios.

F* p<.05

F** p<.01

F*** p<.001

Table 4. Block means for serial position effect

| Scale | Means | | | | |
|---|---|---|---|---|---|
| | First | Second | Third | Fourth | Fifth |
| Incongruity | | | | | |
| Order 1 | 5.24 | 4.91 | 5.06 | 4.91 | 5.21 |
| Order 2 | 4.91 | 4.63 | 4.54 | 4.32 | 4.31 |
| Over-all | 5.07 | 4.77 | 4.80 | 4.62 | 4.76 |
| Interestingness | | | | | |
| Order 1 | 3.21 | 2.84 | 3.24 | 2.88 | 2.91 |
| Order 2 | 3.31 | 2.90 | 2.76 | 2.79 | 2.70 |
| Over-all | 3.26 | 2.87 | 3.00 | 2.83 | 2.81 |
| Pleasingness | | | | | |
| Order 1 | 2.11 | 2.43 | 2.43 | 2.39 | 2.37 |
| Order 2 | 2.28 | 2.40 | 2.34 | 2.30 | 2.10 |
| Over-all | 2.19 | 2.41 | 2.38 | 2.34 | 2.23 |

Table 4 shows that there was little systematic change in the ratings as a function of serial position. While the ratings of incongruity and interestingness tended to decline steadily when the figures were presented in order 2, the over-all means showed no such systematic decline. Post hoc comparisons according to the method of Scheffé (V. Hays, 1963, pp. 484-487), with alpha = .01, were performed on the over-all means. On the incongruity and interestingness scales, the first mean (the mean of the first 14 figures) was significantly higher then the mean of the other four means. The effect was less marked for the pleasingness scale; the only significant contrast was the two highest means (second and third) versus the two lowest means (first and fifth). While some pairwise comparisons were significant, Table 4 shows no orderly increase or decrease in the over-all ratings. The effect of position, therefore, appears to be confined to the first 14 figures.

It should be noted that the significant comparisons above are relatively small differences. For instance, on the incongruity scale, the difference between the first mean and the mean of the last four is 0.34 units. A difference of this magnitude, while statistically significant, is not likely to be psychologically important. Some differneces between means, to be reported later, were considerably larger, e.g., the mean incongruity rating to living figures with the head misplaced and wrong was 2.57 units larger than the rating given to the nonliving figures with a part missing.

3. Sex effect. Because of the unequal numbers of males and females in the six groups, sex was not analyzed in the major analyses of variance reported below. Instead, separate repeated-measures

analyses of variance were performed on the data of each group. In these analyses the 12 repeated measures on each subject (the mean rating given to the five figures that made up each M X C category) were crossed with two groups, male and female. None of the six F ratios was significant at the .01 level. The F ratio for complexity ratings was significant at the .05 level ($F=4.56$, $df=1, 38$). Males rated the 60 altered figures ($\bar{X}=3.27$) as less complex than did the females ($\bar{X}=3.93$).

Since only one of six F ratios for sex was marginally significant, sex was ignored as a factor in subsequent analyses.

## RATINGS OF UNALTERED FIGURES

The mean ratings of the ten unaltered figures on each scale are shown in Table 5. All of the figures, except the ape, were rated low in incongruity, low to moderate in complexity, low to moderate in interestingness, somewhat above moderately pleasing, low in unfamiliarity, and low in conflictfulness. The ape figure was rated more incongruous, complex, interesting, unfamiliar, and conflictful, but less pleasing than the other figures.

## EFFECT OF ORDER OF PRESENTATION, MANIPULATION, AND CLASS OF FIGURE

### 1. Summary: The effects over the six scales.

It should be noted at the outset that direct comparisons of numerical ratings between scales are meaningless, at most uninterpretable. The reasons for this are: 1) assuming that six linear psychological continua exist and are measured by the six scales, there is no assurance (and no test to determine) that any interval,

Table 5. Mean ratings of unaltered figures

| Figure | Scale | | | | | |
|---|---|---|---|---|---|---|
| | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Man | 1.20 | 2.52 | 2.52 | 5.00 | 1.02 | 1.18 |
| Ape | 3.22 | 3.58 | 3.45 | 2.98 | 2.80 | 3.15 |
| Elephant | 1.08 | 2.12 | 2.60 | 5.20 | 1.18 | 1.22 |
| Dog | 1.18 | 2.10 | 2.80 | 5.28 | 1.18 | 1.58 |
| Eagle | 1.15 | 2.25 | 2.50 | 4.78 | 1.30 | 1.70 |
| Car | 1.18 | 2.58 | 2.55 | 5.00 | 1.20 | 1.55 |
| Bicycle | 1.35 | 2.65 | 2.58 | 4.68 | 1.08 | 1.65 |
| Table | 1.55 | 1.82 | 2.02 | 4.00 | 1.08 | 1.50 |
| Chair | 1.18 | 1.78 | 2.00 | 4.30 | 1.22 | 1.42 |
| Umbrella | 1.25 | 1.42 | 2.10 | 4.40 | 1.60 | 1.22 |

e.g., 1-3, on one underlying continuum corresponds to the same psychological distance on any other continuum; 2) even if this could be assumed, there is no assurance that the same level of each continuum is being reflected by each 1-7 interval, i.e., for these figures the interval 1-7 may correspond to a high amount of underlying familiarity, but to a low amount of underlying interestingness. For these reasons, our concern will be to look for similar effects across the six scales.

Table 6 summarizes the six analyses of variance. It can be seen that Order of presentation was a significant factor only in the unfamiliarity ratings. Manipulation and Class resulted in differences on all scales, and the Manipulation X Class interaction influenced five of the six scales.

2. Effects within each scale.

(a) Incongruity.

The analysis of variance of the incongruity ratings (Table 7) showed significant effects of Manipulation (F= 102.94, df= 3, 114, $p<.001$), Class (F=86.68, df= 2, 76, $p<.001$), and Manipulation X Class (F=10.18, df=6, 228, $p<.001$). The factors Order, Order X Manipulation, and Order X Manipulation X Class were significant with $p<.05$, $p<.05$, and $p<.025$, respectively.

Table 8 lists the mean ratings for each of the four manipulations on each of the six scales. Scheffé's tests of contrasts showed that the Misplaced and Wrong figures (MP&W) were rated significantly ($p<.01$) more incongruous than the Missing figures (M), and more incongruous than the mean of the other three manipulations. The Missing figures (M) were rated lowest on incongruity, and the mean

Table 6. Summary of six separate analyses of variance

| Source | df | Scale | | | | | |
|---|---|---|---|---|---|---|---|
| | | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Order (O) | 1,38 | 4.42* | | | | 23.93*** | |
| Manipul. (M) | 3,114 | 102.94*** | 67.55*** | 31.19*** | 11.04*** | 72.30*** | 28.54*** |
| O X M | 3,114 | 2.95* | | | | 2.90* | 4.22** |
| Class (C) | 2,76 | 86.68*** | 55.09*** | 8.06*** | 14.15*** | 59.45*** | 41.67*** |
| O X C | 2,76 | | | | | | |
| M X C | 6,228 | 10.18*** | 7.25*** | 3.84** | 7.44*** | 12.44*** | |
| O X M X C | 6,228 | 2.71* | | 2.48* | 6.15*** | 5.36*** | |

Note.--Entries are F ratios.

F* $p < .05$

F** $p < .01$

F*** $p < .001$

Table 7. Analysis of variance of incongruity ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 39.675 | 4.42 | $<.05$ |
| Subjects within Order (S:O) | 38 | 8.982 | | |
| Manipulation (M) | 3 | 41.521 | 102.94 | $<.001$ |
| O X M | 3 | 1.190 | 2.95 | $<.05$ |
| S X M:O | 114 | 0.403 | | |
| Class (C) | 2 | 68.405 | 86.68 | $<.001$ |
| O X C | 2 | 0.042 | $<1.00$ | NS |
| S X C:O | 76 | 0.789 | | |
| M X C | 6 | 2.486 | 10.18 | $<.001$ |
| O X M X C | 6 | 0.662 | 2.71 | $<.025$ |
| S X M X C:O | 228 | 0.244 | | |
| Total | 479 | 1.726 | | |

for those figures (M) was significantly lower than the means for each of the other three manipulations. The Misplaced figures (MP) and Wrong figures (W) did not differ significantly.

The Class effect can be better understood if we consider the mean rating for each class of figure (Table 9). The living figures with the head manipulated (L-H) were rated most incongruous. That mean (L-H) differed significantly from the mean for the nonliving figures (NL), and from the mean of nonliving figures (NL) and living figures with leg manipulated (L-L). The nonliving figures were rated significantly lower than either of the other two classes. The two classes of living figures (L-H vs. L-L) did not differ significantly.

The Manipulation X Class interaction can be better understood by examining the mean rating for each category of figure on each scale (Table 10). It is clear that within each manipulation rated incongruity varied with the class of figure, and within each class the rating varied with the manipulation. The highest incongruity ratings were made to the living figures with the head misplaced and wrong (L-H, MP&W), the lowest to the nonliving figures with a part missing (NL, M).

(b) <u>Complexity</u>.

The analysis of variance of the complexity ratings (Table 11) disclosed significant effects only of Manipulation ($F=67.55$, $df=3, 114$, $p<.001$), Class ($F=55.09$, $df=2, 76$, $p<.001$), and Manipulation X Class ($F=7.25$, $df=6, 228$, $p<.001$).

Tests of contrasts revealed that the significant Manipulation effect stemmed largely from the significantly lower rated complexity of the Missing figures (M) (Table 8), which differed from each of the

Table 8. Mean ratings for each manipulation

| Manipulation | Scale | | | | | |
|---|---|---|---|---|---|---|
| | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Missing (M) | 4.56 | 2.92 | 2.55 | 2.02 | 4.05 | 3.25 |
| Misplaced (MP) | 5.53 | 3.87 | 3.18 | 1.94 | 5.13 | 3.83 |
| Wrong (W) | 5.42 | 3.76 | 3.24 | 2.07 | 5.16 | 3.71 |
| Misplaced and Wrong (MP&W) | 5.96 | 4.17 | 3.14 | 1.72 | 5.46 | 4.00 |

Table 9. Mean ratings for each class of figure

| Class | Scale | | | | | |
|---|---|---|---|---|---|---|
| | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Living-Head (L-H) | 5.99 | 4.07 | 3.18 | 1.80 | 5.44 | 4.12 |
| Living-Leg (L-L) | 5.43 | 3.89 | 3.16 | 1.80 | 4.90 | 4.04 |
| Nonliving (NL) | 4.69 | 3.08 | 2.74 | 2.22 | 4.52 | 2.94 |

Table 10. Mean ratings for twelve categories of figures

| Category | Scale | | | | | |
|---|---|---|---|---|---|---|
| | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| L-H, M | 5.43 | 3.12 | 2.46 | 1.69 | 4.96 | 3.58 |
| L-L, M | 4.33 | 3.15 | 2.76 | 1.97 | 3.86 | 3.58 |
| NL, M | 3.91 | 2.50 | 2.42 | 2.42 | 3.32 | 2.60 |
| L-H, MP | 6.12 | 4.26 | 3.35 | 1.74 | 5.32 | 4.21 |
| L-L, MP | 5.78 | 4.27 | 3.24 | 1.82 | 5.29 | 4.26 |
| NL, MP | 4.70 | 3.10 | 2.95 | 2.26 | 4.79 | 3.01 |
| L-H, W | 5.94 | 4.14 | 3.52 | 2.20 | 5.56 | 4.15 |
| L-L, W | 5.35 | 3.82 | 3.30 | 1.74 | 4.96 | 4.01 |
| NL, W | 4.98 | 3.31 | 2.90 | 2.28 | 4.97 | 2.97 |
| L-H, MP&W | 6.48 | 4.76 | 3.39 | 1.55 | 5.92 | 4.52 |
| L-L, MP&W | 6.24 | 4.33 | 3.33 | 1.66 | 5.48 | 4.31 |
| NL, MP&W | 5.16 | 3.42 | 2.70 | 1.94 | 4.98 | 3.16 |

Table 11. Analysis of variance of complexity ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 0.290 | < 1.00 | NS |
| Subjects within Order (S:O) | 38 | 12.088 | | |
| Manipulation (M) | 3 | 34.026 | 67.55 | <.001 |
| O X M | 3 | 0.619 | 1.23 | >.10 (NS) |
| S X M:O | 114 | 0.504 | | |
| Class (C) | 2 | 44.623 | 55.09 | <.001 |
| O X C | 2 | 1.867 | 2.30 | >.10 (NS) |
| S X C:O | 76 | 0.810 | | |
| M X C | 6 | 1.611 | 7.25 | <.001 |
| O X M X C | 6 | 0.408 | 1.84 | >.10 (NS) |
| S X M X C:O | 228 | 0.222 | | |
| Total | 479 | 1.750 | | |

other three manipulations. The Misplaced and Wrong figures (MP&W) were rated most complex, but the mean rating of these figures differed only from the Missing (M) figures, and from the mean of Missing, Misplaced, and Wrong figures. The Misplaced (MP) figures did not differ from the Wrong (W) figures.

The Class effect (Table 9) is attributable largely to the significantly lower rated complexity for Nonliving (NL) figures than for either Living figures with head manipulated (L-H) or Living figures with leg manipulated (L-L). The latter two were not significantly different from each other.

Comparison of the incongruity and complexity ratings shows that Manipulation and Class had virtually the same effect on each scale.

Table 10 shows that the effect of either Manipulation or Class depended on the level of the other. While Nonliving (NL) figures as a group were rated low in complexity, the rating varied depending on the manipulation performed. Thus, the Nonliving figures with part Misplaced and Wrong (NL, MP&W) were rated more complex than Living figures with the head Missing (L-H, M), while the L-H figures in general received the highest complexity ratings of the three classes.

(c) Interestingness.

The factors Manipulation ($F=31.19$, $df=3, 114$, $p<.001$), Class ($F=8.06$, $df=2, 76$, $p<.001$), and Manipulation X Class ($F=3.84$, $df=6, 228$, $p<.005$) were significant contributors to differences in interestingness ratings (Table 12). Order and all interactions but O X M X C ($p<.05$) were not significant.

The effect of the different manipulations on rated interestingness is shown in Table 8. The Missing (M) figures were rated least

Table 12. Analysis of variance of interestingness ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 1.240 | < 1.00 | NS |
| Subjects within Order (S:O) | 38 | 14.942 | | |
| Manipulation (M) | 3 | 12.393 | 31.19 | <.001 |
| O X M | 3 | 0.236 | < 1.00 | NS |
| S X M:O | 114 | 0.397 | | |
| Class (C) | 2 | 9.545 | 8.06 | <.001 |
| O X C | 2 | 0.340 | < 1.00 | NS |
| S X C:O | 76 | 1.184 | | |
| M X C | 6 | 1.030 | 3.84 | <.005 |
| O X M X C | 6 | 0.666 | 2.48 | <.05 |
| S X M X C:O | 228 | 0.268 | | |
| Total | 479 | 1.740 | | |

interesting, and that mean differed significantly from the means of each of the other three manipulations. No other pairwise comparisons were significant.

The class of figure rated most interesting was L-H. However, no pairwise comparisons revealed any significant differences.

The Manipulation X Class interaction is illustrated in Table 10. Within any manipulation the ratings varied depending on the class of figure.

(d) Pleasingness.

The pleasingness ratings were influenced (Table 13) by Manipulation ($F=11.04$, $df=3, 114$, $p<.001$), Class ($F=14.15$, $df=2, 76$, $p<.001$), and two interactions: Manipulation X Class ($F=7.44$, $df=6, 228$, $p<.001$) and Order X Manipulation X Class ($F=6.15$, $df=6, 228$, $p<.001$). Order and the O X M and O X C interactions were not significant.

Table 8 shows that, despite a significant over-all F ratio for Manipulation, the means on the pleasingness scale differed little from each other. No pairwise *post hoc* comparisons were significant.

