PERCEPTUAL AND VERBAL MEDIATION IN THE CONCEPT LEARNING OF CHILDREN

By

OWEN LINK McCONNELL
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A dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor of
Philosophy in the Department of Psychology
in the Graduate School of Arts and
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ABSTRACT
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Some investigators have proposed that concept learning in humans can best be explained in terms of internalized processes mediating between the external stimulus and overt response. This approach contrasts with "single-unit" theory, emphasizing direct association between stimulus and response. Some psychologists advocate the developmental hypothesis that single-unit theory applies to lower organisms but that mediational theory holds for advanced organisms. Comparative psychological studies have yielded inconclusive findings with respect to this hypothesis. Some investigators have tried to experimentally influence the hypothesized mediating process by teaching subjects verbalizations which could serve as mediating responses. In general, findings suggest that older children utilize verbal mediators more readily than younger children. The current investigation stems from interest in whether young children have a specific inability to mediate verbally or a more general deficiency in mediation. Are mediating processes in young children possible on a "sensori-motor" level? The purpose of the present research is to compare younger and older children in their use of perceptual cues as a basis for mediation and in their preferences for perceptual versus verbal cues when these are in conflict.

[iii]
Fifty nursery-school children and seventy-five second-grade children learned two successive discriminations. The stimuli, cylinders varying in size (large-small) and brightness (black-white), were arranged on a tray before a vertical clown's face. The child put one of two stimuli taken from the tray into the clown's mouth and was rewarded, when correct, by the clown's nose blinking, an edible item, and praise. In the first discrimination a large, black cylinder was positive; in the second task the "small" object was rewarded, regardless of brightness. Since the first discrimination was solvable on the basis of either size or brightness (or both), the experimenter could attempt to influence the subject to make a mediating response to a particular dimension. The major experimental variables manipulated for this purpose during the initial discrimination were (1) kind of object arrangement on the tray, and (2) kind of verbal label children applied to the stimuli. The size arrangement, for example, had same-sized objects in proximity; but brightness was randomly distributed. In the size verbalization condition the child was instructed to precede his choices with the appropriate size label, i.e., "big" or "little." Independent groups received the following treatments at each age level: (1) size arrangement, (2) brightness arrangement, (3) size arrangement and brightness verbalization, simultaneously, (4) brightness arrangement and size verbalization, simultaneously, and (5) random arrangement, no verbalization (control). The major dependent variable was the mean number of trials to criterion on the second task, as it was assumed that ease of learning the "small" concept was an index of availability of the size dimension relative to the brightness dimension.

The results indicated that both younger and older children responded in a mediational manner to the perceptual arrangements, suggesting that previous findings regarding lack of verbal mediation in young children should not
be generalized to include other modes of mediation. The interfering effect of perceptually emphasizing an irrelevant dimension was stronger for younger children than for older children. Older children were more influenced than the younger children by relevant verbal cues. When relevant verbal cues were pitted against irrelevant perceptual cues, the former dominated with older children, but the latter with younger children. Younger children, however, were not influenced as predicted by relevant perceptual cues nor older children by irrelevant verbal cues. These discrepancies were discussed in terms of the nature of the experimental manipulations. It was tentatively concluded, subject to further verification, that younger children favor perceptual mediation and older children verbal mediation.
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PERCEPTUAL AND VERBAL MEDIATION IN THE
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Chapter I
INTRODUCTION

The general purpose of the present research is the investigation of certain conditions which may influence the dimension selected by the child in his attempt to attain a concept. Dimension selectivity appears to play an important role in concept attainment. Consider, for instance, the child in the process of organizing data about his environment; he confronts a world composed of a tremendous array of potentially discriminable patterns of objects, events, people, impressions, etc. In cognitively bringing together into classes certain objects which appear to belong together, he attends to certain characteristics and ignores others.

The discriminable characteristics which a child attends to when he classifies objects have on various occasions been called qualities, attributes, properties, cues, etc. For the sake of semantic consistency in this presentation, any discriminable feature of an event that is susceptible of some discriminable variation from event to event will be termed a "dimension." The "throwability" of a rock, the "mean" look of its jagged edges, the "fear" it evokes, the "beauty" of its shape, as well as its size, color, weight, etc., are dimensions which may be used to define a concept. That is, not only the external properties of an object but also interoceptive cues of the perceiving subject may be the defining characteristics of a concept. This point needs
emphasizing, for in the present experiment especial consideration is given to the role of internal, symbolic cues, such as the child's words and percepts, in mediating concepts. For example, a watermelon and breakfast cereal have no particular physical similarity; but in our culture they share the common label, "food," which may serve as a basis for grouping them together.

The discriminable variations within a dimension will be called "values" of the dimension. "Value" simply denotes a specific instance of a dimension, e.g., circles and squares are values of the form dimension. Concepts can then be defined in terms of dimensions and values as follows: A concept is a set of stimuli, all members of which have the same value for at least one dimension but a different value for at least one other dimension. For example, the concept "red" would include objects having the red value of the color dimension in common but which might differ on the size dimension, objects being random sizes.

The present research is concerned with factors which influence the child's choice of dimension in a conceptual task. It is beyond the scope of this dissertation to review the variety of factors which may influence dimension preferences in concept attainment. The roles played by such variables as innate disposition, language, ecological validity, face validity, and objectives of the classificatory task have been ably discussed by Bruner, Goodnow, and Austin (1956). The present study focuses on the subject's immediately prior learning experience as one factor in dimension selectivity.

Empirical Foundation of Present Study

A number of studies have demonstrated that the speed of learning discriminations and concepts may vary according to whether the relevant dimensions
have been relevant or irrelevant in previous problems.* Lawrence (1949, 1950) showed that if the same dimension is relevant in two different discriminations (simultaneous and successive), learning one will facilitate learning the other even when the possibility of positive transfer of instrumental responses is ruled out. Lawrence suggested that during the first problem the relevant dimension "acquires distinctiveness" so that, in effect, the initial order of dimension preferences is altered for the second problem. Facilitation is obtained in some cases even when negative transfer of instrumental responses is expected as in reversal of discriminations (Lawrence, 1950; Buss, 1953, 1956; Kendler and D'Amato, 1955; Harrow and Friedman, 1958; House and Zeaman, 1960).

The experimental paradigm used in the majority of these investigations is based on procedures developed by Buss (1953) and Kendler and D'Amato (1955). It consists essentially of the following stages: (1) An initial discrimination utilizing stimuli that differ simultaneously on at least two dimensions, only one of which is relevant; (2) a subsequent discrimination that utilizes the same or similar stimuli but requires a shift in response. One type of shift, called a **reversal shift**, requires the subject to continue to respond to the same dimension but to the opposite value. In another type of shift, called a **non-reversal shift**, the subject is required to respond to a value of the previously irrelevant dimension. For example, suppose that a subject may be initially trained on stimuli that differ simultaneously in brightness (black versus white) and size (large versus small) by being rewarded for responses to black, regardless of size. A reversal shift for this subject would consist of learning to respond to white, and a non-reversal shift would consist of learn-

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*A dimension is relevant if the values of the dimension are correlated with the rewards and punishments; an irrelevant dimension is one whose values have no correlation with the reward.
ing to respond to one of the size values: either small or large.

Mediating Response Theory

Reversal and non-reversal shifts are especially interesting phenomena from a theoretical viewpoint because theories based on single-unit and mediated stimulus-response connections yield opposite predictions about their relative efficiency. Single-unit theory, assuming a direct connection between the external stimulus and the overt response (e.g., Spence, 1936), would predict reversal shift to be more difficult than non-reversal shift. This prediction is made because reversal shift requires that a response that has previously been consistently reinforced be replaced by a response that has previously been consistently extinguished. In a non-reversal shift previous training has reinforced response to the new positive and negative stimuli equally often. Strengthening one of these associations does not require as much extinction of its competitor as in a reversal shift and should, therefore, be acquired more easily.

Mediating response theory, which has been invoked by Dollard and Miller (1950), Osgood (1953), and H. H. Kendler (1961), leads to the exactly opposite prediction. This theory provides one possible mechanism for explaining the acquired distinctiveness of relevant dimensions. It assumes mediation by implicit responses which add interoceptive cues to the relevant external dimensions, thereby making them more distinct. In effect, the interoceptive cues produced by the mediating response determine the overt response (Figure 1). In a reversal shift the initial dimension maintains its relevance; hence, so does the mediating response. Only the overt response needs to be changed; and, since the experimental situation provides only one alternative overt response,
Figure 1. A Schematic Representation of the Mediational Hypothesis. Capital letters refer to directly observable stimulus and response events while lower case letters enclosed in the box refer to those that are inferred.
this presents no great difficulty. In a non-reversal shift the previously acquired mediation is no longer relevant; consequently, both the mediating and the overt responses must be replaced, making this a more difficult task than a reversal shift.

Developmental Studies

Assuming that genetically primitive behavior is governed by single-unit, stimulus-response process and that increasing maturity leads to performance determined by some mediating system of responses, then dimension and value preferences may be affected by learning experience in different ways, depending on where the organism falls on the developmental scale. Operationally, this implies that non-reversal shift would be acquired more easily by primitively functioning organisms, i.e., preferences for the previously irrelevant dimension should be demonstrated in subsequent learning. Reversal shift, or preference for the previously relevant dimension, should be demonstrated in the learning behavior of genetically higher organisms.

