1973

Attribute-identification strategies in the moderately retarded

Richard Martin Anderson
Iowa State University

Follow this and additional works at: https://lib.dr.iastate.edu/rtd
Part of the Experimental Analysis of Behavior Commons, and the Psychiatry and Psychology Commons

Recommended Citation
https://lib.dr.iastate.edu/rtd/6184

This Dissertation is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Retrospective Theses and Dissertations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
INFORMATION TO USERS

This material was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.

2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in "sectioning" the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again — beginning below the first row and continuing on until complete.

4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from "photographs" if essential to the understanding of the dissertation. Silver prints of "photographs" may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.

5. PLEASE NOTE: Some pages may have indistinct print. Filmed as received.

Xerox University Microfilms
300 North Zeeb Road
Ann Arbor, Michigan 48106
ANDERSON, Richard Martin, 1942-
ATTRIBUTE-IDENTIFICATION STRATEGIES IN THE MODERATELY RETARDED.

Iowa State University, Ph.D., 1973
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan

THIS DISSERTATION HAS BEEN MICROFILMED EXACTLY AS RECEIVED.
Attribute-identification strategies
in the moderately retarded

by

Richard Martin Anderson

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major: Psychology

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

Signature was redacted for privacy.

Dean of Graduate College

Iowa State University
of Science and Technology
Ames, Iowa

1973
# TABLE OF CONTENTS

## INTRODUCTION

- Mediation Theories of Discrimination Learning  
  page 2
- Dimension Preference and Ease of Learning  
  page 10
- Effects of Irrelevant Variability  
  page 13
- Effects of Instructional Set  
  page 16
- Delineation of Strategy Behavior  
  page 21
- Summary of Research Objectives  
  page 26

## METHOD

- Subjects  
  page 29
- Selection Criteria  
  page 29
- Apparatus  
  page 31
- Experimental Design  
  page 31
- Procedure  
  page 33

## DISCUSSION OF RESULTS

- Preference Assessment  
  page 37
- Analysis of Acquisition Data  
  page 38
- Dimensional Variability  
  page 42
- Dimension Preference  
  page 45
- Instructional Set  
  page 49
- Analysis of Response Strategies  
  page 52
- Implications for Future Study  
  page 70

## REFERENCES

- REFERENCES  
  page 73

## APPENDIX A: SAMPLE PREFERENCE SCORESHEET

- APPENDIX A: SAMPLE PREFERENCE SCORESHEET  
  page 80

## APPENDIX B: DEFINITION OF STIMULUS SEQUENCE

- APPENDIX B: DEFINITION OF STIMULUS SEQUENCE  
  page 82
INTRODUCTION

Learning in the human adult has been regarded as a conceptual process in which knowledge about the world (e.g., objects or entities) is organized into categories or concepts (Bruner, Goodnow & Austin, 1956). Each category is based on a set of physical characteristics or attributes, which serve to define all of the objects which could be placed into that category. For example, "triangles" is a category of all things having the same basic shape; in this case, shape is called a 'relevant' attribute or dimension. Since triangles may be of any size, color or texture, these dimensions are said to be irrelevant to the concept.

In many laboratory studies of human discrimination learning, the subjects are presented with a series of objects or pictures of objects which vary on two or more dimensions, and are expected to learn to discriminate the objects on the basis of one dimension, disregarding the others. This same task has been used in countless studies, though it has been called both attribute identification (AI), as in Bourne (1966), and discrimination learning, as in Trabasso & Bower (1968).

It has been shown that the normal adult attacks the AI task in a systematic manner by selecting an hypothesis or trial concept and responding on the basis of that concept consistently until it produces an error. After an error trial, the subject selects a new hypothesis (Levine, 1966). If a subject has actually reached a conceptual solution in an AI situation, he would be expected to: 1) state a
verbal rule which defines the class of positive stimuli; and/or
2) respond with minimal error (transfer) to a series of new stimuli exhibiting the same relevant dimensions.

But the picture is not so clear when the conceptual behavior of a young child is in question. Children are generally approached differently than adults—instructions are simplified, problem difficulty is greatly reduced, greater emphasis is placed on rewards, the task is presented as a game rather than a problem. When the 'child' happens to be an adult who has the Mental Age of a young child, the experimental approach is simplified even more. The net result of these natural tendencies to vary (i.e., soften) the approach when evaluating the conceptual abilities of a less capable population has been to measure those abilities on a scale that is not compatible with the scale devised for normal adults, making true comparisons of the populations impossible.

In the following paragraphs, several theoretical, methodological, and statistical foundations for developmental comparisons of attribute identification skills will be examined as to their impact on the field of mental retardation and cognition. It is the purpose of this investigation to explore the possibility that by eliminating procedural biases, the mechanics and dynamics of conceptual learning in the retarded can be drawn into the mainstream of human cognitive theory and research.

Mediation Theories of Discrimination Learning

Theoretical accounts of the human AI learning process have
consistently called upon an implicit response to mediate reception of physical stimuli and the overt responses to those stimuli. The mediator has usually been conceived of as a perceptual or verbal response which highlights individual dimensional components of the stimulus. Different theorists have used a variety of terms, but all of the terms, e.g., coding response (Lawrence, 1963), mediating response (Kendler & Kendler, 1969), observing response (Zeaman & House, 1963), orienting response (Goodwin & Lawrence, 1955), and sampling response (Polidora & Fletcher, 1964), appear to refer to a common selector process.

Two of the above theorists have expounded on the mediation mechanism in an attempt to account for developmental changes in conceptual ability. Kendler and Kendler (1962) have adopted a binary model based on the presence or absence of an ability to associate a physical stimulus with an implicit verbal labeling response. Cues produced by this response, when added to the stimulus complex, then elicit the conceptual response. Prior to the transition to mediated learning, said to occur around 5 to 6 years of age, the child's learning is based on single-unit associational principles.

The attention theory of Zeaman and House (1963), on the other hand, proposes that the mediating response is perceptual in nature and, rather than adding stimulation, serves to limit the amount of effective stimulation to isolated dimensions of the stimuli. On each discrimination trial, the subject makes a chain of two responses;
first, a dimensional observing response is elicited followed by an approach response to one cue on the selected dimension. The probability of observing a given dimension \((P_0)\) is subject to the same laws of reinforcement and extinction as ordinary instrumental responses. Until the relevant dimension is observed, no learning of the relevant cues takes place.

The attention model holds that the development of conceptual ability is a function of changes in the relative strengths of relevant observing responses. It does not postulate any substantive changes in the nature of the learning process as the individual matures.

Most of the research supporting a developmental transition, e.g., Kendler & Kendler (1959); Kendler, Kendler & Wells (1960), has been based on numerous variations of the popular concept shift paradigm. In problems of this type subjects who have succeeded on a unidimensional AI task are presented a second AI (shift) task without delay or warning. Two basic types of shift or transfer tasks have been used. If the subject is asked to sort the stimuli on the basis of a new dimension, the task constitutes an extra-dimensional (ED) shift. If the relevant dimension remains the same, but all previously positive instances are now assigned to the negative category and vice versa, the task is called a reversal shift (RS). Although this design has been vigorously attacked and modified because of methodological problems (Slamecka, 1968), it remains as the prototype for much current research.
Inferences drawn from the shift paradigm by the Kendlers are basically simple. If a child is learning by directly associating overt responses with stimulus cues, the RS task should be the more difficult of the two shifts, as it alone requires that all previous associations be extinguished. If, however, the child's learning is mediated, the ED shift should be the more difficult, as it requires a new mediating response whereas the RS mediator is unchanged.

These inferences generated a landslide of studies which served to cast serious doubts on the validity of the association-mediation transition. In a comprehensive review of concept-shift literature, Wolff (1967) concluded that there is no acceptable evidence that children below the age of 5 learn shift problems in a single-unit associative manner. Investigators have shown that a reversal shift was solved more rapidly than an ED shift by groups of kindergarten children (Smiley & Weir, 1966), preschool children, (Dickerson, 1967), 3-year-olds (Caron, 1969), and retardates with 2- to 4-year mental ages (House & Zeaman, 1962; Heal, Bransky & Mankinen, 1966).

Shepp & Zeaman (1966), after reviewing concept-shift studies using retarded subjects, also found reversal learning to be faster than ED shift learning. They concluded that this mediating process appears to characterize the behavior of rats as well as the behavior of normal and retarded children. Wolff (1967) added that:

The majority of the evidence indicates that retardate [shift] behavior is fully consistent with a two-stage model, as Zeaman and House have indicated. This would suggest either that retardates are not so deficient in verbal
mediation as many have supposed or that the operation of verbal mediating responses is not necessarily implied by ID intra-dimensional shift superiority (p. 384).

Both of the models seek to analyze the phenomenon of dimensional responding during discrimination learning, which cannot be adequately explained with single-unit theory. The Kendlers' mediation model, with its conception of a developmental shift from associative to mediated learning, provokes the suggestion that in mental retardation this transition may be delayed, defective, or completely absent. In his review of concept formation research, Kendler (1961) made the following statement about the position taken by the Russian psychologist, Luria:

As the child matures, the verbal behavior, which may be implicit or explicit, gradually comes to mediate and regulate overt behavior. Behavior that is conditioned without verbal associations is relatively unstable, is dependent on constant reinforcement, and disintegrates at a slight change in the manner of presenting the signals. Behavior that is conditioned via verbal associations is quickly acquired, very stable, and generalizes widely. Normal humans from 5½ years of age and on tend to operate via verbal control, whereas younger children and mental retardates do not. The implications of this position are as interesting as they are congruent with the mediated-response analysis. However, not all the data supporting it are available in English; corroborative work needs to be done (p. 465).

Thus, no consistent evidence in support of a generalized lack of mediated learning ability in the retarded has been produced, yet for nearly half a century such an assumption has pervaded the realm of special education. Application of this premise to methods of teaching preschool children has generated the idea that this population is generally incapable of conceptual thought. The resultant dilemma
was aptly stated by Iano (1971):

The emphasis is on such ideas as that the retarded tend to be rote rather than meaningful learners; that they are poor in reasoning, comprehension, and the ability to generalize or transfer; and that they learn best through automatic drill and repetitive practice. Rote memorization of the curriculum is then encouraged, with a deemphasis on underlying meanings, conceptual understanding, and generalized principles....

