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THE EFFECTS OF STIMULUS INCONGRUITY ON CHILDREN'S LOOKING TIME, AFFECT, AND LABELING RESPONSES

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY
Margaret R. Connolly

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ABSTRACT

THE EFFECTS OF STIMULUS INCONGRUITY ON CHILDREN'S LOOKING TIME, AFFECT, AND LABELING RESPONSES

By

Margaret R. Connolly

This study is an exploratory investigation of perceptual exploration and responsiveness to incongruity by young children. An incongruous stimulus is defined as a stimulus with components that the observer perceives as incompatible on the basis of past experience.

The Ss were 20 kindergarteners, 20 second-graders, and 20 fourth-graders. Each S looked at the congruous and incongruous stimuli in a large picture book. The book contained 15 outline drawings of congruous animals and 15 of incongruous animals. The congruous figures were familiar animals; the incongruous drawings were figures designed with the head of a familiar animal and the body of a car, airplane, or a second familiar animal.

The E and two observers (Os) recorded onto an event recorder the length of time S looked at each picture, the number of times his expression changed while looking, and the duration of each expression change. One O also noted the characteristic expressions of each S. Immediately following the test session each S was asked to give each picture a name.

Duration of looking and duration of expression change were significantly longer to incongruous drawings than to congruous drawings ($ps < 0.01$). There were significantly more first-expression-changes

to incongruous than to congruous figures ($\underline{p} < 0.001$). The percentages of kindergarteners, second-graders, and fourth-graders who acknowledged both components of the drawings were 65, 75, and 95, respectively. No age effects were significant.

The older children's more frequent acknowledgment of the two incompatible components (i.e., incongruity) may be seen as evidence of increasing perceptual flexibility, specifically the ability to 'decenter', with age. However, the present study in-cluded no independent assessment of Ss tendency to center so that this interpretation is merely suggestive for further research. The expression change results suggest that affective responses are an effective response measure for preschool and elementary school children in studies of recognition of stimulus incongruity. The looking time results tend to support previous findings that children are more responsive to incongruous stimuli than to familiar stimuli.

Approved Lauren Harris

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THE EFFECTS OF STIMULUS INCONGRUITY ON CHILDREN'S LOOKING TIME, AFFECT, AND LABELING RESPONSES

by

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INTRODUCTION

One of the most characteristic features of living creatures in the waking state is their selective attentiveness to external stimuli. They attend to some features of their environment; they ignore other features. Since the early 1900's, psychologists have shown increasing interest in selective attention and particularly in the question, what are the determinants and correlates of stimulus selection? Several factors have been identified as effective elicitors of attention. In general, they can be classified either as physiological variables or as environmental variables.

Physiological variables are variables associated with the arousal, or drive state, of the organism. These variables have been investigated quite diligently by psychologists as well as by biologists. For example, the selection of food by a hungry animal is seen as the selection of a stimulus that will satisfy nourishment requirements; similarly, the selection of a quiet, dark room by a tired man is the selection of a stimulus situation that will provide him with a place to rest. Because hunger, rest, thirst, respiration, and elimination are basic physical needs, the explanation of stimulus selection in terms of physiological variables usually stresses the biological significance, or life-preserving function, of the selection. The interesting and from the biological standpoint, somewhat puzzling fact, however, is that animals continue to be active even after fulfilling basic needs. Activity in the apparent absence of the operation of life-sustaining drives is often called 'exploratory' or 'curiosity' behavior.

Various factors have been found to influence curiosity. The current study is concerned with one such factor, 'incongruity'. Incongruity is the perceived incompatibility between or among stimulus components. It has received little attention in the research on curiosity. Typically 'investigation' and 'manipulation' are employed as the indexes of curiosity; however, observation indicates that affective and verbal responses may be reliable measures of the perception of incongruity. No research has attempted to compare the effectiveness of an investigatory response such as looking time with affective and verbal responses. The current study is such an attempt.

Before further discussion of incongruity and the response measures, some general considerations of the history of research on curiosity behaviors and factors influencing curiosity behavior will be presented.

Theoretical Background

Since the early 1900's there have been several explanations of curiosity, or exploratory behavior, all of which seem to stem from two theoretical positions. On the one hand, curiosity has been explained as learned, or conditioned, response no different from other such responses. On the other hand, curiosity has been described as a basic drive or motivational state. Most psychologists who have studied curiosity have come to refer to it in the latter sense for at least the two following reasons: (1) Because it is among the earliest of the infants responses, it seems unlikely that it could be learned. (2) Curiosity behavior does not seem to conform to the usual conditioning principles; for example, the strength of the response elicited by a particular stimulus steadily weakens as the incidence of the stimulus presentation increases so that the response never recovers its initial strength.

Berlyne.

Berlyne (1960), long in the vanguard of research on curiosity and exploratory behavior, argues for a drive reduction explanation of curiosity. In so doing he asserts that drive reduction is positively reinforcing. However, he does not maintain that drive arousal is a negative condition; indeed, it too may be a rewarding state.

Berlyne has tried to identify and relate the presumably environmental variables with drive arousal and the behaviors associated with drive reduction. He labels "collative properties" those seemingly environmental variables that affect the observer's attention to and selection of stimuli, while "investigation" and "manipulation" are the specific curiosity or exploratory behaviors that effect arousal reduction.

The collative properties (so called because their effects seem to be additive or multiplicative) are 'novelty', 'complexity', 'uncertainty', 'change', 'surprisingness', 'conflict', and 'incongruity' (p. 44). Berlyne has attempted to differentiate among these variables through the following characterizations:

(1.) Surprisingness is the incompatibility between the stimulus and the subjects' expectation, where expectation refers to the act or state of waiting for or looking forward to an event that is about to happen.

(2.) Incongruity is the arousal of an expectation that is disappointed by simultaneously perceived elements or by elements perceived in close succession.

(3.) Change is a function of the degree of dissimilarity between successive elements in a series and the speed with which dissimilarity occurs.

(4.) Novelty is a combination of incongruity, change, and surprisingness.

It is an inverse function of frequency, duration, and recency of presentation of stimuli. Novelty, as well as its components, is defined in terms of the organism's perceptual history.

(5.) Uncertainty is a function of incompatible, simultaneously aroused expectations.

(6.) Conflict occurs with the simultaneous arousal of two or more compatible responses.

(7.) Complexity is a function of intra-stimulus variety. It increases with increasing numbers of distinguishable, dissimilar elements. Complexity is relatively independent of the subject's past experience and therefore can be determined objectively by quantifying the elements of the stimulus.

Berlyne (1960) has not identified any unique behaviors that are called 'curiosity' or 'exploratory' responses. He has characterized curiosity by reference to the following responses: 'orientation', e.g., toward the stimulus; 'approach', e.g., walking toward the stimulus; 'investigation', e.g., looking longer at the stimulus; and 'manipulation', e.g., touching, holding, turning the stimulus. Orientation and approach responses seem to be associated with an reinforced by drive arousal. On the other hand, investigation and manipulation, the more specific exploratory behaviors, are associated with and reinforced by arousal reduction.

Berlyne's theory predicts that some combination of the collative properties produces maximum stimulus attractiveness and that arousal is associated with the perception of those specific combinations. The observer's total level of arousal is gradually increased and he approaches the arousing stimulus; he explores the stimulus until the level of arousal returns to its optimal level. The organism, then, is reinforced as a result of arousal reduction. Some arousing stimuli may be avoided. Other stimuli go unnoticed because the arousal level remains below the response-activating threshold. Berlyne predicts a quadratic relation between strength of the collative properties and stimulus attractiveness.

To support the contention that curiosity is a drive that is positively reinforced by the performance of certain activities that promote drive reduction, Berlyne appeals to the similarity of the stimulus-response relationships of curiosity and those of the life-sustaining drives such as hunger. However, exploratory behavior presumably differs from homeostatic behaviors insofar as the stimulus that initially elicits a curiosity response will not elicit that same response on all future occasions, including situations in which presentation follows a period of stimulus deprivation. Berlyne seems to suggest that the curiosity behaviors are associated with the stimulus dimension, e.g., 'novelty', rather than with the stimulus object and that the effect of repeated exposure to 'novelty' parallels that of the life-sustaining stimuli. Organisms do learn to respond discriminatively to such stimulus characteristics as color and size independent of the object. Likewise, they may learn to respond discriminatively to the collative properties as dimensions independent of objects.

Berlyne has proposed two types of curiosity: "perceptual" and "epistemic". Perceptual curiosity is a state of high arousal that is generated by insufficient stimulus information to the sensory systems and is relieved by "specific exploration" (p. 195). For instance, a picture of an animal with an elephant's head a a turtle's body (i.e., an incongruous animal) might be looked at longer than a picture of an elephant. Perceptual curiosity strongly implies overt behavior. Epistemic curiosity, on the other hand, is a state of arousal engendered by conceptual conflict or what Berlyne calls the "incompatibilities between symbolic responses" (p. 283). It implies covert behavior, and as such probably would have to be mediated by language. The present study deals with perceptual curiosity and incongruity.

Berlyne proposes that the organism approaches source of arousal induces the organism's approach when the combination of collative properties is most attractive or when it induces conflict. However, he has stated neither the critical combinations of collative properties nor the necessary and sufficient quantity of each property that must be present to elicit approach. Also, Berlyne has not defined curiosity independent of the situation in which it occurs. Cantor (1963, p. 3), has criticized Berlyne on the former point, i.e., for maintaining that conflict (engendered by these stimulus dimensions) elicits approach and exploration rather than avoidance. Brown (1961) has criticized Berlyne for not defining exploratory behavior independent of its occurrence in a particular situation. Both Brown and Cantor suggest that Berlyne's theory is circular because the collative properties lack independent operational definitions.

<u>Hebb</u>.

Hebb's associationist theory (1949) also speaks to the issue of curiosity and stimulus selection but seems to emphasize learning ("expectancy" and "prediction") rather than drive reduction or arousal. Hebb is concerned with the neurological concomitants of learning, e.g., the hypothesized construction of "cell assemblies" and "phase sequences".

According to Hebb (1949), cell assemblies are systems of functionally "associated" neurons. Neurons that are active simultaneously or in immediate succession "tend to become 'associated', so that activity in one facilitates activity in the other" (p. 70). A phase sequence is a cell assembly or a series of assemblies with all of the intervening motor elements.

With respect to perception Hebb's theory predicts the disruption of previously established cell assemblies by the unexpected. For example, a particular triangle 't' has angles a, b, and c. Each time the subject looks at the angles in a specific sequence, say a-b-c, the cortical associations among the three angles are strengthened in precisely that sequence such that when the triangle 't' is perceived again it is likely to be scanned the same way, a-b-c. If, in fact, an angle 'a' which has been associated only with triangle 't' is common also to triangle 'x', the observer, on seeing x_a, may expect and anticipatorily scan for b and c. Angles b and c do not follow, the subject's expectation is defeated, and he sees some other angles instead. According to Hebb, a "defeated expectation" produces a neurological disruption, one of the consequences of which is exploratory or curiosity behavior.