The developmental hypothesis of a transition from single-unit to mediational stimulus-response process at some point on the evolutionary continuum has been adopted by T. S. Kendler (1961) and others. To date several developmental studies which generally support these predictions have been conducted. Kelleher (1956) found that, for rats, reversal shift was more difficult than non-reversal shift. Experiments by Buss (1953), Eckstrand and Wickens (1954), Kendler and D'Amato (1955), and Harrow and Friedman (1958) confirmed the prediction that college students, unlike rats, acquire a reversal shift more easily than a non-reversal shift. Research with nursery-school children of age 33-63 months indicated a superiority of non-reversal shift over reversal shift.
(Kendler, Kendler, and Wells, 1960). Children of kindergarten age, between five and seven years, divided about evenly, with half favoring reversal shift and half non-reversal shift (Kendler and Kendler, 1959). A recent investigation of the shift behavior of children from five age levels, namely, three, four, six, eight, and ten years, suggested that the proportion of children who reverse (mediate) increases in a gradual manner with age (T. S. Kendler, 1961). These researchers have suggested that age five to seven years may be the major transition period from single-unit to mediated learning behavior for the average child.

Several studies report findings in disagreement with this developmental hypothesis. For discrimination learning in rats, Lawrence (1950) found reversal better than non-reversal performance. House and Zeaman (1960) and Bensberg (1958) showed that reversal shift was also easier than non-reversal shift for mentally retarded children. These findings are not consistent with the assumption that mediation does not occur with lower or retarded organisms. A variety of procedural differences between studies may account for the discrepancy of results; in particular, the degree of initial training may be an important factor (Reid, 1953; Pubols, 1956; Capaldi and Stevenson, 1957; and Bensberg, 1958). It may require more extensive training to develop mediators in organisms at lower stages of genetic development. At any rate, the contradictory findings suggest a complex relationship between developmental status and dimension preferences in shift performance, a relationship influenced by a number of undetermined variables.

One way to extend knowledge of the mediational process is to seek to discover relationships between apparently relevant observable events and the mediating construct in question. Such a technique has been the core design of
two recent studies (Kendler and Kendler, 1961, and Spiker, 1962) to which this experiment is related.

Spiker (1962) studied the influence of overt verbal labels on the child's selection of the dimension to be used in a classificatory task. His subjects were kindergarten children whose chronological ages ranged from five to seven years. The first task was a paired-associate task in which the subject learned to respond with a different verbal response to each of three stimuli which differed from each other in both color and form. The subject's responses were either names for the colors, names for the forms, or proper names, depending on the particular group to which the subject was assigned. The amount of training in this first task was varied in two different experiments. In one experiment the subjects were simply told the appropriate names by the experimenter and were not asked to repeat them. In the other experiment the subjects were given more extensive training in using the labels.

The stimuli for the second task in Spiker's study were the nine combinations formed from the three colors and three forms used in the first task. The task was presented as an ordinary paired-associate task in which the response items were pictures of a swing, a tent, and a cup. Half the subjects in each "verbal-label" group had to associate a given picture with a given color (e.g., swing with blue) while half associated pictures with forms (e.g., swing with square). The results indicated that giving the child the names of the values of the dimension which was to be relevant in a classificatory task was sufficient to produce facilitation. For example, if the child was given the color names for the three stimuli during the first task, he would learn to match the pictures with the colors in the second task more easily than a child who had been given proper names or form names for the stimuli. To produce interference required somewhat more extensive practice in using the names. There
was no interference when the examiner merely labeled the values of the irrelevant dimension, but when the child practiced using these inappropriate labels, interference occurred. Interpreting these results within the framework of mediational theory, Spiker hypothesized that the subjects attempted concept learning with the previously learned value names as stimuli. When these were the names of the values on the relevant dimension, the performance was facilitated. When they were the names of the values on the irrelevant dimension, the performance was either interfered with or the subject discarded the names, depending on the amount of first-task training. Spiker did not attempt to explain why it was harder (or required more practice) to produce interference than facilitation.

Kendler and Kendler (1961) asked not only whether naming stimuli in a discrimination reversal would influence the performance of children but also whether the influence would be different for four- and seven-year-old children. The overall design was complex, due to counterbalancing stimulus preferences, but the logic can be determined from the following account. The stimuli were two-dimensional squares, varying in area (1 in.² and 3 in.²) and brightness (black and white). In the first discrimination a large-black square was simultaneously presented with a small-white square, the former serving as the positive member of the pair. If the child was trained to be a relevant verbalizer, he was instructed to tell the experimenter, before making a choice, whether the large or the small square was correct. He soon learned to precede his choices with the appropriate label, which in this experiment was "large." Since in the second discrimination "small" was the correct stimulus, the label referred to the dimension (size) which was to become relevant. If a child was trained to be an irrelevant verbalizer, he was asked in the first discrimination to tell whether the white or the black square was correct. He would thus learn to say
"black," which was descriptive of the dimension which was to become irrelevant.

Kendler found the major difference between four-year-old and seven-year-old children to occur under the irrelevant verbalization condition. The older children showed marked interference in comparison with a control group, whereas the younger children demonstrated only a weak interfering effect. This finding can be interpreted as suggesting that (1) a general mediational deficiency exists in four-year-olds, or (2) words, specifically, are less able to serve as mediating responses or regulators of discriminating behavior in young children (cf. Luria, 1957). The facilitating effect of relevant verbalization was weak for both younger and older children in Kendler's study. It should be noted that Kendler's finding that the interfering effect was more pronounced than the facilitating effect with older children is contradictory to that of Spiker, who showed that it was more difficult to produce an interfering effect.

O'Connor and Hermelin (1959) found that relevant verbalization interfered with reversal shift in imbeciles. They assume that interference resulted because the imbeciles named each stimulus separately rather than both stimuli as members of a single dimension in the manner of mediating children. Hence, the imbeciles had to inhibit not only the association between the overt choice response and the previously positive stimulus, but also the association between the choice response and the name of the previously positive stimulus. O'Connor and Hermelin's findings, therefore, support the hypothesis of verbal mediational deficiency in developmentally immature children.

Rationale and Aims of the Present Study

The two studies by Kendler and Spiker, which are cited above, stress the
need for extending knowledge of the role of certain variables in mediating dimension preferences. It is traditional for stimulus-response theorists to emphasize the influence of verbal mediators, as stimulus-response behaviorists have historically advocated a verbal basis for thought (e.g., Watson, 1920). The mediating response, however, is typically conceived of as either an implicit perceptual or verbal response to the relevant dimension (T. S. Kendler, 1961). In order to broaden the perspective, the present study is designed to investigate possible perceptual mediators, which may function separately and in combination with verbal mediators in determining dimension preferences. That is, the concern of the present study is twofold: it is concerned with (1) the role of the child's perceptions in influencing mediation and, hence, dimension preferences, and (2) the dimension preferences which result when perceptually and verbally induced sets to mediation are in conflict with one another. The experiment is developmental in nature; and the problem will be explored at two age levels, one below and the other above the hypothetical transition point (i.e., five to seven years) where a change from the single-unit to mediating-response learning mechanism supposedly occurs.

The rationale for the choice of perceptual variables alone and in conflict with verbal variables is as follows: Literature from the field of developmental psychology suggests that younger children use different kinds of mediating and conceptual processes in arriving at their concepts than do older children (Werner, 1948; Piaget, 1954). The organizing behavior of very young children seems to be primarily on a sensori-motor level, which is designated as "concrete" or "perceptual." They are prone to group things on the basis of immediately given attributes, such as sensory data or their emotional and motor reactions to them. They are compelled to depend more on the sensory organization of the field (Witkin, 1954). Older children, on the other hand,
are expected to impose more structure on the material and transform it into symbolic forms, e.g., language. This level of organization is generally called "abstract" or "categorical." The hypothesis that the younger the child, the more perceptually based are his organizations has gained considerable support in experimental findings (Bolles, 1937; Weigl, 1941; Goldstein and Scheerer, 1941; Prothro, 1943; Reichard, Schneider, and Rapaport, 1944; Heidbreder, 1945; and Sigel, 1953).

The concrete-abstract hypothesis implies that perceptual and verbal mediators play different roles in determining the dimension preferences of younger and older children. Kendler and Kendler's (1961) findings which suggest that older children are more responsive to their own verbalizations than are younger children can be interpreted in this light. Younger children, on the other hand, may be either equally or more responsive than older children when the mediating event is perceptual rather than verbal in nature.

Hypotheses

The present study is based on the idea that younger and older children may not differ as much in tendency to use the single-unit versus mediating-response mechanisms as they do in preferring different modes of mediation: specifically in their relative dependence on verbal versus perceptual modes of mediation. Proceeding from the empirical findings and theoretical assumptions stated thus far, the following more specific hypotheses can be stated. It should be noted that these hypotheses contain the assumption that children below the age of five years can mediate perceptually.
**Hypothesis I:** If a child is given a perceptual basis for making a mediating response to a given dimension in a prior learning task where more than one dimension is relevant, then his performance in a subsequent classificatory task in which the given dimension is either relevant or irrelevant will differ from the performance of a child who is not supplied with the perceptual basis for making the mediating response. In short, this hypothesis states that children will employ perceptual mediators when conditions favor them.

**Corollary A:** When perceptual conditions emphasize one of two or more dimensions which are relevant in a prior learning task, learning in a subsequent conceptual task will be facilitated when the emphasized dimension maintains its relevance.

**Corollary B:** When perceptual conditions emphasize one of two or more relevant dimensions in a prior learning task, learning of a subsequent classificatory task will be impeded when the emphasized dimension is irrelevant in this second problem.

The effects postulated in the corollaries are presumed to occur as a consequence of mediating responses to the perceptually emphasized dimensions. It should be noted that these predictions are not a necessary consequence of perceptual emphasis. A directional effect opposite to that of the predictions could occur if the perceptual conditions altered the order of dominance of the stimulus dimensions during initial training _without simultaneously affecting some sort of mediating response which would transfer to the second situation_. In effect, when the perceptual treatment emphasized the dimension which was to maintain relevance, the subject would be making a shift more like a reversal shift. When the perceptual treatment emphasized a dimension which was irrelevant for the next task, the required shift would be more like a non-reversal
shift. Since theory indicates that reversal shift is more difficult than non-reversal shift for children who behave in a single-unit rather than mediational manner, the outcome could be opposite to that predicted if the young children do not mediate.