The Class effect (Table 9) is also uninterpretable. No pairwise comparisons among the means were significant.

The Manipulation X Class interaction is illustrated by the means in Table 10. Once again, the effect of manipulation depends on the class of figure. The Order X Manipulation X Class interaction is difficult to interpret in light of no significant Order effect, or significant O X M or O X C interactions.

(e) Unfamiliarity.

Table 14 presents the analysis of variance of the unfamiliarity ratings. Order ($F=23.93$, $df= 1, 38$, $p<.001$), Manipulation

Table 13. Analysis of variance of pleasingness ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 0.217 | < 1.00 | NS |
| Subjects within Order (S:O) | 38 | 5.796 | | |
| Manipulation (M) | 3 | 3.025 | 11.04 | <.001 |
| O X M | 3 | 0.675 | 2.46 | >.05 (NS) |
| S X M:O | 114 | 0.274 | | |
| Class (C) | 2 | 9.833 | 14.15 | <.001 |
| O X C | 2 | 1.629 | 2.34 | >.10 (NS) |
| S X C:O | 76 | 0.695 | | |
| M X C | 6 | 1.218 | 7.44 | <.001 |
| O X M X C | 6 | 1.007 | 6.15 | <.001 |
| S X M X C:O | 228 | 0.164 | | |
| Total | 479 | 0.812 | | |

Table 14. Analysis of variance of unfamiliarity ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 385.208 | 23.93 | <.001 |
| Subjects within Order (S:O) | 38 | 16.099 | | |
| Manipulation (M) | 3 | 45.965 | 72.30 | <.001 |
| O X M | 3 | 1.845 | 2.90 | <.05 |
| S X M:O | 114 | 0.636 | | |
| Class (C) | 2 | 34.479 | 59.45 | <.001 |
| O X C | 2 | 0.961 | 1.66 | >.10 (NS) |
| S X C:O | 76 | 0.580 | | |
| M X C | 6 | 3.547 | 12.44 | <.001 |
| O X M X C | 6 | 1.527 | 5.36 | <.001 |
| S X M X C:O | 228 | 0.285 | | |
| Total | 479 | 2.971 | | |

($F=72.30$, $df=3, 114$, $p<.001$), and Class ($F=59.45$, $df=2, 76$, $p<.001$) were significant main effects. The interactions of Manipulation X Class ($F=12.44$, $df=6, 228$, $p<.001$) and Order X Manipulation X Class ($F=5.36$, $df=6, 228$, $p<.001$) were also significant. The Order X Manipulation interaction was significant with $p<.05$. The Order X Class interaction was not significant.

The Order effect arose because the figures when presented in order 2 were rated less unfamiliar ($\bar{X}=4.04$) than when presented in order 1 ($\bar{X}=5.85$).

As Table 8 shows, figures whose parts were Misplaced and Wrong (MP&W) were rated most unfamiliar, though this mean differed significantly only from the Missing (M) figures, and from the mean of Missing (M), Misplaced (MP), and Wrong (W) figures. The Missing (M) figures were rated least unfamiliar, and that mean differed significantly from each of the other three. No other pairwise comparisons were significant. This pattern of Manipulation means is the same as occurred for the incongruity and complexity ratings.

The significant Class effect can be attributed to the Living figures with head manipulated (L-H) (Table 9). They were rated significantly more unfamiliar than either the Living figures with leg manipulated (L-L) or Nonliving (NL) figures. The L-L versus NL comparison was not significant.

The effects of Class and Manipulation were dependent on each other, as Table 10 shows. While Nonliving figures (NL) were generally low in unfamiliarity, Nonliving figures with a part Misplaced and Wrong (NL, MP&W) were rated about as unfamiliar as Living figures with the head Missing (L-H, M). The Order X Manipulation X Class interaction indicates that the above effect is also influenced by the order of presentation, that is, the ratings for any M X C combination were lower in order 2 than in order 1.

(f) Conflictfulness.

Analysis of the conflictfulness ratings (Table 15) showed that significant effects were Manipulation ($F=28.54$, $df=3, 114$, $p<.001$), Class ($F=41.67$, $df=2, 76$, $p<.001$), and Order X Manipulation ($F=4.22$, $df=3, 114$, $p<.01$). Order and all other interactions were not significant.

The means for each manipulation are shown in Table 8. The Missing figures (M) were rated significantly less conflictful than any of the other three manipulations. While the Misplaced and Wrong figures (MP&W) were rated most conflictful, that mean differed significantly only from the Missing (M) figures. The MP&W figures, furthermore, were not significantly more conflictful than the mean for the other three manipulations.

The Class effect is indicated in Table 9. The Nonliving (NL) figures were rated significantly less conflictful than either Living figures with head manipulated (L-H) or Living figures with leg manipulated (L-L). The L-H versus L-L comparison was not significant.

It should be noted that the pattern of Manipulation and Class means for the conflictfulness ratings is similar to the pattern for incongruity, complexity, and unfamiliarity ratings.

The Order X Manipulation interaction reflects higher conflictfulness ratings to the four manipulations when presented in order 1 ($\bar{X}=4.11$) than in order 2 ($\bar{X}=3.29$).

Table 15. Analysis of variance of conflictfulness ratings

| Source | df | MS | F | p |
|---|---|---|---|---|
| Order (O) | 1 | 80.688 | 4.03 | $>.05$ (NS) |
| Subjects within Order (S:O) | 38 | 20.024 | | |
| Manipulation (M) | 3 | 12.244 | 28.54 | $<.001$ |
| O X M | 3 | 1.811 | 4.22 | $<.01$ |
| S X M:O | 114 | 0.429 | | |
| Class (C) | 2 | 69.841 | 41.67 | $<.001$ |
| O X C | 2 | 0.217 | $<1.00$ | NS |
| S X C:O | 76 | 1.676 | | |
| M X C | 6 | 0.342 | 1.38 | $>.10$ (NS) |
| O X M X C | 6 | 0.494 | 2.00 | $>.05$ (NS) |
| S X M X C:O | 228 | 0.247 | | |
| Total | 479 | 2.634 | | |

## CORRELATIONS AMONG THE RATINGS

What was the relation between each figure's rated incongruity and its ratings on the other five scales? The ideal way to answer this question would be to have each subject rate each figure six times, once on each scale. Given the number of figures used, however, such procedure would be likely to result in highly contaminated ratings.

The data were analyzed as follows. Each of the 60 altered figures had six ratings associated with it, one for each scale, each being the mean of 40 Ss' ratings. Thus six measures were associated with each of 60 figures. Pearson product-moment coefficients were computed for each pairwise comparison of the rating scales. The correlation of each scale with the others is shown in Table 16. Incongruity ratings correlated positively with rated complexity, interestingness, conflictfulness, and highest with unfamiliarity (r=0.866). Pleasingness ratings were negatively correlated with incongruity ratings (r=-0.645), and with all other ratings. With only one exception (the correlation of pleasingness with interestingness ratings), the obtained correlation coefficients are significant (by t-test) beyond the .002 level. However, the true alpha level for these 15 t-tests is not known, because only 3 of the correlation coefficients can be based on completely independent samples.

## COMPARISON OF INCONGRUITY AND UNFAMILIARITY RATINGS

It was stated in the introduction that one way to explain the effects of incongruity is to assume that incongruous figures are really novel figures, and that it is novelty that attracts and holds

Table 16. Intercorrelations of the six scales

| Scale | Scale | | | | | |
|---|---|---|---|---|---|---|
| | Incon. | Compl. | Int. | Pleas. | Unfam. | Confl. |
| Incongruity | 1.000 | | | | | |
| Complexity | 0.817 | 1.000 | | | | |
| Interestingness | 0.660 | 0.780 | 1.000 | | | |
| Pleasingness | -0.645 | -0.546 | -0.237 | 1.000 | | |
| Unfamiliarity | 0.866 | 0.718 | 0.601 | -0.512 | 1.000 | |
| Conflictfulness | 0.802 | 0.829 | 0.667 | -0.727 | 0.674 | 1.000 |

attention. Contrarily, incongruity may incorporate novelty but add some often important element to it. Ideally, this could be determined through analysis of covariance, subtracting the effect of one factor (novelty) from the other (incongruity), and observing whether any differences remain. Unfortunately, such an analysis was not possible in the current study, because no subject rated any figure more than once. That is, there are not two or more scores associated with the same subject. An analysis using the 60 stimulus figures as 'subjects' is not possible, either, because while each figure does have six scores associated with it, the figures were systematically assigned, not randomly, to the Manipulation and Class conditions.

Instead, a Groups (Incongruity, Unfamiliarity) X Order X Class X Manipulation analysis of variance was performed. This analysis is similar to that presented in Table 2, but it compares two groups rather than all six. The results are summarized in Table 17. The Groups factor is relatively meaningless, for reasons previously discussed. It was argued, however, that if the psychological variables underlying the incongruity and unfamiliarity ratings are different, then the same factor would influence them differently. That is, if "incongruity" and "unfamiliarity" represent different processes, those processes may be differentially influenced by the Class and Manipulation variables. Therefore, "Groups" would interact with those variables, and the Group X Class, Group X Manipulation, and Group X Class X Manipulation interactions would significantly affect the ratings. As Table 17 shows, the G X M interaction was not significant ($F=1.52$, $df=3,228$, $p>.10$), but the G X C ($F=5.32$, $df=2,152$, $p<.01$) and G X M X C ($F=4.20$, $df=6,456$, $p<.001$) interactions were

Table 17. Analysis of variance of incongruity-unfamiliarity

| Source | df | MS | F | p |
|---|---|---|---|---|
| Group (G) | 1 | 41.834 | 3.34 | >.05 (NS) |
| Order (O) | 1 | 336.067 | 26.80 | <.001 |
| G X O | 1 | 88.817 | 7.08 | <.025 |
| Subjects within GXO (S:GXO) | 76 | 12.540 | | |
| Manipulation (M) | 3 | 86.695 | 166.72 | <.001 |
| G X M | 3 | 0.791 | 1.52 | >.10 (NS) |
| O X M | 3 | 2.985 | 5.74 | <.001 |
| G X O X M | 3 | 0.050 | < 1.00 | NS |
| S X M: G X O | 228 | 0.520 | | |
| Class (C) | 2 | 99.237 | 144.87 | <.001 |
| G X C | 2 | 3.647 | 5.32 | <.01 |
| O X C | 2 | 0.575 | < 1.00 | NS |
| G X O X C | 2 | 0.428 | < 1.00 | NS |
| S X C: G X O | 152 | 0.685 | | |
| M X C | 6 | 4.919 | 18.56 | <.001 |
| G X M X C | 6 | 1.114 | 4.20 | <.001 |
| O X M X C | 6 | 1.794 | 6.77 | <.001 |
| G X O X M X C | 6 | 0.394 | 1.49 | >.10 (NS) |
| S X M X C: G X O | 456 | 0.265 | | |
| Total | 959 | 2.390 | | |

significant.

The prediction is partly supported. The ratings of incongruity versus unfamiliarity depended upon the class of figure, and also upon the Manipulation X Class category.

The mean ratings for the Group X Class interaction are shown in Table 18. Post hoc comparisons (alpha=.01) were performed on these means according to the methods suggested by Marascuilo and Levin (1970). These authors point out that the usual post hoc methods applied to interaction means lead to unclear interpretations. Each of the means in Table 18 can be partitioned into 1) the grand mean; 2) the effect of Group; 3) the effect of Class; 4) the joint effect of Group and Class, and 5) error. If the usual post hoc methods were performed on any two of the means and the difference was shown to be significant, it could not be determined whether the difference was due to the interaction, or to either of the main effects.

Marascuilo and Levin propose, therefore, that each mean be transformed into an interaction term by subtracting the two main effects and the grand mean from each cell mean. These interaction terms can then be compared according to Scheffé's method.

Such an analysis was performed on the means in Table 18. It was found that no single interaction term contributed significantly to the over-all F ratio. However, comparison of pairs of interaction terms revealed that the only significant difference was between the interaction term in the Incongruity-Nonliving mean and the interaction term in the Unfamiliarity-Nonliving mean. Thus the Group X Class F ratio is attributable to the different effect of Nonliving figures upon incongruity and unfamiliarity ratings. The Nonliving figures were

Table 18. Mean ratings for Group X Class interaction

| Group | Class | | |
|---|---|---|---|
| | L-H | L-L | NL |
| Incongruity | 5.99 | 5.43 | 4.69 |
| Unfamiliarity | 5.44 | 4.90 | 4.52 |

Table 19. Mean ratings, Group X Manipulation X Class

| Manipulation | Group | Class | | |
|---|---|---|---|---|
| | | L-H | L-L | NL |
| Missing (M) | Incon. | 5.43 | 4.33 | 3.91 |
| | Unfam. | 4.96 | 3.86 | 3.32 |
| Misplaced (MP) | Incon. | 6.12 | 5.78 | 4.70 |
| | Unfam. | 5.32 | 5.29 | 4.79 |
| Wrong (W) | Incon. | 5.94 | 5.35 | 4.98 |
| | Unfam. | 5.56 | 4.96 | 4.97 |
| Misplaced and Wrong (MP&W) | Incon. | 6.48 | 6.24 | 5.16 |
| | Unfam. | 5.92 | 5.48 | 4.98 |

rated only slightly less unfamiliar than the Living figures, but the Nonliving figures were rated considerably less incongruous than the Living figures.

The Group X Manipulation X Class means are shown in Table 19. Inspection suggests that, again, the interaction can be attributed to the different effects of the Nonliving figures upon the manipulations across the two sets of ratings.

# DISCUSSION

Before turning to the major question of how the results help to explicate the concept of incongruity, we must consider certain methodological questions bearing on the interpretation of the rating data. Were the ratings consistent? Were there any effects of serial position, sex of subject, or presentation order? How were the unaltered figures rated?

## Consistency of the ratings

The ratings proved to be fairly consistent on five of the six scales, with coefficients ranging from 0.86 (conflictfulness) to 0.94 (incongruity). The interestingness ratings were the least consistent (0.69). It is not clear whether this lower coefficient is an effect of sampling error, or an indication of greater individual differences among college students in what they consider to be interesting rather than incongruous, complex, pleasing, unfamiliar, or conflictful. Perhaps "interesting" is the most variably-defined, that is, the most idiosnycratic of these six terms. With the possible exception of the interestingness ratings, therefore, the ratings were sufficiently consistent as to be trustworthy. The significant F ratio for Groups (Table 2) indicates that the basis for the consistency was the instructions given to the six groups of subjects.

## Serial position

The position effect in the series of 70 presentations was reflected in higher ratings of incongruity and interestingness for the first 14 figures. After that (arbitrarily determined) point in the series there was little systematic change in those ratings. Serial position influenced pleasingness ratings, but less systematically, and did not influence rated complexity, unfamiliarity, or conflictfulness. This suggests that boredom, habituation, or progressive changes in judgmental context did not affect the ratings beyond the fourteenth figure. Such changes would be expected to occur early in the series as the subjects became familiar with the stimulus figures and with the task they were to carry out, and as they began to anticipate subsequent figures. It was informally observed, however, that during the latter half of the series the subjects rated the figures more quickly and became more active in general, perhaps indicating that they were restless and bored. If this was the case, the ratings were not markedly sensitive to the effect.

That there was little systematic change in the ratings contradicts the finding of nearly all previous studies of looking time, that looking time to all figures decreases as the stimulus series progresses. Perhaps the discrepancy is due to the large number of presentations (70) used in the current study compared with the much smaller number (10-30) usually used in studies of looking time. Over the first 10 to 30 figures in the present research, there was an effect of position in the series, at least on two of the six scales. In any event, the tasks in previous studies and in the current study (to look versus to rate) were different in a number of ways, which may account for the different results.