...As a consequence, the teacher's preconceptions of the children's learning characteristics are confirmed and strengthened: retarded children learn by rote and repetition, they easily forget what they have learned, and they fail to generalize. In this way, the behaviors encouraged by restrictive teaching strategies confirm preconceptions which led to those strategies in the first place (pp. 307-308).

How, then, is the cognitive capacity of the retarded individual to be identified and explained so that existing preconceptions can be altered? More basically, what theoretical orientation provides a framework which will enable basic conceptual ability in the retarded to be demonstrated and, subsequently, developed?

Instead of searching for structural deficits in learning mechanisms, it would seem profitable to examine more closely the way in which retarded subjects interact with the actual stimulus variables. Such an approach does support the research strategy used by Zeaman and House (1963), as follows:

The attention hypothesis (that retardates suffer from low initial probability of observing certain relevant dimensions rather than from poor ability to learn which of two observed cues is correct) is to us a hopeful and exciting notion because it leads so quickly to a search for experimental operations that may change $P_0(1,0)$ and hence accelerate discriminations of subjects who might otherwise seem to be natively and irreversibly poor discriminators (p. 188).
A strikingly similar strategy is implied in the perceptual-differentiation theory of Tighe and Tighe (1966). They contend that the developing individual becomes increasingly sensitive to variables or differences in stimulation, a process called perceptual learning. It is the ability to detect and use new and more exact stimulus differences which determines the facility of discrimination learning. Individual and developmental differences in discrimination ability would be based on varying opportunities for and experiences with perceptual learning. The fact that retarded individuals, especially those confined to institutions, do have a notoriously restricted perceptual learning milieu would suggest that this is a tenable research area.

Differentiation theory holds that reinforcement during discrimination learning tends to focus attention on those stimulus properties which are perceived in relation to it. Treatments which serve to emphasize the relevant stimulus differences should tend to facilitate discrimination learning. Tighe (1965) gave 5- and 6-year-old children pretraining in rendering same-different judgements of stimuli varying independently in height and in brightness. A control group received pretraining unrelated to the tasks involved. Subjects with perceptual pretraining learned a reversal shift significantly faster than an ED shift. Control Ss showed no differences between the two shifts.

Further evidence showed that 6- to 7-year-olds made fewer errors on a reversal shift problem given that they had made below-
median errors on a concept of dimensionality test (Johnson & White, 1967). The test, similar to the Tighes' pretraining, required subjects to order two series of stimuli, which varied along each dimension of the shift task (size and brightness). The same investigators (White & Johnson, 1968) showed that children aged 3 to 6 years were more likely to make an optional reversal shift if they made few errors on the dimensionality test. With these younger children, ease of mandatory RS learning was not related to test scores.

It can be argued that highlighting the dimensional properties of the stimuli enabled young children to later make use of the dimensional concept during an RS task. It can also be generally stated the concept-shift performance is related to an ability to respond to the relevant dimensional properties of the stimuli.

Despite a mild controversy between attentional and differentiation theorists over the relative importance of stimulus- and subject-oriented variables, there seems to be fundamental agreement on the following three principles:

1) human learning ability is affected by individual differences in perceptual biases;

2) perceptual habits are subject to change while basic learning mechanisms are not;

3) conceptual learning ability will be demonstrated to the degree that the subjects perceptual biases are congruent with the requirements of the discrimination or AI task presented to them.
Each of the principles can serve to direct the researcher's attention to a class of treatment variables and a large body of research:

1) effects of differential preferences or biases for attending to various stimulus dimensions;
2) effects of pretraining via instructional set;
3) effects of the amount and type of irrelevant variation in the stimuli.

Each class of variables will be examined and applied to the study of conceptual learning ability in the mentally retarded in the following paragraphs.

Dimension Preference and Ease of Learning

There has been a recent flurry of interest in the question of whether or not a subject's perceptual preferences for stimulus dimensions should affect the difficulty of a discrimination task. If a preference implies high attentional value ($P_0$) for that dimension, then decreasing the relevance of the preferred dimension should serve to increase the difficulty of the task; the greater the relevance, the smoother the course of learning.

Numerous studies have shown that over 70% of the children and adults used as subjects demonstrated definite preferences for specific stimulus dimensions. They also show that the preferences form a developmental progression from color to form (Brian & Goodenough, 1929; Kagan & Lemkin, 1961; Corah, 1964; Suchman & Trabasso, 1966a). The younger child's strong response to color has been interpreted as
a reaction to the more global, diffuse character of the color dimension (Corah, Jones & Miller, 1966), and may be based on an impulsive type of response rather than on an actual preference (White, 1964). The child over approximately 5 years of age is said to be more likely to respond to form because of the increased emphasis upon this dimension in his academic training (Lee, 1965). However, many older children and adults, as well as young children, will either prefer color or respond equally to both dimensions.

Prior to 1966, the suggestion that dimension preference was related to learning rate was based solely on indirect evidence. Problems with color as a relevant dimension were learned faster than form problems by nursery school children (Lee, 1965), while form problems were learned faster by older children (Calvin & Clifford, 1956) and by adults (Kendler, 1961). Direct evidence was obtained by Suchman and Trabasso (1966b), when they found that 4- and 5-year-old children learned an AI task fastest when the problem was based on their preferred dimension, whether color or form. These results were extended by Crane and Ross (1967) to 2nd- and 6th-grade children and by Wolff (1966) to a color vs. height AI task using 6-year-olds.

Several studies have suggested that older children are less affected by dimensional salience than are younger children. Odom and Mumbauer (1971) presented a two-choice AI task with color or form relevant to groups of subjects in grades 1, 5, 7, 10, and college. All Ss had demonstrated form preferences. No groups differed in performance on the task with form relevant; only the 1st- and 5th-
graders had difficulty with the (non-preferred) color task. Odom and Guzman (1972) assessed the preference hierarchy (form, color, position, and number) in a large sample of children 5 to 12 years of age. The relative salience of a dimension was negatively associated with number of errors on an identity test using the same dimensions. The salience effect was most predominant with Ss in the 5 to 8 year range. Using a more complex matching-to-sample AI task, Mitler and Harris (1969) found preference to be related to ease of solution for kindergarten, 1st-grade, and 3rd-grade children. A closer analysis of their results shows that form-dominant 1st-graders performed best on a color-relevant task. The dominance effect was only slight for 3rd-graders. They concluded that the over-all dominance effect was probably due to the kindergarten sample.

Similar, though less extensive, evidence is available with retarded Ss. Using a color-form sorting task, Halpin (1958) found more color than form preferences. As mental age (MA) increased from 3 to 10 years and chronological age increased from 7 to 14, fewer preferences were demonstrated, with more Ss being able to sort on both dimensions. Wilcock and Venables (1968) discovered a relationship between preference and ease of solving a matching-to-sample task in a group of severely retarded subjects. Retardates with Down's syndrome, who were predominantly color dominant, made four times as many errors with form problems as with color problems. Other retardates and normal subjects, who showed slightly more form dominance than color dominance, made more errors on the color problem. This
evidence would have been more impressive, however, if the author had compared scores of tasks based on the preferred vs. non-preferred dimensions.

Preference groups have also been compared in several studies of RS learning with both retarded and normal children. Subjects who originally learned an AI problem with the preferred dimension relevant learned it rapidly, and then learned the reversal shift of the cues faster than they learned an ED shift; those trained on the non-preferred dimension took significantly more trials to learn and showed no RS superiority. This pattern of results has been found with normal 3-year-olds (Caron, 1969), preschool children (Mumbauer & Odom, 1967), kindergarten students (James, O'Brien & Brinley, 1969; Smiley & Weir, 1966), and retarded subjects, IQs 36 to 67 (Heal, Bransky & Mankinen, 1966).

Effects of Irrelevant Variability

The foregoing research on dimensional preference would indicate that individual differences in such perceptual variables may be a critical factor in research devoted to locating and treating the deficiencies of retardate learning. The fact that one dimension is perceptually dominant over another may be responsible for much of the difficulty in learning to generalize concepts. Such learning involves continued attention to one dimension, despite new variations on one or more irrelevant dimensions. If the child's dominant dimension is included in the concept as irrelevant, he may shift his focus of attention to that dimension when it is introduced. He
would be unable to identify the correct concept unless he could shift his attention away from the dominant dimension, which has been found to be difficult for normal preschool children (Kofsky & Osler, 1967).

Additional dimensions can be introduced into an AI task so that the new stimulus variability constitutes: 1) irrelevant variability within trials (IW)—two or more values of the dimension are presented on each multiple-choice trial or, with successive presentation, the dimension is available as the basis for a response choice on every trial; 2) irrelevant variability between trials (IB)—the two values are present on separate trials (this condition is impossible with conventional successive presentation); 3) redundant relevant cue variability (RRC)—every value of a relevant dimension is compounded with only one value of each other relevant dimension.

The Zeaman-House model (1963) makes no theoretical distinction between the effects of IB and IW variability. They do state that, intuitively, the IW cues should retard learning to a greater degree. Increasing the number of relevant dimensions (RRC) should improve learning, as the $P_o$s for those dimensions would be additive. Increasing the number of irrelevant dimensions may either facilitate, retard, or have no effect on learning speed, depending on the relative $P_o$s of the competing dimensions.

Current hypothesis-testing models of adult concept learning (Bourne & Restle, 1959; Bower & Trabasso, 1964) are in general agreement with the Zeaman-House model except that they state that the
addition of irrelevant stimulus dimensions to an AI task will increase
the difficulty of the task. This hypothesis has been confirmed in
extensive studies by Bourne & Haygood (1959) using college students,
and by Osler & Kofsky (1965) using 4-, 6-, and 8-year-old children.
Similar results have been found with retarded subjects when pre­
sented two-choice AI tasks (Lubker, 1967; Evans, 1968) and oddity
tasks (Lubker & Spiker, 1966; Lubker & Small, 1969).

As yet there is no direct comparison of all three types of
variability, though several studies have made IB vs. IW comparisons.
In the Lubker (1967) study, 3rd- and 4th-grade children solved a
form AI task with two IB dimensions, but failed to solve similar
tasks with one or two IW dimensions. Lubker (1969) followed with a
more extensive study of the same population, in which 0, 1, or 2
irrelevant dimensions were presented either IB or IW. Tasks with IW
variability were significantly disrupted relative to IB variability.
There were no reliable differences between problems having 1 or 2
irrelevant dimensions. In the Dickerson (1967) study, IW variability
was also more difficult for kindergarten children, though the tasks
constituted ED shifts from a previous discrimination. The results did
suggest, however, that attention is more readily shifted away from an
irrelevant dimension when it varies between trials. A recent study
by Evans & Beedle (1970) found no over-all effect of IB vs. IW
brightness variability for retardates, MA 5 to 10 years. However,
nested within this factor was a comparison of two degrees of size IW
variability (½ cm. vs. 2½ cm. differential); performance was
significantly impaired when size differences were increased, i.e.,
when size was made a more obvious IW cue. The possibility of in-
advertant confounding of two IW cues makes the authors' conclusion
equivocal.