The collative properties may be associated with defeated expectations in still another way: a particular person 'p' has special characteristics, e.g., blonde hair, glasses, and a white laboratory coat with a red collar. Each time the subject looks at the person he sees these specific features, and the cortical associations among the characteristics are strengthened. If the laboratory coat with the red collar, previously associated only with person 'p', is now worn by visitor 'v', the subject, on seeing the laboratory coat, may expect and anticipatorily look for the blonde hair and glasses. The visitor has blonde hair but no glasses, so the subject does not see what he expects on the basis of his past experience. Again the discrepancy between the perception and the expectation would lead to the disruption of cell assemblies and thence to exploratory behavior.

A very large discrepancy might lead to disruption of very intense associations among cell assemblies, and consequently to either fear or avoidance behavior.

The associationist theory explains curiosity by referring to hypothetical neurological activities. Though there seems to be some evidence for neurological activity (e.g., changes in CNS activity as indicated by alpha rhythm seem to be correlated with perception of collative variables such as novelty) the nature of the neurological changes is unknown. Until psychologists have the equipment to study the exact nature of these changes, Hebb's theory must go unsupported.

Piaget.

Piaget (1952) deals with exploratory behavior from a still different point of view, one that we will call "cognitive-developmental". This view sees exploratory behavior as dependent upon learning but not necessarily as learned behavior *per se*. Piaget's theory deals with the development of conceptual schemas by adaptation of new (novel) stimuli. Adaptation involves the concurrent processes of assimilation and accommodation. Curiosity seems to play a role in the assimilation phase of adaptation.

According to Piaget, assimilation occurs when an organism encounters an object and responds to that object as he responds to a similar, familiar object. The behavior may be adapted to the object's structure but inappropriate to its function: for example, a child may grasp and try to bite a ball. The child's behavior, at this stage in adaptation, might be labeled 'exploratory'. Accommodation is the phase in which the organism has differentiated the new object from other similar objects and has begun to develop behavior patterns specific to the object. He is integrating the stimulus into his mental network of schemas as he is developing the differential responses. The stimulus eventually becomes familiar and is a standard, so to speak, with which future stimuli are compared. It is by reference to familiar stimuli that the future stimuli are perceived as 'novel', 'incongruous', etc.

Adaptation may be slow so that the stimulus changes before it has been fully integrated. Modification of a stimulus that has not been integrated completely into the existing schema would probably prolong the assimilation response pattern. However, change in an object that the organism has integrated into its cognitive schema and for which he has a specific response repertoire available, may disrupt the specific response pattern and cause a reversal to the trial-and-error behaviors characteristic of assimilation. In other words, the stimulus will be explored. Stimulus change could be induced by almost any of Berlyne's collative properties.

Piaget's theory deals with schema development and reorganization that occur simultaneously with adaptation of a stimulus. As the child has more experiences and applies the old schemas to new experiences, the schemas are reorganized and become more complex. During the "perceptual-motor" stage the child may develop rudimentary schemas for classes of objects such as 'round', 'new', 'familiar', as well as schemas for the objects themselves, e.g., 'face', 'ball'. It seems that the young child quickly learns to manipulate round objects differently from the way he handles square objects. This different behavior may suggest the formation of a schema for 'things-that-are-round'. On the other hand, infants and young children frequently have difficulty discriminating food objects. This problem might arise as a function of the variation in size, shape, and texture of food objects; that is, the variety of perceptual cues for the object category 'things-to-eat' precludes easy discrimination of these objects. There is no unique discriminable stimulus dimension for this important stimulus class.

If early cognitive growth is really the development of stimulus-dimension schema rather than a stimulus-object schema, it implies that infants should respond differentially to objects with familiar stimulus dimensions, since these have discriminable cues, and similarly, should not differentiate among objects with predominately unfamiliar stimulus dimensions.

Piaget suggests also that the young child's thoughts about and perceptions of stimuli are 'egocentric', or self-centered. For instance the young child interprets a stimulus according to whichever aspect of the stimulus first drew his attention and he believes that everyone else views the stimulus as he does. About the time the child enters first grade, however, he is losing this egocentric orientation. This change implies that the older child will 'decenter', or attempt to consider and integrate all of the elements of the perceived pattern into a whole. It further implies that the older child's thoughts and perceptions are fairly flexible and less often dominated by that element of the stimulus that elicited his attention initially.

Bruner et al. (1966) hypothesized that young children--even though they do decenter--can integrate the elements of a simple, familiar pattern only. They predict that the ability to integrate the elements of involved patterns emerges during early adolescence.

Considering Piaget and Bruner together, the cognitive-developmental approach seems to imply that children of all ages may look at all elements of a stimulus, but that conceptual development--the ability to integrate all of the information obtained improves with age.

<u>Summary</u>.

There are implications in several current theories for the study of exploratory or curiosity behavior. Berlyne's theory is primarily concerned with drive reduction. It designates the stimulus dimension, <u>viz</u>., complexity, novelty, surprisingness, incongruity, change, and uncertainty, that elicit curiosity behavior. Hebb's theory suggests that simultaneously aroused expectations disrupt behavior patterns by disrupting or cancelling the underlying neurological phase sequences. Piaget's work suggests that any of Berlyne's stimulus properties may elicit responses similar to the exploratory behavior of the assimilation period (e.g., persistent, repetitive responses toward an incongruous stimulus) and that observation of this behavior is more likely among older elementary school children than younger elementary school children.

<u>Definitions of Incongruity</u>

Incongruity, the stimulus variable with which this paper is concerned, poses a number of quite difficult problems of definition. The term 'incongruous' usually implies the unexpected, out-of-place, and internally inconsistent, as determined by the perceiver's past experiences. The theoretical definitions offered by Berlyne (1960), Hebb (1949), Maddi (1961), Harvey (1963), and others seem to imply much the same thing.

According to Berlyne, incongruity "exists when a stimulus induces an expectation which turns out to be disappointed by the accompanying stimuli" (1960, pp. 24-25). The expectations are due to the "synchronous predictive redintegration" (p. 25) activated by some stimulus. In other words, for each stimulus there is a neural correlate and an associated response; an incongruous stimulus simultaneously activates two neural correlates, and as the cerebral neurons for each response fire (or the threshold for their firing is lowered), the responses conflict so that both cannot be carried to completion.

Berlyne (1960) further suggested that incongruity is a unique combination of the other collative properties. However, merely codifying and quantifying the collative properties of incongruity will not yield a satisfactory definition because, as noted above, the ordinary use of the term implies that incongruity is also a function of the observer's previous perceptual experience. The definition presented by Berlyne stresses previous experience less explicitly than do the definitions offered by Maddi (1961) and Lore (1965), or Harvey (1963).

Berlyne's definition is unwieldy for research because its use in research would require pretraining sessions during which each subject learned a specific response to the congruous drawings and a testing session for observing the effects of incongruity on the learned response. For this reason, another definition was used for the current research.

Other definitions are implied or stated by Lore, Hebb, Piaget, and Harvey. Lore (1965) contends that incongruity is a relational concept that can be defined only in terms of the physical properties of the stimulus and the individual's previous experience with objects of the same stimulus class. As indicated above, Hebb would define incongruity as a stimulus property leading to the disruption of cell assemblies as a result of a defeated expectation. Piaget (1952) indicates that the moderate modification of a familiar pattern is the stimulus characteristic most effective for eliciting orientation and exploration. It seems that Piaget is referring to incongruity. Length of looking time, a dependent variable in the present study, is suggested by Piaget's definition. Harvey (1963) defines incongruity as the failure of new receptor input to match stored information--either on a short term basis, as when there are rapid changes in receptor input, or on a long term basis, as when "objects, situations, persons, and [previously] sequentially organized events fail to match the inputs that come" (pp. 60-61). Because it would be difficult to measure precisely receptor input and stored information, Harvey's definition was not used.

Maddi (1961) offers still another definition: "An incongruous stimulus contains elements which are perceived as incompatible with each other on the basis of prior experience with these elements" (p. 256). He suggests also that incongruity may be directly related to complexity, and that it is similar to surprisingness except that it involves a spatial rather than a temporal dimension (p. 267). The general--as distinct from the operational--definition of incongruity used in the current study seems closest to Maddi's. This definition was chosen because an operational definition could be derived from it, i.e., it is possible to determine--with reference to specific stimuli--what combinations of stimulus elements might be perceived as incompatible with each other on the basis of past experience.

Types of incongruity.

Though the present study is about visual incongruity, incongruity also can be experienced with the other senses, and it can be experienced between sense modalities. For instance, one may see a shiny surface and expect it to feel smooth but discover that it is rough to the touch.

Epistemic, or conceptual, incongruity refers to the symbolic conflict arising when properties occur together after one has learned that they occur separately. Though this would seem to be an interesting direction for research, few psychologists other than Berlyne (1954, 1962) have studied epistemic curiosity.

Previous Research

Although there has been much research on curiosity in general and on the properties 'novelty' and 'complexity', little research has been directed to the behavioral concomitants of incongruity. Instead, incongruity has been studied as a component of novelty in research with both animals and humans. Therefore, the following review of research deals with studies of novelty and complexity and attempts to relate the findings to the study of incongruity and perceptual curiosity.

Studies with animals.

Animal studies have dealt with both object novelty and situational novelty. For a more comprehensive review of the early animal literature the reader is referred to Berlyne (1960), Welker (1961), and Brown (1961). The present discussion will be limited to a review of a few selected primate studies.

Butler (1954), for example, found that monkeys learn to discriminate between two colors and to respond to the discriminative stimulus when the reinforcement is a chance to peek into the laboratory, i.e., a change in visual stimuli. The monkeys peeked more often at a changing than an unchanging scene. Harvey (1963) interpreted the higher response rate to the bustling laboratory as a function of the greater incongruity in the changing laboratory scene. Actually, it seems as though the monkeys' choice was for relatively more complexity and relatively more novelty rather than for incongruity. The animal's cage was familiar and probably barren, so that the laboratory, while not completely unfamiliar, was more novel and more complex than the cage. The more 'active' laboratory, of course, provided more change from the cage than did the quiet laboratory. Another significant feature of Butler's study was the endurance of the operant 'peeking' response reinforced only by perceptual curiosity.

Welker improved on Butler's by employing a naturalistic setting and a spontaneous rather than a conditional response. Welker (1956_a, 1956_b, 1956_c) found that young chimpanzees looked at and touched the novel, heterogeneous stimuli more than did older chimpanzees. There were several sets of novel objects, and each presentation of a different set the exploratory behavior, albeit extinguished on the preceding set, reappeared. The young chimpanzees had consistently longer approach latencies to each new set of objects than did the older subjects.

Hebb (1946), too, reported that chimpanzees responded to novel stimuli. These chimpanzees, however, did not approach novelty - they avoided it, screamed, and shook their cages. Hebb called their responses "fear". It is possible that the longer approach latencies of Welker's young chimpanzees indicates mild fear also.

Both Hebb and Welker could be sure that their stimuli were novel since they each were familiar with their subjects' perceptual histories. However, the novelty in Hebb's stimuli lay in their being rearrangements of the elements of familiar stimuli. Thus the dominant characteristic of his novel stimuli appears to be incongruity.

<u>Studies with humans</u>.