It is noteworthy, however, that the unfamiliarity ratings were not affected by serial position. Ordinarily, the effect of unfamiliarity diminishes rather quickly as the number of presentations increases

(Berlyne and Parham, 1968). This did not happen with the present ratings, suggesting that the subjects were judging unfamiliarity on a long-term, personal life history basis, rather than on the short-term basis defined strictly by the presentations in the experiment.

Sex

The only relation between the sex of the subject and ratings was on the complexity scale, with $p < .05$. Previous studies of reactions to complexity, novelty, and incongruity have rarely included sex as a factor, and rarely found it to be important when included. Only Smock and Holt (1962) and Leckart, Briggs, and Kirk (1968) have reported sex differences in looking time.

The unaltered figures

The unaltered figures (Table 5) were rated much less incongruous, complex, interesting, unfamiliar, and conflictful than were the altered figures (Tables D1-D6). The unaltered figures were rated more pleasing, however. These results hold for all of the unaltered figures except the ape. The ape was rated one to two units higher than the other unaltered figures, i.e., more like the altered figures, on five of the six scales, and lower on the sixth (pleasingness). As will be shown shortly, manipulations performed on the ape resulted in some of the highest incongruity ratings. These ratings are difficult to interpret, however, because of the moderate incongruity of the unaltered ape figure.

Order of presentation

Order of presentation of the 60 altered figures influenced only the unfamiliarity ratings (Table 6), and so need not be considered a major factor in the interpretation of the effects of Manipulation and Class of figure. Unfamiliarity ratings were lower ($p < .001$) in order 2 than in order 1. Ratings on the other five scales showed the same trend but not at a significant level. Examination of the order of presentation variable indicates that it is confounded with three other factors, all the result of using intact groups in classrooms. Order 1 was presented to a large lecture class of introductory psychology students (mean age = 19.3 years, S.D. = 2.6 years) and order 2 was presented in five smaller classes to child psychology students (mean age = 22.0 years, S.D. = 3.9 years). Most child psychology students had taken an introductory course, and the proportion of education majors (especially in the summer) was higher in the child psychology course than in the introductory course. Thus, number of data-collecting sessions, age, and age-related experiential factors were confounded with order of presentation. Since this variable affected only the unfamiliarity ratings these confounded factors are of little interest.

In summary, the ratings were highly consistent, were low (within the limits of a 7-point rating scale) on nine of the ten unaltered figures, and were little influenced by serial position, sex, or order of presentation. The effects of Manipulation and Class of figure upon the ratings and the relations among the six scales consequently can be interpreted relatively straightforwardly.

## THE MEANING OF "INCONGRUITY"

Clarification of the meaning of incongruity can be approached from two directions given the present data: first, the specific alterations on specific kinds of figures which produced greater or lesser ratings of incongruity, and second, the manner in which incongruity ratings were related to the five other ratings on the same stimulus figures. Both represent, in a sense, an attempt to establish an operational definition of incongruity by determining what operational definitions the subjects were using when they rated the figures.

Variables which affect incongruity ratings

The first approach to an explication of the term incongruity involves examination of the incongruity ratings alone. Differences in rated incongruity of the figures must be based on some difference between the figures, e.g., whether the head was missing, misplaced, wrong, or misplaced and wrong. Specific differences between stimuli which result in different amounts of incongruity can be said to contribute to the meaning of the term. In brief, that which changes incongruity is part of its meaning.

Differences in rated incongruity between the figures used previously (Appendix A) can be attributed to no specific factor because the figures vary in many ways. The stimuli used in the present research are unique compared to those used previously because the figures were drawn with specifiable differences among them.

The reasoning above involves the assumption that incongruity is a quantifiable dimension. We can also assume that incongruity varies qualitatively, not quantitatively. The range 1 through 7 along which the subjects rated the figures may not represent a graded difference in amount, but rather seven different kinds of incongruity, and there could be more or fewer than seven. Lacking information about the complex of psychological processes represented by the term incongruity, we cannot *a priori* choose one assumption rather than another. In this situation the law of parsimony can be invoked, so that lacking evidence to the contrary, the quantitative assumption will be made here, keeping in mind that it is merely an assumption and that there exists an equally reasonable though more complex alternative.

Tables 8, 9, and 10 depict the means of the four Manipulations, the three Classes, and the 12 Manipulation X Class combinations. In general, altered living figures were rated as more incongruous than altered nonliving figures (Table 9). Within the living figures, alterations of the head resulted in higher incongruity ratings ($\overline{X} = 5.99$) than alterations of the leg ($\overline{X} = 5.43$). This difference was significant at the .05 level.

This suggests that the head is an important part of the figure to alter. There are some obvious features of the heads of all five of the living figures which may lend it importance. While we may occasionally see an animal lacking some other part we very infrequently see an animal with a head missing. As children we are shielded from it and our parents are likely to describe such an occurrence in terms of horror, loathing, and disgust. Animals, at least those depicted here, eat, drink, and orient toward each other with their heads, and the parts serving these functions are located on the head. The head, being highly complex and discriminable, may serve to give information about the orientation of the animal relative to the observer. Fears of snakes, spiders, and octopods may be due, among other things, to the relative indistinctness of the head, and resulting momentary confusion on the part of the human observer whether the organism is approaching or withdrawing.

The human head in particular was an important influence on the incongruity ratings, as evidenced by the effect of placing the man's head on the eagle. The singular nature of man's head is reflected throughout popular literature and mores. Medieval executions, for example, were most frequently beheadings and hangings, and took place in a carnival-like atmosphere. If people were executed through loss of their arms or legs, we do not hear of it.

Ghost stories and horror movies are attractive, albeit with apprehension, to many children and adults. A ghost is usually depicted as an upright figure, but draped and made formless. This not only eliminates any shape of the body, but also makes the head indistinct. "Monsters" are frequently made by changing the head and face (among other changes), for example, the "wolf man," Count Dracula, Frankenstein, "zombies" with staring eyes, and the carnival huckster's "dog-faced boy."

There are many other examples. American Indians are said to have "scalped" European invaders, though there is some debate about who first scalped whom. European and Asian marauders are depicted as lining the walls of a conquered village with the heads of its male occupants. Salome is said to have received the head of John the Baptist on a silver platter. Washington Irving told of Ichabod Crane's retreat in terror from the "headless horseman," and Dick Tracy's cartoon adversaries are people with strange, altered faces and heads.

The importance of the head and particularly the face has not escaped the notice of psychologists. The face in particular has been extensively though unsystematically studied. The "attractiveness" of the face and of eye contact has frequently been noted, especially with respect to the development of mother-infant attachment (Bowlby, 1958; Robson, 1967). The work of Kagan and associates (Kagan, Henker, Hen-Tov, Levine, and Lewis, 1966; Lewis, Kagan, and Kalafat, 1966; McCall and Kagan, 1967) clearly shows that infants four- to eight-months old attend to faces and to altered faces with differential patterns of responding. No systematic alterations were made on the faces, however, so the specific nature of the attention-eliciting alteration is unknown.

The mechanism by which the face becomes attractive (and by inference, how manipulations performed on the head come to be regarded as incongruous) has been a source of some conjecture. Harlow and Suomi (1970) present some evidence that the attractiveness of a surrogate mother's head to an infant rhesus monkey is unrelated to the place where the infant was fed. Therefore, the face does not become attractive through learning. Watson (1967) arrived at the same conclusion from observations of the angle at which mothers presented their faces to infants during feeding, an angle which was different from the one that elicited the greatest number of smiles. The most viable alternative to a learning explanation appears to be one based on some innate releasing mechanism. Bowlby (1958) first suggested this line of reasoning, and it has been extended by Caldwell (1962), Rheingold (1961), and Robson (1967). In essence, they suggest that the mother's eyes elicit the infant's gaze through some unexplained and presumably innate mechanism. The resulting eye contact by the infant is one of several behaviors (crying, smiling, visual following, clinging, and sucking) which innately elicit maternal behavior from the mother. The effect is that the infant stares at his mother's face in a context of alleviation of discomfort and her attention and stimulation.

It is noteworthy that most of the figures used in previous studies to represent incongruity (Appendix A) have been living figures, and the most frequent alteration has been performed on the head. Legs or limbs in general have been altered also, but frequently in combination with one or more alterations to the head or body of the figure. When nonliving figures have been used (the only ones are various drawings of an airplane and a car), they have most frequently been altered with the head and/or legs of a living figure. Because of the considerable randomness of the alterations used in all of these stimuli, the results of these earlier studies do not tell us what class of figure when altered results in greater incongruity. Investigators nonetheless seem to have concluded that alterations on living figures, especially on their heads, would have greater effect, and that intuition is supported by the current results.

The manipulation (Table 8) which yielded the highest incongruity ratings was Misplaced and Wrong; that which yielded the lowest was Missing. The Wrong and Misplaced manipulations were intermediate in effect and did not differ significantly from each other. Figures used in previous studies, however, have involved only one of these manipulations, Wrong part. The only other manipulations that have occasionally been used are 'too many parts' (man with four arms, man with three heads) and 'wrong-sized parts' (cow with disproportionately long legs, man with short stubby legs and long arms). No studies have used figures whose parts were missing, misplaced, or misplaced and wrong. Thus, all previous conclusions about the effect of incongruity on exploration have been based on a manipulation which has only moderate effect on incongruity ratings (the Wrong manipulation was third-ranked among the four used here). The extremes, at least as defined in the present research (Missing, and Misplaced and Wrong) have been missed. Had they been included it is likely that earlier studies would have found greater differences in visual exploration and arousal processes. It is also possible that manipulation of arousal state (through drugs, for instance) would have a greater effect on reactions to the more extreme figures.

The above point is made clearer by examination of Table 10. Of the 12 combinations of Manipulation and Class, the living figures with the wrong head (L-H, W) were rated less incongruous than: living figures with the head misplaced (L-H, MP); living figures with the leg misplaced and wrong (L-L, MP&W), and living figures with the head misplaced and wrong (L-H, MP&W). There is also a broad range of manipulations and classes which were rated less incongruous than the living figures with the wrong head.

Examination of the mean ratings to the 60 individual figures (Appendix D, Table D1) indicates still more differences. The two figures rated most incongruous were the man with the leg misplaced and wrong and the ape with the leg misplaced and wrong. The standard deviations of the ratings to these two figures were the lowest of any of the altered figures. As has been noted already, the score for the ape is difficult to interpret because the unaltered version of that figure was rated moderately incongruous.

We note also that the difference between having a head misplaced and wrong (L-H, MP&W) and having a leg misplaced and wrong (L-L, MP&W)

can be attributed to one figure, the dog. The dog with the misplaced elephant's leg was rated markedly less incongruous than the other four figures with a misplaced, wrong leg.

Nine of the ten figures rated least incongruous were in two categories, living figures with a leg missing (L-L, M) and nonliving figures with a part missing (NL, M). These included the man with a missing leg, which ranked sixth least incongruous of all 60 figures. Undoubtedly, college students have encountered nonliving things with some part missing (a car with missing wheels, or a broken table with no leg) or animals, including people, with missing limbs.

Seven of the ten figures rated most incongruous were in the categories living figures with the head misplaced and wrong (L-H, MP&W) and living figures with the leg misplaced and wrong (L-L, MP&W). The other three were the man and the ape with their heads misplaced, and the eagle with the wrong head (the man's).

Among the living figures the eight altered versions of the man were rated variously. In four cases the man was rated most incongruous of any of the living figures (missing head, misplaced leg, wrong head, and misplaced and wrong head). Note that three of these cases involve the man's head. Of the four cases in which the man was not rated most incongruous, two (involving the leg) resulted in low ratings within the group of living figures (missing leg and wrong leg). When the man's head was misplaced the figure was ranked third in the group of five, and when the leg was misplaced and wrong the figure was second only to the ape and second highest ranked of all 60 figures. In general, manipulations of the man's head resulted in higher rated incongruity than manipulation of the leg. This conclusion is reinforced by examination of the eagle figure, which received the man's head in the wrong head category. Of the five living figures with the wrong head, the eagle was rated only slightly less incongruous than the man with the wrong head.

Among the nonliving figures the umbrella was rated least incongruous across all four manipulations. With three of the four manipulations the bicycle was rated most incongruous. The bicycle appears to be the most complex of the nonliving figures, and the umbrella the least complex.

Relations among the six rating scales

The second approach to clarifying the meaning of incongruity is to examine the extent to which a figure's rated incongruity is similar to the other five ratings of that figure. If some other dimension, such as complexity, is found to be highly related to incongruity, then it may be said that complexity is part of or contributes to the meaning of incongruity.

Table 16 shows that all of the scales except pleasingness correlated positively and highly with incongruity. The percentage of variance in incongruity ratings accounted for by the other scales ($r^2$) ranged from 44% (interestingness) to 75% (unfamiliarity). Thus, figures described as more incongruous were highly likely to be called more complex, more unfamiliar, more conflictful, somewhat less likely to be called more interesting, and moderately likely to be described as not very pleasing. These results substantiate those of Berlyne (1963a), that the more irregular (and more incongruous) figures were rated more interesting but less pleasing.

It also should be noted that all scales correlated negatively with pleasingness, and that all but the pleasingness scale correlated positively with each other. There may be several explanations for the existence of the positive correlations among five of the scales. Perhaps the ratings reflect not only the subjects' reactions to the figures, but also their reactions to the entire experimental task. The task was the same for all subjects, and similarities in rating the task could reduce differences in ratings to the figures, thus spuriously increasing the correlations between the scales.

Perhaps, instead, the five scales do not represent separate dimensions or sets of processes, but rather are five imprecisely used terms reflecting some common process of attention-getting and holding. The question then becomes, what situational factors cause persons to use one term rather than another?

These correlations therefore imply that some of what people mean by incongruity is also whatever they mean by unfamiliarity, complexity, conflictfulness, interestingness, and lack of pleasingness.

This conclusion is reinforced by the similarity of the effects of Manipulation and Class of figure on each of the scales. As Table 8 shows, the Misplaced and Wrong manipulation resulted in the highest ratings of incongruity, complexity, unfamiliarity, and conflictfulness, and the lowest ratings of pleasingness. Likewise, the Missing manipulation resulted in the lowest ratings of incongruity, complexity, interestingness, unfamiliarity, and conflictfulness, and the highest on pleasingness. Both of these results follow the pattern of correlations exactly. Table 9 shows that the nonliving figures were rated lowest on all scales but pleasingness, on which they were the highest rated of any class of figure. Likewise, the living figures with the head manipulated were rated highest of any class on all scales but pleasingness, on which they were rated low. Such similarity of effect of the Manipulation and Class variables, combined with the intercorrelations would argue for some common underlying process. In light of the effect of incongruity on attention and exploration and on some physiological measures, that underlying process is likely to be associated with activation or arousal.

But the question remains whether "unfamiliar" and "incongruous" mean exactly the same, or whether they simply share a good deal of meaning but still differ in some important way. The correlation between the two scales was high ($r = 0.866$). Unfamiliarity ratings accounted for 75% of the variance in incongruity ratings. The remaining 25% may represent the difference in meaning between the two terms, the small but discriminable differences in situations that allow people to describe something as more incongruous than unfamiliar. "Incongruous" and "unfamiliar" therefore mean much the same thing. College students, however, have experienced a world that contains many alterable and frequently altered objects, and make fine and reliable distinctions among situations which allow the use of these different descriptors.

The results of the analysis of variance summarized in Table 17 lend additional support to this conclusion. The two sets of ratings were influenced differentially by the three classes of figures and by the 12 combinations of Manipulation and Class (the F ratios for the G X C and G X M X C interactions were significant at the .001 level). When two entities are influenced differently by the same thing we may conclude that they are different in some way. Thus we may conclude that unfamiliarity and incongruity are somehow different. Whether the similarity indicated by the high correlation is sufficient to consider them to be the same, as Smock and Holt (1962) and Nunnally and colleagues have done is open to question.

