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ABSTRACT

A second year of experimental research on young children examined the instructional power of television in facilitating the acquisition of cognitive skills. In addition, researchers investigated the efficiency of an instructional support system designed to maximize the results of educational television. Subjects were three- to five-year-old Native American children attending Head Start centers on the Papago Reservation in Arizona. The four experimental studies undertaken demonstrated that programed television presentations can influence complex cognitive capabilities in preschool children. Sequentially structured televised instruction based on social learning principles was differentially effective for different cognitive tasks and for different age groups. It was concluded that with a skill such as seriation where perceptual cues are clear, TV modeling of the rules and strategies may be sifficient to teach the concept. Enumeration and conservation skills showed a gradient 0-age-related additive value attributable to direct instruction designed to supplement the TV presentations. One implication of these results was that, in general, a single approach in programing may not be equally effective for the teaching of all kinds of conceptual rules, and direct instruction may be necessary to supplement televised instruction for young children. (CH)

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THE EFFECTS OF TELEVISED INSTRUCTION AND ANCILLARY SUPPORT SYSTEM ON THE DEVELOPMENT OF COGNITIVE SKILLS IN PAPAGO NATIVE-AMERICAN CHILDREN

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STATEMENT OF THE PROBLEM

Introduction

Without a doubt the medium of television has emerged as a significant agent of socialization in our society, for it is now a pervasive element in the daily lives of virtually all Americans. For families with children, television set ownership has reached the saturation point of 98% to 99% (Lyle, 1972). Children begin watching television when they are as young as two or three years old, and they are generally purposeful viewers in that they have favorite programs and regular viewing times long before they enter school. Despite wide variability in the amount of viewing reported in various studies for given demographic groups, it is nonetheless clear that most children watch television every day for a total of two or more hours (Lyle, 1972). In one representative study boys viewed for an average of 34.56 hours per week, and girls watched for an average of 32.44 hours, or better than one third of their waking hours (Stein & Friedrich, 1971).

There is, therefore, no doubt that most children in this country are exposed to a great deal of television and it has been demonstrated that children's viewing does influence their intellectual and social development. However research on the role of television is in its infancy, and its potential impact on the development of children is only beginning to be explored.

Empirical Evidence on the Effects of Television

Most of the recent interest and concern about the influence of television on children's behavior has focused on effects of televised violence on aggressive behavior in children (Surgeon General's Scientific Advisory Committee on Television and Social Behavior, 1972; Friedrich & Stein, 1973; Greenberg, Erikson, & Valhos, 1972; Barker & Ball, 1969). A number of laboratory investigations (vide Bandura, Ross, & Ross, 1963; Kuhn, Madsen, & Becker, 1967) have demonstrated that viewing filmed aggressive behavior increases the liklihood that the observer will carry out similar acts when given the opportunity. Supporting research under more naturalistic conditions (e.g., Friedrich & Stein, 1973; Chafee, 1972), has tended to confirm these findings and to support the contention that the influence of viewing aggressive models is not confined to brief experimental interludes of the psychology laboratory. The evidence pertaining to the influences of televised violence on the behavior of viewer is summarized in The Early Window (Liebert, Neal, & Davidson, 1973).

On the brighter side, there is evidence that television viewing may also influence prosocial behaviors and attitudes. Stein and Friedrich (1971) reported that "Misterrogers' Neighborhood" has as its primary goal the effective development of the child and that the program's " . . . themes of cooperation, persistence in difficult tasks, tolerance of frustration and delay, and verbalization of feelings are understood by children and alter their behavior" (p. 276). In addition, recent laboratory research has indicated that prosocial behaviors such as sharing can be significantly improved through exposure to televised models (Liebert, Sprafkin, & Poulos, 1975).

While much of the present interest in television is centered on its influences on social behavior, the potential of the medium for exerting effects on some aspects of intellectual development is also impressive. "Sesame Street" and "The Electric Company", both productions of Children's Television Workshop, have been enthusiastically promoted and received as a means of providing instruction relating to some cognitive behaviors. That is not to say that such efforts are without their critics and detractors (e.g., Sprigle, 1970; Ingersoll, 1971), but the generally favorable outcomes of the summative evaluation of "Sesame Street" (Bogatz & Ball, 1971) and the results of a large number of other studies of instructional television (vide, Chu & Schramm, 1967; Leifer, Gordon, & Graves, 1973) indicate that television is an effective medium for direct teaching of some intellectual competencies.