Like the animal literature, most of the curiosity research with human subjects centers on novelty and complexity. A few of these studies have dealt with incongruity as a dimension of novelty or, less frequently, of complexity. The subjects typically have been adults, nursery school and kindergarten children, and, in a few cases, infants. One study used elementary school age subjects. There has been no truly developmental study so that age trends must be inferred from a variety of studies, and any inferences must be tentative because of the great variety of methods and analyses used.

Novelty. Most studies with humans have dealt with "relative novelty", since it is easier to manipulate recency of stimulus encounter than the total perceptual history of a subject. The research of Berlyne (1954, 1957, 1958_a, 1958_b, 1962), Cantor and Cantor (1964), Clapp and Eichorn (1965), Pielstock, Woodruff, and Bond (1964), Lintz, Starr, and Medinnus (1965), Harris (1965, 1967_a, 1967_b), Lore (1965), and Smock and Holt (1962) has shown that children and adults tend to "like" (Berlyne's term) novel pictures and objects and that they respond more to these stimuli than to familiar stimuli. Harris (1965) reported that children choose one damaged novel toy over two undamaged familiar toys. On the other hand, the research of Hoats, Miller, and Spitz (1963), Burgess (1957), Kagan et al. (1966), and McCall and Kagan (1967) has not shown significant preference for novel stimuli or greater responsiveness to novelty. The difference in these studies may lie in the age of subjects used, kind of stimuli, etc., as we will see below.

1. Novelty and response frequency. Using exposure frequency as a measure of curiosity, Berlyne (1957) found that college students looked more at incongruous than at congruous pictures and more at novel than at familiar pictures. This result has been found only inconsistently with nursery school children (Clapp and Eichorn, 1967; Burgess, 1957; Lore, 1965).

2. Novelty and response duration. Berlyne (1957), Cantor and Cantor (1964), Johnson (1967), Maw and Maw (1961), Pielstock et al. (1964), and Burgess (1957) have used duration of looking time as a behavioral measure of both preference and curiosity. Longer duration

of looking time has generally been associated with stated preference for the collative variable. Subjects looked longer at relatively more novel stimuli.

3. Novelty and physiological reactions. Lore (1965), Kagan et al. (1966), and McCall and Kagan (1967) reported relations between stimulus selection (as indicated by duration of looking time) and certain physiological correlates of attention. General activity level and cardiac rate decreased while skin conductance increased. Lore (1965) found a correlation between these physiological indexes of attention and the mean duration of looking time at incongruous and novel stimuli for a group of middle class kindergarten children but not for a matched group of "underpriviledged" children. It is especially in research with infants that the effects of novelty and incongruity seem most inseparable. Kagan et al. (1966) found that cardiac deceleration of infants occurred significantly more often within the first 3 seconds of the initial fixation to a picture of a normal face (familiar stimulus) than to a face with 'scrambled' features. McCall and Kagan (1967) obtained the same results using both photographs and drawings of faces. In these two studies the responses were interpreted as "recognitory". It seems likely that infants would respond to a previously perceived stimulus because some of its cues were learned. However, infants do not have well-developed schemas for familiar objects, patterns, persons, events, etc. Thus discrimination of incongruity is unlikely because there is no standard with which to compare the unfamiliar stimulus. After the infant has discriminated the particular and fixed patterning of the elements of several stimuli, he may be more affected by a rearrangement of the components of those stimuli.

4. Novelty and affective responses. Kagan et al. (1966) have reported affective responses in studies of curiosity. They found that 4-month-old infants smile more to normal faces than to scrambled faces. There was no evidence of differential affective responsiveness among their subjects to novel, i.e., modified familiar (hence incongruous) stimuli. (Hebb and Welker obtained essentially the same results with young chimpanzees.) Piaget (1952) notes that infants often respond affectively while observing slightly modified stimuli. The infants show "surprise", "puzzlement", "startle", smiles, and laughter. The expression changes, according to Piaget's reports, seem to follow the initial orienting reaction and occur simultaneously with exploratory responses.

5. Incongruity as a dimension of novelty. Berlyne (1957, 1958, 1963), using adults, and Clapp and Eichorn (1965) and Lore (1965), using preschool and kindergarten children, found greater responsiveness to incongruous than to congruous stimuli. Burgess (1957), on the other hand, found no significant preference for incongruity among nursery school children. Berlyne (1958) controlled for "identification time" and found that the adults' preference for incongruous stimuli was not a function of identification time alone.

In conclusion, it seems that incongruity may not be an effective dimension of novelty with children younger than elementary school age. Responsiveness to incongruity does not seem to be a function of stimulus identification alone.

Complexity. Complexity is the second of the two "collative properties" to receive considerable attention by psychologists. Complexity is relatively easy to define physically by using standard information-theoretic means, but its psychophysical component is apparently closely tied to the individual subject's past experience just as in the case of other collative variables.

1. Pattern complexity and preference. Numerous studies using subjects within the age range of approximately 5-18 years (Berlyne, 1957, 1958, 1963; Burgess, 1957; Clapp and Eichorn, 1965; Pielstock, Woodruff, and Bond, 1964; McCall and Kagan, 1967; Munsinger and Kessen, 1964; Munsinger, Kessen, and Kessen, 1964; Smock and Holt, 1962; Munsinger, 1965; Munsinger and Kessen, 1966) suggest an age invariant verbally-stated preference for stimuli of intermediate degrees of complexity. However, younger children show a greater preference for more complex forms than do adults (Pielstock et al., 1964; Munsinger and Kessen, 1964; Munsinger, Kessen and Kessen, 1964).

Using a paired-comparison design, Berlyne (1963) found that adults' stated preference correlated negatively with duration of looking time, i.e., more adults rated less irregular (LI) patterns as more pleasing, but more irregular (MI) patterns as more interesting. When allowed to choose a pattern for further viewing the adults chose the MI patterns significantly more often than the LI patterns.

In summary, it seems that children and adults prefer patterns of moderate complexity. When asked to choose patterns that are more interesting, adults choose MI patterns, i.e., patterns similar to those which children prefer. When asked to choose "pleasing" patterns, adults choose LI patterns, i.e., patterns similar to those which older children prefer.

2. Pattern complexity and recognition. Munsinger and Kessen (1966) found that although younger children prefer the more irregular patterns, they remember the LI (meaningless) patterns more readily than the MI ones. Adults were slightly superior in the recognition

of previously seen complex patterns.

3. Pattern complexity and response duration. Johnson (1967) reported a longer looking at more complex than at simple patterns by adults and children.

4. Pattern complexity, preference, and intelligence. Pielstock et al. (1964) found that "gifted children" (Binet IQ $\geq$ 132) are more responsive to pictures of greater variability than are children of average intelligence (Binet IQ 92 - 108). It thus seems as though intellectually gifted children prefer the MI patterns, whereas average children prefer the LI patterns. The responses of average children were similar to those of older children and adults. The preferences of the sixth-grade gifted children, however, were more similar to the adults' preferences than to those of the young gifted children or the young average children.

Summary

The foregoing review suggests that little is yet known about the relation between incongruity and curiosity or about the relation between age and incongruity. Several studies have investigated the curiosity-inducing property of incongruity as a dimension of novelty using duration and frequency of looking time and physiological measures as dependent variables. No study has attempted to deal with incongruity as a dimension of complexity, though this suggestion was made by Maddi (1963). No study has investigated the relation between age and incongruity, although several studies using subjects of varying ages have included a few incongruous pictures in the set of novel stimuli.

The Present Study

The present study focuses on the visual exploration of incongruous pictures, with special attention directed to children's spontaneous responses to pictures. The incongruous stimuli were outline drawings consisting of the head of one animal and the body of either another animal or of an inanimate object. This operational definition thus does not take into account each child's unique experiences, but the study was concerned more with between-subject than within-subject comparisons. The current operational definition and stimuli are similar to those used by Berlyne (1960), Lore (1965), and others.

The incongruous figures and congruous 'control' figures were shown to kindergarten, second-grade, and fourth-grade children. These groups were used to expand the age range employed in previous studies, most of which have used only pre-school and kindergarten children.

The investigation was concerned with several response classes that might indicate sensitivity to incongruity or other collative properties in the child's everyday life. These responses are:

(1) The duration, or length, of time the subject looks at the stimulus picture and frequency of looks at the stimulus. These measures, as noted earlier, have been used frequently as indexes of perceptual curiosity. Looking time frequency was defined as the number of looks at each stimulus, and looking time duration as the length of time spent looking at each stimulus.

Looking time seems to be the obvious and natural index of stimulus selection. However, because it is usually a demand characteristic of the perceptual situation, it probably has limited value when used alone. It should be more meaningful when combined with other measures.

(2) The number of times S changes his expression while viewing a picture, the incidence of an expression change to the congruous and incongruous pictures, and the duration, or length, of all expression changes to each picture.

Casual observation of adults and children indicated that smiles, laughter, frowns, widened eyes, and comments were reliably associated with observation of the stimulus. Expression change has been reported as a dependent variable by very few psychologists, although an early exploratory study by Swan (1938) indicated that expression change was a potentially fruitful dependent variable with nursery school children. Swan reported that the children were very expressive: frowns, chuckle-laughs, and talking-to-self occurred at least once for 75% of the children in a 90 minute free play situation, and all children smiled at least once. Other facial expressive behavior included laughing, crying, lifting eyebrows, pursing lips, and sucking. Further, it was noted that children who talked more showed fewer silent facial expressions. Charlesworth (1968) suggested that facial expressiveness may provide information about the subject's cognitive activity. An expression change measure may disclose age changes in the perception of incongruity insofar as that perception depends on the complexity of the subject's schemas and his level of cognitive development.

Psychologists have not used affective responses as dependent variables because they can be inhibited and/or faked, and because they are thought to be very dependent upon the subject's past experiences, personality, and age. Though these reasons may be valid for adolescents and adults, the evidence suggests that affect is expressed relatively openly by children in the age range used in the current study (Miller, 1960).

(3) The name assigned to each incongruous stimulus. Many subjects in a pilot study spontaneously named the figures while viewing them. Some of the children named just one component of the incongruous figures, while other children named both components or tried to make up a new name using the names of both figures. Labeling therefore was used to help decide whether the differential responsiveness to the figures could be interpreted as perception of incongruity or whether it might be a visual habit.

Psychologists frequently have attempted - but with little success - to relate intelligence (IQ scores) to responsiveness to visual stimuli. Curiosity indeed might be expected to correlate with the scores on some subtests of the Stanford-Binet, such as 'picture absurdities', but not with others such as 'arithmetic'. The low correlations found between IQ scores and responses to visual stimuli therefore should be of no surprise. A pilot study suggested that labeling was a direct and reliable indication of the child's ability to recognize and communicate information about pictures and as such could be a useful measure of cognitive development.

Since older children undoubtably have had more experience with animal pictures than have younger children, they ought to be able to label the pictures more rapidly and specifically. However, the current research did not study labeling per se but rather sought to use spontaneously emitted labels as an indication of perceived incongruity. Therefore age differences in labeling ability need not necessarily be considered a drawback. A pilot study indicated that young children could assign an animal class name, e.g., 'bird' and 'dog', to any component of an incongruous figure that they could not name exactly, e.g., 'flamingo', 'wolf'. It was felt that such naming was a sufficient indication of whether or not the child perceived a figure with two incompatible components.