Another possibility is that perceptual treatments could have no effect on subsequent learning, either because the two learning situations are, in effect, independent or because the perceptual data are not utilized by the subject at all.

**Hypothesis II:** The perceptual effects will be more pronounced for younger children than for older children.* Older children are expected to be affected by the perceptual conditions too because, as Werner (1948) has pointed out, lower level conceptual processes are not lost in development but merely become subordinate to higher level processes. The older children, however, are expected to be less strongly influenced by the perceptual conditions because they have achieved greater independence of the perceptual field and tend to impose other symbolic mediators, e.g., verbal ones, to a greater extent upon the stimuli.

**Hypothesis III:** If a verbal basis for establishing a mediating response to one dimension and a perceptual basis for developing a mediating response to another dimension are simultaneously presented, and both dimensions are relevant to the learning situation, then older children will be more influenced by the verbal aspect and younger children by the perceptual.

*Though this hypothesis is stated differentially in terms of "younger" and "older" children, it does not imply that the hypothesis holds regardless of what section of the developmental continuum is sampled. It is an empirical question to determine over what portion of the continuum the hypothesis is true. More consideration is given to this problem in the next chapter.
Corollary A: When verbal labels are applied to a future relevant dimension and perceptual emphasis given to a future irrelevant dimension, older children will be affected positively on the future learning task and younger children negatively.

Corollary B: When perceptual emphasis is given to a future relevant dimension and verbal labels applied to a future irrelevant dimension, older children will be negatively influenced, younger children positively, on the future learning task.
Chapter II

METHOD

Description of Learning Tasks

The experimental technique used to investigate the effect of learning experiences on dimension preferences entailed the presentation of an initial discrimination immediately prior to a subsequent concept learning task. The tasks had to be adapted to the abilities of the various subjects in at least two respects: (1) the combined tasks had to be short enough to be accomplished within a single session without the subject's tiring or losing interest; (2) the problems had to be simple enough for three- to four-year-old children, yet adequately challenging for seven- to eight-year-olds. Tasks were designed in an increasing order of complexity, since the second task tends, all other things held constant, to be learned more quickly than the initial discrimination (Harlow, 1949).

The first discrimination presented a stimulus pair differing simultaneously on two dimensions, size and brightness, both of which were relevant. The discriminanda were one-inch dowels: one was 2-1/4 inches tall and enameled black, the other was 1-1/8 inches tall and enameled white. The large, black cylinder was the positive stimulus.

The second problem presented the same stimulus pair used in the first discrimination with the reinforcement pattern reversed, i.e., the small, white
object was rewarded instead of the large, black one. In addition, another 
pair of stimuli that also differed simultaneously on the same dimensions was 
presented in random alternation with the original pair. The new pair consisted 
of a large, white dowel and a small, black one. The small, black member of 
this pair was consistently positive. The reinforcement patterns for the two 
successive problems are shown in Figure 2. Since in the second task the cor-
rect member of either pair had the same value (small) for the size dimension 
but a different value for the brightness dimension, the subject was, in effect, 
learning a simple "size" concept. Random alternation of the two stimulus pairs 
prevented the subject's learning a brightness sequence, such as black, white, 
black, white, etc.

Treatments

The first discrimination described above allowed equal opportunity, 
in a physical sense, for two mediating responses to develop. This opportunity 
existed, of course, because there were two relevant dimensions in the first 
discrimination to which mediating responses could become attached. In the 
second discrimination only one dimension maintained its relevance. The situa-
tion was, therefore, opportune for (1) attempting to influence the strength 
of one of the mediating responses relative to the other during the first dis-
crimination and (2) assessing the effect of the manipulation via speed of 
learning the second discrimination.

The treatments were constructed with a view toward providing subjects 
with perceptual or verbal bases for establishing mediating responses to one or 
the other relevant dimensions during the first discrimination. The rationale, 
it can be recalled, was that different bases (perceptual versus verbal) may
Figure 2. Stimulus-Reinforcement Patterns.
govern mediating responses and dimension preferences in children of different ages.

Perceptual treatments. In order to induce a perceptual basis for mediating responses, the stimuli were arranged on a tray so as to produce different patterns of end-organ stimulation. Hence, during the initial training forty cylinders (ten each of the following types: large, black; large, white; small, black; small, white) were arranged on a tray in a manner calculated to produce different gestalts and emphasize different dimensions. The same forty objects were used for all perceptual arrangements; only their configuration on the tray varied.

Size object arrangement. Discriminanda were arranged on the basis of size by placing all large cylinders on one side of a neutral gray tray and all the small cylinders on the other side. Objects were randomly distributed with respect to brightness. This arrangement was expected to create or enhance perceptual mediating responses to the size dimension.

Brightness object arrangement. When discriminanda were arranged according to brightness, another tray painted half black and half white was used to intensify the color effect. Black cylinders were placed on the black background and white ones on the white ground, size being randomly distributed. Figure 3 shows the objects arranged on the trays according to size and brightness. The plywood trays were 8-1/2 by 13 inches and depressions slightly larger than the cylinder bases were bored 1/4 inch deep to enable steady and exact placement of the cylinders. Spaces between rows and columns of objects were equidistant: 1/2 inch.

Perceptual and verbal conflict treatments. The conflict conditions were intended to bring perceptually induced mediating responses into competition with verbally acquired ones in order to see which would dominate. A
Figure 3. Stimulus Objects Arranged According to Brightness and Size
verbal basis for mediation was provided by instructing subjects to apply verbal labels to the values of one dimension during the initial discrimination.

Size object arrangement, brightness verbalization. When the perceptual treatment emphasized size in the manner previously described, the subject was instructed as follows: "Before choosing one [object], tell me which color you think is right: the black one or white one."

Brightness object arrangement, size verbalization. When the object arrangement involved brightness grouping, the subject was instructed to tell the experimenter, before making the overt response, which size he thought was correct: the big one or little one. Hence, in the conflict conditions the verbalizations intervening between presentation of the stimulus pair and the overt response were always descriptive of the dimension not emphasized by the object arrangement.

The effects of the above treatments were measured against the performance of age-appropriate control groups. In the control condition discriminanda were distributed randomly on a neutral gray tray with respect to both brightness and size, and no instructions concerning verbalization were given.

Apparatus

An effort was made to present the learning tasks and treatments in a way which would create the semblance of a game and spontaneously arouse the child's interest and motivation. The apparatus shown in Figure 4, which is an adaptation of that designed by Robinson (1962), added considerable appeal to the learning situation. The happy face of a clown was enameled in yellow, blue, red, and white on a plywood board, measuring 2-1/2 feet by 3 feet, which was mounted upright on a small child's table. A large hole was cut out for the clown's mouth, and its nose was a red light bulb capable of being blinked
Figure 4. The Apparatus, Showing Random Arrangement of Objects on Tray
by the experimenter via a foot switch. The plywood piece bearing the clown's face was mounted far enough back from the front edge of the table that the discriminanda could be displayed on a tray on the table in front of the face. It was not so far back that the mouth of the clown was beyond the comfortable reach of the child, and the mouth was high enough for a child to place an object in it without danger of knocking over the discriminanda placed below it. When one of the cylindrical stimulus objects was placed in the mouth of the clown by the subject, it would roll down an incline and stop against a rail at the right side of the apparatus, where it could be removed by the experimenter. Sugar-coated cereal or peanuts, which served as rewards, could be manually started down an ejection chute from the right side of the apparatus to be dispensed through a small, circular hole into a plastic container on the left side. The experimenter who operated the dispenser and foot switch from the right side could thereby reach to the tray to take objects from it without colliding with a subject reaching for his reward. A white side board which helped to keep the child's attention directed toward the discriminanda was on the left of the center piece but was omitted on the right side to allow the experimenter free access to the discriminanda.

Procedure

The children were run individually in a quiet room in which the experimenter and subject were alone. With nursery-school children the experimenter spent a day or two participating in nursery-school activities and getting acquainted with the children prior to the experimental session. Whenever it appeared necessary, additional time was spent with an individual just prior to the learning tasks in order to assure good rapport. During learning, the sub-
ject was seated in a child's chair directly in front of the clown and discriminanda. The experimenter was seated to the subject's right side, facing the apparatus at a forty-five degree angle. When the child was comfortably seated, the experimenter said, "X, this is Happy, the clown. Say 'Hello' to Happy." Whether or not the child responded, the experimenter blinked the red light which substituted for the clown's nose and said, "Happy says 'Hello' to you."

First discrimination. Following the introduction, the experimenter said, "We are going to play a game that I think will be fun. You see, Happy is hungry. Here is his food." At this point the tray containing the arranged objects was carefully called to the subject's attention. "Some of them he likes, and some of them he does not like." A large, black cylinder and a small, white one were taken from the tray and placed one inch apart on the table between tray and subject. Gesturing to these objects, the experimenter said, "Happy likes to eat only one of them."