Hypothesis-testing models also predict that increasing the
number of redundant relevant dimensions will improve learning rate.
This has been confirmed by Bourne & Haygood (1961) and by Trabasso
& Bower (1968). The latter investigators showed that RRC learning
may transfer to either one or to both dimensions of the task; transfer
was demonstrated with non-reinforced test stimuli having only one of
the relevant dimensions present. Their cue-selection theory accurately
predicted that RRC learning rate and transfer accuracy were functions
of the relative difficulties of the single-cue problems. To date,
the RRC paradigm has not been used in research with the mentally
retarded.

Based on the above findings, it was predicted that the subjects
in the present investigation would find an IW task more difficult than
an IB task; both tasks would be more difficult than an RRC task, using
the same dimensions. It was anticipated that dimension preferences
will serve to heighten the effects of dimension variability. Further-
more, it was expected that on tests of RRC transfer retarded subjects
would show little or no learning of the non-preferred dimension, but
would exhibit learning of the preferred dimension.

Effects of Instructional Set

Assuming that the demonstration of a definite dimension preference
on a matching test indicates the availability of that dimensional concept, then the conditions that affect the usability of the concept can be examined independently (Mitler & Harris, 1969). Treatments such as dimensional training, verbal labeling, and overtraining have all been shown to improve concept usability as reflected in learning transfer tasks. However, one very important methodological factor has been largely ignored in the experimental literature, that of instructional set. The possible significance of this variable has been discussed, as in the following statement by White (1966):

If S is given substantial training on a conceptual problem, he will become a hypothesis-tester. If given training on a problem that requires another strategy, he will learn an appropriate strategy and his data will reflect the usage of that strategy in subsequent conceptual tasks. Presumably, instructions may serve the same function (p. 12).

The importance of instructional set has also been emphasized by Bruner et al. (1956):

What does the person take on as the objective of his [problem solving] behavior? The first consideration here is whether or not the person is consciously or 'reportedly' seeking a concept (p. 56).

If the subject is not seeking a conceptual solution, but attempts to memorize the stimuli in rote fashion, he will show little evidence of a conceptual solution when expected to transfer his learning to new stimuli. His general capability to form a conceptual solution, however, has not yet been determined.

In most studies of adult AI learning, the subjects are informed directly that they are to identify which dimension is the correct basis for sorting or catagorizing the stimuli. They are also commonly
informed of the dimensions that are involved in the task. Add this to their years of academic experience in discovering and manipulating conceptual materials, and the result is a strong 'set' to seek a consistent rule for solving the problem.

Conversely, in most studies of AI learning in children, subjects are only told to find which stimuli are correct. Any set for a conceptual solution must come from within the subject, who has had little supervised experience in such situations. If the subject is an institutionalized retarded person, he may never have received reinforcement for conceptual thought or problem solving behavior. Comparisons of adult and child conceptual abilities may, therefore, be biased in favor of the adults.Capabilities of the child and retardate may be under-estimated, especially on the simple types of AI tasks usually presented, whenever concept-orienting instructions are not given.

The available evidence related to this question is limited, but consistent. For example, Reed (1946) demonstrated that more adult subjects had learned a simple rule for categorizing when given specific instructions to that effect (86%) than when instructed to learn stimulus names (67%). Later, Weiss (1954) ran a study specifically designed to compare the effects of specificity of instructions. Results showed that preschool children learned faster under each of two conditions: informing them that one stimulus will always be correct and calling the child's attention to the relevant dimensions of the stimuli.
Osler and Fivel (1961) suggested that self-instructional activities of more intelligent children may have led to their superiority over normal children on a concept identification task which used very general instructions. Only the more intelligent subjects acted like hypothesis testers. The concepts used in the tasks were Bird, Animal, and Living Thing. In a replication of the study (Osler & Weiss, 1962) the problem to be solved was defined more clearly and the subjects were directed to test hypotheses. With the more specific concept-orienting instructions, the differences due to intelligence disappeared. This change was due entirely to improvement in the normal group.

In more recent years, little systematic attention has been given to the instructional variable. The only study found to date which looked at simple dimensional concepts involved kindergarten children given matching-to-sample tasks (Levin & Hamermesh, 1967). When S was only given the instruction, 'If you do really well on this game and make the red light come on often enough, you will get these prizes to keep', none of the Ss solved the problem. However, the addition of the sentence, 'If you look carefully at all three pictures you can figure out how to make the red light come on all the time', significantly increased the proportion of solvers. This sentence tells the child that some characteristic of the stimuli consistently determines which choice will be correct, and that the E expects him to learn what that characteristic is. The instruction then fills both conditions outlined by Weiss (1954).
The only evidence relating instructions to performance in AI situations requires a post-hoc comparison of conditions in similar studies. Two such comparisons are presented below.

1) Lubker (1967) presented an AI task having 2 IW dimensions to children 8 to 10 years of age. Their instructions were not concept-oriented and the Ss' performance remained at chance levels throughout the full 72 trials. Klugh and Janssen (1966) presented the identical task to retarded adults with MAs of 3 to 8 years and to normal children, 5 to 6 years of age. Their instructions were concept-oriented and, after on 56 trials, 78% of the retardates and 50% of the normals reached criterion.

2) Two studies presented kindergarten children with an AI task based on either the preferred or the non-preferred dimension. Smiley and Weir (1966) used only one irrelevant (IW) dimension, but omitted the concept-orienting instructions. All Ss learned the dominant discrimination, while over 33% of the Ss had failed to learn the non-dominant task after 100 trials. Suchman and Trabasso (1966b), however, used a more difficult task (3 IW dimensions), but gave concept-orienting instructions. The dominant dimension was learned faster than the non-dominant dimension, but nearly all Ss were able to reach criterion within 32 trials.

In the present investigation the two types of instructions described above were to be compared as to their effects on acquisition of simple AI problems by moderately retarded adults. If concept-orienting instructions do actually serve to improve the usability of
dimensional responding, they should yield more rapid learning relative to traditional stimulus-orienting instructions.

**Delineation of Strategy Behavior**

Traditional descriptions of discrimination performance have centered around a plot of trials against percentage of correct responses. Because individual curves are too irregular to interpret and too cumbersome to publish, most researchers have chosen to plot the average performance of an entire group. The form of the resultant learning curve has often been presented as evidence for various basic processes involved in learning. But to what extent is the form of the group curve, and thus the nature of the underlying process, characteristic of the individual learner?

It has been recognized that large groups are commonly heterogeneous, with individuals reaching criterion on widely differing trials (Sidman, 1952). Since such differences can be obscured when scores are averaged, Hayes (1953) placed subjects (rats learning a brightness discrimination) into more homogeneous groups according to the trials on which they made the final error. The learning curves were no longer negatively accelerated—prior to the criterion, performance hovered about the chance level; at criterion, the curves all rose rapidly to maximum performance. The only characteristic distinguishing the groups was the length of the pre-criterion phase. Hayes also demonstrated that the shape of the individual learning curves can be retained in a group average curve, if the data are plotted on an abscissa where each point represents X trials before
reaching criterion. Such a plot has been called the 'backward learning curve'.

In all of their comprehensive studies of discrimination learning in the retarded, Zeaman and House (1963) have used the backward learning analysis, since the retarded, especially those in institutions, are by definition, a deviant, heterogeneous population. They have consistently found the characteristic of chance performance followed by rapid solution, even with the severely retarded. As the Mental Age (MA) of the subjects dropped, the length of the chance phase increased and the percentage of eventual learners dropped.

The most common interpretation of the phase of chance responding is that it represents a period where the subject is shifting the focus of his observing response (attention) from one dimension to another. For some theorists, a shift represents the rejection of one hypothesis and selection of another (Krechevsky, 1938; Trabasso & Bower, 1968). To others, the shift is less voluntary, being based only on the relative probabilities of each observing response (Zeaman & House, 1963). Shepp and Zeaman (1966) later found the length of the pre-criterion phase to be directly related to the degree of difficulty of both size and brightness discriminations (based on absolute magnitude of physical differences between positive and negative cues). All seem to agree, though, that the initial probability of selecting or observing a given dimension is based on prior experience and individual preferences. These probabilities should be a major factor in determining the length of the pre-criterion phase and, thus, in the
difficulty of the learning task.

Many investigators have felt that the pre-solution behavior their subjects displayed was systematic to a certain degree, and that their choices represented trial solutions based on irrelevant dimensions. There have been only a few attempts to actually decode pre-solution behavior in AI learning situations. Harlow's (1950) method of identifying error factors was used with retarded subjects by Baumeister (1966) and by Ellis, Girardeau, and Pryor (1962). This method provides a usable summary of a subject's response to error trials, but does not sample responses leading to reward. Levine (1963) felt that deduction of a subject's learning strategy should be based on both correct and incorrect choice trials; he designated a correct choice on trial \( n \) as a 'win', an incorrect choice as a 'lose'. On trial \( n+1 \), the subject could repeat his response with respect to a given stimulus dimension ('stay') or he could respond to the opposite cue ('shift'). For every stimulus dimension, including position in two-choice tasks, the subject's response to any \( n+1 \) trial must be described, with respect to the previous outcome, as either win-stay, win-shift, lose-stay, or lose-shift.

Levine then generated a list of response sequences by considering all possible pairs of the above responses; these sequences operationally defined a set of four basic hypotheses (Hs) or inferred strategies. Two of the Hs are called Response-set Hs; they are win-stay:lose-stay (response perseveration) and win-shift:lose-shift (response alternation). The remaining two Hs are called Prediction Hs or Outcome-Contingent Hs,
since the response (stay or shift) differs with the outcome of the preceding trial; they are win-stay:lose shift (predicts that the correct cue remains the same) and win-shift:lose stay (predicts that the correct cue will alternate). Obviously, if the subject applies the win-stay:lose-shift H to the relevant dimension of the task consistently, he will have achieved the solution.