Some support for a distinction between incongruity and novelty can be obtained from Charlesworth (1969). Charlesworth writes of surprise, not incongruity, but his definition of surprise is similar to the variety of definitions that have been proposed for incongruity. In surprise, "two identifiable (and hence potentially manipulatable) factors must be involved--an expectancy about the forthcoming event and a stimulus that fails to confirm this expectancy" (Charlesworth, 1969, pp. 268-269).

To the extent that incongruity and surprise are similar, though not necessarily identical, Charlesworth's argument that surprise is distinct from novelty may hold for incongruity as well. Charlesworth differentiates surprise and novelty on several bases. The most important is that

> what makes an event surprising is that the individual mis-expects it rather than does not expect it (as in the case of novelty), and that this expectation presupposes previous experience.
>
> A surprise event can be either novel, in the sense that it is unfamiliar in addition to being unexpected, or not novel, in the sense that the subject has already had experience with it but did not expect it" (Charlesworth, 1969, pp. 275-276).

If surprise and novelty can be so differentiated it would seem reasonable to distinguish between incongruity and novelty on the same grounds.

Such a distinction between incongruity and novelty leads to a prediction about duration of visual exploration. If novelty and incongruity are different dimensions, then familiarization should influence looking time to low-, medium-, and high-incongruous figures differentially. In effect, making the figures equally familiar would still result in different looking times, because the figures differ in amount of incongruity.

The relation between incongruity and complexity deserves some consideration. Incongruity and complexity ratings correlated almost as highly ($r = 0.817$) as did incongruity and unfamiliarity. Figures with the head missing were rated low on incongruity, and the current research suggests that the head is an important part to alter. The head is a finely differentiated and complex structure, and removing it may make a figure considerably less complex, while to misplace a wrong head may considerably increase a figure's complexity. Both of these cases are confirmed by, respectively, decreases and increases in complexity ratings (Table 10). Furthermore, examination of the figures used by Nunnally and his coworkers (Appendix A) suggests that figures judged more incongruous were more complex.

The relations between complexity, interestingness, and pleasingness reported by Day (1967) and Berlyne, Ogilvie, and Parham (1968) were not confirmed by this research. Berlyne et al. found positive correlations between pleasingness and complexity, and pleasingness and interestingness. The present research shows that pleasingness is negatively related to these two variables. However, Berlyne et al. did not use the "Incongruity" category, and the stimulus figures used here are considerably different from the rest of Berlyne's figures and from the randomly-generated polygons that Day used, so that direct comparison of the results may not be possible.

## Summary

The altered figures clearly were more incongruous, complex, interesting, unfamiliar, conflictful, and less pleasing than their unaltered counterparts. Not all manipulations and classes of figures had equal effect on incongruity ratings. The range of manipulations and classes of figures, then, contributes to the meaning of incongruity. Specifically, the figure rated most incongruous was a living figure whose head was both misplaced and wrong, although nearly as great an effect was achieved by misplacing a wrong leg. The figure rated least incongruous was a nonliving figure with a part missing, and the next least incongruous were the living figures with a leg missing.

Incongruity may also be defined in terms of the ratings on the other five scales. These ratings indicate that incongruity shares meaning with complexity, interestingness, unfamiliarity, conflictfulness, and displeasingness. Some evidence has been presented, however, that "incongruity" may have some meaning unaccounted-for by "unfamiliarity."

Because no measures other than the ratings were made, this research does not help us choose among any of the various "theories" about the mechanism by which novelty, complexity, and incongruity affect orienting and exploratory behavior. Such would be difficult in any case, since the various theories are very similar. They all implicate past experience as a determiner of a standard of comparison or state of readiness which, if not "matched" by present conditions, results in changes in arousal processes. These changes bring about changes in orientation, investigation, and exploration, which if pursued, bring the arousal state back into the "normal" or "optimal" range.

The present research does bear on several previous speculations about the nature of incongruity. Berlyne's speculation that incongruity is a unique combination of "collative" variables and therefore distinct from novelty is largely confirmed. Similarly, Maddi's (1961) anticipation of "blurred distinctions" between novelty, complexity, and incongruity is thoroughly borne out, as are his speculations of positive relations between these variables. However, the definition of incongruity in terms of novelty (Smock and Holt, 1962; Nunnally et al., 1969) received little support. The evidence is that incongruity is novelty, but is also something more. That "something" is likely best described as some particular way of altering particular kinds of figures.

## FURTHER RESEARCH

The research reported here is exploratory. The intent was to clarify incongruity, a complex feature of the environment which has remained unclear. Incongruity may help to explain a variety of behaviors because of its particular effects on motivational and attentional processes, and because of the cognitive activity which it implies. Research on physiological concomitants of incongruity (as with the other collative variables) has not been extensive, and should benefit by the availability of a large number of figures which vary in amount of incongruity as well as on five other dimensions.

Ludic behaviors, particularly exploration, have been discussed at length, but play, another ludic behavior, may also benefit from an analysis in terms of incongruity. Beach (1945), Maddi (1961), Mason (1965), Welker (1961), and White (1959) have noted that relatively little is known about play. There has been speculation, especially by Maddi and Mason, that "play" is the broad class of behaviors by which organisms keep themselves stimulated or aroused. Observation of children's toys and games suggests that many allow and encourage children to alter something, to change a thing that is already familiar. This suggests that play and incongruity are related, and that responses aroused by incongruity may also be aroused during play. It might be possible, then, to make toys or games of the stimuli used in the present research, and observe their effect on children's play. If the stimuli influence play as they do exploration, then the same explanation of exploratory behavior (in terms of attention eliciting and maintenance of optimal arousal) may be applied to play.

A clearer definition of incongruity may help to study fear also. The observations by Köhler, Valentine, and Hebb suggest that incongruity is an important factor in the development of a variety of fears which are difficult to explain by reference to learning, for example, fear of the dark or "separation anxiety." The conditions under which fear is aroused rather than exploration would be of particular interest.

There are a number of further steps that could be taken that are more directly related to the present research. The relation between amount of incongruity and visual exploration is of some theoretical importance, but the attempt by Nunnally, Faw, and Bashford (1969) to relate them was inconclusive. That research should be redone with selected stimuli used in the current research to represent a broad range of incongruity. The addition of familiarization trials to both altered and unaltered figures would provide an experimental basis to distinguish between novelty and incongruity.

A developmental study of exploratory and evaluative reactions to the currently-used stimuli would make clearer the role of experience and perhaps cognitive development in those reactions, though Connolly's (1969) results would indicate that very young children (2- to 5-year-olds) would have to be studied. The role of experience could be made more explicit through discrimination learning using complex stimuli, and observing overt and physiological reactions when the discriminative stimuli are altered in various ways. This could be either with children or nonhuman animals.

Finally, the present research shows that the head is of some importance. A variety of studies (see, for example, Goldstein and Mackenberg, 1966; Haaf and Bell, 1967; McCall and Kagan, 1967) have observed infants' and young children's reactions to altered faces. Few of these studies have involved systematically altered facial features, however. Systematic alterations, like those used on the present figures, and observations of differential orienting and exploratory behavior could determine precisely what features of the face give it its importance.

# REFERENCES

## REFERENCES


Attneave, F. Physical determinants of the judged complexity of shapes. Journal of Experimental Psychology, 1957, 53, 221-227.

Attneave, F. & Arnoult, M. D. The quantitative study of shape and pattern perception. Psychological Bulletin, 1956, 53, 452-471.

Beach, F. A. Current concepts of play in animals. American Naturalist, 1945, 79, 523-541.

Berlyne, D. E. Novelty and curiosity as determinants of exploratory behavior. British Journal of Psychology, 1950, 41, 68-80.

Berlyne, D. E. The arousal and satiation of perceptual curiosity in the rat. Journal of Comparative and Physiological Psychology, 1955, 48, 238-246.

Berlyne, D. E. Conflict and information theory variables as determinants of human perceptual curiosity. Journal of Experimental Psychology, 1957, 53, 399-404.

Berlyne, D. E. The influence of complexity and novelty in visual figures on orienting responses. Journal of Experimental Psychology, 1958, 55, 289-296. (a)

Berlyne, D. E. Supplementary report: Complexity and orienting responses with longer exposures. Journal of Experimental Psychology, 1958, 56, 183. (b)

Berlyne, D. E. The influence of the albedo and complexity of stimuli on visual fixation in the human infant. British Journal of Psychology, 1958, 49, 315-318. (c)

Berlyne, D. E. Conflict, arousal and curiosity. New York: McGraw-Hill, 1960.

Berlyne, D. E. Complexity and incongruity variables as determinants of exploratory choice and evaluative ratings. Canadian Journal of Psychology, 1963, 17, 274-290. (a)

Berlyne, D. E. Motivational problems raised by exploratory and epistemic behavior. In S. Koch (Ed.), Psychology: A study of a science. Vol. 5. New York: McGraw-Hill, 1963. (b)

Berlyne, D. E. Curiosity and exploration. Science, 1966, 153, 25-33.

Berlyne, D. E. Arousal and reinforcement. In D. Levine (Ed.), Nebraska symposium on motivation 1967. Lincoln, Nebraska, University of Nebraska Press, 1967.

Berlyne, D. E. & Borsa, D. M. Uncertainty and the orientation reaction. Perception and Psychophysics, 1968, 3 (1-B), 77-79.

Berlyne, D. E. & Frommer, F. D. Some determinants of the incidence and contents of children's questions. Child Development, 1966, 37, 177-189.

Berlyne, D. E. & Lawrence, G. H., II. Effects of complexity and incongruity variables on GSR, investigatory behavior, and verbally expressed preference. Journal of General Psychology, 1964, 71, 21-45.

Berlyne, D. E. & Lewis, J. L. Effects of heightened arousal on human exploratory behavior. Canadian Journal of Psychology, 1963, 17, 398-410.

Berlyne, D. E. & McDonnell, P. Effects of stimulus complexity and incongruity on duration of EEG desynchronization. Electroencephalography and Clinical Neurophysiology, 1965, 18, 156-161.

Berlyne, D. E. & Parham, L. C. C. Determinants of subjective novelty. Perception and Psychophysics, 1968, 3, 415-423.

Berlyne, D. E. & Peckham, S. The semantic differential and other measures of reaction to visual complexity. Canadian Journal of Psychology, 1966, 20, 125-135.

Berlyne, D. E. & Slater, J. Perceptual curiosity, exploratory behavior, and maze learning. Journal of Comparative and Physiological Psychology, 1957, 50, 228-232.

Berlyne, D. E., Borsa, D. M., Craw, M. A., Gelman, R. S., & Mandell, E. E. Effects of stimulus complexity and induced arousal on paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 291-299.

Berlyne, D. E., Craw, M. A. M., Salapatek, P. H., & Lewis, J. L. Novelty, complexity, incongruity, extrinsic motivation and the GSR. Journal of Experimental Psychology, 1963, 66, 560-567.

Berlyne, D. E., Ogilvie, J. C., & Parham, L. C. C. The dimensionality of visual complexity, interestingness, and pleasingness. Canadian Journal of Psychology, 1968, 22, 376-387.

Bexton, W. A., Heron, W., & Scott, T. H. Effects of decreased variation in the sensory environment. Canadian Journal of Psychology, 1954, 8, 70-76.

Bowlby, J. The nature of the child's tie to his mother. International Journal of Psychoanlaysis, 1958, 39, 350-373.

Brennan, W. M., Ames, E. W., & Moore, R. W. Age differences in infants' attention to patterns of different complexities. Science, 1966, 151, 354-356.

Bronson, G. W. The development of fear in man and other animals. Child Development, 1968, 39, 409-431. (a)

Bronson, G. W. The fear of novelty. Psychological Bulletin, 1968, 69, 350-358. (b)

Brown, J. S. The motivation of behavior. New York: McGraw-Hill, 1961.

Bruner, J. S. Personality dynamics and the process of perceiving. In R. R. Blake & G. V. Ramsey (Eds.), Perception: An approach to personality. New York: Ronald Press, 1951.

Bruner, J. S. & Postman, L. On the perception of incongruity: A paradigm. Journal of Personality, 1949, 18, 206-223.

Butler, R. A. Discrimination learning by rhesus to visual exploration motivation. Journal of Comparative and Physiological Psychology, 1953, 46, 95-98.

Butler, R. A. Incentive conditions which influence visual exploration. Journal of Experimental Psychology, 1954, 48, 19-23.

Butler, R. A. Investigative behavior. In A. M. Schrier, H. F. Harlow, & F. Stollnitz (Eds.), Behavior of nonhuman primates. Vol. II, New York: Academic Press, 1965.

Caldwell, B. M. The usefulness of the critical period hypothesis in the study of filiative behavior. Merrill-Palmer Quarterly of Behavior and Development, 1962, 8, 229-242.

Cantor, G. N. Responses of infants and children to complex and novel stimulation. In L. P Lipsitt & C. C. Spiker (Eds.), Advances in child behavior and development. Vol. 1. New York: Academic Press, 1963.

Cantor, G. N. Children's "like-dislike" ratings of familiarized and unfamiliarized visual stimuli. Journal of Experimental Child Psychology, 1968, 6, 651-657.

Cantor, G. N., Cantor, J. H., & Ditrichs, R. Observing behavior in preschool children as a function of stimulus complexity. Child Development, 1963, 64, 683-689.

Cantor, J. H. & Cantor, G. N. Observing behavior in children as a function of stimulus novelty. Child Development, 1964, 35, 119-128. (a)

Cantor, J. H. & Cantor, G. N. Children's observing behavior as related to amount and recency of stimulus familiarization. _Journal of Experimental Child Psychology_, 1964, _1_, 241-247. (b)

Charlesworth, W. R. The role of surprise in cognitive development. In D. Elkind & J. H. Flavell (Eds.), _Studies in cognitive development: Essays in honor of Jean Piaget_. New York: Oxford University Press, 1969.

Clapp, W. F. & Eichorn, D. H. Some determinants of perceptual investigatory responses in children. _Journal of Experimental Child Psychology_, 1965, _2_, 371-388.

Cofer, C. N. Motivation. _Annual Review of Psychology_, 1959, _10_, 173-202.

Connolly, M. R. The effects of stimulus incongruity on children's looking time, affect, and labeling responses. Unpublished M.A. thesis, Michigan State University, 1969.

Dashiell, J. F. A quantitative demonstration of animal drive. _Journal of Comparative Psychology_, 1925, _5_, 205-208.

Day, H. Exploratory behavior as a function of individual differences and level of arousal. Unpublished doctoral dissertation, University of Toronto, 1965.

Day, H. Looking time as a function of stimulus variables and individual differences. _Perceptual and Motor Skills_, 1966, _22_, 423-428.

Day, H. Evaluations of subjective complexity, pleasingness, and interestingness for a series of random polygons varying in complexity. _Perception and Psychophysics_, 1967, _2_, 281-286.

Dember, W. N. _The psychology of perception._ New York: Holt, Rinehart and Winston, 1960.

Dember, W. N. Alternation behavior. In D. W. Fiske & S. R. Maddi (Eds.), _Functions of varied experience_. Homewood, Ill.: Dorsey, 1961.

Dember, W. N. & Earl, R. W. Analysis of exploratory, manipulatory, and curiosity behaviors. _Psychological Review_, 1957, _64_, 91-96.

Dember, W. N., Earl, R. W., & Paradise, N. Response by rats to differential stimulus complexity. _Journal of Comparative and Physiological Psychology_, 1957, _50_, 514-518.

Denny, M. R. & Leckart, B. T. Alternation behavior: Learning and extinction one trial per day. _Journal of Comparative and Physiological Psychology_, 1965, _60_, 229-232.

Dodd, C. & Lewis, M. Attention distribution as a function of complexity and incongruity in the 24-month old child. Paper read at annual meeting of Eastern Psychological Association, Philadelphia, April, 1969.

Ellis, N. C. & Arnoult, M. D. Novelty as a determinant of spontaneous alternation in children. Psychonomic Science, 1965, 2, 163-164.