"Sesame Street" has apparently been highly successful in imparting a number of basic cognitive skills. For example, children have been taught to associate a label (e.g., a letter name) to a visual symbol, and to count by rote. These basic cognitive skills are typically classified by psychologists as associative learning skills. On the other hand, the evaluation of "Sesame Street" indicates that the program has not been as successful in teaching more complex skills such as conservation of number, higher order numerical operations and concepts such as those involved in simple set theory, matching by position, and parts of whole. These more complex cognitive skills were selected for special instructional attention in the second year of "Sesame Street" programming, but the ETS evaluation (Bogatz & Ball, 1971) indicated that these more ambitious objectives were not attained with four-year-old disadvantaged children.

It has therefore, been demonstrated that programming of a "Sesame Street" variety can produce such outcomes as rote counting, identification and labeling of letters of the alphabet, simple discriminations of similarities and differences, and the use of some simple relational words; but it is still particularly important to find ways to employ television effectively to teach complex cognitive skills to young children.

There is widespread concern in our society about the fact that many children fail to profit from their early school experiences because of insufficient preschool opportunities to learn from the instruction provided. The effects of such difficulties in dealing with early school learning are often cumulative, and impose increasing obstacles to the child's academic success as he progresses through school. This problem is particularly evident among native American children who have been reared in a culture which emphasizes skills and values different from those which characterize the curricula of most schools. Beyond the school difficulties which may result from discontinuities between the home and school culture, native American children are often reared in settings which are extremely isolated from contacts with the dominant culture. As a result, they have few opportunities to learn skills valued in the dominant culture through direct observation and interaction with its members. To obtain the skills necessary to function and find fulfillment in a pluralistic society is the unrealized hope of many native Americans. Television seems an obvious tool for coping with this problem because of its demonstrated role as an agent of socialization in the lives of those children who have access to it. "Sesame Street" represents the most visable attempt to date to use television to "make up for the lack of traditional institutional capability" (Nassau Board of Cooperative Educational Services, 1972, p. 19), and even that effort has not successfully influenced the development of complex intellectual skills.

Except for the work to be reported here, little direct experimentation has been undertaken in the important area of teaching complex cognitive skills to young children through the medium of educational television. Therefore full utilization of this pervasive medium to supplement insufficient educational opportunities has not been adequately persued. The development and examination of innovative programming techniques is therefore an important area of investigation both for the basic psychological information on learning processes that could be obtained and for the identification of potential remedies for some of our present educational problems.

Goals for the Present Research

The first goal of the present research was to examine the instructional power of the television medium in facilitating the acquisition of complex cognitive skills. In order to provide an educationally relevant as well as stringent test of the educational value of the medium, target cognitive skills were selected which are crucial to later cognitive skill development and the development of logical thought (e.g., seriation, conservation; Piaget, 1952), or which facilitate acquisition of more advanced mathematical skills (enumeration), or which assist in the development of information-seeking skills (question-asking). In addition the investigators were concerned with examining the effects of television with a population whose geographical isolation from the opportunities and services of an urban setting would indicate that a well validated supplementary education system would be of practical value. Hence, Papago native-American preschoolers attending reservation Head Start Centers were chosen as the sample population. This group, then, would serve as a stringent test of the television programming, but could also be considered as representative of a target population to whom effective televised instruction would provide a needed supplementary educational support system to supplement the current shortage of specialized educational personnel in remote areas. The initial goal constituted the research objectives for the first year's program conducted in 1973-74. The results of this work and the rationale for program development have been reported elsewhere (Henderson, Zimmerman, Swanson, & Bergan, 1974; Henderson, Swanson, & Zimmerman, 1975; Henderson, Swanson, & Zimmerman, in press).

While results pertaining to this initial goal clearly indicated that such programs were highly effective in imparting the target conceptual skills (Henderson, Zimmerman, Swanson, & Bergan, 1974). Complete mastery of the skills was not attained by 100% of the children exposed to the programs. Therefore, the second goal of the research was to first replicate the initial goal and in addition to investigate the efficiency of a minimal manpower ancillary instructional support system designed to maximize the results of carefully and systematically programmed educational television. It is to this second goal that the present report is primarily directed. The achievement of these objectives could offer viable and practical solutions to some of our current educational shortcomings of preschool education among those populations of children previously labeled as "culturally disadvantaged".