<u>Predictions</u>.

The predictions below stem from Berlyne's theory of the effects of the collative properties, and from the research cited above - especially the studies of Berlyne, Burgess, and Lore.

(1) The mean duration of looking time to incongruous figures will exceed the mean duration looking time to congruous figures.

(2) The mean duration of looking time to incongruous pictures will be longest for kindergarteners, intermediate for second-graders, and shortest for fourth-graders. Alternatively, this same ordering is expected when the statistic of interest is proportion of total looking time spent looking at the incongruous figures because younger children simply may look longer at everything.

(3) The mean duration of expression change to incongruous figures will exceed the mean duration of expression change to congruous figures.

(4) The mean duration of expression change for kindergarteners and second-graders will exceed the mean duration of expression change for fourth-graders.

(5) The mean number of expression changes to incongruous pictures will exceed the mean number of expression changes to congruous pictures.

(6) There will be a direct relation between acknowledgment of both components of the incongruous figures and grade in school, though it is expected that the difference will be larger between kindergarten and second-grade than between second and fourth grade.

METHOD

Subjects.

The subjects were 60 children (27 boys and 33 girls) enrolled at the Spartan Village School on the campus of Michigan State University. The sample included 20 kindergarteners (5 years 3 months--6 years 10 months), 20 second-graders (6:2--8:5), and 20 fourth-graders (9:2--11:7). There were 9 boys and 11 girls from each grade.

Materials.

The stimuli were designed using picture books, coloring books, etc., as a guide to what should be familiar for children of the age range studied. Thirty pictures were designed: 15 congruous (C) and 15 incongruous (I). The C stimuli were ditto copies of animal drawings. The I stimuli were ditto pictures of combinations of two congruous animals such that the completed figure had the head of one animal and the body of another. Several figures were combinations of an animal's head and the body of an airplane or a car. (Copies of the congruous and incongruous pictures used are included in Appendix A.)

There was no control for complexity as measured by number of independent turns, number of sides, etc. (Munsinger and Kessen, 1964). However, the pictures were designed with minimum internal detail. Gibson (1963) reports that simple drawings, such as cartoons, facilitate children's perceptual performance in picture identification by "eliminating noise from the stimulus" (p. 189).

The congruous pictures were used to control for novelty, i.e., if the congruous drawings were novel, Ss would probably respond similarly to both novelty and incongruity making it impossible to determine which had been discriminated.

It was expected that the older children would be more familiar, because of longer experience, with the kinds of pictures typically shown in picture books (e.g., with the various zoo and farm animals). Nevertheless most of the kindergarten children, after 7 months in school, were able to identify the congruous animals and to handle the books in which they were bound with skill sufficient to that needed in the task. It is very unlikely that any of the subjects would have seen the particular incongruous figures used in this study.

Four identical sets of the original 30 figures were bound into 11 inch x 18 inch folders. Four C - I randomizations were carried out using a revised Gellerman sequence (Gellerman, 1933). The C - I randomizations were performed in blocks of ten (3 blocks for each book) with the following restrictions: (a.) there were five C and five I figures in each block; (b.) there were no more than three C or three I figures in succession; and (c.) the first figures in each book were one C and one I. The figures were assigned numbers (C = 1 - 15, I = 16 - 30), and then, according to the above criteria, were arranged within each book so that each book contained the same pictures but in different orders. The orders used are presented in Table 1, Appendix B.

Because younger children might be less adept in handling the materials, thick pages were used to permit easy turning by even the youngest subjects. (Pages that are difficult to turn could draw the child's attention from the pictures to the duty of obeying E's instructions to turn only one page at a time.)

The picture book was placed on a bookrest which was fastened to the table with masking tape. The back of the rest slanted forward so that the book would rest on the ledge and back of the bookrest. The bookrest was approximately 18 inches x 12 inches and was positioned so as to permit easy view of the pictures for even the youngest Ss.

Procedure.

Ten days prior to the starting date, E visited each of the participating classrooms for 30 minutes in order to meet and talk to the children. At this time E described the children's role as follows:

> I guess just about everyone likes to look at pictures; I know that I do, and I bet that you do too. There are lots of different kinds of pictures and we see them in many places. There are pictures in books and magazines, pictures we hang on the wall, and moving pictures. I have some pictures that I have drawn and put into a book for you to look at. Some of the pictures you have seen before and some will be new and different.
>
> It is important that you don't tell anyone else about the pictures once you have seen them. We want them to be a surprise for everyone. Do you think you can keep it a secret: I think that you will enjoy looking at the pictures.

On the first day E escorted the first child from his classroom to the test room, an 11 x 8 foot spare room in the school. The door of the room contained a one-way mirror. The S sat before the book stand. Sometimes the younger Ss had to be propped up to enable clear view of the pictures and easy manipulation of the pages. The table (3 feet high) for the bookrest was placed in front of the one-way mirror such that S was 7 feet from the mirror. The Os were seated in the adjoining room 1½ feet behind the mirror. In that room they were hidden behind a screen so that S could not see them as he entered the test room.

The closed book lay on the bookrest and remained balanced as S turned the pages. The E spoke the following instructions from memory:

> Remember when I came to your room and told you about the picture books that I had? (E reminded Ss who had forgotten.) Well, this is one of them; the first page is empty but each page after that has a picture on it. You are to turn the pages one at a time, like this (E lifted the blank page by the bottom corner) and look at each picture for as long as you want. Then turn the page and look at the next picture for as long as you want. Remember to turn just one page at a time.

> Any questions: Wait until I sit down over here and then you may begin. Ok, go ahead.

The E then moved to a corner of the room approximately 6 feet from S. From this position she could see S's eyes clearly.

After S looked at the last picture E said,

> Now let's go back to the first page with pictures on it. I would like you to look at each picture again and name it for me so that I can write it down here on this paper.

If S paused or asked about a picture, E said "You give it a name. Tell me what it looks like." The E did not suggest that more than one name might be "correct", or that there was a "correct" name.

After the naming, S returned to his classroom, brought the next S to the test room, and then rejoined his class.

Apparatus.

The recording apparatus was a four channel Rustrak event recorder, operated simultaneously by E and two observers, O_1 and O_2. The E was in the room with S, but E's hand control was concealed and operated silently. A fan in the test toom masked outside noises. The observers and the event recorder were in the adjacent room and were never seen or heard by S.

After the instructions O_1 started the event recorder. The E depressed the button on her hand control when S began to look at the picture and released it whenever S looked away from the picture. The O_1 recorded each page turn with two 'blips' of a second control, and with the third hand control recorded the onset and duration of S's changes of expression. The O_2 recorded onset, duration, and offset of S's looks at E with a fourth hand control. All four controls were wired to the single recorder for simultaneous recording of the various events.

Dependent variables.

Duration of looking time was the length of time S looked at the picture. It was computed by subtracting the duration of looks away from the drawing, e.g., looks at E, looks at the edge of the page, looks around the room, from the total picture presentation time. Picture presentation time was that period of time between page turns. A page turn began when the overlying page was raised to approximate vertical with the next page, and the page turn ended when that page was raised to approximate vertical with the next page.

An expression change was defined as any change in expression while S observed each drawing. Expressions such as the following were recorded: smiles, frowns, laughs, raised eyebrows, widened eyes, opened mouth, pursed lips, creased forehead.

Each S was asked to name all pictures. The child was presumed to have perceived both components of the incongruous figure if he labeled both correctly, or if he mislabeled one (i.e., if his name for one component was in fact incorrect but nevertheless was different from the name for the first component, e.g., duck with dog's head instead of duck with wolf's head).

Reliability of dependent variables. Prior to the testing, the reliability, or percent agreement, for each dependent variable was assessed using the following formula:

$$\frac{\text{total number of overlapping recordings}}{\text{total number of separate recordings}} \times 100$$

The reliability for looks at E was 83.1; for expression change, 76.5; for non-orientation to the stimulus, 96.8.

The experimental setting.

In the most general sense, this research seeks to identify the natural attractors of children's attention and to determining the behavioral indexes of that attention. To accomplish these aims, it is important that feelings of self-consciousness, anxiety, and fear be minimized. Primarily for these reasons, certain considerations were observed in the design of the current study. The children were tested in a familiar room in their own school. The table and chairs in the room were similar to those used in all other rooms in the school.

In a pilot study, 4-to 6-year old children enthusiastically looked at some C and I pictures when asked to do so by a friendly adult, and everyday observation indicates that most elementary school children are familiar with and like to look at picture books. The stimuli used in this study, therefore, were bound into books designed to resemble picture books.

The demand characteristics of the situation were minimal. General experience with children indicated that the fewer specific demands made upon the child, the more spontaneous his behavior. The child in the current study was almost completely in control of the situation. He simply was asked to do what he would do normally--to look at a picture book. He had two rules to remember while looking at the book, both rules to insure uniform behavior across all children and to permit recording of his behavior. Few children had trouble turning only one page at a time.

In much previous research, the stimuli have been presented either by E or S in a tachistoscope or (timed) slide projector. But the use of mechanical gadgets with young children can be criticized inasmuch as the child's interest in operating or controlling E's operation of the mechanical device may bias the results. (Indeed, this may explain why the CDS, or "culturally deprived," subjects in Lore's study did not respond differentially to incongruity and asymmetry. It may also explain why Burgess did not obtain significant differences in looking times for his 5-year-old subjects.) Also, young S's behavior may reflect boredom or satiation with a gadget rather than responsiveness to the experimental stimuli. No one seems to have reported any sort of control for the effects of the presentation apparatus. The absence of any mechanical gadgets in the test room in the current study makes such controls unnecessary.

RESULTS

Duration of looking time.

Duration of looking time (length of time S looked at a picture) was calculated as total length of time (in seconds) the picture was presented minus total duration (in seconds) of all looks away from the picture. The scores for all Ss were summed and divided into 3 blocks of 10 trials, each block containing 5 incongruous pictures and 5 congruous pictures. An analysis of variance (Table 1) with congruity-incongruity and trial block as 'within' variables and grade as 'between' variable disclosed significant effects for the congruity-incongruity dimension ($F = 17.80$, $df = 2/114$, $p < .01$). [A one-way analysis of variance for pairs of trial blocks disclosed a significant incongruity x trial block interaction for trial blocks I and III only ($F = 7.75$, $df = 1/118$, $p < .01$).] No other main effects or interactions were significant.

The mean duration of looking time across trial blocks was 7.99 seconds ($SD = 6.87$) to the incongruous figures and 7.71 seconds ($SD = 4.85$) to the congruous figures. Table 2 presents these totals in addition to subtotals for each grade in school and each trial block. As can be seen, across all trial blocks and all grades the mean duration of looking time was longer to incongruous figures than to congruous figures.