Levine's (1963) method of deriving quantitative measures for the various Hs is based on the frequencies of the four original response types (win- or lose-stay and win- or lose-shift). Frequencies for the appropriate pairs of response types are summed to yield scores for each of the four Hs. Because the shift vs. stay pairs of Hs are complementary, Levine devised a differential score (D-score) to evaluate the difference in strength between members of each pair of complementary Hs. For example, if 70% of the responses had represented position perseveration, then the remaining 30% would represent position alternation; the D-score would reflect the difference in these two proportions.

To date, only four discrimination learning studies have been found which used modifications of the D-score (Hill, 1965; Harter, 1967; Harter, Brown & Zigler, 1971; Moffit & Coates, 1969). The latter three studies involved retarded subjects. The D-score measure was sensitive to several treatment variables and did appear to have a certain amount of face validity when viewed as a summary of discrete response frequencies. However, it has serious shortcomings if it is to be interpreted as a measure of an absolute amount of strategy or
hypothesis-testing behavior. The term, strategy, implies that a series of consecutive choices are made on the basis of a consistent rule. The D-score says nothing about the number of consecutive instances of a given H; it was designed to evaluate 2nd trial responses of learning set tasks and only reflects frequencies of discrete events. Furthermore, because of the artificial pairing of the individual response types, e.g., win-stay added to both lose-stay and win-shift, all of the resultant H measures carry the onus of being post-hoc, confounded statistics.

In a study of oddity learning using preschool children, Croll (1970) analyzed consecutive 6-trial blocks. A given strategy was said to have occurred in a block, if all six responses were consistent with that one strategy. While the technique was somewhat sensitive to localized strategies, it proved able to identify only the strongest and most consistently used strategies, those being solution and stimulus perseveration. In addition, the strength of a strategy response in a given subject could not be determined, nor could the strength of the group effects be readily subjected to statistical tests.

Fellows (1968) has suggested an alternative to strategy preference measures such as the D-score. He proposed a measure (designated here as the H-score) which would reflect the length of consecutive runs by an S on each of Levine's Hs. The H-score would show the extent to which an H had dominated periods of responding. It would not, of course, indicate how many periods occurred and how they
were related; such information, though valuable, would require lengthy qualitative analysis of individual response patterns.

Currently, the usefulness of the H-score has not been tested in actual experimental condition. Therefore, an H-score analysis will be applied to the results of the present investigation with the hope that it will provide a viable description of the seemingly random responding which often precedes AI solution. If the H-score also proves to be sensitive to factors which affect problem difficulty, it may provide a valuable tool for the diagnosis and remediation of conceptual learning disabilities.

Summary of Research Objectives

The major goal of the present investigation was to clarify the cognitive capabilities of the mentally retarded by careful examination of the dynamics of attribute-identification learning. It was felt that this population is amenable to both the methods and the theories of cognitive research with normal adults. To this end, four research areas, described in the foregoing pages, have been selected for study; three of these areas offer methods which, though commonly used with normal populations, have not been systematically applied to retarded groups. These methods are: 1) instructions specifically designed to orient the Ss to the concept-identification aspects of the task; 2) use of the Redundant-Relevant-Cue paradigm; and 3) quantitative measures of sequential response patterns or inferred strategies. The fourth research area, the effects of dimension preferences, has frequently been applied to retarded groups via the discrimination-shift paradigm.
However, it is felt that if the preference variable is a viable construct, then its effects should be apparent in AI tasks having differing forms of dimensional variability.

Based on the above general research strategy, the present study has been divided into four major areas of concern.

1 - Dimensional Variability. The moderately retarded, like normal children and adults, will find AI tasks more difficult when a second dimension varies IW rather than IB; both tasks will be more difficult than an RRC task composed of the same two dimensions. Furthermore, on tests of RRC transfer, the S's are expected to show evidence of conceptual learning. In combination with Area 2 below, it is expected that there will be superior transfer shown on the S's preferred or dominant cues.

2 - Dimension Preference. A moderately retarded S's P for a stimulus dimension, as inferred from a forced-choice preference test, will interact with the degree of relevance of that dimension in an AI learning task. This implies that if the demonstration of a preference reflects a dominant P for that dimension, then any changes in the relevance of the dimension in an AI setting should be positively related to changes in the ease of solution. Such a relationship has not been established with retarded Ss in a basic AI learning situation. When the dimension with higher P is present IW, learning should be impeded. In IB tasks, the P of the irrelevant dimension should be itself irrelevant; if the P differential of redundant relevant dimensions were great enough, identification of the dimensions with
lower $P_o$ values should be of greater difficulty. However, the latter effect cannot be evaluated without absolute measurement of $P_o$, which is beyond the scope of the present investigation.

3 - Instructions. With instructions designed to orient the Ss toward conceptual solution, learning will be enhanced as compared to instructions which simply orient the Ss to the stimulus-reward contingencies of the task. This variable is intended to reflect the instructional set differential typically found between experiments using adult Ss and those using children or retarded Ss. Since concept-instructions are intended to provide S with a dimensional set, the effects of dimensional preference should be enhanced under these conditions.

4 - Analysis of Strategy Behavior. It is expected that the application of backward learning and $H$-score analyses to the data will indicate that the retarded do respond to an AI situation in a non-random strategic fashion. Relevance of the preferred dimension and use of concept-orienting instructions should serve to increase the degree as well as the nature of the strategy behavior. The latter effect should be characterized by developmentally more advanced strategies, i.e., fewer position habits and more outcome-contingent habits (White, 1964).
METHOD

Subjects

A total of 72 residents of Gracewood (Georgia) State School and Hospital were selected from a sample of 132 adults, aged 16-35, with IQs in the 36-55 range (moderately retarded). Criteria for selection were the absence of gross physical handicaps, the ability to pass the screening test described below, and demonstration of a consistent Color-Form dimension preference.

Six males and six females, half preferring Color and half preferring Form, were assigned to each of 6 groups so that all groups were matched on IQ. Age and IQ characteristics of the groups are presented in Table 1. Mental age data are not presented as they are directly proportional to IQ after age 15. Each group was assigned to one of 6 treatment conditions, created by the factors, Type of Variability (IB, IW, or RRC) and Instructions (Stimulus- or Concept-orienting).

Selection Criteria

Screening test

Four subtests from the Leiter International Performance Scale (Leiter, 1969) were administered to all potential subjects as follows: (#II-1) Matching Colors; (III-1) Matching Forms; (IV-1) Matching Form and Color; (IV-4) Matching Form, Color, and Number. Success on two of the tasks indicated satisfactory ability to discriminate the patterns and colors used in the study. Only 4 Ss failed the test and were removed from the sample.
Table 1. Age and IQ characteristics of primary treatment groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>IB-Concept</td>
<td>24.75</td>
<td>16-32</td>
</tr>
<tr>
<td>IB-Stimulus</td>
<td>24.09</td>
<td>16-34</td>
</tr>
<tr>
<td>IW-Concept</td>
<td>24.75</td>
<td>16-35</td>
</tr>
<tr>
<td>IW-Stimulus</td>
<td>23.50</td>
<td>16-28</td>
</tr>
<tr>
<td>RRC-Concept</td>
<td>24.17</td>
<td>16-35</td>
</tr>
<tr>
<td>RRC-Stimulus</td>
<td>24.67</td>
<td>16-30</td>
</tr>
</tbody>
</table>

Assessment of dimension preference

Immediately following screening, Color-Form dimension preferences were assessed with a 3-choice matching task based on the test used by Suchman and Trabasso (1966a). Each 6½ in. x 8 in. preference card contained three stimulus figures cut from Con-Tact paper and arranged so that the distance between any two figures was approximately equal. Figures varied on the dimensions of Color (red or blue), Form (circle or square), and Size (2.7 sq. in. or 4.5 sq. in.).

There were eight practice plates, on which two identical figures differed from the third on all three dimensions. Color, Form, and Size varied independently on twelve test plates and were each represented by one pair of figures. On six additional test plates, only Color and Form varied, with one pair representing an error choice. Relative positions of the figures were varied so that any position
response bias would result in a random preference score.

The entire series of 18 test plates was presented once in a pre­arranged order; the S's task was to "Point to the two figures that are alike (or the same)." A sample score sheet is presented in Appendix A.

Apparatus

All attribute identification (AI) tasks were based on a two­choice pattern discrimination, with each pattern projected from a carousel slide projector onto the back of a separate frosted plexiglass stimulus panel. Pressure applied to the stimulus panel tripped a microswitch which activated either a door chime, if the response was correct, or a 1­sec. buzzer, if the response was incorrect. A delay timer advanced the projector to the next slide 2 sec. after each response.

Stimulus panels were 10 cm. x 11 cm. and were separated horizontally by 11 cm. The subjects were seated facing the apparatus, which was housed in a black wooden console, with the stimulus panels visible at shoulder height. The E was seated beside the console at all times.

Experimental Design

Each AI task consisted of 2­choice pattern discrimination training with either Color (red vs. blue) or Form (circle vs. triangle) as the relevant dimension and with the remaining dimension varying in one of three ways. In Condition IB, the second dimension was irrelevant and varied between trials, e.g., Trial 1 - red vs. blue
circles, Trial 2 - red vs. blue triangles, correct choice always red. In Condition IW, this dimension was again irrelevant, but varied within each trial, e.g., Trial 1 - red circle vs. blue triangle, Trial 2 - red triangle vs. blue circle, correct choice red. Conditions IB and IW differed only in the pairing of the stimulus figures; the same individual stimuli were presented in both cases. In Condition RRC, both dimensions were relevant and completely redundant, e.g., circles were always red, triangles always blue.

Subjects assigned to Conditions IB and IW were presented two AI tasks with a 4-week delay between tasks to minimize carry-over effects. On one task, the S's preferred dimension was relevant with the non-preferred irrelevant; on the other task, the opposing, non-preferred, dimension was relevant with the preferred irrelevant. Presentation order of the two tasks was randomized, but remained balanced across all experimental variables. Subjects in Condition RRC were presented a single AI task in which both the preferred and non-preferred dimensions were relevant.

In order to increase the number of distinct stimulus pairs to a total of 16, two additional stimulus factors were inserted. Position of the relevant cue (left or right stimulus panel) was varied IW throughout and size of the stimulus figures (on a 5-to-3 ratio) was varied IB (as well as IW in the RRC task).