THEORETICAL AND EMPIRICAL BASIS FOR THIS RESEARCH

Theoretical Model for the Research

According to Bandura's (1969) analysis of behavioral acquisition is an information-processing model, there are four sets of processes which account for the learning and the performance of an acquired behavior. The first two sets of processes (i.e., attentional and retentional process) affect whether or not the specific behavior observed will be encoded and retained by an observer. The second two sets of processes (motor reproduction and motivational processes) affect whether or not a behavior that has been acquired and retained in the behavioral repertoire of the observer. Research has indicated that different variables are associated with acquisition as opposed to performance (Bandura, 1969), and of primary concern in the construction of an instructional display would be to include those variables relevant to the acquisitional process. Hence any sequence of instruction whether live or on film or tape, must be constructed so as to maximize behavioral acquisition.

There are a number of learning facilitators that affect attentional and retentional processes which have been preivously identified in social learning research as well as research on conceptual learning, that can be systematically incorporated into television programming to maximize the effectiveness of instructional content. The programming approach selected for this work was designed to include as many as possible of the variables identified as facilitators of concept acquisition in order to avoid the omission of any potentially additive factor.

Learning Facilitators that can be Provided by Television

Performance Models: The provision of performance models is one factor that has been verified as a powerful learning facilitator in research on concept acquisition. There is extensive literature in the social-learning tradition which suggests that live models are effective in teaching abstract rule-governed behavior. While there is not yet an accumulation of research demonstrating that equivalent effects can be achieved with film presented models, film and live models have been found to be comparable in their influence on social behavior.

Initially investigations of the effects of vicarious processes focused on the development of a variety of affective, motor and self-regulatory behaviors (Bandura & Menlove, 1968; Bandura, Blanchard, & Ritter, 1968; Marshall & Hahn, 1967; Bandura & Kupers, 1964), but more recent studies have shown that cognitive behaviors such as language responses can be transmitted and modified through observation of a model (Zimmerman & Rosenthal, 1974b). There is evidence that children's verb tense and use of prepositions can be influenced through exposure to a model (Bandura & Harris, 1966; Odom, Liebert, & Hill, 1968; Liebert, Odom, Hill, & Huff, 1969) and that children's sentence kernel structure as well can be modified through vicarious processes (Carroll, Rosenthal, & Brysch, 1972; Rosenthal & Whitebook, 1970). Harris and Hassemer (1972), found that modeling procedures were effective in increasing the length and complexity of the language of both monolingual and bilingual children. These studies suggest that a wide variety of syntactic rules can be acquired by children and appropriately adapted into their own speech patterns following observation of language models.

Zimmerman and Rosenthal's (1974b) review of research on children's learning of rule governed behaviors through observation has shown that modeling procedures have been effective in children on a wide variety of conceptual responses such as abstract classes for question-asking (Rosenthal, Zimmerman, & Durning, 1970; Rosenthal & Zimmerman, 1972b), question-asking skills (Zimmerman & Pike, 1972; Henderson & Garcia, 1974; Henderson & Swanson, 1975), Piagetian conservation responses (Rosenthal & Zimmerman, 1972a; Zimmerman & Rosenthal, 1974a), geometric classification tasks (Denney & Acito, 1974) and even creative responses (Zimmerman & Dialessi, 1973). Evidence of significant retention of the vicariously learned response was found over as long a delay as a seven week period (Zimmerman & Bell, 1972; Zimmerman & Rosenthal, 1974a) and in all of these studies both acquisition and generalization were found.

The child observer in these studies was required to <u>induce</u> a particular property or rule from a highly diverse or complex modeling sequence and to generalize this property to novel conceptual tasks. By randomly varying nonrelevant aspects of the task on which the model performed, it was possible to avoid limiting the conceptual response being taught to the specific task used in training. Hence these procedures promoted substantial generalization (Zimmerman & Rosenthal, 1974b).

Furthermore, modeling has proved to be an efficacious procedure in field research as well as in controlled laboratory settings (Henderson & Garcia, 1973; Henderson & Swanson, 1974). The effects of vicarious instruction has been demonstrated so many times in both applied learning experiments, and therefore a modeling paradigm was adopted as the primary conceptual basis for the television programming design reported here.

Linear Sequencing: A second facilitating factor suggested in the literature on concept acquisition is the employment of a linearly constructed format. Research has indicated that when teaching abstract rules it is necessary to present many examples of a rule in succession to promote generalization. In laboratory studies utilizing a modeling paradigm to teach concept acquisition, it has been observed that learning is most effective when numerous examplars are employed in which relevant criterial attributes of the concept are held constant, while all nonrelevant attributes are systematically varied (Zimmerman & Rosenthal, 1974b). This process seems to facilitate discrimination learning between instances and noninstances of the concept. To accommodate this substantiated procedure in television instruction, a concept should optimally be taught by depicting repetitive instances of the concept which systematically vary only in nonrelevant attributes. It seems probable that to do this effectively, the rule being taught must be presented according to a linear sequence, in which the component skills required in the performance of the terminal behavior are systematically presented.