The foregoing analyses were concerned only with group effects. The incongruity-congruity effects also may be viewed in terms of the scores of individual subjects. Figure 1 presents, by trial block, the total number of subjects in each grade level who looked longer at the incongruous than at the congruous figures. As can be seen, an equal

TABLE 1

SUMMARY OF ANALYSIS OF VARIANCE OF DURATION OF LOOKING TIME TO INCONGRUOUS AND CONGRUOUS ANIMAL DRAWINGS

Source	*df*	SS	MS	*F*	*p*
Between	59	245,339.070			
Grade (C)	2	2,176.31	1,088.155	<1.00	
Error$_b$	57	243,162.76	4,266.018		
Within	300	96,700.842			
Trial Block (B)	2	15,321.695	7,660.548	17.8066	<0.01
C x B	4	1,585.335	398.385	<1.00	
Error	114	49,043.70	30.20		
Congruity (A)	1	3,378.311	3,378.311	19.5235	<0.01
C x A	2	121.582	60.791	<1.00	
A x Error$_b$	57	9,863.136	173.657		
B x A	2	379.097	189.548	1.2814	<0.05
C x B x A	4	205.718	51.480	<1.00	
AB x Error$_b$	114	16,862.865	147.919		
Total	359	342,099.9125			

TABLE 2

MEAN DURATION OF LOOKING TIME TO INCONGRUOUS AND CONGRUOUS FIGURES AS A FUNCTION OF GRADE IN SCHOOL AND TRIAL BLOCK

TRIAL BLOCK		GRADE IN SCHOOL							
		Kindergarten		Second		Fourth		Total	
		Incon.	Con.	Incon.	Con.	Incon.	Con.	Incon.	Con.
I	$\bar{X}$ =	10.26	8.47	10.41	8.67	8.56	7.02	9.74	8.05
	SD =	(7.16)	(4.82)	(3.85)	(4.09)	(1.87)	(1.19)	(9.60)	(6.96)
II	$\bar{X}$ =	6.74	6.27	8.59	7.18	7.71	5.71	7.68	6.38
	SD =	(3.30)	(2.64)	(2.83)	(2.28)	(1.98)	(0.98)	(5.57)	(4.23)
III	$\bar{X}$ =	5.27	4.80	6.66	5.91	6.26	5.41	6.06	3.65
	SD =	(2.15)	(2.17)	(1.90)	(1.57)	(1.22)	(1.09)	(5.37)	(3.37)
Total	$\bar{X}$ =	7.42	6.51	8.55	7.25	7.51	6.04	7.99	7.71
	SD =	(4.20)	(3.21)	(2.86)	(2.64)	(1.69)	(1.09)	(6.87)	(4.85)

number of subjects in each grade looked at the incongruous figures longer than at the congruous figures in trial block I. In trial blocks II and III, however, the number of kindergarteners and second-graders looking longer at the incongruous figures remained constant or decreased, while the number of fourth-graders increased. Across all 3 trial blocks, 20 of the 60 subjects always looked longer at the incongruous figures than at the congruous figures.

Table 3 presents the frequency distribution for the 8 possible patterns of longer duration of looking time across trial blocks, i.e., whether the longer looking time per trial was to the incongruous figures (I) or to the congruous figures (C). Five kindergarteners, 6 second-graders, and 1 fourth-grader looked longer at the congruous figures in each of the 3 trial blocks. Finally 12 kindergarteners, 15 second-graders, and 17 fourth-graders looked at the incongruous figures longer than at the congruous figures in 2/3 of the trial blocks.

Still another way to examine the duration of looking time data is to consider the percent of total looking time to the incongruous figures; Table 4 presents these percentages. The mean percent of total looking time at incongruous figures was 54%. As can be seen, across all trial blocks and across all levels in school, more than 50% of the total looking time was to the incongruous figures. For kindergarten and second-grade, percentage of total looking time to the incongruous figures decreased regularly but slightly across trial blocks. The distribution of percentages for fourth-graders was irregular.

Duration of expression change.

Across all Ss the mean duration of expression change to incongruous figures was 2.35 seconds (SD = 0.85), to congruous figures,

Figure 1. Number of subjects (per trial block) with longer looking times to incongruous than to congruous figures.

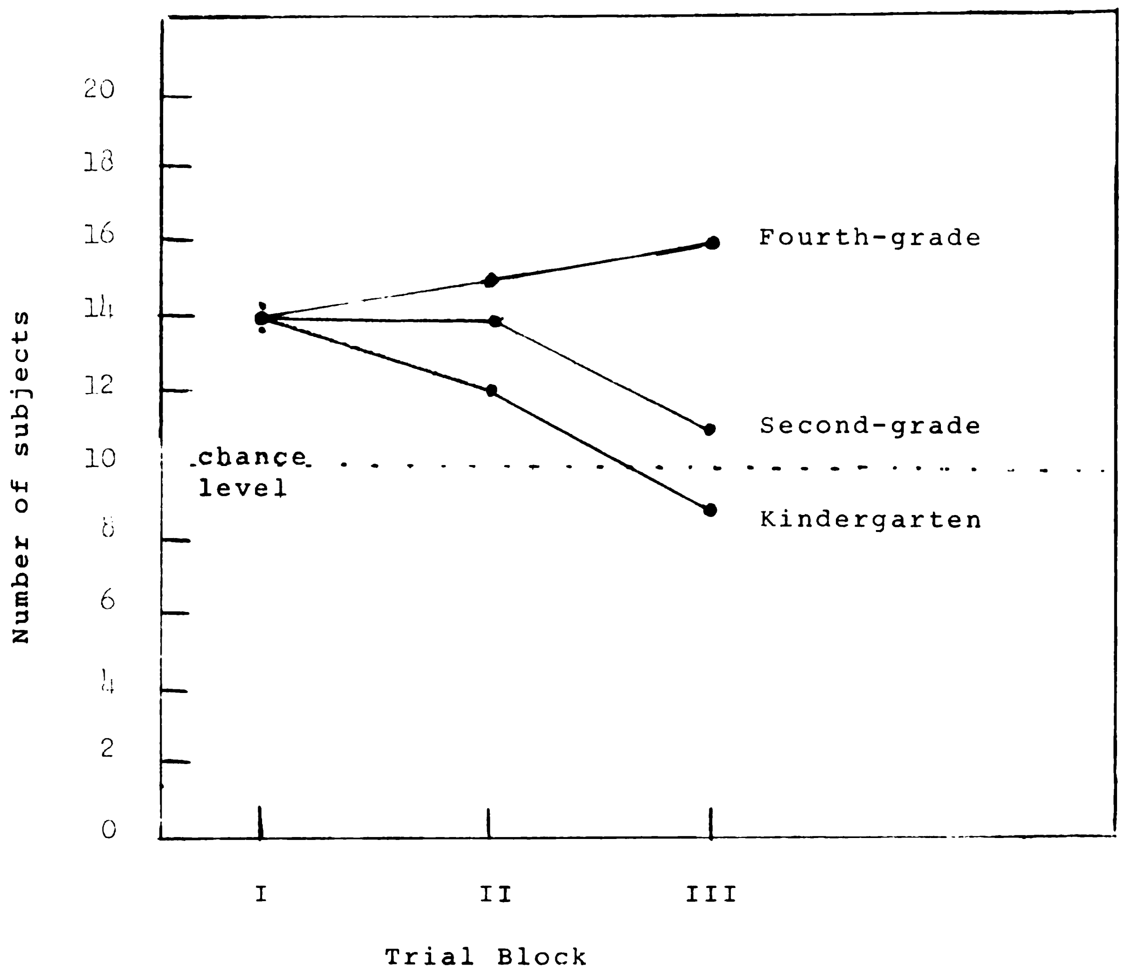


TABLE 3

FREQUENCY DISTRIBUTION OF THE 8 POSSIBLE PATTERNS OF RESPONSE FOR EACH GRADE LEVEL

8 Possible Patterns of Longer Duration of Looking Time to Congruous (C) or Incongruous (I) Figures per Trial Block		Kindergarten	Second Grade	Fourth Grade
1. I I I	N=	5	6	9
2. I I C		5	4	3
3. I C I		1	3	2
4. C I I		1	2	3
5. I C C		3	1	0
6. C I C		0	2	0
7. C C I		2	0	2
8. C C C		3	1	1
special C C=I C			1	
	Total	20	20	20

TABLE 4

PERCENT OF TOTAL LOOKING TIME TO INCONGRUOUS FIGURES AS A FUNCTION OF TRIAL BLOCK AND GRADE IN SCHOOL

Grade in school	Trial Block I	II	III	Total
Kindergarten	55%	52%	52%	53%
Second	55%	54%	53%	54%
Fourth	55%	57%	54%	54%
Total	55%	54%	53%	54%

0.70 ($SD = 0.59$). Analysis of variance (Table 5) indicated that this difference was significant ($F = 19.87$, $df = 1/240$, p .0005). The analysis also disclosed a significant book effect ($F = 2.81$, $df = 3/48$, $p < .05$), but no effects of grade, trial block, or any combination of grade, book, trial block, and congruity.

As shown in Figure 2 the mean duration of expression change was longer to the incongruous pictures than to the congruous pictures in each book, though, for reasons as yet not understood, Book 2 elicited significantly longer expression changes than did the rest.

<u>Frequency of expression change</u>.

Frequency of expression change is the total number of expression changes to each picture. Across all Ss the mean frequency of expression change to incongruous pictures was 1.68 ($SD = 0.43$), and to congruous pictures, 1.45 ($SD = 0.45$). This difference, however, was not significant ($F = < 1.0$, $df = 1/240$, $p < 0.70$).

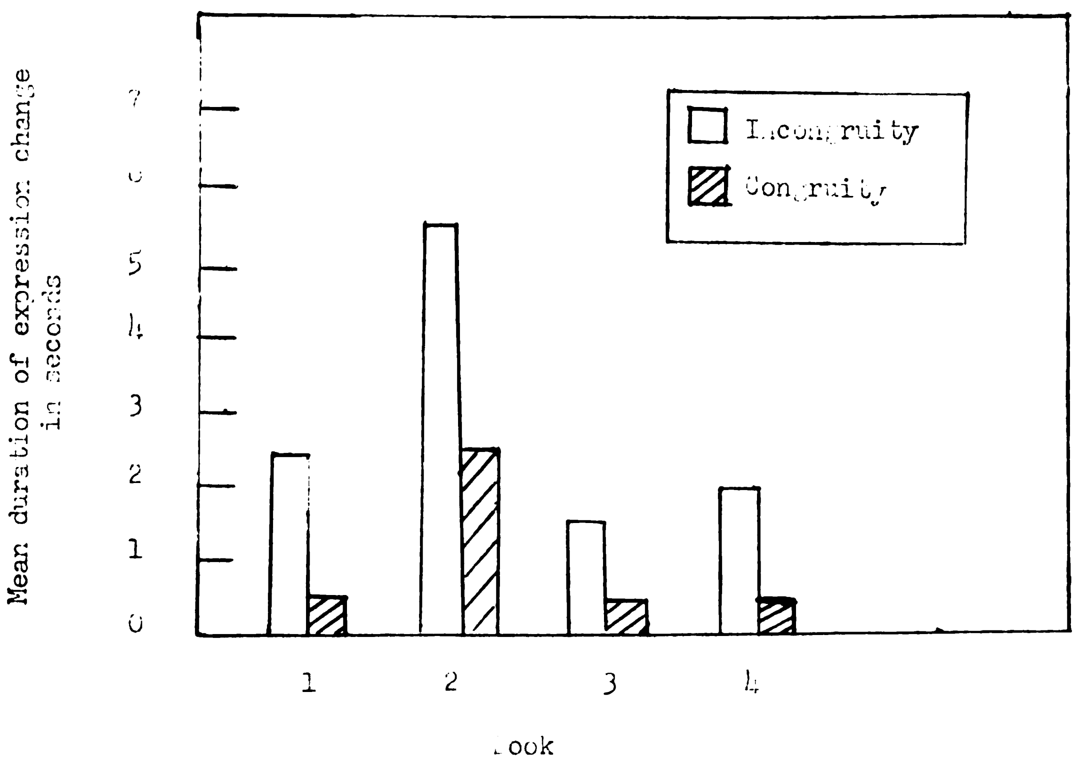
The failure of the frequency of expression change measure to interact significantly with the congruity-incongruity dimension may be due partially to the significant interaction of congruity and duration of expression change. Observation of Ss disclosed that some expression changes were much stronger than others. For instance, some expressions were 'weak', e.g., turning up slightly the corners of the lips. Others were more intense, e.g., laughter. The weak expression changes were shorter than the more intense changes. For the most part the expression changes made to congruous pictures were short (and weak), while those made to incongruous pictures were long and intense. Thus several weak expression changes could be made in the time required for one intense expression change so that the frequency of expression change