All Ss viewed the stimulus pairs in a constant order based on six 12-trial stimulus sequences, as described by Fellows (1967). In order to apply these position sequences to the multi-dimensional
tasks of the present study, the attributes of each irrelevant dimension were keyed to a separate series of two sequences (size to #5-#6, position of the relevant cue to #2-#4, and the IB or IW dimension to #7-#7). This combination of sequences protected each dimension from differential reinforcement due to systematic responding on any other dimension. By collating these three sequences, a series of 24 stimulus pairs was defined; the series is described in detail in Appendix B. Following every 24th pair, the sequence was reversed; thus, a complete sequence consisted of 48 stimulus pairs. The criterion of successful performance throughout was 10 consecutive correct responses.

Procedure

Prior to the initial AI task, each S was given 5 trials experience on a simple discrimination task, in which multi-colored pictures of a girl and a football were paired. As this is one of the easiest discrimination tasks for the severely and moderately retarded (Zeaman & House, 1963), any S failing to learn to "pick the correct picture" on 4 out of 5 trials was eliminated from the sample. Instructions for all were similar to those given to the Stimulus-oriented groups, as described below. The pretraining task also served to familiarize S with the mode of responding, the experimenter, and the environment. Every attempt was made to put the Ss at ease. The E was present at all times, verbally supplementing each positive and negative feedback signal.
Concept-orienting instructions

Prior to each AI task, all Ss assigned to the Concept-oriented groups were given the following instructions modeled after those used by Klugh and Janssen (1966):

"Now I want to see how quickly you can solve a puzzle. This puzzle has to do with pictures of objects like these (present first stimulus pair). You see that these pictures are not alike; in fact, they are different in a lot of ways. I'm going to show you some more pictures like these. Each time they come on I want you to push the picture that's the kind of thing that will ring the bell. All the ones that ring the bell are alike in some way. Let's see how quickly you can learn what kind of picture makes the bell ring every time. If you pick the wrong kind of picture, you'll hear a bad buzzer."

Before each trial, E said, "Which one is the kind of picture that rings the bell?" After each response, E said, "Yes, that's the correct kind!" or "No, that's the wrong kind!" Periodically, E reminded the S, "Remember, all the ones that ring the bell are alike in some way."

Stimulus-orienting instructions

Prior to each AI task, all Ss assigned to the Stimulus-oriented groups were given the following instructions modeled after those used by Kendler and Kendler (1959):

"We are going to play a game, so listen carefully and I'll tell you how the game is played. Here are two pictures (first slide). When the pictures come on, you will choose one of them and push it. If you push the correct one, a bell will ring. If you are wrong,
you'll hear a bad buzzer. Each time the pictures come on, you can choose only one of them. The goal is to see how soon you can ring the bell every time you choose."

Before each trial, E said, "Which one will ring the bell?" After each response, E said, "Yes, that's the correct one!" or "No, that's the wrong one!" Periodically, E reminded S, "Remember, the game is to see how soon you can ring the bell every time you choose."

**General procedures**

Subjects were tested individually, and allowed to pace their own performance, with the E present only to give directions, feedback, and support. Following S's response, the stimuli remained visible for a 2-sec. interval, while the appropriate feedback signals were given. No correction was made for incorrect responses; the projector advanced to the next slide after each response. Only verbal plus auditory feedback was used, since Hamilton (1965) found that the use of tangible rewards with this population tended to distract the S's attention away from the stimuli. However, each S was given a small prize following the completion of the session.

**RRC test series**

In order to determine whether attention was focused on either or both of the dimensions in Condition RRC, those Ss were given ten additional stimulus pairs after attaining criterion. In four of the pairs, the Color variability was replaced by a new constant value (grey triangle and circle). In four other pairs, the Form dimension was similarly replaced (red and blue stars). The final two pairs
contained the same cues as in the original RRC stimuli, but with the
Color-Form pairings reversed; thus, the two dimensional response
tendencies would conflict.

No feedback signals were given during the test series. He
was simply told that the new pictures were like the ones he had just
seen, and was asked to choose the pictures that were the kind (like
the ones) that had been ringing the bell before.
DISCUSSION OF RESULTS

Preference Assessment

An individual's preference score was considered unidimensional, if 12 out of 18 responses were to a single dimension, either color or form. This 2:1 criterion was met by 119 of 132 or 90% of those Ss eligible for inclusion in the experimental sample (IQ 36-55). Of those Ss above IQ 55, 95% met the criterion; of those below IQ 36, only 38% met criterion.

Table 2 shows the proportion of Ss, at each IQ interval, who were classified as preferring either form or color, or as preferring neither dimension (including position and mixed preferences). These data were tested for the presence of a monotonic trend with IQ by applying Kendall's rank correlation coefficient ( tau ) (Siegal, 1956).

Table 2. Proportion of individual preferences by IQ interval

<table>
<thead>
<tr>
<th>IQ</th>
<th>No. of Ss</th>
<th>Proportion of individual preferences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Form</td>
</tr>
<tr>
<td>25-35</td>
<td>24</td>
<td>.00</td>
</tr>
<tr>
<td>36-40</td>
<td>34</td>
<td>.23</td>
</tr>
<tr>
<td>41-45</td>
<td>27</td>
<td>.30</td>
</tr>
<tr>
<td>46-50</td>
<td>44</td>
<td>.36</td>
</tr>
<tr>
<td>51-55</td>
<td>27</td>
<td>.37</td>
</tr>
<tr>
<td>56-60</td>
<td>24</td>
<td>.38</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>
The increase in form preference was significant \((p < .001)\), as was the decrease in preference for neither dimension \((p < .05)\). No group, however, preferred form more frequently than color.

**Analysis of Acquisition Data**

A simple matched groups analysis of variance (ANOVA) was used as a preliminary comparison of the three types of dimensional variability (IB, IW, and RRC). This ANOVA was based on the total number of errors made by all Ss on their initial tasks. As shown in Table 3, the three treatments did differ significantly, with Scheffe' mean comparisons indicating that the RRC task \((\bar{X} = 2.79)\) yielded significantly fewer errors \((p < .05)\) than both the IB task \((\bar{X} = 12.29)\) and the IW task \((\bar{X} = 13.67)\).

**Table 3. Analysis of variance: all initial tasks**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of variability</td>
<td>2</td>
<td>841.62</td>
<td>4.75(^a)</td>
</tr>
<tr>
<td>Ss / type</td>
<td>69</td>
<td>177.22</td>
<td></td>
</tr>
</tbody>
</table>

\(^a_p < .05.\)

Two learning rate parameters, number of trials to criterion and total number of errors, yielded a Pearson product-moment correlation of 0.986 and produced comparable results throughout. The trials to criterion measure was arbitrarily selected for use in the following analyses.
IB and IW acquisition

Only 6 Ss failed to reach criterion on a single AI task (2 from Group IB and 4 from Group IW), yielding a relatively high success rate of 94%; no S failed both of his tasks. Combined data from the first and second tasks of Groups IB and IW were examined with a repeated measures 5-way ANOVA (Preference x Instructions x Variability x Order x Task) (Winer, 1962). Because standard deviations and means of the sub-groups tended to be correlated, the data were treated with a $X' = \log(x + 1)$ transformation. Since the transformation did not alter the pattern of results, the original data have been presented for maximum meaningfulness. A summary of the analysis is shown in Table 4. A significant main effect was found for Task (color vs. form), indicating that identification of a color concept required considerably more trials than did the identification of a form concept. All additional results are discussed below under the individual content areas.

RRC acquisition

The design of the RRC condition differed in several respects from the previous tasks, and was treated with a separate analysis. A 2-way ANOVA (Preference x Instructions) of trials to criterion data yielded no significant results and has not been presented. As reported earlier, the Ss had little difficulty with the RRC problem; only two Ss committed more than five total errors.

On the RRC test trials, each S was asked to identify four color
Table 4. Analysis of variance: all IB and IW tasks

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>P (Preference)</td>
<td>1</td>
<td>44.01</td>
<td></td>
</tr>
<tr>
<td>I (Instructions)</td>
<td>1</td>
<td>90.09</td>
<td></td>
</tr>
<tr>
<td>V (Variability)</td>
<td>1</td>
<td>11,331.76</td>
<td>8.05&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>O x T</td>
<td>1</td>
<td>1,312.76</td>
<td></td>
</tr>
<tr>
<td>P x V</td>
<td>1</td>
<td>7,402.59</td>
<td>5.26&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>I x V</td>
<td>1</td>
<td>152.51</td>
<td></td>
</tr>
<tr>
<td>P x I x V</td>
<td>1</td>
<td>2,630.09</td>
<td>1.73</td>
</tr>
<tr>
<td>O x I x V</td>
<td>1</td>
<td>981.76</td>
<td></td>
</tr>
<tr>
<td>O x D</td>
<td>1</td>
<td>36.26</td>
<td></td>
</tr>
<tr>
<td>O x T x I</td>
<td>1</td>
<td>3,737.51</td>
<td>2.66</td>
</tr>
<tr>
<td>O x T x V</td>
<td>1</td>
<td>3,914.26</td>
<td>2.78</td>
</tr>
<tr>
<td><strong>Error between</strong></td>
<td>36</td>
<td>1,407.42</td>
<td></td>
</tr>
<tr>
<td>O (Order)</td>
<td>1</td>
<td>2,677.59</td>
<td>1.92&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>T (Task)</td>
<td>1</td>
<td>15,733.76</td>
<td>11.31&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>O x P</td>
<td>1</td>
<td>1,544.01</td>
<td>1.11</td>
</tr>
<tr>
<td>T x P (Dominance) (D)</td>
<td>1</td>
<td>2,291.26</td>
<td>1.65</td>
</tr>
<tr>
<td>O x I</td>
<td>1</td>
<td>1,464.84</td>
<td>1.05</td>
</tr>
<tr>
<td>T x I</td>
<td>1</td>
<td>142.59</td>
<td></td>
</tr>
<tr>
<td>O x V</td>
<td>1</td>
<td>8,085.01</td>
<td>5.81&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T x V</td>
<td>1</td>
<td>78.84</td>
<td></td>
</tr>
<tr>
<td>D x I</td>
<td>1</td>
<td>5,031.51</td>
<td>3.62</td>
</tr>
<tr>
<td>D x V</td>
<td>1</td>
<td>2.34</td>
<td></td>
</tr>
<tr>
<td>O x P x I</td>
<td>1</td>
<td>78.84</td>
<td></td>
</tr>
<tr>
<td>O x P x V</td>
<td>1</td>
<td>3,301.76</td>
<td>2.37</td>
</tr>
<tr>
<td>O x I x V</td>
<td>1</td>
<td>437.76</td>
<td></td>
</tr>
<tr>
<td>T x I x V</td>
<td>1</td>
<td>4,690.01</td>
<td>3.37</td>
</tr>
<tr>
<td><strong>Error within</strong></td>
<td>34</td>
<td>1,391.66</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup><sub>p < .01.</sub>

<sup>b</sup><sub>p < .05.</sub>

<sup>c</sup>Error terms include all 4- and 5-way interactions.
stimuli and four form stimuli. Errors made on these two sets of stimuli were examined with a repeated measures 3-way ANOVA, which has been summarized in Table 5. Again, as on the single-cue AI tasks, significantly more errors were made when identifying the color cue.
Dimensional Variability

When an S was presented both a color task and a form task, the presence of an irrelevant dimension within each stimulus setting did impede the rate of AI acquisition (see Table 6 for the means and standard deviations of all main effect variables).