Endsley, R. C. Effects of differential prior exposure on preschool children's subsequent choice of novel stimuli. Psychonomic Science, 1967, 7, 411-412.

Eriksen, C. W. Discrimination and learning without awareness: A methodological survey and evaluation. Psychological Review, 1960, 67, 279-300.

Fantz, R. L. Pattern vision in young infants. Psychological Record, 1958, 8, 43-47.

Faw, T. T. & Nunnally, J. C. The effects on eye movements of complexity, novelty, and affective tone. Perception and Psychophysics, 1967, 2, 263-267.

Faw, T. T. & Nunnally, J. C. The influence of stimulus complexity, novelty, and affective tone on children's visual fixations. Journal of Experimental Child Psychology, 1968, 6, 141-153. (a)

Faw, T. T. & Nunnally, J. C. A new methodology and finding relating to visual stimulus selection in children. Psychonomic Science, 1968, 12, 47-48. (b)

Festinger, L. A theory of cognitive dissonance. Evanston, Ill.: Row, Peterson, 1957.

Flavell, J. H. The developmental psychology of Jean Piaget. Princeton, New Jersey: Van Nostrand, 1963.

Glanzer, M. The role of stimulus satiation in spontaneous alternation. Journal of Experimental Psychology, 1953, 45, 387-393.

Glanzer, M. Curiosity, exploratory drive and stimulus satiation. Psychological Bulletin, 1958, 55, 302-315.

Goldstein, A. G. & Mackenberg, E. J. Recognition of human faces from isolated facial features: A developmental study. Psychonomic Science, 1966, 6, 149-150.

Green, F. M. Effect of novelty on choices made by preschool children in a simple discrimination task. Child Development, 1964, 35, 1257-1264.

Haaf, R. A. & Bell, R. Q. A facial dimension in visual discrimination by human infants. Child Development, 1967, 38, 893-899.

Harlow, H. F. Learning and satiation of response in intrinsically motivated complex puzzle performance by monkeys. Journal of Comparative and Physiological Psychology, 1950, 43, 289-294.

Harlow, H. F. Mice, monkeys, men, and motives. Psychological Review, 1953, 60, 23-32.

Harlow, H. F. & Suomi, S. J. Nature of love--simplified. American Psychologist, 1970, 25(2), 161-168.

Harlow, H. F., Harlow, M. K., & Meyer, D. R. Learning motivated by a manipulation drive. Journal of Experimental Psychology, 1950, 40, 228-234.

Harris, L. The effects of relative novelty on children's choice behavior. Journal of Experimental Child Psychology, 1965, 2, 297-305.

Harris, L. Effects of amount of relative novelty on children's choice behavior. Psychonomic Science, 1967, 8, 319-320. (a)

Harris, L. Effects of relative novelty on preschool children's choice of toys, choice latency, and visual orientation. Paper read at the meeting of the Society for Research in Child Development, New York, March, 1967. (b)

Harris, L. & Granskog, A. Variability in maze drawings of young children: Effects of stimulus change and C.A. Unpublished manuscript, Michigan State University, 1968.

Hays, W. L. Statistics for psychologists. New York: Holt, Rinehart, and Winston, 1963.

Haywood, H. C. & Wachs, T. D. Effects of arousing stimulation upon novelty preference in rats. British Journal of Psychology, 1967, 58, 77-84.

Hebb, D. O. On the nature of fear. Psychological Review, 1946, 53, 259-276.

Hebb, D. O. The organization of behavior. New York: Wiley, 1949.

Hebb, D. O. Drives and the C.N.S. (Conceptual nervous system). Psychological Review, 1955, 62, 243-254.

Hebb, D. O. & Riesen, A. H. The genesis of irrational fears. Bulletin of the Canadian Psychological Association, 1943, 3, 49-50.

Heron, W., Doane, B. K., & Scott, T. H. Visual disturbance after prolonged perceptual isolation. Canadian Journal of Psychology, 1956, 10, 13-18.

Hershenson, M. Visual discrimination in the human newborn. Journal of Comparative and Physiological Psychology, 1964, 58, 270-276.

Hershenson, M., Munsinger, H., & Kessen, W. Preference for shapes of intermediate variability in the newborn infant. Science, 1965, 147, 630-631.

Hoats, D. L., Miller, D. B., & Spitz, H. H. Experiments on perceptual curiosity in mental retardates and normals. American Journal of Mental Deficiency, 1963, 68, 386-395.

Hunt, J. McV. Motivation inherent in information processing and action. In O. J. Harvey (Ed.), Motivation and social interaction. New York: Ronald Press, 1963.

Hunt, J. McV. Intrinsic motivation and its role in psychological development. In D. Levine (Ed.), Nebraska symposium on motivation 1965. Lincoln, Nebraska: University of Nebraska Press, 1965.

Johnson, G. C. Effects of stimulus complexity and familiarization on free-looking times of children and adults. Unpublished M.A. thesis, University of Minnesota, 1968.

Kaess, D. W. & Weir, M. W. Response technique as a factor in determining children's preference for complexity. Psychonomic Science, 1968, 11, 367-368.

Kagan, J., Henker, B. A., Hen-Tov, A., Levine, J., & Lewis, M. Infants' differential reactions to familiar and distorted faces. Child Development, 1966, 37, 519-532.

Kagan, J., Moss, H. A., & Sigel, I. E. Psychological significance of styles of conceptualization. Society for Research in Child Development Monographs, 1963, 28(2), 73-111.

Kempen, G., Hermans, B., Klinkum, A., Brand, M., & VerHaaren, F. The word-frequency effect and incongruity perception: Methodological artifacts? Perception and Psychophysics, 1969, 5(3), 161-162.

Köhler, W. The mentality of apes. New York: Harcourt, Brace, 1927.

Leckart, B. T. Looking time: The effects of stimulus complexity and familiarity. Perception and Psychophysics, 1966, 1, 142-144.

Leckart, B. T., Briggs, B., & Kirk, J. Effect of novelty on stimulus selection in children. Psychonomic Science, 1968, 10, 139-140.

Lester, D. Sex differences in exploration: Toward a theory of exploration. Psychological Record, 1967, 17, 55-62.

Leuba, C. Toward some integration of learning theories: The concept of optimal stimulation. Psychological Reports, 1955, 1, 27-33.

Lewis, M., Goldberg, S., & Rausch, M. Attention distribution as a function of novelty and familiarity. Psychonomic Science, 1967, 7, 227-228.

Lewis, M., Kagan, J., & Kalafat, J. Patterns of fixation in the young infant. Child Development, 1966, 37, 331-341.

Lore, R. K. Some factors influencing the child's exploration of visual stimuli. Unpublished doctoral dissertation, University of Tennessee, 1965.

Lorenz, K. The comparative method in studying innate behavior patterns. In Symposium of the Society for Experimental Biology. Vol. IV, Physiological mechanisms in animal behavior. Cambridge, England: Cambridge University Press, 1950.

Maddi, S. R. Exploratory behavior and variation-seeking in man. In D. W. Fiske & S. R. Maddi (Eds.), Functions of varied experience. Homewood, Ill.: Dorsey, 1961.

Marascuilo, L. A. & Levin, J. R. Appropriate post hoc comparisons for interaction and nested hypotheses in analysis of variance designs: The elimination of type IV errors. American Educational Research Journal, 1970, 7(3), 397-421.

Mason, W. A. Determinants of social behavior in young chimpanzees. In A. M. Schrier, H. F. Harlow, & F. Stollnitz (Eds.), Behavior of nonhuman primates. Vol. II. New York: Academic Press, 1965.

May, R. B. Stimulus selection in preschool children under conditions of free choice. Perceptual and Motor Skills, 1963, 16, 203-206.

McCall, R. B. & Kagan, J. Attention in the infant: Effects of complexity, contour, perimeter and familiarity. Child Development, 1967, 38, 939-952.

McDougall, W. An introduction to social psychology. Boston: Luce, 1908.

McClelland, D. C., Atkinson, J. W., Clark, R. W., & Lowell, E. L. The achievement motive. New York: Appleton-Century-Crofts, 1953.

Melzack, R. The genesis of emotional behavior: An experimental study of the dog. Journal of Comparative and Physiological Psychology, 1954, 47, 166-168.

Mendel, G. Children's preferences for differing degrees of novelty. Child Development, 1965, 36, 453-465.

Millman, J. & Glass, G. V. Rules of thumb for writing the ANOVA table. Journal of Educational Measurement, 1967, 4, 41-51.

Minton, H. L. A replication of perceptual curiosity as a function of stimulus complexity. Journal of Experimental Psychology, 1963, 66, 522-524.

Montgomery, K. C. A test of two explanations of spontaneous alternation. Journal of Comparative and Physiological Psychology, 1952, 45, 287-293.

Montgomery, K. C. Exploratory behavior as a function of "similarity" of stimulus situations. Journal of Comparative and Physiological Psychology, 1953, 46, 315-319.

Moruzzi, G. & Magoun, H. W. Brain stem reticular formation and activation of the EEG. Electroencephalography and Clinical Neurophysiology, 1949, 1, 455-473.

Mowrer, O. H. Learning theory and behavior. New York: Wiley, 1960.

Munsinger, H. & Kessen, W. Uncertainty, structure, and preference. Psychological Monographs, 1964, 78 (Whole no. 586), 1-24.

Munsinger, H. & Kessen, W. Stimulus variability and cognitive change. Psychological Review, 1966, 73, 164-178.

Munsinger, H. & Weir, M. W. Infants' and young children's preference for complexity. Journal of Experimental Child Psychology, 1967, 5, 69-73.

Munsinger, H., Kessen, W., & Kessen, M. L. Age and uncertainty: Developmental variation in preference for variability. Journal of Experimental Child Psychology, 1964, 1, 1-15.

Murray, S. K. & Brown, L. T. Human exploratory behavior in a "natural" versus a laboratory setting. Perception and Psychophysics, 1967, 2, 230-232.

Nissen, H. W. A study of exploratory behavior in the white rat by means of the obstruction method. Journal of Genetic Psychology, 1930, 37, 361-376.

Nunnally, J. C., Faw, T. T., & Bashford, M. B. Effect of degrees of incongruity on visual fixations in children and adults. Journal of Experimental Psychology, 1969, 81, 360-364.

Pavlov, I. P. Conditioned reflexes. Oxford: Clarendon Press, 1927.

Piaget, J. The origins of intelligence in children. New York: International Universities Press, 1952.

Piaget, J. Play, dreams and imitation in childhood. New York: Norton, 1962.

Pielstick, N. L. & Woodruff, A. B. Exploratory behavior and curiosity in two age and ability groups of children. Psychological Reports, 1964, 14, 831-838.

Razran, G. The observable unconscious and the inferable conscious in current Soviet psychophysiology: Interoceptive conditioning, semantic conditioning, and the orienting reflex. Psychological Review, 1961, 68, 81-147.

Rheingold, H. L. The effect of environmental stimulation upon social and exploratory behavior in the human infant. In B. M. Foss (Ed.), Determinants of infant behavior. Vol. I. New York: Wiley, 1961.

Robson, K. S. The role of eye-to-eye contact in maternal-infant attachment. Journal of Child Psychology and Psychiatry, 1967, 8, 13-25.

Schnierla, T. C. Behavioral development and comparative psychology. Quarterly Review of Biology, 1966, 41, 283-302.

Smock, C. D. & Holt, B. G. Children's reactions to novelty: An experimental study of "curiosity motivation." Child Development, 1962, 33, 631-642.

Spears, W. C. The assessment of visual discrimination and preferences in the human infant. Unpublished doctoral dissertation, Brown University, 1962. Cited in Cantor, G. N. Responses of infants and children to complex and novel stimulation. In L. P. Lipsitt & C. C. Spiker (Eds.), Advances in child behavior and development. Vol. 1. New York: Academic Press, 1963.

Stenson, H. H. The physical factor structure of random forms and their judged complexity. Perception and Psychophysics, 1966, 1, 303-310.

Thomas, H. A flexible apparatus for presenting pairs of visual stimuli to children. Journal of the Experimental Analysis of Behavior, 1966, 9, 119-120. (a)

Thomas, H. Preferences for random shapes: Ages six through nineteen years. Child Development, 1966, 37, 843-859. (b)

Tinbergen, N. The study of instinct. Oxford: Clarendon Press, 1951.

Valentine, C. W. The innate bases of fear. Journal of Genetic Psychology, 1930, 37, 394-420.

Watson, J. B. & Raynor, R. Conditioned emotional reactions. Journal of Experimental Psychology, 1920, 3, 1-14.

Watson, J. B. Behaviorism. New York: Norton, 1924.

Watson, J. S. Why is a smile? Trans-action, May, 1967, 36-39. (Reprinted in Merrill-Palmer Newsletter, July, 1967.)

Welker, W. I. Some determinants of play and exploration in chimpanzees. Journal of Comparative and Physiological Psychology, 1956, 49, 84-89. (a)

Welker, W. I. Effects of age and experience on play and exploration of young chimpanzees. Journal of Comparative and Physiological Psychology, 1956, 49, 223-226. (b)

Welker, W. I. An analysis of exploratory and play behavior in animals. In D. W. Fiske & S. R. Maddi (Eds.), Functions of varied experience. Homewood, Ill.: Dorsey, 1961.

White, R. W. Motivation reconsidered: The concept of competence. Psychological Review, 1959, 66, 297-333.

Willis, E. J. & Dornbush, R. L. Preferences for visual complexity. Child Development, 1968, 39, 639-646.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Witkin, H. A. Individuality in development. In B. Kaplan & S. Wapner (Eds.), Perspectives in psychological theory: Essays in honor of Heinz Werner. New York: International Universities Press, 1960.

Witkin, H. A., Lewin, H. B., Hartsman, M., Machover, K., Meisner, P. B., & Wapner, S. Personality through perception. New York: Harper, 1954.