TABLE 5

SUMMARY OF ANALYSIS OF VARIANCE OF MEAN DURATION OF EXPRESSION CHANGE TO INCONGRUOUS AND CONGRUOUS ANIMAL DRAWINGS

Source	*df*	SS	MS	*F*	*p*
Between	59				
Book (A)	3	621.646	207.215	2.813	<0.05
Grade (C)	2	274.801	137.403	1.865	
A x C	6	394.466	60.744	<1.00	
Error	48	3,536.431	73.676		
Within	300				
Block (B)	2	2.705	1.352	<1.00	
Congruity (D)	1	390.542	390.543	19.872	0.0005
B x D	2	38.492	19.246	<1.00	
A x B	6	160.061	26.677	1.357	
A x B x D	6	20.803	3.467	<1.00	
B x C	4	61.324	15.331	<1.00	
B x C x D	4	35.944	8.986	<1.00	
A x D	3	43.857	14.619	<1.00	
C x D	2	21.051	10.526	<1.00	
A x B x C	12	237.894	19.824	1.009	
A x C x D	6	152.901	25.484	1.297	
A x B x C x D	12	69.839	5.820	<1.00	
Error	240	4,716.570	19.652		
Total	359	10,779.330			

Figure 2. Mean duration of expression change as a function of book.



effect might have been attenuated.

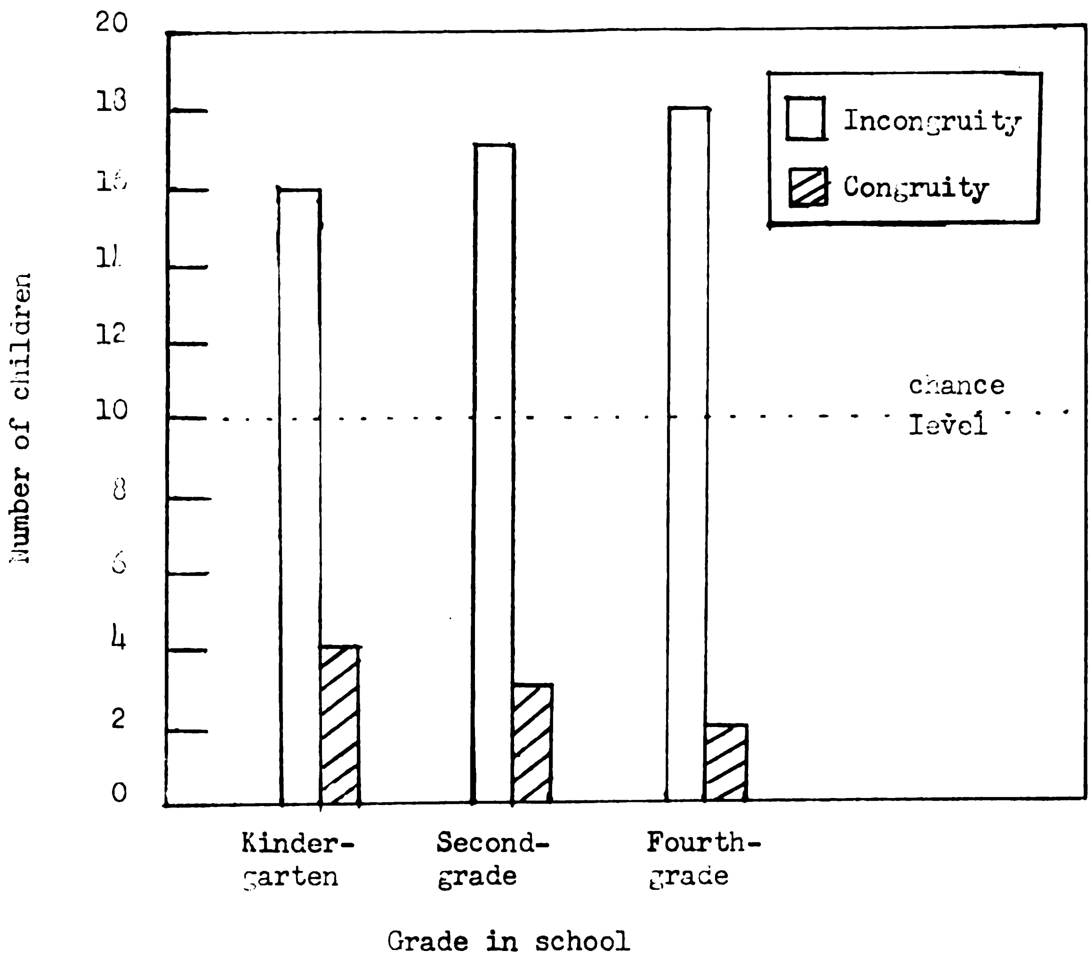
Incidence of first expression-change. For these reasons a new statistic, occurrence of the first-expression-change, was employed. Only the first-expression-change to a picture was counted; all others were disregarded. The computation yielded 270 reactions on a total of 900 trials on which incongruous pictures appeared (30%), and 85 reactions on the 900 trials with congruous pictures (9%). A test of correlated proportions disclosed that this difference was significant ($p < .001$).

These data also may be considered in terms of the number of subjects whose incidence of first-expression-change to all 15 incongruous pictures equaled or exceeded the incidence of first-expression-change to all 15 congruous pictures (incongruity $\geq$ 50% $>$ congruity). There were 17 such Ss. Figure 3 depicts these scores by grade in school. As can be seen, more than 75% of the Ss of each grade level responded more to incongruity than to congruity.

Naming of incongruous pictures.

No subject failed to give the correct name, or at least the correct class name, to the animals or objects in the congruous pictures. For example, the flamingo was called a 'bird' or given the name of another bird, such as 'stork', or 'ostrich'. A subject received a score for 'incongruity acknowledgement' if two components were named for 10 or more of the 15 incongruous figures. For the incongruous pictures, the majority of the children either consistently acknowledged only one component in each picture, or consistently acknowledged both components in each drawing. Across all subjects, 76% of the incongruous figures (681 of 900) were 'named' correctly. An analysis of variance by grade

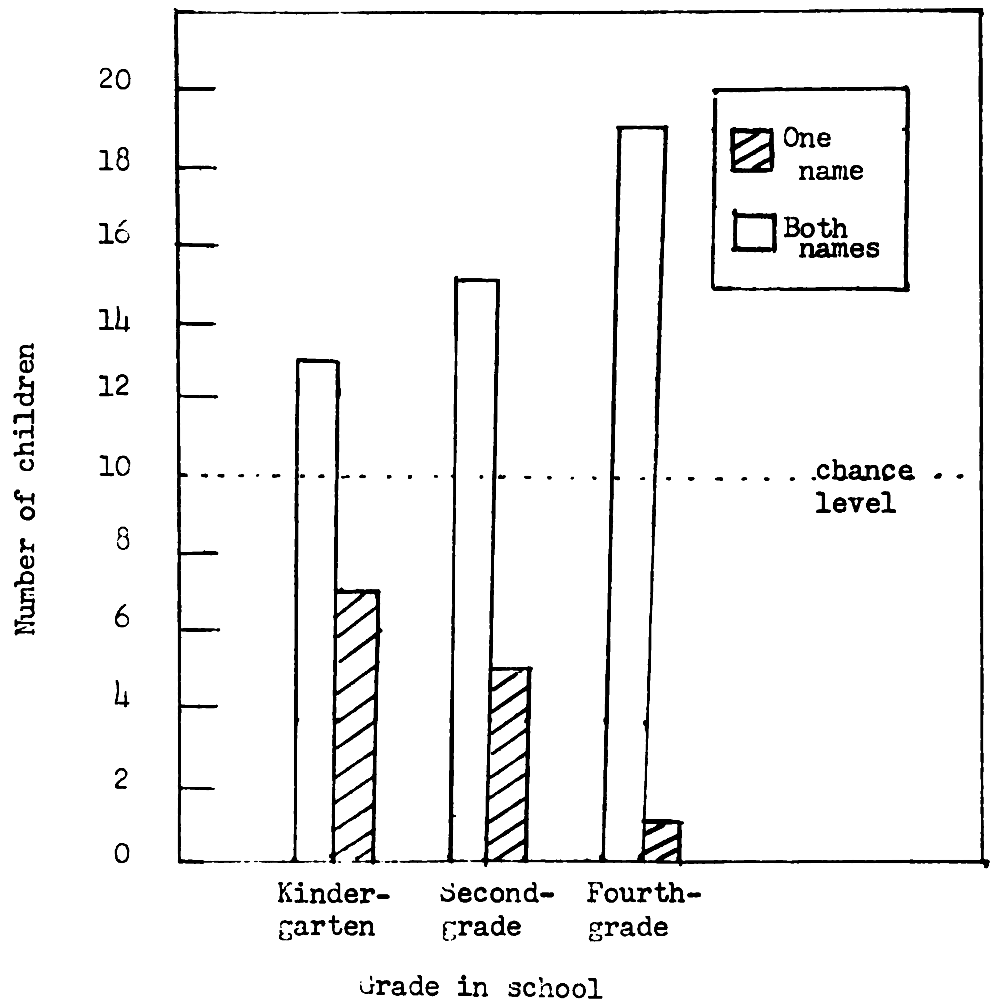
Figure 3. Number of subjects whose incidence of first-expression-change to incongruous figures equaled or exceeded the incidence of first-expression-change to congruous figures.



disclosed no significant effects (*F* = 2.877, *df* = 2/57, *p* $>$.05), although the differences were in the predicted direction, i.e., the frequency of two-component responses increased directly with grade in school.

Figure 4 summarizes the age scores for 'incongruity acknowledgement'. The mean number of components named for the incongruous figures was 1.56, 1.72, and 1.93 by the kindergarteners, second-graders, and fourth-graders, respectively. Kindergarteners failed to name 10 of the 300 incongruous pictures (3%); second-graders, 3/300 (1%); and fourth-graders, 2/300 (0.9%).

Figure 4. Number of children in each grade acknowledging one or both components of the incongruous pictures.