At this juncture the procedure varied somewhat depending on the age of the child and experimental group to which he was assigned. Second-grade children were allowed a choice of reward: Frosty-0 cereal or peanuts. They were instructed, "Before you try to put the one Happy likes in his mouth, tell me what you like best: Frosty-0's or peanuts." These rewards were materially presented, and the chosen type was used as reward during learning. Nursery-school children were not given a choice, as sugar-coated cereal was less likely to bring objection from their parents. If the child was learning under a verbal treatment condition, the instructions, "Before choosing one, tell me which size [or color] you think it is: big or little [or black or white]" were given. These instructions were repeated on each trial until the appropriate verbalization set was established.
The remaining procedure was identical for all subjects. The child was instructed on each trial to "put the one Happy likes in his mouth." When the correct object was chosen, the experimenter blinked Happy's nose three times in rapid succession via the foot pedal and exclaimed, "Happy likes the one you gave him! Now he wants to give you something." A Frosty-0 or peanut was simultaneously dispensed. The subject was told, "You can eat it now, or save it until later, whatever you wish." The total reinforcement effect was very potent and appeared to highly motivate the child. To prevent his settling for less than optimal performance, the child was also told that it was possible to get a reward on every trial: "Happy will give you a Frosty-0 [or peanut] every time if you give him the right one. See if you can give him the right one every time." If the incorrect choice was made, the experimenter simply said, "No, he doesn't like that one."

After each trial the two used cylinders were returned to the same spots on the tray from which they were taken, and two new stimuli from other positions were presented. The stimuli were chosen from predetermined positions which assured that all possible appropriate stimuli were paired before the same objects were chosen again. This virtually ruled out the subject's associating to specific stimulus objects, as ten possible pairs existed for the initial discrimination and twenty possible pairs for the concept learning task. On each trial correct position was varied according to Gellerman's (1933) series. After a criterion of nine out of ten correct trials was attained by the subject within fifty trials, the conceptual task was administered.

Second discrimination. Concept learning was introduced by the experimenter's remark, "Fine! Now it is time for Happy's dessert." The original tray containing either the size, brightness, or random object arrangement was
placed out of sight behind the apparatus and a new tray put on the table in front of the subject. This change took only a few seconds as the second tray, a neutral gray one, was already prepared with forty more objects, just like the removed ones, displayed in random order with respect to both size and brightness dimensions. Figure 4 shows this tray and the placement of the stimulus pair in front of it. This arrangement was identical to that used during the initial training of the control groups, but the actual shift of trays was made even for the control groups in order to maximize procedural similarities between the control and experimental groups. Those subjects in the conflict treatments who had been instructed to apply verbal labels during initial training were informed at the beginning of the second task, "You don't need to tell me which one you think is right anymore; just go ahead and put it in Happy's mouth." The stimulus pairs used in the second task were taken from the tray, and the subject's choices were rewarded in the same manner as in the first discrimination. The criterion for the concept learning task was nine out of ten correct responses, or a limit of fifty trials.

When the criterion of concept learning was reached, the subject's readiness to verbalize the correct concept was assessed by asking, "Which ones did Happy like for dessert?" The subject's answer was recorded verbatim. The subject was then asked, "Did he like any other kind?" If the incorrect dimension [brightness] was mentioned in reply to these questions, he was asked in addition whether Happy liked all the objects of that color, thus giving the subject a chance to respond, "No, he doesn't like all the black and white ones, he liked only the little black ones and little white ones, etc."
Subjects

The subjects were 125 children drawn from primary and nursery schools in Durham, North Carolina. Fifty were nursery-school children, with mean age of 3.8 years (range: 3.1 to 4.4). This age level was chosen as a compromise between the wish to select subjects as young as possible, so as to maximize their reliance on perceptual processes, and the requisite that the child have adequate verbal ability to understand and apply the verbal labels in the conflict situations. The primary-school children were seventy-five second-graders, with mean age of 8.0 years (range: 6.8 to 8.8). Choice of this age level provided a sufficiently great gap in age between the younger and older subjects and, at the same time, excluded five- and six-year-old children who, developmental literature suggests, are often in a state of transition from perceptual to conceptual modes of functioning.

Subjects in the various experimental groups were matched fairly closely on sex and, within an age level, on chronological age and intelligence.* Tables 1 and 2 show sex, age, and intelligence characteristics of the children. No significant differences were found within age levels between means or variances for these variables among the experimental groups. To the extent that the different intelligence tests used at each age level are comparable, it appears that the older children were slightly more intelligent than the younger ones. This difference in intelligence may have broadened the developmental gap between ages somewhat.

*Intelligence data were obtained from the group-administered Kuhlman Anderson Test, Form C, for the second-graders and from the Peabody Picture Vocabulary Test, individually administered, for the nursery-school children. All intelligence testing and scoring was done by the experimenter within one month of the child's participation in the experiment.
Table 1
Sex, Age, and Intelligence Characteristics of Second-Grade Children

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Object Arrangement</th>
<th>Verbalization</th>
<th>n</th>
<th>Male</th>
<th>Female</th>
<th>C.A.</th>
<th>S.D.</th>
<th>M.A.</th>
<th>S.D.</th>
<th>I.Q.</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>--</td>
<td></td>
<td>15</td>
<td>8</td>
<td>7</td>
<td>8.1</td>
<td>.4</td>
<td>9.0</td>
<td>.6</td>
<td>111.6</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>Brightness</td>
<td>--</td>
<td></td>
<td>15</td>
<td>8</td>
<td>7</td>
<td>8.0</td>
<td>.4</td>
<td>8.9</td>
<td>.7</td>
<td>111.2</td>
<td>11.6</td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td>--</td>
<td></td>
<td>15</td>
<td>7</td>
<td>8</td>
<td>8.0</td>
<td>.4</td>
<td>8.9</td>
<td>.5</td>
<td>111.1</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>Brightness</td>
<td>Size</td>
<td></td>
<td>15</td>
<td>7</td>
<td>8</td>
<td>8.1</td>
<td>.3</td>
<td>9.0</td>
<td>.6</td>
<td>111.1</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>Brightness</td>
<td></td>
<td>15</td>
<td>7</td>
<td>8</td>
<td>7.9</td>
<td>.5</td>
<td>8.7</td>
<td>.4</td>
<td>111.3</td>
<td>8.8</td>
<td></td>
</tr>
</tbody>
</table>
Table 2

Sex, Age, and Intelligence Characteristics of Nursery-School Children

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sex</th>
<th>C.A.</th>
<th>M.A.</th>
<th>I.Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S.D.</td>
<td>S.D.</td>
<td>S.D.</td>
</tr>
<tr>
<td>Object Arrangement</td>
<td>n</td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.3</td>
</tr>
<tr>
<td>Brightness</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.5</td>
</tr>
<tr>
<td>Random</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.3</td>
</tr>
<tr>
<td>Brightness Size</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.4</td>
</tr>
<tr>
<td>Size Brightness</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.3</td>
</tr>
</tbody>
</table>
The subjects were assigned at random to the experimental groups without regard to other variables. Two second-graders and four nursery-school children were eliminated for failure to learn the first discrimination within fifty trials. Though an attempt was made to obtain all eligible subjects within the nursery schools sampled, several unusually shy and uncooperative children did not participate.

Socio-economic characteristics of the population sampled were assessed by rating fathers' occupations. The scale used to measure the relative social rank of occupations was one developed by Alba Edwards (1943) at the Bureau of Census and is the general occupational classification used in the censuses of 1940 and 1950. Table 3 summarizes the representation of subjects by socio-economic category. The largest percentage of subjects' fathers consists of professionally trained workers who are engaged chiefly in intellectual pursuits, as contrasted with other service pursuits and pursuits directly related to the production, exchange, and distribution of goods. Proprietors, managers, and officials, in combination with the clerks or "white-collar" workers, contain the majority of the remaining fathers. Relatively few "blue-collar" workers and no unskilled workers were included in the sample. Paired comparisons, using the chi-square test, of those experimental groups which differed significantly with respect to the criterion measure did not reveal any significant differences in socio-economic level.
Table 3
Socio-Economic Status of Subjects' Fathers Measured by Edward's Occupational Scale
(The Figures Used are Percentages)

<table>
<thead>
<tr>
<th></th>
<th>1 Professional Persons</th>
<th>2 Proprietors Managers Officials</th>
<th>3 Clerks and Kindred Workers</th>
<th>4 Skilled Workers and Foremen</th>
<th>5 Semiskilled Workers</th>
<th>6 Unskilled Workers</th>
<th>Deceased or Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery-School Children</td>
<td>46.0</td>
<td>10.0</td>
<td>22.0</td>
<td>14.0</td>
<td>6.0</td>
<td>.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Second-Grade Children</td>
<td>37.3</td>
<td>20.0</td>
<td>17.3</td>
<td>9.3</td>
<td>13.3</td>
<td>.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Total</td>
<td>40.8</td>
<td>16.0</td>
<td>19.2</td>
<td>11.2</td>
<td>10.4</td>
<td>.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>
Design of Experiment

As an aid to clarity, the main combinations of ages and treatments during the first discrimination can be conceptualized as two 3 by 2 factorial designs, diagrammed in Figure 5. All children learned the same size (small) concept during the second discrimination.
### Perceptual Arrangements

<table>
<thead>
<tr>
<th>Age Level</th>
<th>Nursery School</th>
<th>Size</th>
<th>Brightness</th>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Grade</td>
<td>n = 10</td>
<td>n = 10</td>
<td>n = 10</td>
<td></td>
</tr>
<tr>
<td>Second Grade</td>
<td>n = 15</td>
<td>n = 15</td>
<td>n = 15</td>
<td></td>
</tr>
</tbody>
</table>

### Conflict Treatments

<table>
<thead>
<tr>
<th>Age Level</th>
<th>Nursery School</th>
<th>Size Arrangement</th>
<th>Brightness Arrangement, Size Verbalization</th>
<th>Random Arrangement, No Verbalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Grade</td>
<td>n = 10</td>
<td>n = 10</td>
<td>n = 10</td>
<td></td>
</tr>
<tr>
<td>Second Grade</td>
<td>n = 15</td>
<td>n = 15</td>
<td>n = 15</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5. Experimental Design
Chapter III

RESULTS

The data are analyzed in several ways, each employing a different measure as the dependent variable. First, the hypotheses are tested using number of trials to criterion as a measure of learning difficulty. The middle section deals with the shape of learning curves, in an attempt to describe the course of learning and possible mechanisms involved in it. A final section is based on the subject's verbal definition of the concept which is learned. The view in this final section is toward revealing the presence and emphasis of dimensions in the subject's awareness and possible relationships between these cognitions and the experimental treatments.