APPENDICES

# APPENDIX A

## "Incongruous" figures used by other investigators

Berlyne (1957); Minton (1963):

"Animals" series, seven figures:

1. elephant
2. dog with elephant's head
3. camel
4. camel with lion's head
5. lion
6. giraffe
7. leopard

"Birds" series, seven figures:

1. bird perched on branch, face front
2. bird perched on branch, left profile
3. bird with three heads, one at each end of body and another attached just above the wing, pecking at food
4. bird on flat area, with food in front
5. bird with front legs of elephant and rear legs of dog
6. bird perched on branch, facing left
7. bird pecking at food, facing left

Berlyne (1958a, b; 1963a); Berlyne and Lawrence (1964); Berlyne and Lewis (1963); Berlyne and McDonnell (1965); Berlyne, Craw, Salapatek, and Lewis (1963):

Category E, Incongruity, four pairs of figures:

pair 1. normal bird versus bird with three heads
2. elephant versus dog with elephant's head
3. bird perched on branch versus bird with front legs of elephant and rear legs of dog
4. leopard versus camel with lion's head

Category F, Incongruous juxtaposition, two pairs of figures:

pair 1. car above rabbit versus car with hind end of rabbit above rabbit with hind end of car
2. flower alongside airplane versus flower with airplane fuselage as stem, alongside airplane with stem of flower as fuselage

Clapp and Eichorn (1965):

Berlyne's (1957) "birds" series

Connolly (1969):

drawing number:

16. flamingo with elephant's head
17. turtle with elephant's head
18. boy with deer's head and foot of duck
19. horse with turtle's head
20. horse with bird's head
21. boy's head with neck of giraffe
22. bird with deer's head
23. elephant with giraffe's neck and bird's head
24. airplane without wings, with elephant's head
25. car with head and front legs of rabbit as front end
26. fox with body and two legs of duck
27. car with rear wheel replaced with flamingo's leg, and with front end replaced with neck and head of flamingo
28. squirrel with elephant's head
29. elephant with turtle's head
30. fish with dog's head

Dodd and Lewis (1969):

four figures:

1. man
2. same man standing on both sides of himself, resulting in three identical men
3. man with three heads
4. man with head upside-down

Faw and Nunnally (1967):

four pairs, two taken from Berlyne's (1958) Category F "Incongruous juxtaposition":

1. rabbit versus rabbit with body of car
2. one other (unspecified)

plus

3. man standing with horse versus man with horse's body standing with horse with man's head
4. dog standing with giraffe versus giraffe with dog's head standing with dog with giraffe's head

Faw and Nunnally (1968):

Faw and Nunnally's (1967) figures, plus:

Set 1. normal man
man with short stubby legs and long arms
man with four arms
man with wings and dog's head

Set 2. normal Holstein cow
cow with polka dots
Holstein cow with disproportionately long legs
cow with broad black diagonal stripes on its body

Hoats, Miller, and Spitz (1963):
Berlyne's (1958) Category E "Incongruity" plus:
one pair: mouse versus child-like drawing of mouse, with "stick" legs, something large in mouth, very long ears, and stove-pipe tail

Lore (1965):
pair 1. fish with dog's head versus dog
2. dog with elephant's head versus elephant
3. rabbit with rear end of car versus rabbit

Nunnally, Faw, and Bashford (1969):
Set 1. normal bird
bird with cocker spaniel ears
bird with cocker spaniel ears and fur instead of feathers
bird with cocker spaniel ears, fur instead of feathers, and an airplane wing
Set 2. normal Holstein cow
cow with polka dots
Holstein cow with disproportionately long legs
Holstein cow with disproportionately long legs, airplane tail, and an elephant's trunk
Set 3. ordinary convertible car
convertible with square wheels
convertible with square wheels and two front ends
convertible with square wheels, two front ends, and a sail
Set 4. normal man
man with short stubby legs and long arms
man with four arms
man with wings and a dog's head

Smock and Holt (1962):
Berlyne's (1957) "animals" and "birds" series

# APPENDIX B

## A conceptual scheme for incongruity

An object or situation may be judged incongruous depending upon:

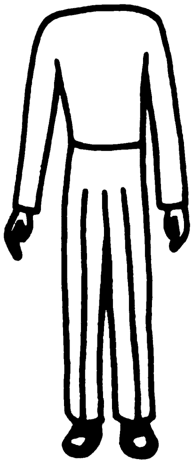
I. Characteristics of the object
    A. type of object
        1) nonliving
        2) living
    B. orientation
    C. behavior
        1) normal
        2) abnormal
    D. operations performed on the object
        1) misplaced part
        2) wrong part
        3) misplaced and wrong part
        4) missing part
        5) too many parts
        6) orientation of part or parts
        7) separation of parts
            a) correct relative positions
            b) incorrect relative positions (scrambled)
        8) colors of parts
        9) sizes of parts

II. Characteristics of the two-object situation
    A. types of objects
    B. relative and absolute orientations of objects
    C. "congruity" of objects
        1) both incongruous
        2) both congruous
        3) one incongruous, one congruous
    D. relative sizes of objects
    E. nature of interaction: behavior toward each other
        1) none
        2) normal roles
        3) reversal of roles
        4) abnormal behavior of one
        5) abnormal behavior of both

# APPENDIX C

## Stimulus figures

Living, head missing (L-H, M)



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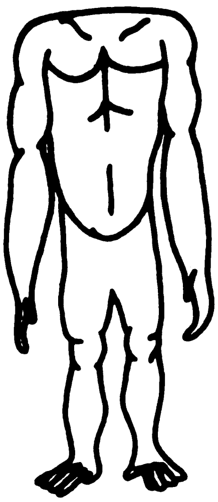

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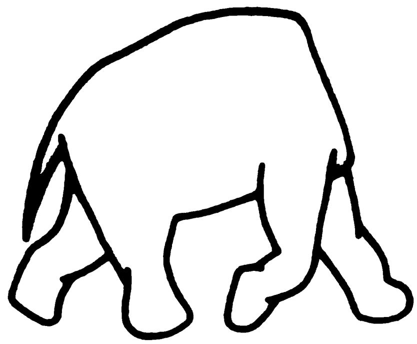

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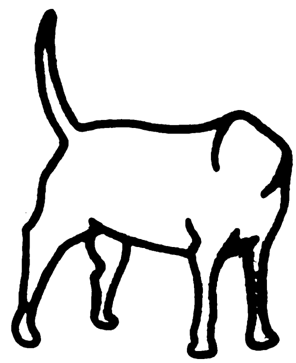

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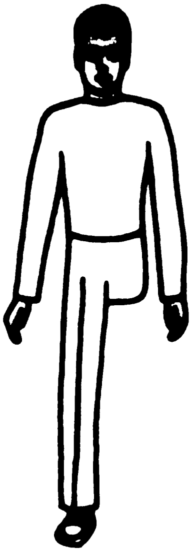
Living, leg missing (L-L, M)



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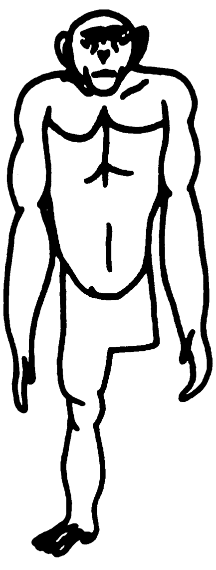

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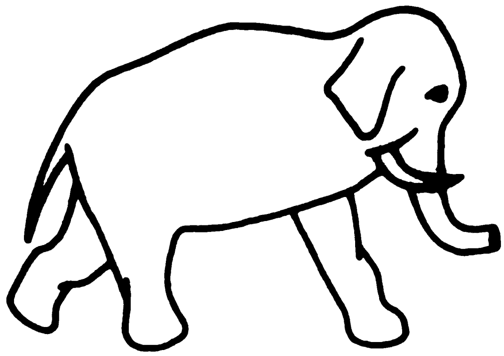

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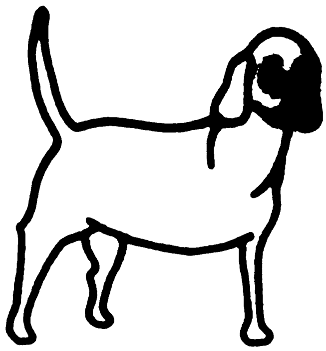

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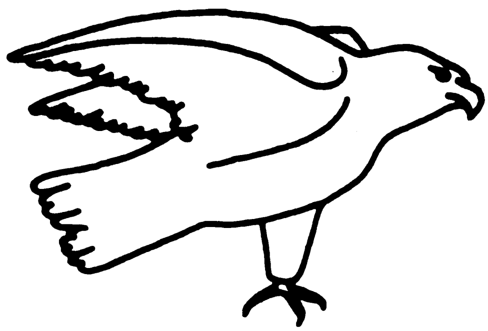
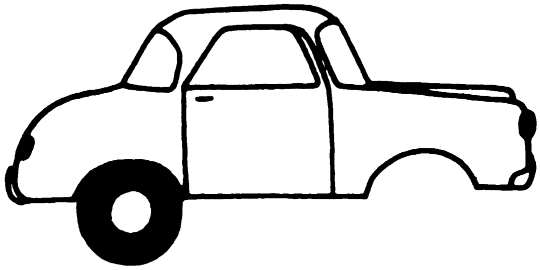


10

Nonliving, part missing (NL, M)



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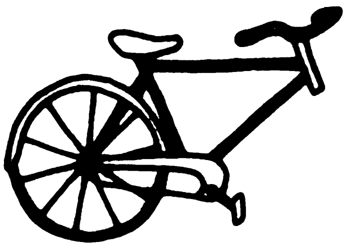

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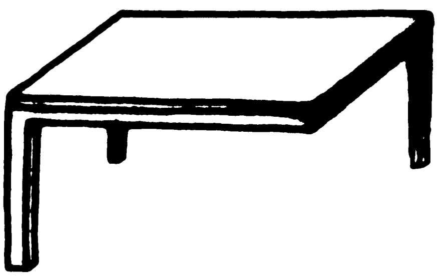

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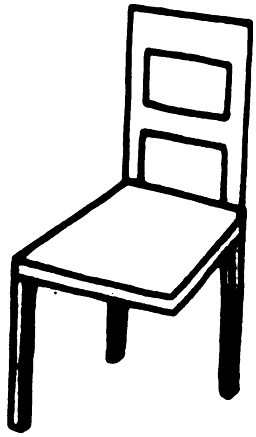

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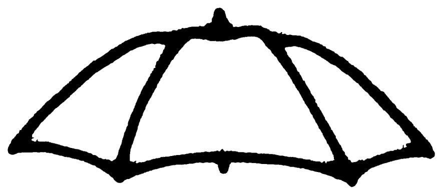

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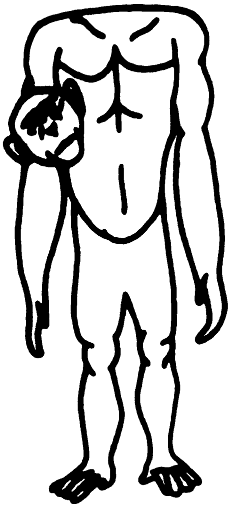
Living, head misplaced (L-H, MP)

16



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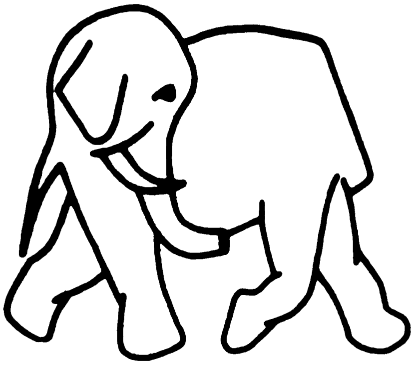

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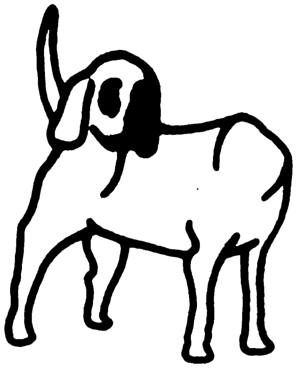

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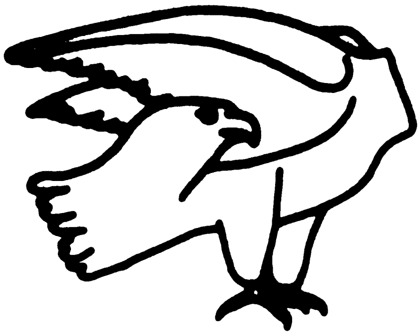

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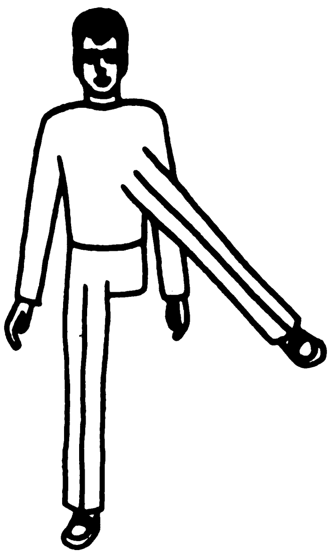
Living, leg misplaced (L-L, MP)



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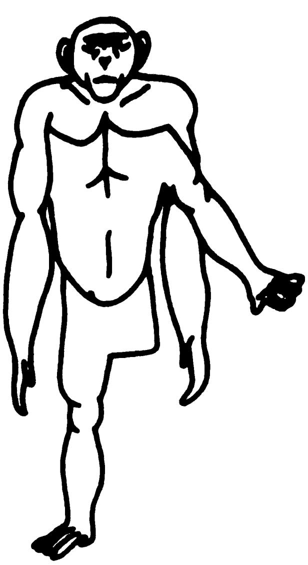

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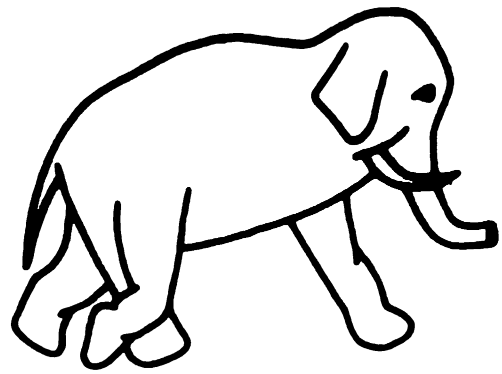

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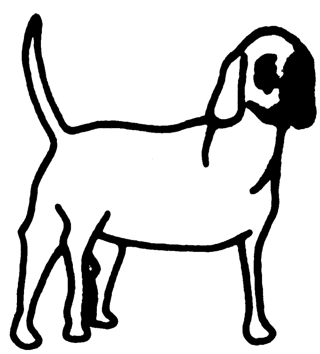

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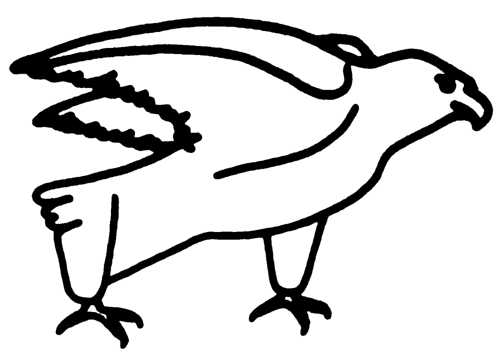

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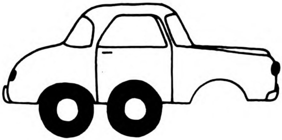
Nonliving, part misplaced (NL, MP)



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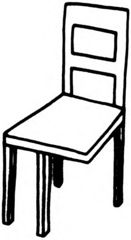

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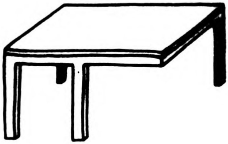

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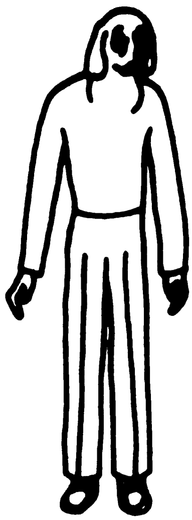
Living, head wrong (L-H, W)



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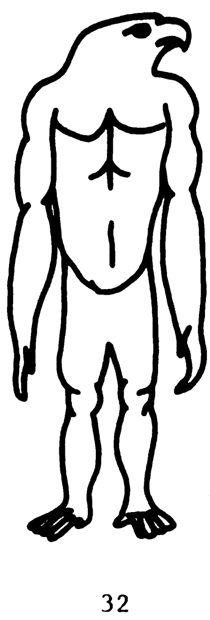

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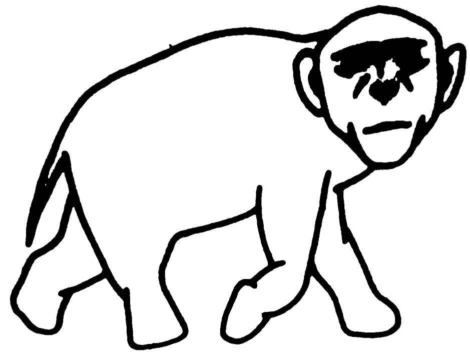

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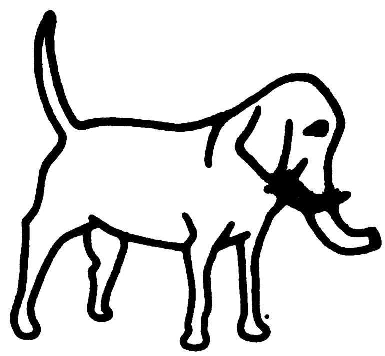