"Sesame Street" does not employ such a sequenced approach but rather has adopted a mosaic or fragmented format with instances of different concepts or entertainment segments presented in juxtaposition. It is possible that the mosaic or fragmented pattern may be adequate to promote associative learning but may seriously hamper the acquisition of abstract rules. The mosaic format used on "Sesame Street" consists of juxtaposing scenes in which a rule is depicted with scenes in which there is no overt, or even implicit attempt to depict the rule. The material presented in the scenes directly following those in which a concept is presented usually have little or no relationship to the preceeding material, or the relationship is so subtle that most preschool children cannot be expected to recognize it even on an intuitive level.

Simple association learning, where "Sesame Street" has made its greatest impact, appears not to require sequential programming since labeling response are tied directly to the concrete objects and events. But to accomplish abstraction within a mosaic format, it would be necessary for a child to recall previous examples of the concept presented earlier which were then followed by intervening irrelevant instructional experiences. From a learning theory point of view, this requires the child to be able to discriminate the intervening experience and disassociate it from the concept being learned. This type of mosaic format, then, would appear to unnecessarily tax the child's memory processes during concept learning since successive instances of a concept are not presented linearly and in close proximity. In addition to the delay in presenting concept instances, an intervening and irrelevant experience (with regard to the initial rule being learned) may be interposed between concept instances, which is likely to create cognitive interference.

One reason offered in support of a mosaic pattern is that by varying the materials and situations the interest and attention of the child is maintained (Nassau Board of Cooperative Educational Services, 1972). In the "Sesame Street" program format, variety and novelty are achieved by this fragmented design that includes instances of more than one concept. However, there is no reason to believe that novelty could not be obtained with linear sequencing by using varied examples, all of which illustrate the same superordinate principle. Past research leads us to believe that under these circumstances heterogeneity of exemplars would substantially enhance the generalization of the concept and facilitate attentional processes.

In the research effort under consideration here, our programming strategy employed a linear rather than a fragmented programming pattern. This strategy was judged to be consistent with demonstrated principles of concept acquisition. To insure linearity of instructional components, televised program content was analyzed and organized on the basis of a hierichial task analysis approach (White & Gagné, 1974) since the facilitative effects of task analysis had been carefully documented in a number of studies (Resnick, 1967; Resnick, Siegel, & Kresh, 1970; White, 1973). The task analysis approach provides a structure for the programming of systematic television instruction and insures the desired linearity of instruction congruent with the research on the learning of abstract rules.

Additional Learning Facilitators: There are a number of other important variables indicated in laboratory and field research which television is uniquely suited to provide. For example, variety of concept exemplars is suggested in the literature as an important variable in contributing to the generalizability of a concept across tasks and situations (Rosenthal & Zimmerman, 1974b). Television can provide more varied situations than are normally available in the classroom. Such stimulus variety not only promotes generalization across tasks, but can also function as an attentional device by offering novelty and interest. Similarly, a wider range of performance models can be included in program design than would be normally available in the classroom, for example puppet characters, adults of different roles, and animal characters. Variety of this magnitude, while logistically impossible in a classroom environment, is easily accomplished through television programming.

When television instruction is targeted directly to differing cultural groups, relevant cultural materials can be employed to increase the relevancy and the familiarity of task materials and task context. In addition, ethnicity of the model has been demonstrated to be a potentially important variable (Bandura, 1969; Garcia & Zimmerman, 1972) and television can be easily adapted to provide like-ethnicity models whether or not such individuals are normally available in the classroom. Since an information-processing approach posits that learning will not occur unless attentional processes are activated in the utilization of both novel factors and culturally familiar situations to increase attention to the model display would seem to strengthen any program for teaching a concept. In short, television is unique in offering a scope of situations and variables that are richer and broader than those available in the classroom. In addition to its ability to bring uniqueness and variety to the learning situation, television can also be designed to include other important facilitators of learning without sacrifice to that uniqueness. Television can be programmed to include (1) verbal rule provision, (2) generalized feedback, (3) short sequencing, and (4) redundancy of exemplars within a linear presentation. Such components may serve to enhance both attentional and retentional processes.