The nature of the Variability main effect must be qualified, however, by the significance of the Order x Variability interaction. The predicted difference between types of irrelevant variability did not occur on the initial AI tasks, as was indicated in the preliminary 3-way ANOVA. The initial equivalence of the IB and IW conditions is contrary to previous findings, but could possibly be attributed to problem-solving naivete', the discrimination-learning setting being a novel experience for all Ss. When the Ss were presented the second AI task, simple effects tests showed that those in Group IW took significantly more trials to learn, while those in Group IB tended to require fewer trials than on the initial task (see Table 7).

The increase in IW difficulty may be partially explained by the fact that the same stimulus pairs were used for both the first and second tasks; the second task can be viewed as a delayed ED shift. In spite of the one-month delay between problems, the increase in difficulty supports a number of recent concept-shift studies which find that, regardless of age, ED shifting tends to be more difficult than Reversal shifting only when the original relevant dimension becomes the IW dimension on the shift task (Caron, 1970; Dickerson, Wagner & Campione, 1970; Fritz & Blank, 1968). If novel cues had been selected
Table 6. Mean trials to criterion: main effect variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>First task</td>
<td>29.52</td>
<td>35.62</td>
</tr>
<tr>
<td>Second task</td>
<td>40.08</td>
<td>48.96</td>
</tr>
<tr>
<td>Form task</td>
<td>22.00</td>
<td>29.64</td>
</tr>
<tr>
<td>Color task</td>
<td>47.60</td>
<td>50.09</td>
</tr>
<tr>
<td>Color preference</td>
<td>34.12</td>
<td>43.06</td>
</tr>
<tr>
<td>Form preference</td>
<td>35.48</td>
<td>43.22</td>
</tr>
<tr>
<td>Concept-oriented</td>
<td>33.83</td>
<td>42.03</td>
</tr>
<tr>
<td>Stimulus-oriented</td>
<td>35.77</td>
<td>44.21</td>
</tr>
<tr>
<td>Irrelevant between</td>
<td>23.94</td>
<td>38.39</td>
</tr>
<tr>
<td>Irrelevant within</td>
<td>45.67</td>
<td>44.81</td>
</tr>
<tr>
<td>Dominant task</td>
<td>29.92</td>
<td>37.84</td>
</tr>
<tr>
<td>Non-dominant task</td>
<td>39.69</td>
<td>47.35</td>
</tr>
</tbody>
</table>
Table 7. Mean trials to criterion: simple interaction effects

<table>
<thead>
<tr>
<th>Variability x order</th>
<th>1st task</th>
<th>2nd task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrelevant within</td>
<td>31.21</td>
<td>&lt;60.12</td>
</tr>
<tr>
<td>Irrelevant between</td>
<td>27.83</td>
<td>20.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preference x instructions</th>
<th>Color preference</th>
<th>Form preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept-oriented</td>
<td>24.38</td>
<td>43.29</td>
</tr>
<tr>
<td>Stimulus-oriented</td>
<td>43.88</td>
<td>27.66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dominance x instructions</th>
<th>Dominant task</th>
<th>Non-dominant task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept-oriented</td>
<td>21.71</td>
<td>45.96</td>
</tr>
<tr>
<td>Stimulus-oriented</td>
<td>38.12</td>
<td>33.42</td>
</tr>
</tbody>
</table>

\(^{a}_p < .01.\)
\(^{b}_p < .05.\)

for the second IW task, it is likely that much of the negative transfer would have been eliminated (Bilsky & Heal, 1969).

The various effects of dimensional variability on low-IQ Ss are in agreement with hypothesis-testing models of AI learning. Because of the relative ease with which the present tasks were solved, it is felt that the population can be approached with more complex forms of
AI problems, i.e., multiple-cue sorting tasks and rule-learning problems, with a reasonable chance of success. Until such areas are tapped, the cognitive capacity of the retardate may be grossly under-estimated. Once such areas are explored, it will be possible to use more elegant methods of inferring strategy and dimensional sets, such as the information analysis described by Osler & Kofsky (1965).

Dimension Preference

Questions regarding the viability of the dimensional preference or dominance concept with mentally retarded adults were not answered by the AI acquisition data in this study. The acquisition data did not directly support the hypothesis that a preference for a dimension facilitates the learning of that dimension, e.g., Task x Preference interaction. This interaction is, in effect, a comparison of those Ss learning a preferred dimension (dominant) with those learning a non-preferred dimension (non-dominant). Thus, the Task x Preference interaction can be considered equivalent to a main effect of Dominance (D).

Preference with redundant cues

Unlike the AI tasks, the RRC test stimuli reflect a significant effect of Dominance (Preference x Cue interaction); nearly twice as many errors were made on tests of the non-preferred cue. Scheffe' mean comparisons indicated that the Ss with a preference for form made significantly fewer errors on the form cue tests than they made on the color cue tests; in addition, their errors were also
significantly fewer than the Ss with color preferences made on the same form cue tests.

The significant dominance effect found on the RRC tests provides additional support for the application of the RRC paradigm to retarded as well as normal learners. One of Trabasso & Bower's (1968) basic premises was that the stimulus control exerted by individual dimensions can be evaluated by a series of transfer tests. In the present study, the cue which controlled choice on the preference test controlled choice on the RRC test trials and, by implication, controlled attention during RRC acquisition.

One promising use of the RRC paradigm would be a detailed examination of the retardates' ability to respond to compound stimulus dimensions. At present, this ability is being explored with a relatively complex learning-set procedure, as seen in House & Zeaman's (1963) miniature experiments. A more direct comparison of the Zeaman-House and Trabasso attention models would be possible by comparisons of learning-set and RRC data.

Preference as a situational set

With a mean Mental Age of approximately 7½ years, the bulk of the sample lay beyond the point at which preferences are presumed to shift to the form dimension. However, the majority of the population and 50% of the sample had demonstrated a preference for color. In light of the relative ease with which the form tasks were solved, it could be argued that a bulk of the demonstrated color preferences represented transient shifts in set influenced by
prior experience. (Most of the Ss in the sample were attending some type of academic program, in which color is used as a prominent teaching tool).

Dimension preferences have recently been found to be task-specific (Olmstead & Sigel, 1970) and have been altered with various training procedures. Gaines (1970) assigned young children with color and form preferences to discrimination training on either their preferred or non-preferred dimension. Preferences were assessed again one week later. A significant number of children has changed preferences following difficult training on their non-preferred cues. More lenient training conditions were effective only in switching color responders to form, though the frequency of change was higher (47% of the sample) than with difficult training. Corah (1966) was able to induce a shift in the opposite direction in kindergarten children, from form to color preference, by giving matching-to-sample training on color cues.

Johnson, Warner, and Silleroy (1971), using 4½- to 6-year-olds, found that learning-set training on one non-preferred dimension, i.e., presence of a dot or direction of an arrow, facilitated learning on yet another non-preferred dimension, number. Neither simple preference testing nor training on the preferred dimension had such an effect. The authors suggested that the non-dominant training had established a strategy for refecting or inhibiting attention to the more salient cues. A preference change was not noted, however, since preferences were not re-assessed after training.
Evidence that preferences may represent situational sets was also found in the Variability x Order interaction of the present study. On the initial task, no difference was noted between IB and IW learning rates. On the second task, in which the relevancies of the dimensions had been reversed, the Ss continued to respond to the dimension which had been relevant in the previous task, regardless of preference. In other words, perseveration on the irrelevant cues increased markedly. It could be argued that the Ss' preferences had been altered, at least temporarily, by the initial training experience.

The preceding discussion emphasizes the importance of the distinction between the "availability" and the "usability" of a dimensional response (Hitler & Harris, 1969). Availability of a dimension is indicated by S's consistent responding on a free-choice preference test. The degree to which that dimension can function as a cue in an AI learning situation indicates the usability of the dimension and, apparently, may or may not be related to availability. Perhaps a crucial question facing preference research is what are the factors which determine or influence free-choice preference responding. When a child passes the critical 4- to 6-year age perhaps his perceptual biases become less dominating, only serving to guide his behavior in arbitrary choice situations.

The appearance of significant dominance effects in the RRC data can readily be interpreted to support such a premise. During an RRC training series, no external constraints are placed on the S in his choice of attending to either of the relevant dimensions. Therefore,
it would be reasonable to expect that the dimension(s) selected would be correlated with the dimension selected on a test of preference.

Instructional Set

Instructional set failed to produce a reliable effect on the rate of AI acquisition. However, the interaction of this factor with Dominance (D x I) was the strongest of those effects approaching significance. Since the institutionalized retarded typically yield abnormally high error variances, it was felt that this factor should be examined for simple effects (see Table 7). It was predicted that the Dominance effect would be enhanced by concept-orienting instructions. The results of simple effect tests did show that the dominant dimension was learned significantly faster than was the non-dominant dimension, only when the Ss were given concept-orienting instructions; stimulus-orienting instructions failed to produce any Dominance effect.

The Dominance effect described above gives tentative support to the notion that conceptual directions can serve to highlight the dimensional characteristics of the stimuli for retarded learners. But the picture is complicated by an additional Dominance x Instructions interaction found in the RRC test trial data. Figure 1 shows that a dominance effect on the form cue was found with stimulus-oriented Ss, whereas a dominance effect on the color cue was found with concept-oriented Ss. Simple effect tests indicated that only the former effect was significant. Perhaps the simpler directions evoked consistent dominance responses only in the RRC setting because of the free-choice aspects of the task. Again, it is suggested that the
Fig. 1. Interaction of preference, type of instruction, and relevant cue variables; mean number of errors on four RRC test trials.
major effects of perceptual biases and preferences are limited to settings which offer an unconstrained choice of dimensional responses. It would be instructive to apply both types in directions to simple preference and optional-shift tasks.