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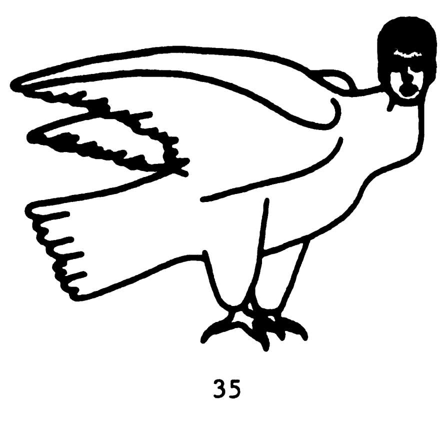

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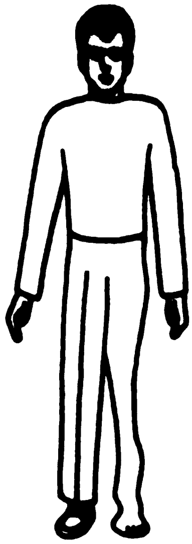
Living, leg wrong (L-L, W)



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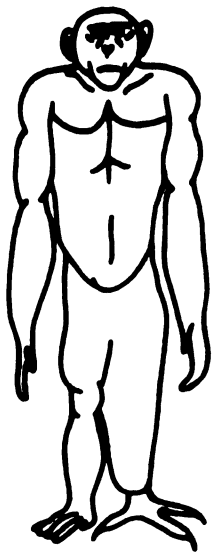

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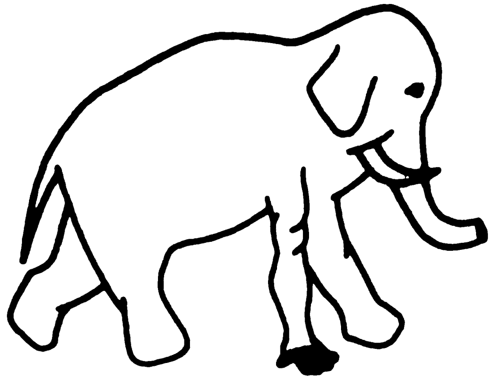

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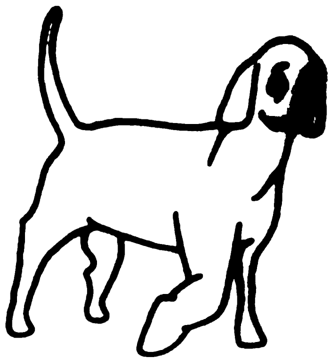

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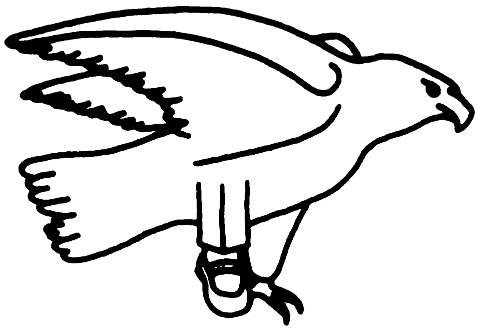
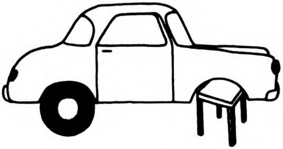


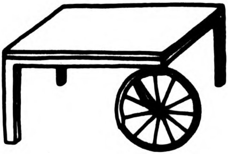
40

Nonliving, part wrong (NL, W)

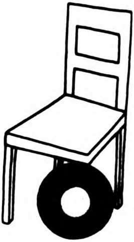


41

42



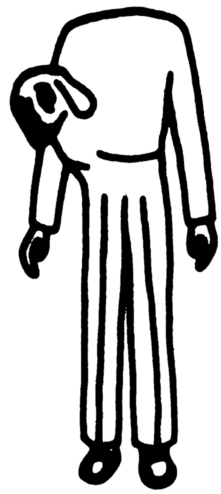
43



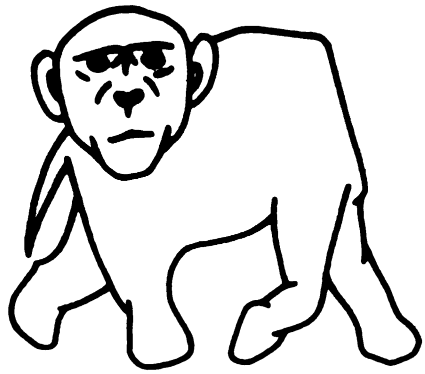
44

45

Living, head misplaced and wrong (L-H, MP&W)



46



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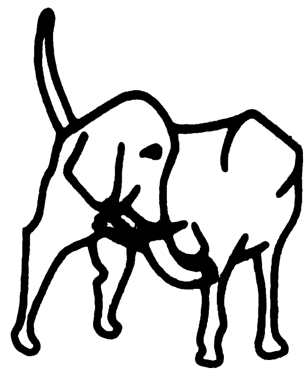
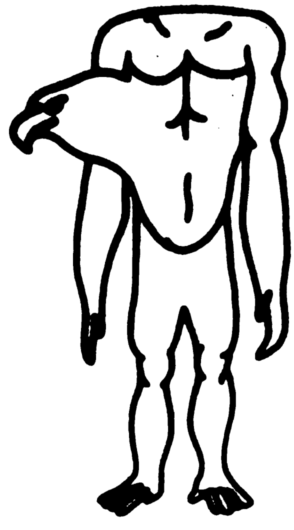


49



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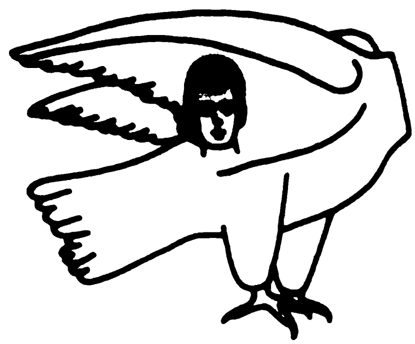
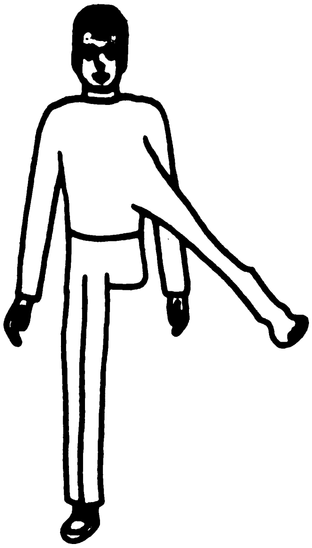
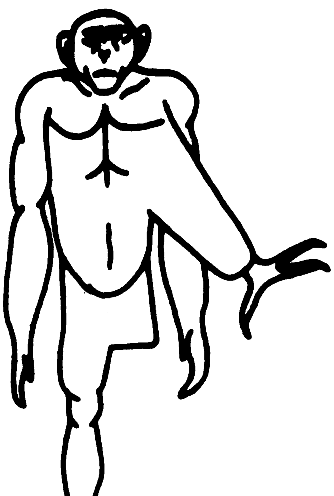


50

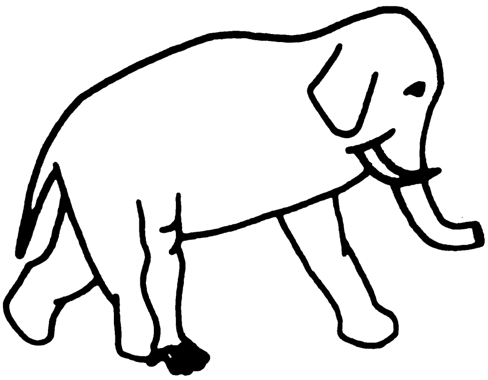
Living, leg misplaced and wrong (L-L, MP&W)



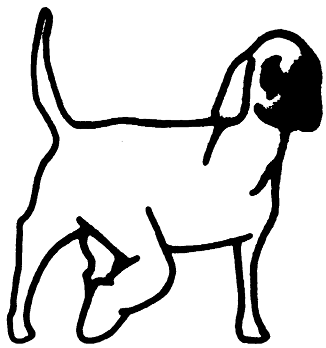
51



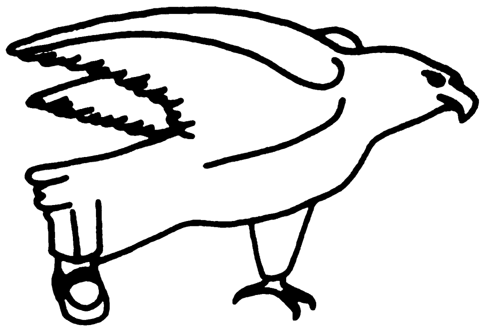
52



53

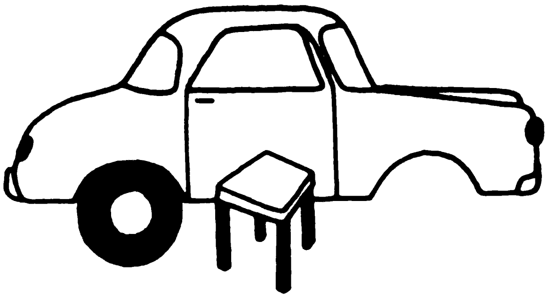


54

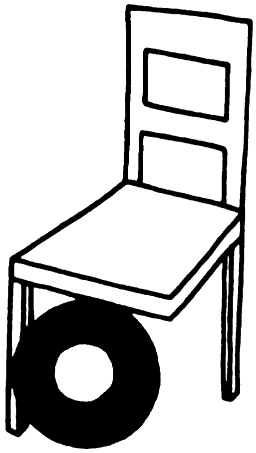


55

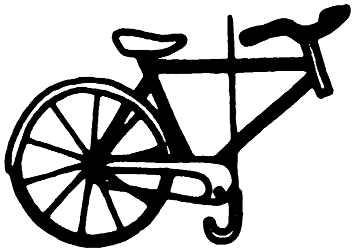
Nonliving, part misplaced and wrong (NL, MP&W)



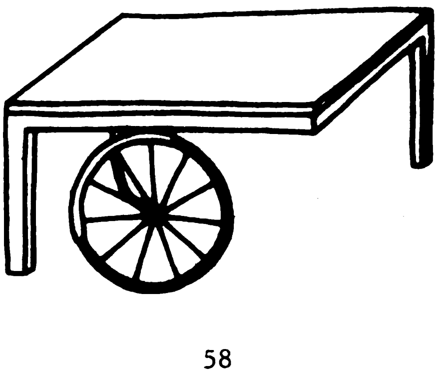
56



59



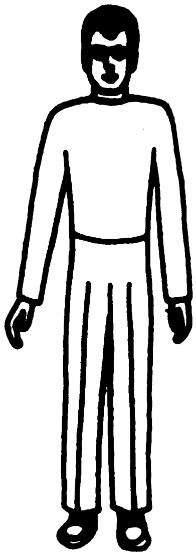
57



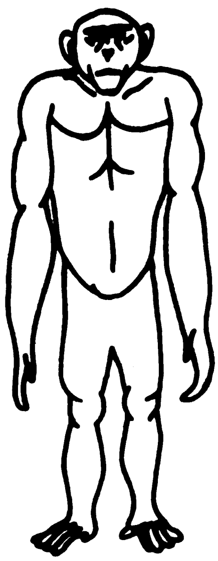
58

60

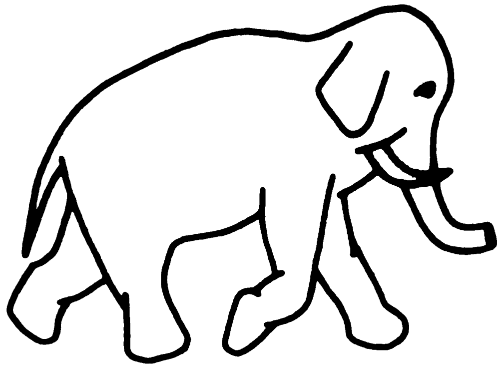
Unaltered, living



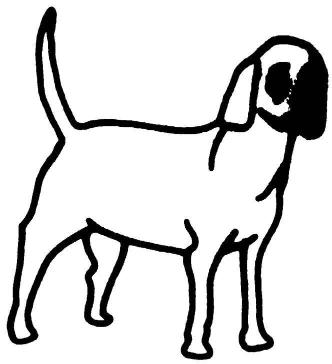
61



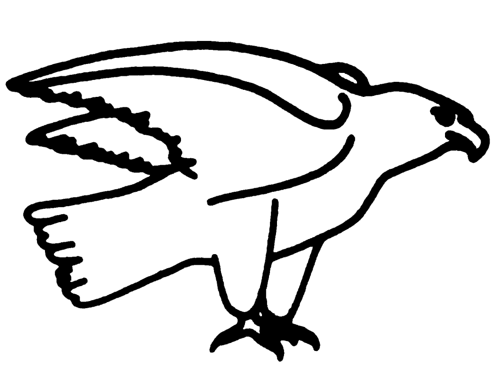
62



63

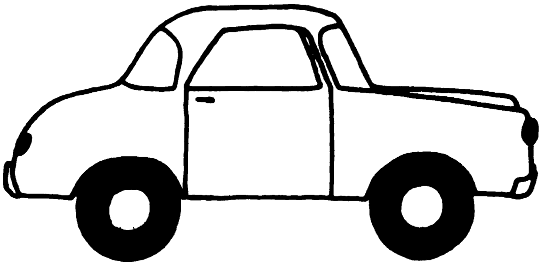


64

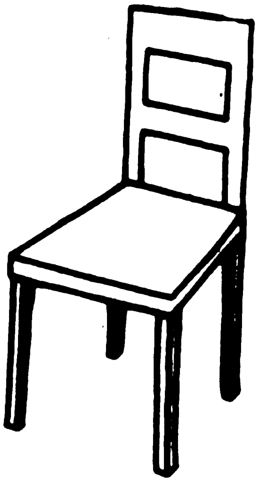


65

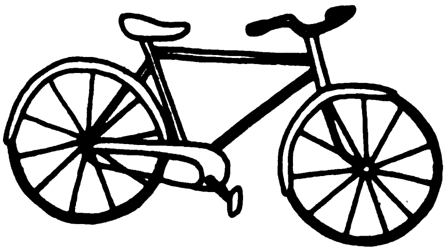
Unaltered, nonliving



66

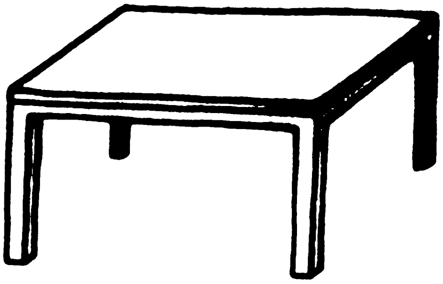


69



67

70



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# APPENDIX D

## Ratings of the altered figures

Table D1. Incongruity ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 5.80 | 1.44 | man | 31 | 6.28 | 1.11 |
| 2 | 5.18 | 1.53 | ape | 32 | 5.75 | 1.61 |
| 3 | 5.32 | 1.59 | elephant | 33 | 5.55 | 1.36 |
| 4 | 5.75 | 1.30 | dog | 34 | 5.85 | 1.14 |
| 5 | 5.10 | 1.78 | eagle | 35 | 6.25 | 0.95 |
| L-L, M | | | | L-L, W | | |
| 6 | 3.95 | 1.82 | man | 36 | 4.38 | 1.82 |
| 7 | 5.22 | 1.58 | ape | 37 | 5.75 | 1.19 |
| 8 | 4.28 | 1.71 | elephant | 38 | 5.72 | 1.11 |
| 9 | 4.32 | 1.53 | dog | 39 | 5.02 | 1.54 |
| 10 | 3.88 | 1.56 | eagle | 40 | 5.88 | 1.20 |
| NL, M | | | | NL, W | | |
| 11 | 3.70 | 1.40 | car | 41 | 5.48 | 1.36 |
| 12 | 4.20 | 1.99 | bicycle | 42 | 5.70 | 1.51 |
| 13 | 3.88 | 1.70 | table | 43 | 5.28 | 1.77 |
| 14 | 4.25 | 1.66 | chair | 44 | 4.85 | 1.70 |
| 15 | 3.52 | 1.60 | umbrella | 45 | 3.62 | 1.58 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 6.12 | 1.40 | man | 46 | 6.62 | 0.67 |
| 17 | 6.05 | 1.06 | ape | 47 | 6.60 | 0.74 |
| 18 | 5.98 | 1.35 | elephant | 48 | 6.12 | 1.38 |
| 19 | 6.25 | 1.10 | dog | 49 | 6.55 | 0.96 |
| 20 | 6.18 | 1.06 | eagle | 50 | 6.50 | 0.91 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 6.45 | 1.01 | man | 51 | 6.68 | 0.69 |
| 22 | 6.35 | 1.03 | ape | 52 | 6.72 | 0.55 |
| 23 | 5.38 | 1.25 | elephant | 53 | 6.00 | 1.13 |
| 24 | 5.60 | 1.53 | dog | 54 | 5.55 | 1.55 |
| 25 | 5.12 | 1.76 | eagle | 55 | 6.28 | 1.24 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 4.60 | 1.41 | car | 56 | 4.88 | 1.83 |
| 27 | 4.98 | 1.44 | bicycle | 57 | 5.65 | 1.44 |
| 28 | 4.88 | 1.54 | table | 58 | 5.38 | 1.79 |
| 29 | 4.55 | 1.96 | chair | 59 | 4.88 | 1.79 |
| 30 | 4.48 | 1.75 | umbrella | 60 | 5.00 | 1.60 |