Television programming can also be designed to promote active rehearsal by viewers. This potential capability of the medium has received little systematic attention, but clearly, rehearsal can be included through the provision of a cue for the child to engage in the task along with the television model. While this procedure has been included in television instruction (Henderson, Zimmerman, Swanson, & Bergan, 1974) and subjective data indicate that children do respond to such cues, the particular additive affect of these procedures have not been examined. It nevertheless appears to be a promising device to allow for active as well as passive participation in the learning situation.

Furthermore television can be programmed to promote discrimination learning through the inclusion of both correct and incorrect exemplars. If typical error patterns in children's responses visavis a particular concept can be assessed in advance of program production, typical errors can be cued and combined with corrective feedback. While such a procedure is difficult with concepts that produce highly idiosyncratic error patterns, it can be employed with skills that typically result in the production of predictable incorrect responses (e.g., conservation).

All of the variables mentioned so far have been hypothesized to have an effect on the <u>attentional</u> and <u>retentional</u> aspects of learning, i.e. the acquisition phase. Reinforcement and the expectation of reinforcement have been hypothesized to have an efficacious influence on the <u>production</u> of acquired responses (Bandura, 1969; 1971). Since one normally anticipates that the observer will produce as well as acquire a conceptual behavior, inclusion of variables to promote performance is important also. Both task specific and general reinforcement to the model can be provided easily within television programming, and to some extent social reinforcement can be provided by the television to the observer if opportunities for active participation are incorporated in the programming.

The research under consideration here utilized all of these variables in television program design, and while it was not possible to systematically analyze individual components as to their differential and additive effectiveness, the televised instruction proved to be highly effective in teaching selected conceptual behaviors to preschool children (Henderson, Zimmerman, Swanson, & Bergan, 1974).

Limitations of Unsupplemented TV Instruction

Active Participation: Despite the fact that sequentially programmed television instruction can be an extremely effective teaching procedure, providing results of practical magnitude, not all children exposed to such a package attain criterion level performance (Henderson, Zimmerman, Swanson, & Bergan, 1974). The reasons for such failure could be numerous, but there is the possibility that failure to reach criterion results from limitations associated with the medium itself, interacting with particular characteristics of the child (e.g., age).

One limitation of televised instruction is the lack of opportunity for active participation in the learning. It has been hypothesized by some psychological theorists (e.g., Piaget, 1970) that active participation with the environment is a necessary requisite to learning. Manipulation of objects, then could be considered a prerequisite to acquiring notions regarding object relationships. If indeed this is an optimal condition for concept acquisition ,then instructional programming should provide opportunity for active subject involvement. While television programming can provide cues for rehearsal, such cues cannot insure that the observer will in fact take an active role. Participation remains a voluntary activity on the part of the viewer. Some children may respond actively while others may remain passive attenders. The specific effects of this activity versus passivity dimension in television programming needs to be analyzed systematically, but may be a serious limitation of instruction.

A considerable amount of actual physical practice may be required for optimal learning to occur. Such a degree of participation is difficult for television alone to promote; the television can provide opportunities for practice but not the insurance that actual overt practice will occur. Furthermore, differential amounts of practice time may be required to meet each individual child's needs, and television alone is not well-suited to provide for that requirement.

Programming Flexibility: A second possible limitation of the medium is lack of flexibility once the programming is completed. The object of programming is to provide instances and noninstances of the concept such that the subject can learn to discriminate correct and incorrect responses. This requires that the programmers be very familiar with the kinds of errors children perform in regard to a particular concept, and that they provide instances of those specific errors to facilitate discrimination. With careful piloting and systematic observation , common error patterns can be determined and included in the program design. For example, in the case of seriation, we found that error analysis of children's responding was a straight-forward matter that did not evidence extensive idiosyncratic error patterns. Children either responded correctly or attended to irrelevant cues such as color or shape of the objects to be ordered. This situation might be remedied by programming strategies in which they are systematically varied.

Other kinds of skills, however, present a greater problem in error analysis because error patterns within some tasks appear to be highly idiosyncratic. Adequate programming taking into account all such errors, would be an almost impossible task, or would result in an impractical and overly lengthy product. With tasks that are characterized by extensive idiosyncratic error television programming alone seems insufficient to provide extensive and corrective discrimination training.