DISCUSSION

The results indicate that both duration of expression change and duration of looking time are related to stimulus incongruity. Frequency of expression change, however, was not clearly associated with incongruity, though there were more expression changes to the incongruous than to the congruous pictures. The fourth dependent variable, naming, indicated an increasing likelihood with age for Ss to name both components, though the implied interactions were not significant.

Looking time.

Incongruity. The prediction that looking time would be longer to incongruous than to congruous pictures was supported ($p < 0.01$). These results are consistent with other data in that longer looking times are generally associated with collative variables.

Trial block. The duration of looking time measure was clearly associated with trial block ($p < 0.01$). In general, the mean duration of looking time (MDLT) decreased across trial blocks ($p < 0.01$). Further analysis revealed that the only significant difference was between trial blocks I and III. These results suggest that the children probably began to tire of the task as they proceeded through the book. It also may indicate a 'response set' toward the situation and pictures, i.e., the children may have learned, in general, what to expect and consequently adopted a response pattern for the situation.

Although the trial block x incongruity interaction was not significant, it can be seen that, across trial blocks, the response gradient for congruity dropped off more sharply and steeply than did the gradient for incongruity. If this decrease reflects fatigue or boredom with the task, it may be that the children tired of the congruous pictures faster than the incongruous pictures.

Grade in school. The grade effect was not significant ($F = 1.86$, $p > 0.17$). However, inspection of the mean duration of looking times (MDLT), by grade in school, suggests some previously unknown differences among the children in the elementary school grades.

Berlyne (1960) and others have suggested that duration of looking time indicates responsiveness to incongruity. But to respond to incongruity presupposes recognition of congruity, or the existence of a schema or standard for congruity, against which any incongruous stimulus would be compared. Therefore it was predicted that those children with well-developed schemas for the congruous figures (in this study, presumably the fourth-graders) would have relatively shorter looking times to the congruous figures than would children with less well-developed schemas for congruous pictures (presumably kindergarteners and second-graders). The data lend some support to this prediction. The fourth-graders' mean duration of looking times to congruous figures as well as to all figures were shorter than were the same mean duration of looking times (MDLTs) of the second-graders' and the kindergarteners'. The kindergarteners had the shortest MDLT to incongruous figures. Whichever MDLTs are compared (total MDLT, MDLT to congruous figures, or MDLT to incongruous figures) there is greater similarity between the fourth-graders and the kindergarteners than between the fourth-graders and the second-graders. If duration of looking time indicates recognition of incongruity, then the kindergarteners apparently were more capable of recognizing incongruity than were the second-graders. This, however, would imply the untenable conclusion that the kindergartener's schemas for congruous figures were more developed than were the schemas of the second-graders. The conclusion is untenable because schemas become more complex with age. The data may suggest that schemas are developed early so that what seems to be further development is primarily the elaboration of the basic concept. A class, for example, may be subdivided into dogs, cats, etc. and then subdivided further. Finer distinctions would require additional criteria and more refined discriminations. Younger children may know the basic concepts well enough to classify an animal if the definiens of that class (e.g., wings for birds) are present in the stimulus. Second-graders probably have more criteria to apply to a stimulus than do kindergarteners. Older children probably have still more subclasses. Second-graders may look longer at a figure to determine to which of the subclasses it belongs--or whether it belongs to any. Fourth-graders, on the other hand, have had more experience applying the class criteria to stimuli and may not need to look at figures long to classify them.

Some of the children (not only second-graders) seemed to be trying to identify the fitures. They asked such questions as "What's this?"; "Is this a rabbit?"; and others made such comments as "I wonder what this is?"; "This is a funny picture."; "I've never seen this before.". The comments apparently were spontaneous and were not encouraged by E either before or during the test session. Though Berlyne (1958) reported that "figure identification" is not a significant variable for adult subjects. This suggests that further studies are needed to determine whether "figure identification" is a variable that must be controlled in perceptual studies with children.

Though the MDLTs of kindergarteners and fourth-graders were similar, a comparison of the standard deviations for grades indicates greater similarity between second-graders (2.74) and kindergarteners

(3.71) than of either grade with the fourth-graders (1.39). The great variability in the two lower grades might influence the sample means sufficiently to produce the above results. Indeed, one or two second-graders responded very differently from their peers, and because the sample size per grade was small their responses skewed the distribution so that the second-grade data may not accurately represent a second-grade response pattern. More Ss at each grade level are needed.

The raw data suggest greater variability among kindergarten and second-grade boys than among their female peers. Similar observations have been reported (Anastasi, 1958, pp. 456-458) on intelligence scores for young boys. The greater variability of the boys scores may be the major cause of the skewed distributions for these grades. Smock and Holt (1962) found first-grade boys significantly more responsive to incongruity than first-grade girls; indeed, girls did not respond differentially to incongruity. The current results suggest that girls may respond more to incongruity than to congruity. An analysis of the current results by sex might disclose a significantly longer response to incongruous pictures, but Smock and Holt's findings would suggest that the difference would not be significant.

Naming.

The results lend some support to the hypothesis of a direct relation between grade in school and acknowledgment of both components of the incongruous figures. The fourth-graders acknowledged both components more often than did the second-graders, and the second-graders acknowledged both components more often than did the kindergarteners. Though these differences were not significant ($F = 2.88$, $0.05 < p < 0.10$) they suggest nonetheless that naming may be useful in similar research on incongruity.

The usual index of ability to recognize and identify what is familiar or complex has been the IQ score. The use of the IQ is predicated, therefore, on the assumption that whatever the test measures is related to visual responsiveness to the collative properties of stimuli. However, the IQ is not the only possible index of this ability. The results of the current study suggest that naming is a direct indication of the child's ability to recognize what is familiar and to communicate what he perceives. Naming also may be directly related to what is being investigated in the current study, i.e., the child's sensitivity to incongruity. The child who labels, or acknowledges, both components of the figure indicates that he perceives at once elements that do not usually occur together. (If they occurred together, he would so indicate by using the single appropriate label.) The use of a double label thus suggests that the observer senses the incongruity. In the current study, incongruity thus would seem to have been acknowledged most consistently by the fourth-graders.

The fourth-graders, as well as a majority of the second-graders, are within the age range (7 - 11 years) suggested for the developmental period which Piaget (1952) has called 'concrete operations', and the kindergarteners are within the 'preoperational' age range (5 - 7 years). According to Piaget, the preoperational child tends to 'center' on one aspect of the stimulus and, having centered, tends to resist change. On the other hand, the concrete operational child tends to 'decenter' and shows conceptual and perceptual flexibility, mobility, and reversibility. These latter characteristics should enable the child to recognize and acknowledge all of the elements that he perceives even though he may not yet be able to integrate the information.

Sixty-five percent of the kindergarteners in the current study acknowledged both components of the incongruous drawings. In terms of Piaget's cognitive stage theory these children might be said to be 'decentering' (i.e., are into the period of concrete operations) while the remaining 45% are still 'centering'. One-fourth of the second-graders (two 8-year olds, two 7-year olds, and one 6-year old) behaved as if they too might be centering insofar as they acknowledged only one component of the incongruous figures. One fourth-grader, 11 years old, also responded to the incongruous pictures sometimes by giving one name, but more often by not naming the picture at all.

The subjects could be classified as preoperational or concrete operational only on the basis of age, and age is an imperfect criterion for determining cognitive-developmental stage. On the basis of this classification, the results suggest that, in general, the children who are within the concerete operations age range acknowledged both components of the incongruous drawings more frequently than did children not within this age range. It must be added that this interpretation is tentative because no independent measure of centering was obtained. Such an independent measurement marks a profitable direction for further research.

Another possible interpretation of the naming data is that some of the second-grade and fourth-grade subjects had little contact with picture books of animals prior to the experiment. But such an interpretation is unlikely because these children lived in a university community and attended school and undoubtably had seen many picture books of animals.

A third possible interpretation of the differences within and across age groups is in terms of 'personality'. The subject might defend himself against perceiving the incompatible elements by acknowledging only one in each incongruous picture. The pictures were not designed to be noxious or repulsive, but if any child perceived them in this way, he might have spent less time looking at them. This explanation is not supported by the looking time data. Repulsion or avoidance could be expressed by crying, refusal to look at the book, fearful expressions, or comments. The expression change data disclosed no such fearful responses.

Although an interpretation in terms of centering seems more plausible than an interpretation in terms of deprivation or personality, the current findings can only suggest the direction of future work.

Frequency of expression change.

It was expected that the school-age child would have well-developed schemas for animals. It was expected also that the modification of a familiar figure would elicit affective responses in the form of expression changes. The prediction that expression change would be associated more often with an incongruous than a congruous figure was not supported, though the differences were in the predicted direction.

Across all grades, there were significantly more incidences of first-expression-change to incongruous figures than to congruous figures. Furthermore there appeared to be a slight but direct relation between grade in school and the occurrence of an expression change to incongruous figures. The greater responsiveness of fourth-graders suggests that this measure is a useful one for research with elementary school children. Indeed, expression change seemed to be gradually more discriminating as age increased.

Duration of expression change.

The present study supports the prediction that longer expression changes reliably indicate perception of and/or recognition of stimulus incongruity. Some examples of the children's expression changes are as follows: Subject 7: pursed her lips, held her mouth open and chin slack; Subject 18: did not smile, screwed up his whole face, raised his eyebrows, usually said the name of the picture as a question; Subject 6 (3/25): did not smile, gritted her teeth and narrowed her eyes until they were slit-like. There was, obviously, a wide range of facial expressions and, likewise, a wide range in the duration of the expression changes.

The association between duration of expression change and congruity was highly significant ($p < .0005$). Longer expression changes, e.g., laughs, broad smiles, and comments, were reliably associated with children's perception of incongruity, suggesting that duration of expression change could be used in further studies of the perception of collative variables.

Grade effects. It was expected that the kindergarten and second-grade children would have somewhat longer expressions because of their greater 'openness' of expression than would the fourth-grade children. However, duration of expression change was not significantly associated with grade in school. The results instead suggest that the older subjects may have longer expression changes. In retrospect, this finding is not surprising, since longer expression changes were associated with incongruity, and it was expected that the older children perceived incongruity more readily than did the younger children.

<u>Book effects</u>. Duration of expression change was significantly related to book ($p < 0.05$). Across all books, duration of expression change was greater to incongruous than to congruous figures. Longer expressions, however, seemed to be associated with Book 2 than with any other book. The reason for this association is unknown.

Before being divided into sets of 10 for the 3 trial blocks, the pictures were randomly ordered within books following the stipulations mentioned above under Method. Perhaps pictures should have been counter-balanced by trial block (the same pictures occurring within a trial block) with the trial blocks arranged in all possible orders.

In conclusion, it appears that duration of expression changes and duration of looking time are the most reliable indexes of perception and recognition of incongruity. Frequency of expression change poses difficulties of definition, and it is not clearly associated with incongruity. Naming, although not so reliable an index of incongruity as the two duration measures, suggests some interesting grade differences in the perception of incongruity.

The results suggest that duration of expression change is a potentially fruitful dependent measure for future research on collative variables. The results support much previous research insofar as duration of looking time was associated with incongruity.