Table D2. Complexity ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 3.05 | 1.55 | man | 31 | 4.08 | 1.54 |
| 2 | 3.80 | 1.65 | ape | 32 | 4.42 | 1.41 |
| 3 | 2.70 | 1.51 | elephant | 33 | 4.15 | 1.61 |
| 4 | 2.92 | 1.42 | dog | 34 | 3.52 | 1.68 |
| 5 | 3.15 | 1.35 | eagle | 35 | 4.55 | 1.50 |
| L-L, M | | | | L-L, W | | |
| 6 | 3.25 | 1.45 | man | 36 | 3.85 | 1.44 |
| 7 | 3.72 | 1.36 | ape | 37 | 4.22 | 1.54 |
| 8 | 2.98 | 1.21 | elephant | 38 | 3.62 | 1.44 |
| 9 | 2.82 | 1.41 | dog | 39 | 3.52 | 1.50 |
| 10 | 2.98 | 1.37 | eagle | 40 | 3.90 | 1.45 |
| NL, M | | | | NL, W | | |
| 11 | 2.95 | 1.36 | car | 41 | 4.42 | 1.68 |
| 12 | 2.85 | 1.41 | bicycle | 42 | 4.18 | 1.58 |
| 13 | 2.45 | 1.22 | table | 43 | 2.85 | 1.27 |
| 14 | 2.32 | 1.25 | chair | 44 | 2.95 | 1.30 |
| 15 | 1.92 | 1.31 | umbrella | 45 | 2.15 | 1.33 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 4.82 | 1.39 | man | 46 | 4.48 | 1.60 |
| 17 | 4.62 | 1.58 | ape | 47 | 4.90 | 1.55 |
| 18 | 3.62 | 1.72 | elephant | 48 | 4.62 | 1.44 |
| 19 | 3.92 | 1.53 | dog | 49 | 5.10 | 1.45 |
| 20 | 4.28 | 1.52 | eagle | 50 | 4.68 | 1.59 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 4.62 | 1.55 | man | 51 | 4.65 | 1.56 |
| 22 | 5.15 | 1.48 | ape | 52 | 5.35 | 1.41 |
| 23 | 3.78 | 1.35 | elephant | 53 | 4.05 | 1.58 |
| 24 | 3.95 | 1.47 | dog | 54 | 3.22 | 1.54 |
| 25 | 3.85 | 1.48 | eagle | 55 | 4.38 | 1.35 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 3.48 | 1.43 | car | 56 | 4.15 | 1.49 |
| 27 | 3.85 | 1.39 | bicycle | 57 | 4.08 | 1.62 |
| 28 | 2.78 | 1.25 | table | 58 | 3.12 | 1.30 |
| 29 | 2.98 | 1.39 | chair | 59 | 3.22 | 1.56 |
| 30 | 2.40 | 1.34 | umbrella | 60 | 2.50 | 1.26 |

Table D3. Interestingness ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 2.12 | 1.02 | man | 31 | 3.45 | 1.65 |
| 2 | 2.85 | 1.51 | ape | 32 | 3.68 | 1.87 |
| 3 | 2.38 | 1.28 | elephant | 33 | 3.68 | 1.79 |
| 4 | 2.48 | 1.38 | dog | 34 | 3.58 | 1.66 |
| 5 | 2.50 | 1.28 | eagle | 35 | 3.20 | 1.88 |
| L-L, M | | | | L-L, W | | |
| 6 | 2.80 | 1.47 | man | 36 | 2.98 | 1.51 |
| 7 | 2.88 | 1.60 | ape | 37 | 4.02 | 1.64 |
| 8 | 3.10 | 1.41 | elephant | 38 | 3.25 | 1.41 |
| 9 | 2.72 | 1.45 | dog | 39 | 2.98 | 1.56 |
| 10 | 2.30 | 1.14 | eagle | 40 | 3.25 | 1.66 |
| NL, M | | | | NL, W | | |
| 11 | 2.50 | 1.38 | car | 41 | 3.55 | 1.85 |
| 12 | 2.90 | 1.22 | bicycle | 42 | 3.48 | 1.62 |
| 13 | 2.25 | 1.15 | table | 43 | 2.70 | 1.38 |
| 14 | 2.02 | 0.95 | chair | 44 | 2.50 | 1.36 |
| 15 | 2.42 | 1.13 | umbrella | 45 | 2.30 | 1.04 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 3.42 | 2.01 | man | 46 | 2.90 | 1.58 |
| 17 | 3.20 | 1.99 | ape | 47 | 3.48 | 2.01 |
| 18 | 3.62 | 1.61 | elephant | 48 | 3.80 | 1.95 |
| 19 | 3.48 | 1.80 | dog | 49 | 3.72 | 2.06 |
| 20 | 3.02 | 1.76 | eagle | 50 | 3.05 | 1.71 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 3.20 | 1.91 | man | 51 | 3.58 | 1.92 |
| 22 | 3.75 | 1.96 | ape | 52 | 3.68 | 2.10 |
| 23 | 3.35 | 1.69 | elephant | 53 | 3.18 | 1.81 |
| 24 | 2.90 | 1.41 | dog | 54 | 2.92 | 1.44 |
| 25 | 2.98 | 1.48 | eagle | 55 | 3.30 | 1.68 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 2.98 | 1.58 | car | 56 | 2.90 | 1.50 |
| 27 | 3.25 | 1.56 | bicycle | 57 | 3.10 | 1.66 |
| 28 | 3.18 | 1.22 | table | 58 | 2.68 | 1.40 |
| 29 | 2.50 | 1.15 | chair | 59 | 2.30 | 1.22 |
| 30 | 2.85 | 1.56 | umbrella | 60 | 2.65 | 1.30 |

Table D4. Pleasingness ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 1.88 | 1.24 | man | 31 | 2.20 | 1.47 |
| 2 | 1.68 | 0.94 | ape | 32 | 2.02 | 1.31 |
| 3 | 1.80 | 0.99 | elephant | 33 | 2.40 | 1.35 |
| 4 | 1.32 | 0.53 | dog | 34 | 2.38 | 1.50 |
| 5 | 1.78 | 1.21 | eagle | 35 | 1.98 | 1.49 |
| L-L, M | | | | L-L, W | | |
| 6 | 1.48 | 0.91 | man | 36 | 1.65 | 1.21 |
| 7 | 1.55 | 0.85 | ape | 37 | 1.92 | 1.27 |
| 8 | 2.65 | 1.39 | elephant | 38 | 1.70 | 0.88 |
| 9 | 1.80 | 1.09 | dog | 39 | 1.72 | 0.82 |
| 10 | 2.38 | 1.03 | eagle | 40 | 1.70 | 0.88 |
| NL, M | | | | NL, W | | |
| 11 | 2.68 | 1.29 | car | 41 | 2.15 | 1.08 |
| 12 | 2.18 | 1.17 | bicycle | 42 | 2.20 | 1.34 |
| 13 | 2.25 | 1.06 | table | 43 | 1.98 | 1.17 |
| 14 | 2.30 | 1.07 | chair | 44 | 2.35 | 1.33 |
| 15 | 2.68 | 1.29 | umbrella | 45 | 2.75 | 1.26 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 1.65 | 1.19 | man | 46 | 1.40 | 0.98 |
| 17 | 1.78 | 1.23 | ape | 47 | 1.42 | 1.08 |
| 18 | 2.40 | 1.48 | elephant | 48 | 1.90 | 1.39 |
| 19 | 1.48 | 0.91 | dog | 49 | 1.50 | 0.91 |
| 20 | 1.42 | 0.75 | eagle | 50 | 1.52 | 0.85 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 1.22 | 0.42 | man | 51 | 1.35 | 0.86 |
| 22 | 1.58 | 1.28 | ape | 52 | 1.55 | 1.22 |
| 23 | 2.08 | 1.14 | elephant | 53 | 1.65 | 0.92 |
| 24 | 1.88 | 1.42 | dog | 54 | 1.85 | 1.25 |
| 25 | 2.35 | 1.37 | eagle | 55 | 1.88 | 1.52 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 2.32 | 1.23 | car | 56 | 2.22 | 1.23 |
| 27 | 2.15 | 1.03 | bicycle | 57 | 1.85 | 0.89 |
| 28 | 2.32 | 1.02 | table | 58 | 1.85 | 0.80 |
| 29 | 2.22 | 1.25 | chair | 59 | 1.92 | 1.00 |
| 30 | 2.28 | 1.18 | umbrella | 60 | 1.85 | 0.80 |

Table D5. Unfamiliarity ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 4.88 | 2.05 | man | 31 | 5.52 | 1.75 |
| 2 | 5.10 | 1.74 | ape | 32 | 5.55 | 1.75 |
| 3 | 5.20 | 1.90 | elephant | 33 | 5.55 | 1.89 |
| 4 | 5.18 | 1.97 | dog | 34 | 5.62 | 1.60 |
| 5 | 4.48 | 2.01 | eagle | 35 | 5.52 | 1.96 |
| L-L, M | | | | L-L, W | | |
| 6 | 3.50 | 1.96 | man | 36 | 4.78 | 2.12 |
| 7 | 4.72 | 2.04 | ape | 37 | 4.68 | 2.13 |
| 8 | 4.02 | 2.19 | elephant | 38 | 5.22 | 2.01 |
| 9 | 3.60 | 1.72 | dog | 39 | 4.92 | 1.85 |
| 10 | 3.48 | 1.85 | eagle | 40 | 5.18 | 2.05 |
| NL, M | | | | NL, W | | |
| 11 | 3.22 | 1.78 | car | 41 | 4.82 | 1.92 |
| 12 | 3.20 | 1.68 | bicycle | 42 | 5.58 | 1.82 |
| 13 | 3.02 | 1.64 | table | 43 | 5.08 | 1.91 |
| 14 | 3.10 | 1.65 | chair | 44 | 5.22 | 1.89 |
| 15 | 4.02 | 1.99 | umbrella | 45 | 4.15 | 1.97 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 5.60 | 1.84 | man | 46 | 5.88 | 1.51 |
| 17 | 5.40 | 1.77 | ape | 47 | 6.02 | 1.56 |
| 18 | 4.80 | 2.48 | elephant | 48 | 5.88 | 1.59 |
| 19 | 5.25 | 2.02 | dog | 49 | 6.05 | 1.57 |
| 20 | 5.55 | 1.92 | eagle | 50 | 5.75 | 1.96 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 5.75 | 1.72 | man | 51 | 5.55 | 2.01 |
| 22 | 5.78 | 1.75 | ape | 52 | 6.08 | 1.72 |
| 23 | 5.10 | 2.02 | elephant | 53 | 5.80 | 1.64 |
| 24 | 5.08 | 1.99 | dog | 54 | 4.22 | 2.28 |
| 25 | 4.75 | 2.19 | eagle | 55 | 5.72 | 1.77 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 4.28 | 2.05 | car | 56 | 4.22 | 1.82 |
| 27 | 5.10 | 1.84 | bicycle | 57 | 5.45 | 1.66 |
| 28 | 5.02 | 1.98 | table | 58 | 5.10 | 1.89 |
| 29 | 4.75 | 2.02 | chair | 59 | 5.15 | 1.99 |
| 30 | 4.80 | 2.03 | umbrella | 60 | 5.00 | 1.84 |

Table D6. Conflictfulness ratings

| Figure number | Mean | S.D. | Figure | Figure number | Mean | S.D. |
|---|---|---|---|---|---|---|
| L-H, M | | | | L-H, W | | |
| 1 | 3.40 | 1.85 | man | 31 | 4.40 | 1.81 |
| 2 | 3.50 | 1.81 | ape | 32 | 4.25 | 1.98 |
| 3 | 3.18 | 1.81 | elephant | 33 | 3.92 | 1.95 |
| 4 | 4.32 | 1.73 | dog | 34 | 3.58 | 1.99 |
| 5 | 3.50 | 1.73 | eagle | 35 | 4.60 | 1.82 |
| L-L, M | | | | L-L, W | | |
| 6 | 3.88 | 2.05 | man | 36 | 4.28 | 1.91 |
| 7 | 3.78 | 1.62 | ape | 37 | 4.28 | 1.65 |
| 8 | 3.12 | 1.62 | elephant | 38 | 3.80 | 2.07 |
| 9 | 3.98 | 1.93 | dog | 39 | 3.82 | 1.69 |
| 10 | 3.15 | 1.37 | eagle | 40 | 3.88 | 1.80 |
| NL, M | | | | NL, W | | |
| 11 | 2.40 | 1.35 | car | 41 | 3.08 | 1.77 |
| 12 | 2.80 | 1.49 | bicycle | 42 | 3.65 | 2.08 |
| 13 | 2.72 | 1.62 | table | 43 | 3.05 | 1.75 |
| 14 | 2.48 | 1.47 | chair | 44 | 2.60 | 1.46 |
| 15 | 2.58 | 1.52 | umbrella | 45 | 2.48 | 1.62 |
| L-H, MP | | | | L-H, MP&W | | |
| 16 | 4.95 | 1.96 | man | 46 | 4.42 | 2.00 |
| 17 | 4.05 | 1.92 | ape | 47 | 4.80 | 2.11 |
| 18 | 3.65 | 2.20 | elephant | 48 | 4.60 | 1.95 |
| 19 | 4.38 | 1.92 | dog | 49 | 4.68 | 2.10 |
| 20 | 4.02 | 2.02 | eagle | 50 | 4.10 | 1.92 |
| L-L, MP | | | | L-L, MP&W | | |
| 21 | 4.85 | 1.78 | man | 51 | 5.00 | 1.84 |
| 22 | 4.85 | 1.98 | ape | 52 | 5.10 | 2.15 |
| 23 | 3.68 | 1.87 | elephant | 53 | 3.98 | 1.87 |
| 24 | 4.25 | 1.90 | dog | 54 | 3.42 | 1.99 |
| 25 | 3.68 | 1.79 | eagle | 55 | 4.05 | 2.11 |
| NL, MP | | | | NL, MP&W | | |
| 26 | 2.95 | 1.89 | car | 56 | 3.10 | 1.78 |
| 27 | 3.18 | 1.58 | bicycle | 57 | 3.50 | 1.95 |
| 28 | 2.88 | 1.71 | table | 58 | 3.45 | 1.85 |
| 29 | 3.28 | 1.78 | chair | 59 | 2.82 | 1.82 |
| 30 | 2.78 | 1.46 | umbrella | 60 | 2.95 | 1.43 |