Effective Feedback: A third learning facilitator that is difficult for television alone to provide is effective feedback for the child's responses. The provision of feedback and reinforcement is hypothesized by social learning theorists to affect motivational process and has been demonstrated to be an effective procedure in learning experiments and a powerful additive factor in modeling research (Zimmerman & Pike, 1972; Zimmerman & Rosenthal, 1974a; Zimmerman & Rosenthal, 1974b). Hence, provision for reinforcement should be considered in a complete instructional system. Television programming can include feedback and reinforcement to the model-respondent , feedback both of a general variety as well as that related to specific characteristics of the model's performance. Feedback to the child viewer, however, is more difficult to incorporate into instructional-tape content. Following encouragement to participate, general reinforcement can easily be provided but such reinforcement probably serves as an effective facilitator only for those children who actively respond to the invitation, and then only when they respond appropriately.

Even for the child who emits correct, active responses, such a feedback provision is of a very general nature. For those children who do not engage in the desired activity or who respond inappropriately, generalized feedback does not serve the desired function of strengthening an appropriate response. Television reinforcement and feedback then, is somewhat limited, may not serve the desired function, and is at best, nonspecific with regard to the subject's individual performance.

Objective Sequencing: A fourth limitation of television instruction as a sole instructional medium concerns the a priori assumptions which guide the design of programming content and structure. Normally any program sequence will be designed to cover a specified set of standard objectives. Even when such objectives are integrated within a linear format, the objectives themselves, as well as the step increments between them, reflect an a priori decision rather than differential sequencing of objectives based on individualized response patterns. Such an approach may be effective for the majority of observers, but may not prove to be the optimal sequencing for all children. It is hard to envision a television-programming approach that could avoid this problem and individualize to a sufficient extent if television constitutes the sole avenue of instruction.

Related to inflexibility in sequencing is the problem of using redundant exemplars to maximum benefit. Since research on concept acquisition suggests the use of numerous exemplars from which the observer can induce a rule, it is necessary to at the least provide more than one exemplar. However, the number of concept instances to include is not as clearly indicated from the research literature. Great redundancy may be required before some children can abstract the rule, while other children may require very few. For some insufficient exposure may result in a lack of mastery prior to progression into a more complex instructional segment. For others, too much redundancy may lead to boredom and loss of attention. In either case, failure to reach mastery of the target behavior may result either through inadequate instruction or restriction of attentional processes. Choices of presented instances must be made during program development, hence there is a possibility that misjudgment may occur.

In summary, even when carefully sequenced, gradually graded in difficulty, and based on sound psychological principles, television instruction alone is not a complete instructional tool. Television is an effective facilitator of learning and certainly is an efficient basic tool for imparting complex concepts to most children, but it can provide for active participation only in a limited way. Furthermore, television instruction presents problems for systematically programming idiosyncratic errors, and it cannot be easily adapted to the provision of individualized feedback, reinforcement, and to individual needs for repetition.

Overcoming the Limitations of TV with Ancillary Instruction

One method by which some of the limitations of television instruction may be overcome is through the addition of an ancillary instructional system designed specifically to parallel television instruciton. Such a system could be designed to provide instructional facilitators lacking with television alone. Sine a supplementary system is by definition a support rather than an independent instructional method, its purpose would be to efficiently augment the instruction components of the video teaching.

Therefore, such a system need not stand alone as an instructional device and should not require specialized personnel or be unduly time-consuming. Rather it should consist of brief support activities that maximize the efficacy of television by providing only those learning facilitators for which television is not suited. A sufficient test of the value of an ancillary system would be its production of a significantly additive improvement over television instruction alone. The goal of the present research was to design a support system staffed by paraprofessional personnel, and to evaluate its additive value as an adjunct to linearly sequenced television programming.

Facilitating conditions already provided by the video system include (1) multi-incident modeling, (2) generalized positive reinforcement to the model-respondent, (3) verbal rule provision, (4) variety of concept exemplars, and (5) systematic linear sequencing. The additional facilitating conditions incorporated within the ancillary system are (1) opportunity for rehearsal, (2) provision of individualized feedback and reinforcement, and (3) correction of idiosyncratic errors.

The four conceptual skills selected for study were: (1) seriation, (2) enumeration, (3) question-asking, and (4) conservation of number. For each skill both television instruction and accompanying ancillary instruction were designed, developed and evaluated as to their statistical and practical effect on the acquisition of the complex intellectual skills.

OBJECTIVES AND HYPOTHESES

Objectives

1. To determine the effecti veness of (a) televised instruction and (b) ancillary group instruction, in promoting acquisition of question-asking skills.