Since various statistical procedures are used in testing significance of differences, assumptions concerning each test will be discussed in conjunction with its specific use. When a specific directional hypothesis is tested, the probability value (p) is based on a one-tailed test of significance; in all other instances two-tailed tests are employed. Probability values are reported as "significant" if they achieve the .05 level and as indicating a "trend" if $.05 < p < .10.
Testing of Hypotheses Using Number of Trials to Criterion as a Measure of Learning Difficulty

Table 4 presents the results of the initial training discrimination.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age Group</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Object Arrangement</td>
<td>Verbalization</td>
<td>Nursery School</td>
<td>Second Grade</td>
</tr>
<tr>
<td>Size</td>
<td>--</td>
<td>11.4</td>
<td>10-25</td>
<td>13.3</td>
</tr>
<tr>
<td>Brightness</td>
<td>--</td>
<td>11.1</td>
<td>9-16</td>
<td>12.1</td>
</tr>
<tr>
<td>Random</td>
<td>--</td>
<td>10.7</td>
<td>10-18</td>
<td>11.5</td>
</tr>
<tr>
<td>Brightness</td>
<td>Size</td>
<td>12.4</td>
<td>10-21</td>
<td>12.2</td>
</tr>
<tr>
<td>Size</td>
<td>Brightness</td>
<td>10.9</td>
<td>10-16</td>
<td>13.9</td>
</tr>
</tbody>
</table>

There were no significant differences between the groups with respect to either variability or central tendency. Combined with the intelligence data, these results allow one to conclude that any differences among treatment groups in concept learning are related to factors other than general learning ability.

Hypotheses related to the perceptual treatments. Hypothesis I stated that the object arrangements, via their impact on mediating responses, would have a significant effect on difficulty of concept learning. Specifically, it was predicted that size arrangement would facilitate and brightness arrangement would interfere with learning a size concept, in comparison with the perform-
ance of a random-arrangement control group. Hypothesis II stated that object arrangements would have stronger interfering and facilitating effects for nursery-school children than for second-graders.

The predictions are best tested by analysis of variance technique performed upon the data in a 3 by 2 factorial design. Table 5 presents the mean number of trials to criterion and the standard deviation for each experimental cell. Transformation of the raw data was necessary because the Bartlett test

<table>
<thead>
<tr>
<th>Object Arrangement</th>
<th>Age Group</th>
<th>Nursery School</th>
<th>Second Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Size</td>
<td>19.1</td>
<td>9.9</td>
<td>15.3</td>
</tr>
<tr>
<td>Random</td>
<td>22.9</td>
<td>13.4</td>
<td>19.2</td>
</tr>
<tr>
<td>Brightness</td>
<td>36.5</td>
<td>17.1</td>
<td>23.0</td>
</tr>
</tbody>
</table>

(Walker and Lev, 1953, p. 194) revealed heterogeneity of variance of a regular type; means were positively correlated with variances. The original scores, which are given in Appendix A, were transformed to a logarithmic scale in accordance with recommendations by Steel and Torrie (1960, p. 156). Letting $X$ and $X'$ represent the original and transformed scores respectively, the most satisfactory transformation was found to be $X' = \log(X + 1)$. The Bartlett

*When some values are less than 10, $\log(X + 1)$ is desirable because it behaves like the square root transformation for numbers up to 10 and differs little from $\log X$ thereafter.
test performed on the log transforms indicated that homogeneity of variance had been established.

The summary for the analysis of variance is given in Table 6. Since the interaction is non-significant, it is meaningful to consider main effects. The main effect of object arrangements was significant at the .05 level. The direction of effects was consistent with Hypothesis I which stated that the size arrangement would facilitate, the brightness arrangement interfere with learning, and the random arrangement would be intermediate. This trend is clearly revealed by combining across age levels (Table 5): the resulting means are 16.8, 20.7, and 28.4 for size, random, and brightness object arrangements respectively.

The analysis of variance also indicated a significant overall difference between the performance levels of the younger and older subjects \( (F = 5.43, p < .025) \). Though the predicted trend generally was present within each age level, some interesting differences can be noted. The histogram shown in
Figure 6 serves as graphic illustration. For second-grade children, size and brightness arrangements had opposite but weak effects; neither effect was significantly different from that of the control condition. The combined effect, i.e., difference between size and brightness arrangements, was significant (t = 2.08, p < .025). For the nursery-school children the size arrangement had only a very slight, non-significant effect in a facilitating direction, but the brightness arrangement had a marked interfering impact. In spite of the small number of subjects, the mean of the brightness arrangement group differed from the control group mean (t = 1.93, p < .05), as well as from the mean of the size arrangement group (t = 2.25, p < .025). The main contribution to the discrepancy between the performance of younger and older children was made under this brightness-arrangement condition, the interfering effect being much stronger for the younger than for the older children (t = 2.28, p < .025). This finding tends to support Hypothesis II, which stated that the perceptual effects would be more pronounced for younger children than for older children.

Hypotheses related to the perceptual-verbal conflict treatments. Hypothesis III stated that in situations where both perceptual and verbal cues provide a basis for mediation, it is characteristic of the younger child to rely more heavily on the former and the older child to utilize the latter, relatively speaking. The effects associated with the conflict treatments were assessed by the non-parametric Mann-Whitney U test because transformation of the data could not sufficiently correct for heteroscedasticity. Median and mean trials to criterion for the experimental groups are reported in Table 7. Cell medians are the logical measures of central tendency in that the Mann-Whitney U test makes use of ranks, but means are also entered in the table to permit comparison with Table 5. The histogram shown in Figure 7 is a visual
Figure 6. Histogram of Mean Trials to Criterion under Perceptual Conditions.
Table 7
Median and Mean Trials to Criterion for Perceptual-Verbal Conflict Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age Group</th>
<th>Nursery School</th>
<th>Second Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Brightness Size</td>
<td>23.0</td>
<td>30.4</td>
<td>10.0</td>
</tr>
<tr>
<td>Random --</td>
<td>13.5</td>
<td>22.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Size Brightness</td>
<td>22.5</td>
<td>26.1</td>
<td>11.5</td>
</tr>
</tbody>
</table>

aid in comparing treatment effects.

Tested first was Corollary A which stated that when verbalization is relevant (size) and object arrangement is irrelevant (brightness) to learning a size concept, the older children will show positive transfer and the younger children negative transfer. The difference in performance of older and younger children was highly significant for the treatment ($U = 9.5, p < .001$). The older children learned significantly faster than their control group ($U = 52.5, p < .01$), indicating that relevant verbalization produced positive transfer even when opposed by irrelevant perceptual arrangement. The nursery-school children showed a trend to learn slower than their control group ($z = 1.31, p < .10$, when scores are corrected for ties). This result signifies that the interfering effect of brightness object arrangement on the younger children was not overcome by supplying relevant verbal information. Hence, the results confirm Hypothesis III-A.

Hypothesis III, Corollary B, stated that relevant object arrangement (size) and irrelevant verbalization (brightness) would affect the younger
Figure 7. Histogram of Mean Trials to Criterion under Perceptual-Verbal Conflict Conditions
children's size concept learning positively, the older children's negatively, in comparison with control groups. Neither the younger nor older children in this treatment condition differed significantly from their controls. Hence, the children neither responded clearly in terms of the verbal nor perceptual treatments under this condition. Since no clear effect was found, it was pertinent to look at this result in relation to each condition of the conflict situation independently. For this specific purpose fifteen second-graders with subject characteristics comparable to the other groups were given the brightness verbalization treatment independently. Since the size object arrangement had already been administered independently as one of the perceptual treatments, this enabled one to judge the independent contributions of the perceptual and verbal treatments to the result of the conflict situation. Learning was found to be fastest in the size object arrangement condition, slowest in the brightness verbalization condition, and intermediate in the conflict situation (means of 15.3, 19.9, and 18.9 respectively). The conflict condition is closer to the brightness verbalization condition than to the size object arrangement condition, suggesting that any tendency of the verbalization to interfere is not counteracted by size arrangement. None of the differences, however, are significant. One can only conclude that if irrelevant verbalization can have some interference, it is not strong enough under these experimental conditions (which may not be a good test of Corollary B) to be demonstrated.

Comparison of the perceptual and conflict treatments. All treatment means for nursery-school and second-grade children learning the size concept are simultaneously graphed in Figure 8. This graph shows that the point of largest deviation for younger and older children is clearly the conflict condition involving brightness object arrangement and size verbalization. The
second-grade children were superior under this condition to all other experimental groups, showing immediate learning (no child exceeding four trials over the minimum number possible) and exceptionally small variance ($s^2 = 1.8$, as compared to a range in variance of 97.2 to 310.4 for remaining cells). The younger children's performance under this condition was, on the other hand, second only to the brightness object arrangement condition in slowness. It should be noted that these results are in line with the basic hypothesis that verbalization has a greater impact on older children, particularly with regard to facilitation when the cue is relevant. Object arrangement had a greater effect on younger children, especially when it provided an irrelevant cue.

Learning Curves

Graphical representation of the temporal course of improvement in learning often provides evidence for basic mechanisms involved in learning. It is difficult to obtain individual curves for the simpler learning situations, such as the discriminations made in the present experiment, because learning occurs so quickly that one can rarely get enough reliable samples of performance to graph an individual curve. The shape of individual learning curves for these subjects can probably best be approximated with group data by means of backward learning curves (Hayes, 1953). The backward learning curve is intended to show the course of learning in the immediate region of the criterion.