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Appendices

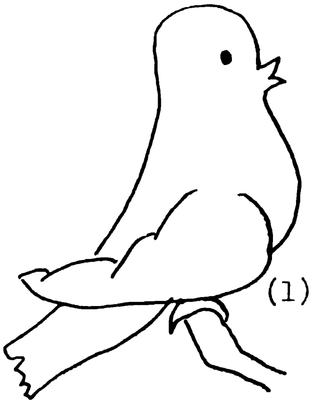
Appendix A*

(1) Congruous Drawings

(2) Incongruous Drawings

*All drawings are reduced to approximately one-third or one-fourth the original size.

Congruous Drawings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(2)


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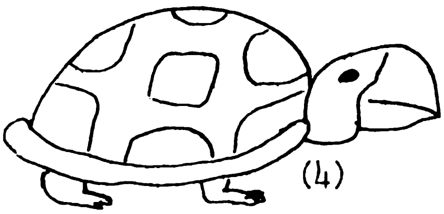
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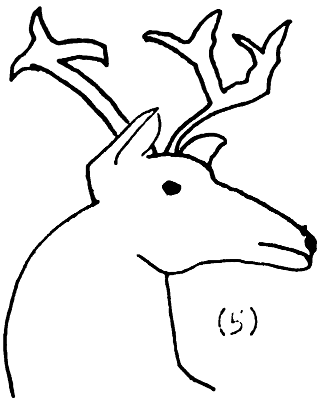
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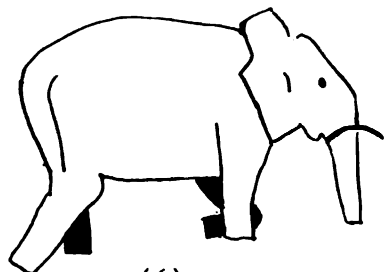
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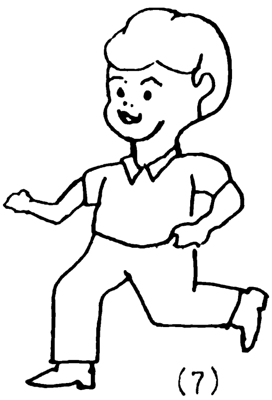
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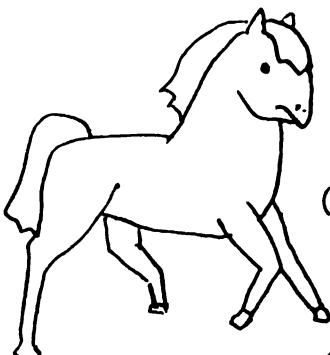
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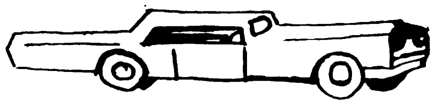
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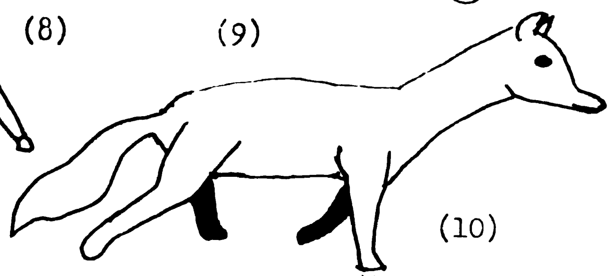
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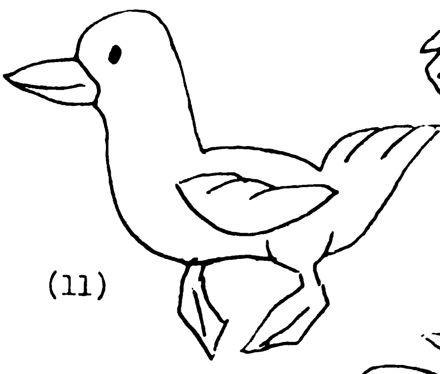
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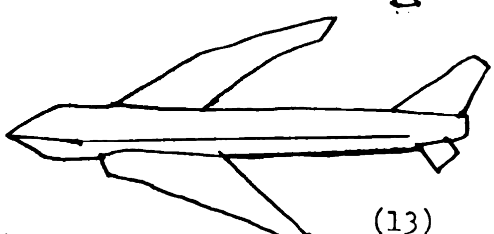
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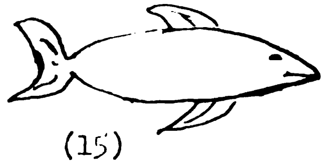
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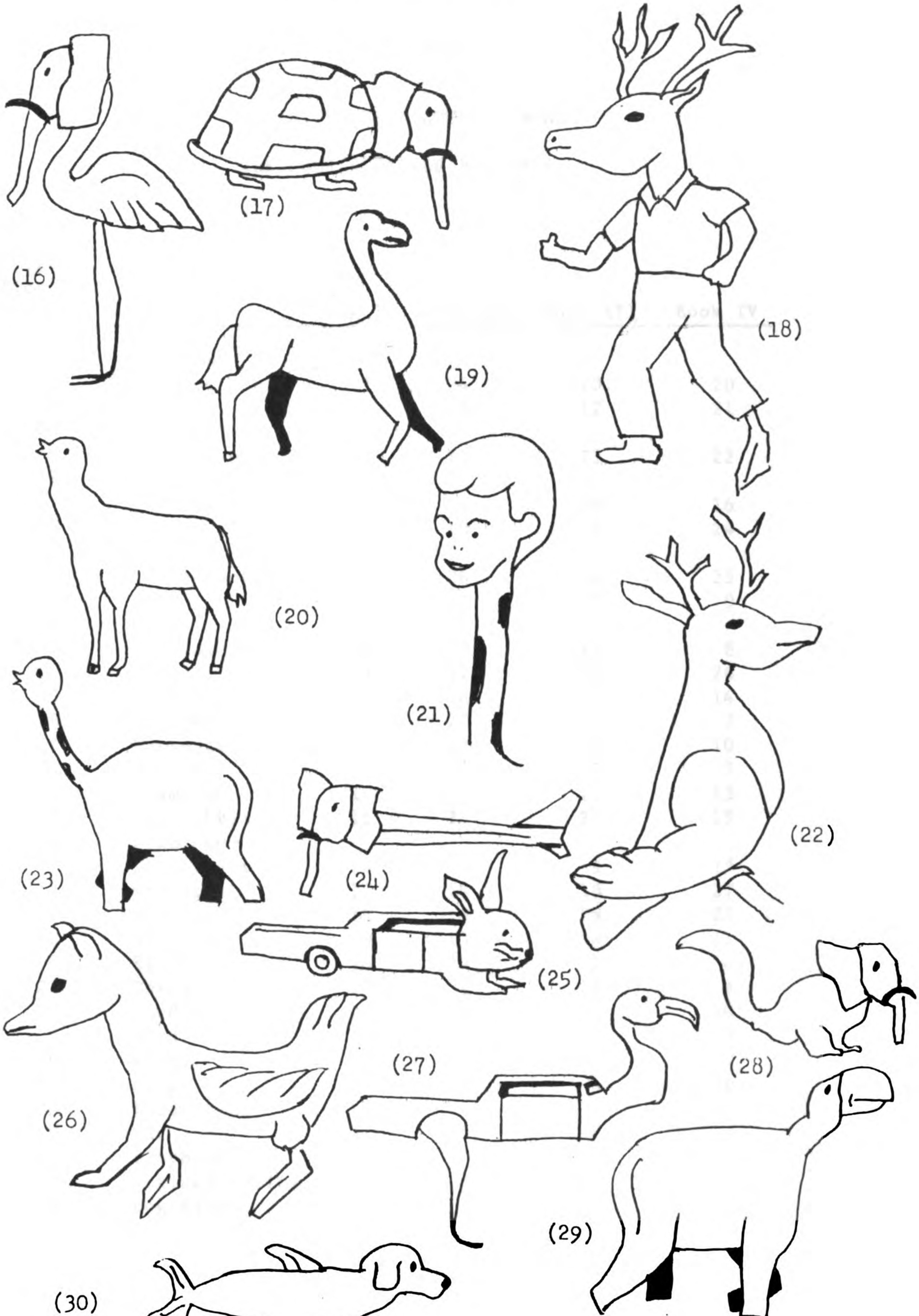
Incongruous Drawings



APPENDIX B

ORDER OF THE PICTURES AMONG THE FOUR BOOKS OF PICTURES

Original Picture Numbers	Picture	Book I	Book II	Book III	Book IV
21	Elephant-plane	1	24	20	20
8	Horse	2	7	12	21
28	Squirrel-elephant	3	11	23	22
29	Elephant-turtle	4	23	19	16
5	Deer	5	10	1	24
17	Turtle-elephant	6	26	30	25
13	Jet	7	2	17	9
27	Car-flamingo	8	15	15	8
14	Rabbit	9	17	21	26
15	Fish	10	8	7	14
18	Boy-deer	11	27	5	7
19	Horse-turtle	12	12	2	10
4	Turtle	13	29	27	3
2	Flamingo	14	5	11	13
25	Car-rabbit	15	21	25	19
16	Flamingo-elephant	16	6	9	15
3	Squirrel	17	14	18	27
26	Fox-duck	18	9	29	29
12	Giraffe	19	13	24	11
6	Elephant	20	20	22	4
21	Boy-giraffe	21	1	28	2
22	Bird-deer	22	16	3	30
1	Bird	23	25	6	23
10	Wolf	24	22	8	17
11	Duck	25	18	4	18
20	Horse-bird	26	4	16	28
9	Car	27	30	26	1
23	Elephant-giraffe-bird	28	19	10	5
30	Dog-fish	29	3	13	12
7	Boy	30	28	14	6

APPENDIX C

LONGER MEAN DURATION OF LOOKING TIME PER TRIAL BLOCK FOR EACH INDIVIDUAL SUBJECT

Kindergarten Ss	Trial Block I	II	III	Second-grade Ss	Trial Block I	II	III	Fourth-grade Ss	Trial Block I	II	III
1	I	I	I	1	I	I	C	1	C	I	I
2	C	C	C	2	I	I	I	2	I	I	I
3	I	I	I	3	I	C	C	3	I	I	I
4	I	I	C	4	I	I	C	4	I	I	C
5	C	C	C	5	I	I	I	5	I	I	I
6	I	I	C	6	I	I	I	6	I	I	I
7	I	I	I	7	I	I	I	7	I	I	I
8	C	C	C	8	I	I	C	8	I	I	I
9	I	I	I	9	I	I	I	9	I	I	I
10	I	C	C	10	C	I	C	10	I	I	C
11	I	I	I	11	C	I	C	11	C	C	C
12	I	C	I	12	I	C	I	12	C	I	I
13	C	I	I	13	C	I	I	13	I	I	I
14	I	I	C	14	C	C	C	14	C	C	I
15	C	C	I	15	I	I	I	15	I	I	C
16	I	C	C	16	C	C	C	16	I	C	I
17	I	I	C	17	I	C	I	17	C	I	I
18	I	C	C	18	I	C	I	18	I	C	I
19	C	C	I	19	C	I	I	19	I	I	I
20	I	I	C	20	I	I	C	20	C	C	I

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