2. To determine the effectiveness of (a) televised instruction, and (b) ancillary group instruction in promoting acquisition of seriation skills.

3. To determine the effectiveness of (a) televised instruction and (b) ancillary group instruction in promoting acquisition of conservation skills.

4. To determine the effectiveness of (a) televised instruction and (b) ancillary group instruction in promoting acquisition of enumeration skills.

Hypotheses

1. Supplementary group instruction will significantly augment the effects of television instruction in promoting children's acquisition of question-asking skills.

2. All treatment groups (whether exposed to one or both types of training) will evidence significantly more proficiency in question-asking than untreated control children.

3. Supplementary group instruction will significantly augment the effects of television instruction in promoting children's acquisition of seriation skills.

4. All treatment groups (whether exposed to one or both types of training) will evidence significantly more proficiency in seriation than untreated control children.

5. Supplementary group instruction will significantly augment the effects of television instruction in promoting children's acquisition of conservation skills.

6. All treatment groups (whether exposed to one or both types of training) will evidence significantly more proficiency in conservation than untreated control children.

7. Supplementary group instruction will significantly augment the effects of television instruction in promoting children's acquisiting of enumeration skills.

8. All treatment groups (whether exposed to one or both types of training) will evidence significantly more proficiency in enumeration than untreated control children.

BACKGROUND FOR THE SPECIFIC EXPERIMENTS

Four skill areas were selected for video programming, ancillary support and validation. The categories were enumeration, conservation of number, seriation, and question-asking. While these skills differ from one another in important ways, they have in common the fact that they involve the learning and performance of behaviors which are dependent upon one or more abstract rules or principles.

Seriation

Importance of Seriation: The ability to seriate was chosen for study in the present research because it is recognized as an important developmental skill that has attracted a great deal of attention by Piagetian researchers, and because it is considered a difficult task for young children to accomplish. As Siegel (1972a) points out, "the ability to order subjects in a series according to some dimension, such as size, is recognized as an important aspect of a child's ability to understand logical concepts" (p.135). Furthermore seriation has attracted research interest in terms of its sequential place in the development of concrete operational thought (Murray & Younis, 1968); Brainerd, 1973d) and is considered by some to be one behavioral index of ordination processes basic to the development of more advanced numerical concepts (Brainerd, 1973b, 1973e). Due to the psychological as well as educational interest in the development and acquisition of this concept, it was chosen as an important one for which to design television and ancillary instruction.

Selected Research on Seriation: Seriation is defined as "an additive arrangement of assymetrical transitive relations" (Moore & Gallagher, 1973, p. 613); that is, the child can infer the A>C given the A>B and B>C. This is usually examined by directing a child to put an array of objects in order from the smallest to the largest. However, the ability to order, particularly following numerous trail and error attempts, is not usually considered sufficient to demonstrate the concept of seriation. Rather, to be considered properly operational, the child's approach must involve a systematic search for the smallest (or largest) object first, and a systematic continuation of that strategy until the objects are all placed in an ordered array (Inhelder & Piaget, 1964). Similarly, Moore and Gallagher (1973) emphasize the necessity for a systematic strategy for comparison in order to demonstrate the concept of seriation. They delineate a strategy that they consider to constitute a demonstration of true series relationships and use of measurement:

> A systematic and complete comparison of the chosen rod with reference rods to eliminate all possibilities; incorporation of measurement with reference points such as the edge of the table (p. 613).

Seriation has attracted research attention because it has been considered one method for examining a child's understanding of size relationships with more than two objects through his ability to systematically order an assymetrical array.

Piaget breaks the acquisition of the concept of seriation into two stages (Elkind, 1964). The first involves the ability to make a simple size discrimination, i.e. to select the smallest or largest object from a set of objects introduced in disarray; the second involves the building of a "stairway" from a disarrayed set. This second stage has been further analyzed into three steps (Inhelder & Piaget, 1964):

1. In the first step, the child puts the objects in small sub-series of two and three elements but cannot coordinate them into an overall series.

2. In the second step, a child can accomplish the construction of a stairway but only after considerable trial and error; and finally,

3. In the third, the child can seriate a set of objects in a systematic manner, i.e. the operational method.

Piaget's findings indicate that while four-year-olds can accomplish discrimination problems, the more complex seriation operations are not evidenced until age six or seven (Elkind, 1964). Some children may have success with the true operational method at age six, but the majority cannot succeed at this performance until age seven or eight (Inhelder & Piaget, 1964). With children younger than four or five, the concept of seriation even with a small number of objects is usually not in evidence (Sieget, 1972a).