In constructing backward learning curves the criterion trials and the first trial preceding the criterion are eliminated to avoid a spurious resemblance to learning. Percentage of correct responses is then calculated for
criterion trial minus two, criterion trial minus three, etc. The curves are progressively extended to the left until the median subject is dropped or until the number of remaining subjects becomes too small for estimating reliable percentages. It is desirable to have a post-criterion trial to complete the curve. In order to provide a post-criterion trial, the criterion of nine out of ten correct responses was changed to eight out of nine correct responses. This left at least one post-criterion trial for each subject.

Backward learning curves for the size, brightness, and random object arrangement groups are presented in Figures 9 and 10, for nursery-school and second-grade children respectively. Curves for the conflict treatments were essentially of the same form and therefore are not repeated. It can be observed that the end stage of learning is similar for all experimental groups. The differences in number of trials to criterion among the experimental groups are apparently a result of the duration of random responding prior to the first effective learning trials. Actual learning occurs very suddenly, within a trial or two. This type of performance may indicate that what creates the delay in learning is the search for the relevant dimension, i.e., the one whose values are correlated with reinforcement. Once it is found, association of cue and response is formed very rapidly.

It appears that the younger children, in contrast to the older ones, may be making more errors than expected by chance prior to the sharp upswing in the learning curve. Because it was suspected that the younger children might be perseverating to the large, black object, which was rewarded in the first discrimination, a comparison was made of the percent of responses made to that object on the first trial of the concept learning task versus the percent made to the other member of the pair (small, white object). Only twelve percent of the younger children spontaneously shifted from the large, black
Figure 9. Backward Learning Curves for Nursery-School Children under Perceptual Conditions.
SECOND-GRADe CHILDREN

PERCENT CORRECT

TRIALS

C-10 C-9 C-8 C-7 C-6 C-5 C-4 C-3 C-2 POST CRITERION

Figure 10. Backward Learning Curves for Second-Grade Children under Perceptual Conditions
object to the small, white one when the task shifted, whereas 70.9 percent of the older children did ($x^2 = 45.5$, $p < .001$). The exchange of trays and the experimenter's remark, "Now it is time for Happy's dessert," activated a shift to the previously unrewarded object for the older children but produced only a slight change in choices for the younger ones. This spontaneous, anticipatory shift on the part of the older children, even before the altered pattern of reinforcement was experienced, is not only further evidence of a cognitive approach much less concrete than that of the younger children but also indicative of the older children's greater reliance on and/or attention to verbal cues.

Subject's Verbal Definition of the Concept Learned

Immediately after attaining criterion on the size concept task, each subject was instructed to tell the experimenter what kind of objects Happy liked. Since the majority of nursery-school children were at a loss to verbally define the concept at all, the following analysis applies only to second-graders. Table 8 gives examples of the type of responses most characteristic for each group, each example being one individual's actual response. The verbatim definitions, such as those illustrated, were classified according to the dimensions referred to (Table 9).

A chi-square test showed a significant difference among experimental groups with respect to dimensions referred to ($x^2 = 55.2$, df = 15; $p < .001$). Eighty percent of the subjects in the random object arrangement (control) group included both dimensions in their expression of the concept. The most "size only" definitions (86.7%) were given by the group learning under the size verbalization, brightness object arrangement condition. The largest percentage
Table 8

Exemplary Verbal Definitions Given by Second-Graders after Learning "Size" Concept

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Characteristic Verbalizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>&quot;He liked the little white ones and little black ones.&quot;</td>
</tr>
<tr>
<td>Size</td>
<td>&quot;I thought it was usually the little one.&quot;</td>
</tr>
<tr>
<td>Brightness</td>
<td>&quot;I started taking black and white of the little ones.&quot;</td>
</tr>
<tr>
<td>Brightness</td>
<td>&quot;Little ones.&quot; &quot;Short ones.&quot;</td>
</tr>
<tr>
<td>Size</td>
<td>&quot;He liked both black and white, only they were little ones like this.&quot;</td>
</tr>
<tr>
<td>Brightness</td>
<td>&quot;He liked black and white, didn't he?&quot; &quot;Little black ones and little white ones.&quot;</td>
</tr>
</tbody>
</table>
Table 9
Dimension Referred to when Defining "Size" Concept
(Figures are percentages on n per treatment group)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Object Arrangement</th>
<th>Verbalization</th>
<th>n</th>
<th>Brightness</th>
<th>Size</th>
<th>Both Size and Brightness</th>
<th>Unable to Verbalize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>--</td>
<td>15</td>
<td>13.3</td>
<td>6.7</td>
<td>80.0</td>
<td>13.3</td>
<td>0</td>
</tr>
<tr>
<td>Size</td>
<td>--</td>
<td>15</td>
<td>6.7</td>
<td>80.0</td>
<td>13.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brightness</td>
<td>--</td>
<td>15</td>
<td>26.7</td>
<td>26.7</td>
<td>26.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Brightness</td>
<td>Size</td>
<td>15</td>
<td>0</td>
<td>86.7</td>
<td>13.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Size</td>
<td>Brightness</td>
<td>15</td>
<td>6.7</td>
<td>40.0</td>
<td>53.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>--</td>
<td>Brightness</td>
<td>15</td>
<td>40.0</td>
<td>13.3</td>
<td>40.0</td>
<td>0</td>
<td>6.7</td>
</tr>
</tbody>
</table>
of "brightness only" responses (40%) was found in the group receiving the brightness verbalization treatment alone. Apparently, the dimensions noted in the older children's definitions were especially influenced by the type of verbal labels applied during initial training. The size object arrangement, which emphasized a dimension compatible with the concept, led also to an increase in the number of "size only" expressions. The brightness object arrangement, which emphasized a dimension incompatible with the concept, resulted in heterogeneity of dimension referred to: an equal percentage of subjects gave "brightness only," "size only," and both "size and brightness" definitions. (It also contained the largest percentage of subjects unable to verbalize at all.) It is as though perceptually emphasizing a dimension at variance with the concept produced verbal confusion about the concept; whereas verbally emphasizing the irrelevant dimension tended to cause incorrect verbalizations.

It is also of interest to note to what extent the dimension expressed was associated with speed of learning. The three groups of second-graders who learned the size concept the fastest, described the concept most frequently in terms of size alone; whereas the three groups who learned the slowest most frequently explained the concept (though incorrectly) in terms of brightness alone. Groups intermediate in their learning had the highest proportion of children who mentioned both dimensions in their descriptions of the concept. In conclusion, the treatments had effects which were expressed both in speed of learning and in the dimension that was used to define the learned concept.
Chapter IV
DISCUSSION

The present study was based on the general hypothesis that immediately prior learning experience could influence dimension selectivity. In particular, it sought to demonstrate that arrangements of discriminanda and verbalizations of the subject during an initial discrimination would affect dimension availability in a later conceptual task differently for nursery-school and second-grade children. It sought to show that nursery-school children as well as second-graders could behave in a mediational manner but that mediational processes would be more susceptible to perceptual influences with the younger children and to verbal influences with the older ones.

Some of the present findings were consistent with the predictions while others were not. Hypothesis I, stating that both younger and older children would respond in a mediational manner when the perceptual arrangements emphasized one dimension over another, was generally supported. The interfering effect on the younger children's performance of perceptually emphasizing an irrelevant dimension made the largest contribution to the support of this hypothesis. Hypothesis II, which affirmed that the perceptual effect would be greater for younger children than for older children, was supported with respect to the interfering effect of irrelevant perceptual cues but not with respect to the facilitating effect of relevant perceptual cues. Hypothesis III-A, which stated that older children would be influenced more by
relevant verbal cues than by irrelevant perceptual cues and vice versa for younger children, was clearly confirmed. The converse hypothesis, III-B, was not supported, as younger children were not influenced as expected by relevant perceptual cues nor older children by irrelevant verbal cues. In this chapter the findings will be discussed in their theoretical and methodological implications and in their relationship to earlier research.

Dimension Preferences

An assumption was made throughout this experiment that the ease with which the values of a dimension were associated with the instrumental response was an index of the preference status of the dimension. The fewer the number of trials taken to reach criterion, other things held constant, the greater the preference for a relevant dimension.

According to the above operational definition of dimension preferences, different dimension preferences were present during concept learning for the various experimental groups, since their speed of learning differed. During the initial discrimination the object configurations and verbalizations emphasized one dimension, probably making it dominant over the second dimension. During concept learning there were no such external props to cause different preference hierarchies; yet subjects learned the concept with varying ease, depending on the treatment to which they had been subjected earlier. It was as if the initial dimension preferences produced by the experimental manipulations continued to operate even after the external factors responsible for their production ceased to exist.

It is pertinent at this point to ask whether or not the behavioral indices of dimension preferences were coordinated with phenomenological events.
Katz (1935) has noted that in some instances cue preferences may be defined by certain subjective states. Though this was not a central question in the present study, it was felt that some evidence of a subjective nature might help to substantiate the behavioral definition. In so far as the subjects' verbal descriptions of the concept may reflect their phenomenological experience of the dimensions, there did appear to be a correspondence between the behavioral and subjective indices of dimension preferences. Subjects learning the size concept most rapidly defined the concept most frequently in terms of the size dimension, those learning most slowly expressed the brightness dimension most often, and those intermediate in speed of learning tended to mention both dimensions. Though this is no basis for affirming a cause and effect relationship between these apparent preferences and speed of learning, the correlation does support the interpretation that the treatments yielded different dimension preferences which were concordant with speed of learning.

Mediational Versus Single-Unit Stimulus-Response Theory

A major interest of the present study was whether the child's choice of the preferred dimension would correspond to predictions made from mediational theory or from single-unit stimulus-response theory. The diametrically opposite predictions of these two theories are made clearer by the following analysis of the actual learning situation according to each theory.