An additional interaction effect reaching significance, that of Preference x Instructions in the AI data, was an unexpected result and cannot be interpreted without additional data. The means in Table 7 showed that Ss having a preference for color reached criterion more rapidly when presented with concept-orienting instructions. Those having a preference for form, however, learned more rapidly with stimulus-orienting instructions. These two simple effects were of nearly equal magnitude, but were not significant.

Further research is suggested regarding the response of the retarded to more sophisticated types of conceptual instructions. It should be noted that, despite attempts to make the conceptual instructions used here parallel to those used in current AI research, they actually little information about the problem-solving nature of the task other than the references to types of stimuli and the need for consistency. In retrospect, it would appear that this investigator was also guilty, as has been the custom among psychologists, of "watering-down" the complexity of any directions given the retarded. The implicit assumption that moderately retarded individuals cannot understand and profit from more sophisticated instruction has yet to be fairly evaluated.
Analysis of Response Strategies

Backward learning curves

As a preliminary to the analysis of response strategies, an empirical (forward) learning curve depicting group acquisition of the combined IB and IW data was plotted in Figure 2. To put this curve into traditional form, each S's data has been extended to the full 150 trials by assuming errorless performance following the criterion run. Paralleling this negatively accelerated curve is a cumulative plot of the percentage of Ss having reached criterion. The contiguity of the two curves suggests that the group curve reflects the distribution of individual learning rates rather than depicting an average individual's learning rate.

A further step in clarifying the course of the Ss' learning has been depicted in Figure 3, where acquisition of the color and form tasks has been plotted in terms of backward learning curves. To aid in the interpretation of these curves, the abscissa variable, Blocks, has been numbered from right-to-left, i.e., Block 1 refers to the Ss' first 10 trials prior to the error which preceded the criterion run. As the Block number increases, of course, more Ss will have reached criterion; thus, the N increases as the abscissa value grows smaller. As can be seen, the color and form curves both hover relatively close to chance levels throughout the precriterion phase of learning, never exceeding 70% correct choice. The curve for the form task, which was significantly easier than color, begins in a later block, but roughly parallels the color curve. In Figure 4, backward curves comparing the
Fig. 2. Group (forward) learning curves for all Ss solving (N = 90); percent correct per 10-trial block and cumulative number of Ss reaching criterion
X—Correct Trials per Block
O—Cumulative Number of Solutions

BLOCKS OF 10 TRIALS
Fig. 3. Backward learning curves comparing Form task versus Color task conditions; percent correct responses per pre-criterion block for all Ss reaching criterion after the 9th trial
Form Task

Color Task

10-TRIAL BLOCKS PRIOR TO CRITERION RUN
Fig. 4. Backward learning curves comparing IB versus IW conditions; percent correct responses per pre-criterion block for all Ss reaching criterion after 9th trial
IB and IW tasks display a similar pattern of results, with the exception of the slope of the IB curve, which appears more erratic than might be expected from chance. The performance of the six non-learners also failed to rise much above chance levels throughout the full 150 trials; their data have not been presented.

Precriterion strategies

Since attention theory postulates that the precriterion phase of learning is a period when S is testing a variety of hypotheses about the relationships between the stimulus dimensions and reinforcement, each S's choice data was inspected for indications of hypothesis behavior. The data for this analysis were generated with Fellows' (1967) Hypothesis Habit statistic (H-score), as follows:

1) Each S's data was inspected for continuous sequences of each of the four basic Hs (perseveration, alternation, win-stay:lose-shift, and lose-stay:win-shift) with respect to each of the three stimulus dimensions (Position, Relevant Cue, and Irrelevant Cue).

2) H-sequences of 5 trials or less were considered chance and were given a score of zero. A sequence of 6 trials was scored as 1, a sequence of 7 was scored as 2, a sequence of 8 as 3, etc. For each of the S's, the resulting values were summed within each strategy and entered as the H-score data for that S.

3) Since lose-stay:win-shift behavior was negligible, having a total H-score of only 20, this strategy was not considered separately from its counter-part, win-stay:lose-shift.
Data for 44 Ss (30 from Group IB and 14 from Group IW), who had reached criterion in less than 10 trials, were excluded from the analysis, since insufficient strategy behavior was established. Mean H-scores for the remaining 52 Ss (18 IB and 34 IW) are depicted in Figure 5. The dominating IB strategy and the most prevalent strategy overall was Position Contingency. Position Alternation was the next most frequent strategy, showing equal incidence in both groups. The highest H-score in the IW group was related to perseveration on the Irrelevant dimension which was present in their tasks. The most basic strategy, Position Perseveration, was used infrequently throughout. H-scores for all other strategies, including all Relevant dimension hypotheses (other than solution), were negligible. It should be noted that the two groups in this sub-sample did not differ appreciably in mean trials to criterion (IW = 62.18, IB = 58.67).

Though it shall remain an issue for individual interpretation, the backward learning curves appear to offer a more realistic representation of the course of an S's learning in the present study than do the traditional curves. This interpretation is supported by the magnitude of strategic behavior (determined by H-scores) found prior to solution, bearing in mind that each Individual component of an H-score represents a run of at least 6 responses to a non-relevant dimension.

**Group differences in strategy behavior**

In an attempt to relate the strategy data to the experimental variables, the IW data were prepared for a 4-way ANOVA (Instructions
Fig. 5. Mean H-scores for Ss in Groups IB and IW solving in 10 or more trials to criterion.
x Task x Preference x Order) in the following manner. Since the N's for the four Instruction x Preference sub-groups were unequal (N = 7,8,9,10), data for 6 of the Ss were eliminated so that each subgroup contained 7 Ss. Those eliminated were chosen randomly from appropriate groups so that sub-groups of each of the two-factor interactions (with the unavoidable exception of Preference x Order) were also composed of 7 Ss. The Dominance (T x P) x Instructions factor also had sub-groups of 7 Ss, and was included in the analysis. All other three factor sub-groups were composed of either 3 or 4 Ss and were included in the error terms.

The resultant ANOVA was applied in turn to the H-scores based on Position Alternation (P_A), Position Contingency (P_C), and Irrelevant Cue Perseveration (I_P). The results of these ANOVAs are shown, respectively, in Tables 8, 9, and 10. H-scores for all other strategies were negligible and not subject to analysis.

**Summary of effects**

A summary of the main effects of the treatment variables on the three strategies is presented in Figure 6. The H-score analysis of Position Alternation indicated significant main effects of all four treatment variables, plus a significant interaction effect of Dominance. The net result of these effects was an increase in P_A habits occurring with stimulus-oriented instructions, with form preference, with color as the relevant cue, and with the non-dominant dimension relevant; there was also a decrease in P_A on the Ss' second
Table 8. Analysis of variance of H-scores from IW data: position alternation

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Instructions)</td>
<td>1</td>
<td>32.14</td>
<td>8.19(^a)</td>
</tr>
<tr>
<td>T (Task)</td>
<td>1</td>
<td>137.29</td>
<td>13.14(^b)</td>
</tr>
<tr>
<td>P (Preference)</td>
<td>1</td>
<td>89.29</td>
<td>22.75(^b)</td>
</tr>
<tr>
<td>O (Order)</td>
<td>1</td>
<td>24.15</td>
<td>6.15(^a)</td>
</tr>
<tr>
<td>T x P (Dominance) (D)</td>
<td>1</td>
<td>51.57</td>
<td>13.14(^b)</td>
</tr>
<tr>
<td>I x T</td>
<td>1</td>
<td>32.14</td>
<td>8.19(^a)</td>
</tr>
<tr>
<td>I x P</td>
<td>1</td>
<td>0.14</td>
<td>--</td>
</tr>
<tr>
<td>I x O</td>
<td>1</td>
<td>51.57</td>
<td>13.14(^b)</td>
</tr>
<tr>
<td>I x D</td>
<td>1</td>
<td>17.29</td>
<td>4.40</td>
</tr>
<tr>
<td>T x O</td>
<td>1</td>
<td>11.56</td>
<td>2.95</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>3.92</td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}P < .05.\)

\(^{b}P < .005.\)

... task. Position Contingency habits also increased significantly under the stimulus-oriented condition.

The Irrelevant Perseveration data indicated a significant increase is the use of I\(_p\) when color was the relevant cue. This strategy also yielded a significant Order effect, but in the direction opposite to that found in the P\(_A\) data, i.e., an increase in I\(_p\) occurred on the second task.
Table 9. Analysis of variance of H-scores from IW data: position contingency

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Instructions)</td>
<td>1</td>
<td>234.32</td>
<td>8.73&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>T (Task)</td>
<td>1</td>
<td>18.89</td>
<td>--</td>
</tr>
<tr>
<td>P (Preference)</td>
<td>1</td>
<td>38.89</td>
<td>1.45</td>
</tr>
<tr>
<td>O (Order)</td>
<td>1</td>
<td>0.89</td>
<td>--</td>
</tr>
<tr>
<td>T x P (Dominance) (D)</td>
<td>1</td>
<td>2.89</td>
<td>--</td>
</tr>
<tr>
<td>I x T</td>
<td>1</td>
<td>10.33</td>
<td>--</td>
</tr>
<tr>
<td>I x P</td>
<td>1</td>
<td>124.33</td>
<td>4.64&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>I x O</td>
<td>1</td>
<td>0.33</td>
<td>--</td>
</tr>
<tr>
<td>I x D</td>
<td>1</td>
<td>1.76</td>
<td>--</td>
</tr>
<tr>
<td>T x O</td>
<td>1</td>
<td>0.04</td>
<td>--</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>26.82</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup><sub>P < .05</sub>  
<sup>b</sup><sub>P < .01</sub>

**H-scores versus learning rate measures**

Application of the H-scores data to the independent variables in the study strongly supports results from the basic acquisition data. The greater difficulty of the second IW task was associated with a significant decrease in PA habits and an increase in IP habits. In addition, the color task, more difficult than the form task, also
Table 10. Analysis of variance of H-scores from IW data: irrelevant perseveration