When a treatment (either perceptual or verbal) emphasized the size dimension over the brightness dimension, single-unit theory would expect the values of the size dimension to be more readily associated with the instrumental behavior demanded. That is, when the subject is rewarded for feeding the large, black object to Happy, a stronger positive association is formed to
the "large" cue than to the "black" cue. Likewise, "small" is extinguished more than "white," as discrimination is viewed as a combination of condition ing and extinction. The subject is primarily learning to respond to the "large" cue. Suppose that the subject, after reaching criterion, is shifted to the task where he is required to learn the size concept, i.e., respond to the smaller object on each trial. As response to the large cue will prove incorrect, the subject may either shift to a new dimension (brightness) or shift to the other value (small) within the same dimension (size). Single-unit theory predicts that he would shift to the brightness dimension, since "black" and "white" have not been extinguished as strongly as "small." In other words, the subject should demonstrate a preference for the dimension not emphasized previously. This preference would interfere with his learning the "small" concept.

Mediation theory, on the other hand, holds that the subject learns during the first discrimination to make an implicit cue-producing response to the size dimension taken as a whole. He learns a readiness to respond to a whole dimension and not merely learns the association of discrete responses to specific values. During the first discrimination, the mediating-response to the size dimension becomes a great deal stronger than that to the brightness dimension. Thus, when conceptual learning is introduced, he favors a shift to the other value within the size dimension. The mediational sequence would have to be extinguished before he would shift to the brightness dimension. The mediating subject, therefore, shows a preference for the originally emphasized size dimension, which has a facilitating effect on learning the "small" concept.

A similar analysis can be made of the situation in which the brightness dimension is emphasized over the size dimension, though the predicted effects are exactly opposite to those above. Interference would be produced for medi-
ators and facilitation for children responding in single-unit fashion.

Data confirming Hypothesis I. The results of the perceptual treatments in the present experiment agreed with the mediational view rather than with single-unit theory and, thereby, support Hypothesis I. Emphasizing the size dimension through object arrangement facilitated learning of the "small" concept, whereas emphasizing the brightness dimension interfered with learning it. In the light of past research (Kendler and D'Amato, 1955; Harrow and Friedman, 1958; Kendler and Kendler, 1959, 1961; Spiker, 1962) it is not surprising to find that the older children did show perceptual mediation, but it was not as strong as the effect reported in studies on verbal mediation.

The finding that nursery-school children also responded to the perceptual treatments in a mediational fashion deserves comment. Experimenters using the stimulus-response model have sometimes concluded that children of nursery-school age do not mediate, since they learned non-reversal shift easier than reversal shift under some conditions (Kendler, Kendler, and Wells, 1960). Studies focusing on verbal mediators (e.g., Kendler and Kendler, 1961) have generally been interpreted to mean that younger children are inferior in the use of verbal mediators and, by way of implication, in use of mediation in general.* The younger children in the present experiment, how-

*Since completion of the present experiment, Reese (1962) has reviewed evidence concerning the "mediational deficiency hypothesis." He concluded that studies of reversal and non-reversal learning, transposition, and acquired equivalence of cues indicate that there is a deficiency in mediation in young children, compared with older children. It is significant that the studies Reese reviewed were primarily concerned with verbal mediation. He proposes that in some cases the mediational deficiency is a characteristic of an early stage of concept formation rather than of human development: "It is proposed, then, that with a well-learned concept there is no necessary deficiency in mediation as a function of age, but with a less well-established concept there is a deficiency at any age." In the sense that concrete, perceptually based concepts may be better established than abstract, verbal concepts among young children, the present finding of perceptual mediation in nursery-school children is compatible with Reese's conclusion.
ever, reacted quite strongly when they were given a perceptual basis for making a mediating response to the irrelevant brightness dimension. Under this condition they were superior in a mediational sense to the older children, for they showed more interference in learning the size concept. This finding suggests that it is an over-simplification of the problem to ask at what point on the evolutionary continuum a transition is made from the single-unit to a mediational mode of responding. Attempts need to be made to differentiate the various types of mediational processes which may be used at various phases of development (cf. Werner, 1948, p. 216, on analogous processes in conceptualization).

Different Types of Mediating Responses

An issue of major proportion in the present study is the relative importance of perceptual and verbal mediating processes at the two age levels. Hypotheses II and III, pertaining to this matter, stated that (1) the perceptual arrangements would have more pronounced effects on the younger children and (2) the perceptual arrangements would dominate the verbal cues for the younger children when the two were in conflict, but the reverse would hold for the older children.

Data confirming Hypotheses II and III. When the brightness object arrangement was administered independently, it had significantly greater interference on the performance of younger than older children learning the size concept. This is commensurate with Hypothesis II and suggests that younger children exceed older children in tendency to be directed by sensory organization and to use perceptual mediators.

The most pertinent data regarding the children's affinity for different
kinds of mediators are provided by the conflict situations, where they may respond either to perceptual or to verbal cues. In the conflict condition where the size dimension was verbally labeled while the brightness dimension was simultaneously emphasized by perceptual arrangement, the older children showed positive transfer and the younger children negative transfer. This finding, which agrees with Hypothesis III-A, can be explained in several ways.

One explanation is based on the idea of differential stimulus-pull. According to this view, the following interpretations are possible: (a) the perceptual aspects were more compelling for the younger children than for the older children, (b) the verbal cues were less compelling for the younger than for the older children, and (c) the observed effect was a combination of (a) and (b). The finding that brightness object arrangement, when administered independently, led to greater interference for younger than for older children supports explanation (a). The design of the experiment precludes evidence of (b), since the size verbalization treatment was not given independently to younger and older children. One cannot say whether the younger children's negative transfer was a result of greater perceptual pull or less verbal pull for them than for the older children. Probably both factors contributed to the over-all effect, but further research is needed to substantiate this.

Another explanation of the results is in terms of the differential function of language at the two age levels. It may be that in the early stages of development, speech is more a means of communication than a mechanism for mediation (cf. Luria, 1957). Younger and older children may be equally responsive to the words, but the words simply have different functions for them. Note that the negative transfer which the younger children demonstrated in the conflict situation in comparison to their control group cannot be ex-
plained merely by the assumption that they lacked understanding of the verbal labels. The younger children had sufficient knowledge of the meanings of the labels to use them correctly in describing the stimuli, though they did not seem to use them as mediators. Actually, the stimulus-pull and differential-function explanations are not incompatible; both conditions may be present.

It is also noteworthy that the children had little practice in using the names as mediating stimuli, since the first task was learned quickly. Spiker's study (1962) indicated that considerable practice was needed to produce an interfering effect with verbal mediators. House and Zeaman (1960) found that mentally retarded children performed better on reversal than on non-reversal shift when given 125 over-learning trials. These findings suggest that the difference between the younger and the older children could be that the younger ones require more practice in order to use the less tangible verbal mediators.

The positive transfer which the older children showed under the size verbalization, brightness object arrangement condition is interesting in its own right. This outcome is consistent with Spiker's finding (1962) that having the child name the values of the dimension which was to become relevant produced facilitation. However, the results are different from those of Kendler and Kendler (1961), who found no verbal facilitation (only interference) with seven-year-old children. It is difficult to understand why facilitation was not evident in the Kendlers' experiment. The chief difference between the verbal treatments in their experiment and the present one concerns the perceptual properties of the stimuli to which the names were applied. The discriminanda in the Kendlers' experiment were two-dimensional drawings; whereas the stimuli in the present experiment were three-dimensional objects. One might argue that the names were more easily associated with the values of real
objects than of drawings. However, the strong interference of irrelevant verbal labels in the Kendlers' experiment invalidates this argument of a general ineffectiveness of their verbal treatments. T. S. Kendler (1962) reported that the groups of seven-year-olds in their experiment were drawn from one school in a fairly high socio-economic neighborhood and another in a low socio-economic community. The composition of each experimental group was not specified, but possibly mismatching is responsible for the absence of a facilitation effect.

Data failing to confirm Hypotheses II and III. Two findings fail to support Hypotheses II and III and therefore require explanation: (1) the lack of facilitation of relevant (size) object arrangement for younger children, and (2) the lack of interference of irrelevant (brightness) verbalization for the older children.

The weak impact of the relevant (size) object arrangement on the younger children may be explained on the basis of an ineffectual experimental manipulation. Comparison of the two object arrangements shown in Figure 3 suggests that the arrangements differ in intensity of effect. The size arrangement does not appear to emphasize the size dimension as effectively as the brightness arrangement enhances the brightness dimension. In the size arrangement the brightness variations remain fairly impressive; therefore, they may have somewhat obscured the size patterning for the children, especially for the more globally perceiving younger children.

The above explanation also suffices to show why the younger children failed to show positive transfer in the conflict situation in which the relevant object arrangement was paired with irrelevant verbalization. When an objectively weak perceptual arrangement is paired with a stronger verbal treat-
ment, the verbal effect may still emerge dominant even though the child gives relatively more weight psychologically to the perceptual arrangement. For example, suppose that the objective intensities of perceptual and verbal treatments are 1 and 2, respectively. If subjective factors are 3 to 2 in favor of the perceptual arrangement, the verbal effect will still dominate because 1 x 3 is less than 2 x 2. This is possibly what happened in the present experiment, as a small negative effect (non-significant) was observed. The problem which is faced here is in part one of quantification. Since more refined measurement procedures are not available, the hypotheses in the present experiment can be stated only in the roughest ordinal terms.

The failure of older subjects to show negative transfer in the conflict situation where verbalization is irrelevant (and perceptual arrangement relevant) is more difficult to explain. One possible explanation is that older children are not easily confused by discrepant information, i.e., they may have the power to abstract verbal and perceptual data and develop both kinds of mediating responses simultaneously. If the preferred verbal mediators do not suffice, perceptual mediators are in readiness. This interpretation seems dubious in conjunction with the present experiment in view of the fact that the irrelevant verbalization treatment administered independently had only a slightly greater interfering effect than when it was paired with relevant perceptual arrangement in the conflict situation. A more plausible explanation is that it is more difficult at this age level to produce interference than facilitation by way of overt verbalization. It would probably require greater habit strength to persist in using inappropriate value names in the face of infirming evidence than to test out and adopt relevant labels that lead to problem solution. Spiker (1962) found that it was, indeed, harder to establish verbal interference than facilitation; so the present results and
interpretation are consistent with his data. On the other hand, the results are different from those of Kendler and Kendler (1961), who found verbal interference greater than facilitation with seven-year-old children. The possibility of mismatching in the Kendlers' study has already been discussed. Another possible source of the difference between the present finding and the Kendlers' was the greater simplicity of the initial discrimination in the present experiment. T. S. Kendler (1962) reported data which indicated that her subjects required 4.15 mean trials more to learn the first discrimination than did the second-graders in the present experiment. According to Spiker's (1962) findings this additional practice in using irrelevant labels could have produced a greater interference effect in the Kendler experiment. Perhaps subjects in the present experiment had insufficient practice to permit interference effects to appear.

The Nature of the Learning Process

If implicit responses and stimuli intervene between the external stimulus and overt response, as mediational theory holds, then a double acquisition function would apply to learning. The first step would involve acquisition of the mediating response which produces the appropriate symbolic cue. Problem solution would be delayed until the appropriate symbolic cue is present when the subject makes the correct response. The second stage, that of problem solution, would consist of forming the association between the symbolic cue and overt response.

The course of learning in the current study, as constructed from backward learning curves, did show that actual problem solution was delayed for some time and then occurred suddenly. The chance level of responding which was
present up to the point immediately preceding problem solution suggests that nothing was learned up to that point about the finally-to-be-learned response, though a considerable amount may have been learned about which dimension was relevant. According to mediational theory, one would expect that the habit strength of the mediating response to the relevant dimension gradually was increasing on successive trials until it suddenly emerged above threshold or became dominant over other competing habits. The final stage of discrimination, i.e., determining which value of the relevant dimension was positive, should only have taken a trial or two, as only two values were present. The learning curves showed that this appeared to be the case.

Qualification of Mediating Response Theory and Presentation of an Alternative Viewpoint

In the present experiment an attempt was made to coordinate some observable events with mediating mechanisms. The observable events (words, perceptual patterns) should not be confused with mediational mechanisms. Coordination of these observable events with mediational theory is useful in developing it, but a distinction must be retained between the concept of mediating response and these events. H. H. Kendler (1961, p. 196) explains the epistemological status of mediating response as follows:

The implicit stimulus and response events need not be conceived as having an existence independent of their relations to independent and dependent variables. These implicit events are theoretical constructs. Their epistemological status is closer to such concepts as drive and habit than to directly observable stimulus and response events.

The mediating response is, of course, not the only type of mediating mechanism which can explain the results. An alternative explanation, which assumes mediation by "observing responses," has been invoked by Wyckoff (1952,
Observing responses do not add cues in the sense that mediating responses do, but simply increase the probability that the relevant external cues will be perceived by the organism. The observing response model has a close kinship with theories of perceptual learning (Solley and Murphy, 1960). Observing responses are learned responses which lead to distinctive stimulation from one aspect of a stimulus complex in contrast to another.*

Predictions based on observing response theory do not differ for the present experiment from those made from mediating response theory. The major difference is that the former model characterizes mediation in perceptual terms and the latter theory more in symbolic terms. It is interesting to note that in the present experiment a corresponding distinction is made in characterizing mediating processes of younger and older children. Perhaps the observing response model is more appropriate for describing what actually is accomplished when young children mediate, i.e., perceptual learning occurs. The mediating response model may characterize more correctly what happens when older children mediate: words provide internal cues which substitute for the external stimulus.

Mediating response and observing response theories are not basically incompatible and can be combined into the following hypothetical chain of events:

- **S** → **r$_1$** → **s$_1$** → **r$_2$** → **s$_2$** → **R**
- external stimulus, observing response, perceived stimulus, symbolic mediating response, symbolic cue, overt response

where capital letters refer to directly observable stimulus and response events while lower case letters refer to those that are inferred. Kendler, Gluckberg

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*This functional definition is similar to that made by Kurtz (1955).*
and Kestenbaum (1961) attempted to separate the effects of observing response from mediating response. With the use of a tachistoscope they found that the superiority of a reversal over a non-reversal shift in college students was a function not only of appropriate mediating response but also of proper perceptual orienting act. Most rapid learning occurred when both factors were present simultaneously. This area seems to be a fertile one for future research, and so will be discussed further in the next section.

Suggestions for Further Research

Consideration of the results obtained in this investigation in relation to theory, method, and other studies, has suggested a number of problems for further investigation.

1. One study is suggested by the failure of the younger children to demonstrate positive transfer when the initial discrimination provided a relevant perceptual cue. It was thought that the size object arrangement did not achieve the desired intensity of effect due to the materials used in the experiment. One could increase the relative difference in size between large and small objects with the aim of enhancing the size effect. It would be interesting to compare several gradations of size differences in their influence on the performance of young and old children. This procedure could conceivably help to unravel the interaction of developmental differences in degree of reliance on perceptual cues in learning and of developmental differences in perception per se (i.e., with respect to diffuse versus differentiated percepts). One might find that it takes larger size differences to achieve an effect with younger children; but that once these children take note of the perceptual size information, it is more compelling for them than for older children.
2. Failure of the older children to show interference when they were instructed to use irrelevant verbal cues also needs further investigation. Is the matter of degree of initial training important, as Spiker's study (1962) implies? If so, how much training is needed to establish interference? Also, does the difficulty of the test discrimination make a difference? Is it harder to create interference of a mediational type on a simple task because possibilities of confusing the subject are reduced, or is the interfering effect independent of task complexity? Experiments in which degree of training and task complexity are independently varied would help to answer these questions.

3. A central point of inference in the interpretation of data has been the assumption that mediating responses to an entire dimension were established. In the current experiment the same values were retained for each dimension in the second task and only the reinforcement pattern was reversed. A better test of the mediating hypothesis might be to introduce new values for the previously emphasized dimension in order to determine if mediating responses include other values of the dimension, which would also be preferred over the values of the previously unemphasized dimension. For example, the training discrimination might involve a color dimension (red and green values) and a size dimension (large and small values). In the test discrimination the size values could remain the same but the color values could be changed to yellow and blue, and the subject would be required to learn a color concept. Will emphasizing the color values in the first task lead to easier learning of a color concept based on new color values? According to theory it should, because mediating responses should have a broad topography which includes other values in addition to those present in the original training.

4. Assuming that the hypothesis that younger children are less influ-
enced by verbal labels than by the perceptual characteristics was essentially supported, then further research could take several directions. One could set out to determine how resistant younger children are to using verbal responses as mediators. There was some evidence that the verbal cues were used to some extent by the younger children in the current undertaking. Would providing more extensive training lead to further utilization of these cues, or is this an alien function of words for nursery school children? That is, are words merely a means of communication at this age level, as some Soviet psychologists suggest?

Another course for research would be to compare various principles of gestalt organization with respect to their effect on perceptual mediation. Besides the principle of proximity which was explored in this study, Wertheimer (Ellis, 1938) has called attention to a number of other laws of perceptual organization, such as the factors of similarity, uniform destiny, einstellung, closure, direction, etc. Heidbreder (1949) suggests that the inclusiveness of the cue and its figure-ground position are two important determinants of cue preference. Empirical work is required to establish which configural arrangements best facilitate perceptual mediation.

5. A final suggestion for research is that an attempt be made along lines of the Kendler, Gluckberg, and Kestenbaum (1961) experiment to separate the effects of observing response (or perceptual learning) from mediating response. These experimenters found that college students showed most rapid learning when both an appropriate mediating response and the proper perceptual orienting act were present. It would be of considerable interest to determine if nursery-age children would perform in like manner to the college students, or to older children, on a similar type task. In their study Kendler and associates defined the observing response in terms of gross re-
ceptor orientation. Solley and Murphy (1960) have pointed out that perceptions may be changed at any of several stages of the perceptual act, receptor orientation being only one phase of a chain of events which include expectancy, attending, reception, autonomic and proprioceptive arousal, and trial and check. This list of perceptual components highlights the complexity of what may be involved in the modification of dimension preferences through perceptual learning. Such processes as "trial and check" smack of cognitive functioning. Obviously the boundaries between perceptual and conceptual processes have not been clearly delimited. The task of parceling out their differential effects is a challenge that will long confront the researcher.

A summary of the dissertation can be found in the Abstract in the front matter of the dissertation.
APPENDIX
## APPENDIX

Raw Data: Trials to Criterion in Concept Learning

<table>
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<tr>
<th>Treatments</th>
<th>Size</th>
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REFERENCES
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Bensberg, G. J. Concept learning in mental defectives as a function of appropriate and inappropriate "attention sets." J. educ. Psychol., 1958, 49, 137-143.


Buss, A. H. Rigidity as a function of reversal and non-reversal shifts in the learning of successive discriminations. J. exp. Psychol., 1953, 45, 75-81.


Harrow, M., and Friedman, G. B. Comparing reversal and non-reversal shifts in concept formation with partial reinforcement controlled. J. exp. Psychol., 1958, 55, 592-598.


Kendler, T. S. Personal communication to the author, 1962.


Reid, L. S. The development of noncontinuity behavior through continuity learning. J. exp. Psychol., 1953, 46, 197-212.


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