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Instructions)</td>
<td>1</td>
<td>137.28</td>
<td>2.83</td>
</tr>
<tr>
<td>T (Task)</td>
<td>1</td>
<td>343.00</td>
<td>7.08a</td>
</tr>
<tr>
<td>P (Preference)</td>
<td>1</td>
<td>120.14</td>
<td>2.48</td>
</tr>
<tr>
<td>O (Order)</td>
<td>1</td>
<td>302.28</td>
<td>6.24a</td>
</tr>
<tr>
<td>T x P (Dominance) (D)</td>
<td>1</td>
<td>41.28</td>
<td>--</td>
</tr>
<tr>
<td>I x T</td>
<td>1</td>
<td>137.29</td>
<td>2.83</td>
</tr>
<tr>
<td>I x P</td>
<td>1</td>
<td>0.15</td>
<td>--</td>
</tr>
<tr>
<td>I x O</td>
<td>1</td>
<td>112.01</td>
<td>2.31</td>
</tr>
<tr>
<td>I x D</td>
<td>1</td>
<td>17.29</td>
<td>--</td>
</tr>
<tr>
<td>T x O</td>
<td>1</td>
<td>252.00</td>
<td>5.20a</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>48.47</td>
<td></td>
</tr>
</tbody>
</table>

*P < .05.

yielded greater amounts of both $P_A$ and $I_p$ responding. Thus, H-score measures did appear to mimic the learning rate measures in their sensitivity to several task variables. Further study will be needed to determine if behaviors represented by H-scores are themselves causative factors in AI learning difficulty. If so, they may serve as potential antecedents for mediated learning studies and as prescriptive anchors for remediation techniques.
Fig. 6. Mean H-score comparisons for all main effect variables; starred comparisons reached significance.
TYPE OF STRATEGY

MEAN H-SCORE

PA PC IP PA PC IP PA PC IP

- Stimulus Inst. - 1st Task - Form Task
- Concept Inst. - 2nd Task - Color Task

- Dominant Cue
- Non-dominant Cue

- Prefer Color
- Prefer Form
One example of the diagnostic potential of H-score analysis is evident in the significant \( I_P \) interaction of Task x Order. The Ss displayed significantly more \( I_P \) on the second task when it was based on color cues than when based on form cues; this amount was greater than shown on either initial task. Such a result would suggest that the high degree of form perseveration exhibited on color might be attributed to negative transfer from the prior presentation of a form task. In other words, after exposure to a problem based on form cues, the Ss continued to respond to the same cues on the second problem; there was no such effect when a color task was presented first. This would suggest that shifting from a potent dimension, such as form, to a more subtle cue may be delayed and may require additional cueing and instruction. An understanding of such an effect may assist the academic teacher as well as the conceptual-shift researcher.

Instructions

When extended to instructional effects, which were not supported by the acquisition data, the H-score data provides some interesting results. As predicted, concept-orienting instructions yielded significantly fewer Position habits (both \( P_A \) and \( P_C \)) than did stimulus-orienting instructions. Because of the high incidence of position errors typically found with the mentally retarded (Ellis et al., 1962; Schusterman, 1964) and with preschool and kindergarten children (Croll, 1970; Carmean & Carmean, 1971), it may be profitable to further assess the impact of the directions given to immature subjects.

Instructional effects also interacted significantly with several
other variables. Individual comparisons were made on the simple effects of these interactions, using Scheffe' mean comparison tests at the .05 level of significance, with the following results:

1) Instructions x Order interaction - The significant reduction in $P_A$ from the first to the second task, described previously, was displayed only by those $S$s receiving the concept-oriented instructions. The reduced level was significantly lower than shown on both of the stimulus-oriented tasks.

2) Instructions x Task interaction - Subjects exposed to a stimulus-oriented color task exhibited significantly more $P_A$ than was found on all other tasks. Thus, it appears that the combined presence of the more difficult task, color, and the stimulus-oriented directions served to increase the strength of the $P_A$ strategy.

3) Instructions x Preference interaction - Those $S$s having a preference for the form dimension exhibited more $P_C$ habits when presented with stimulus- rather than concept-oriented instructions.

It would appear, based on the accumulated evidence, that instructing the $S$ to observe the kind or type of stimulus may serve to inhibit his responsiveness to the simple location of that stimulus. It should also be noted that increased levels of $P_A$ habits were similarly associated with requiring the $S$ to identify his non-dominant dimension; moreover, high $P_A$ was produced with each of those factors originally expected to cause increases in problem difficulty. Additional research may show that with further increases in the difficulty. Additional research may show that with further increases in
problem difficulty. Additional research may show that with further increases in the difficulty of AI problems and in the dimensional emphasis of the instructions, corresponding increases in position habits may be of a strength to actively inhibit learning rate.

Implications for Future Study

It is felt that the results of this investigation concur with the following statement by Hartup & Yonas (1971):

There is increasing evidence that children learn simple discrimination tasks in an all-or-none fashion. Not even children with low IQs improve gradually on such tasks....Experimental findings are consistent with the notion that a process of hypothesis generation and testing occurs, even in very young children (p. 360).

AI acquisition by the moderately retarded did appear to occur in an all-or-none fashion and a significant amount of simple hypothesis testing was generated during the presolution period. An obvious conclusion is that strategy behavior is an available response which can be modified and developed in the retarded. This suggests that the retarded can be given training in more systematic and strategic modes of reasoning and, consequently, can develop more adaptive and independent learning skills. Substantial numbers of retarded learners lack the reasoning strategies required for skills such as stating word definitions, completing analogies, using clustered recall, analyzing visual sequences, and identifying conceptual similarities. In a recent approach to the latter skill, McIvor (1972) was successful in teaching mildly retarded (IQ 50 to 70) adolescents a strategy for "testing-out" and finding a descriptive property common to a triad of nouns.
Several questions thus beg for immediate attention, such as: Can the moderately and mildly retarded learn to use additional hypothesis-testing strategies?; Will the learning of such strategies further the conceptual development of the retarded?; and What systematic strategies are available to the more severely retarded? Future research into the strategies generated by and necessary for complex AI learning may help to supply the answers, which can provide teachers of the mentally retarded with valuable tools for modifying some of the learning handicaps fundamental to retardation.

The psychologist's role in treatment facilities for the retarded has been rapidly changing. Instead of merely describing and predicting behavior, he is being assigned the task of producing the predicted behaviors. Currently, the emphasis is on producing self-care skills and on eliminating aberrant behaviors and proponents of behavior modification techniques have answered the challenge. The next challenge to be issued concerns what the psychologist can do to produce more intelligent behaviors in the retarded (Throne, 1972). An open field awaits the cognitive psychologist to apply some of the fundamentals of conceptual learning.

Whether or not the mentally retarded individual can acquire greater cognitive flexibility remains to be proven or disproven. However, a person, especially one who has been sheltered in an institution, should not be expected to perform at a level beyond the one on which he is approached. The intellectual output required of the retarded person in his daily routine, as well as in the laboratory, is all too
often far below his actual capabilities. Researchers should be able to demand and receive more mature thought processes from the retarded simply by providing information, structuring tasks, and directing studies on a more normalized, adult level. The point of difficulty at which any level of retardate can no longer comprehend and compete has yet to be determined empirically. Once determined, the search for techniques to help the retarded overcome that difficulty becomes tomorrow's goal.
REFERENCES


Corah, N. L. Color and form in children's perceptual behavior. 
*Perceptual and Motor Skills*, 1964, 18, 313-316.

____, The effect of instruction and performance set on color-form 
perception in young children. *Journal of Genetic Psychology*, 

____, Jones, S. A. & Miller, B. B. The relation of verbal intel-
ligence and color-form discrimination ability to children's color-
matching and form-matching behavior. *Journal of Psychology*, 1966, 
62, 221-228.

Crane, N. L. & Ross, L. E. A developmental study of attention to cue 
redundancy introduced following discrimination learning. *Journal 

Croll, W. L. Response strategies in the oddity discrimination of pre-
school children. *Journal of Experimental Child Psychology*, 1970, 
9, 187-192.

Dickerson, D. J. Irrelevant stimulus dimensions and dimensional 
transfer in the discrimination learning of children. *Journal of 
Experimental Child Psychology*, 1967, 5, 228-236.

____, Wagner, J. F. & Campione, J. Discrimination shift per-
formance of kindergarten children as a function of variation of 
the irrelevant shift dimension. *Developmental Psychology*, 1970, 
3, 229-235.

Ellis, N. R., Girardeau, F. L. & Pryor, M. W. Analysis of learning 
sets in normal and severely defective humans. *Journal of 
Comparative and Physiological Psychology*, 1962, 55, 860-865.

Evans, R. A. Some stimulus factors involved in the discrimination 
learning of mental retardates. *American Journal of Mental 
Deficiency*, 1968, 73, 61-69.

____, & Beedle, R. K. Discrimination learning in mentally retarded 
children as a function of irrelevant dimension variability. 

Fellows, B. J. Chance stimulus sequences for discrimination tasks. 

____, *The Discrimination Process and Development*. Oxford: Pergamon 

Fritz, B. & Blank, M. Role of the irrelevant cue in rapid reversal 
learning in nursery school children. *Journal of Comparative and 


APPENDIX A: SAMPLE PREFERENCE SCORESHEET
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>P</td>
<td></td>
<td>(9)</td>
<td>F</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>X</td>
<td></td>
<td>(10)</td>
<td>C</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>X</td>
<td></td>
<td>(11)</td>
<td>S</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>X</td>
<td></td>
<td>(12)</td>
<td>F</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>P</td>
<td></td>
<td>(13)</td>
<td>C</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>X</td>
<td></td>
<td>(14)</td>
<td>C</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>X</td>
<td></td>
<td>(15)</td>
<td>S</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>P</td>
<td></td>
<td>(16)</td>
<td>F</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

**Preference Test**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(17)</td>
<td>C</td>
<td></td>
<td>(18)</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(19)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(20)</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(21)</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(22)</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(23)</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(24)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Choice Code**

P = Matching pair
X = Error
F = Form
C = Color
S = Size
APPENDIX B: DEFINITION OF STIMULUS SEQUENCE
Dimension

(P) Position
(S) Size
(I) IB and IW

Cue Code

1 = Left
2 = Right

1 = Large
2 = Small

1 = Red
2 = Blue

1 = Triangle
2 = Circle

Example: 2-1-2 = Large Blue Circle on the Right
Paired with: Large Red Circle (IB Color)
Large Blue Triangle (IB Form)
Large Red Triangle (IW)