Other researchers (Siegel, 1972a; Gollin, Moody, & Schadler, 1974; Moore & Gallagher, 1973) have attempted to get at seriation concepts in less complex ways than through the task of complete ordering of an array. Siegel (1972a) used two, three, and four unordered stimulus arrays with three to nine-year-old children and required them to identify both the terminal size relationships and the middle size relationships. She found that even the youngest children had no difficulty identifying the end poisitions but had considerable difficulty with the middle positions. However, while it may be assumed that the children had to order the array prior to making a judgment , the children were not explicitly required to do this. Gollin, et al (1974) similarly examined relational size problems with respect to middle position with five-year-old children; he found that identification could be learned by this age group. Again the ability to manually order an array was not directly examined. Moore and Gallagher (1973) used a task which involved finding a pre-identified object in an array, but in addition they examined the strategy by which the children reached a solution. They found that the majority of kindergarten children made judgments without the use of a comparison strategy, but by the third grade most of the children in the sample employed an operational strategy.

From this brief review one can see that operational definitions of the concept of seriation for research purposes cover a wide range of complexity from the simple discrimination of size relationships through the complete ordering of an array; and while the more simple components are evidenced with young children, the more complete operational capability appears at an older age.

Two of the aforementioned studies have sought to teach aspects of seriation and have attained positive results. Siegel (1972a) provided simplified verbal instruction and tangibly reinforced correct responses across trials. Gollin et al (1974), trained children by using a reference point, either experimenter- or subject-supplied, coupled with informative feedback. They state that "affording the children the opportunity to establish a referent enabled them to solve an otherwise unsolvable relational size problem" (p. 106). Control children who were not supplied with a referent were significantly less successful in accomplishing the task.

In both studies, the ability to impose order on an array was neither assessed nor trained.

Rationale for the Present Research: One could conclude from inspection of the work on seriation reviewed that there are many aspects to the concept, most of which researchers have assessed developmentally, but only a fraction of which have been trained. None appeared to have utilized social learning principles in training aspects of the skills with the exception of our past year's research (Henderson, Swanson, & Zimmerman, in press). It appears that the work to date can be analyzed into a series of subskills that define seriating behaviors:

1. The ability to discriminate terminal size positions (Siegel, 1972a; Elkind, 1964),
2. The ability to discriminate middle placed size relationships (Siegel, 1972a; Golling, 1974),
3. The ability to impose order on an array with a systematic strategy (Inhelder & Piaget, 1964; Elkind, 1964),
4. The ability to impose a second set of stimuli on an order array (Elkind, 1964; Inhelder & Piaget, 1964), and
5. The ability to discriminate ordered and unordered arrays, while not specifically encountered in the literature, could also be viewed as a relevant capability.

It could be hypothesized that a hierarchial relationship exists among these subskills, and the consistency in reports concerning these skills usage appear developmentally would tend to support such a conjecture.

Training was undertaken in four of the skill components in the set delineated previously. The four components of the concept incorporated into instructional design were: (1) discrimination of terminal size relationships, (2) discrimination of ordered arrays, (3) the ability to systematically impose order on an array, and (4) the ability to interpose additional elements into an ordered array. Piagetian researchers have found that imposition of a second array (component 4) was evidenced only in much older children (7-8 years) and no previous research had attempted training in such a complex task. However, even this aspect was included for evaluation in the current work.

The four subskills were cast into a task hierarchy unified through the teaching strategy selected rather than through suggested developmental occurrence. Successful performance on the final step in the hierarchy would satisfy the most stringent definition of seriation. The serial ordering investigated in the present study was not confined to the length dimension as has been the case with most seriation research, but rather was extended to include seriation operations with three dimensional objects.

The systematic strategy for array order suggested in the literature (Inhelder & Piaget, 1964), involved the child's looking for the longest (or shortest) element in the disarray, removing it, and then looking for the longest. This procedure was the one chosen to be modeled and reinforced in both instructional components in this study. First, instruction concentrated on simple tasks involving repeated discrimination of the longest of a variety of objects. A systematic comparison strategy was used to facilitate discrimination, and a verification procedure was also modeled. The verification procedure involved training the ordered array with the hand in order to ensure that its configuration went "down like stairs". The tape emphasized the modeling of the strategy while the ancillary instruction offered opportunity for guided practice and feedback. This strategy, modeled repetitively and with increasing stimulus complexity, is congruent with previous conceptualization of the concept of seriation.

Enumeration

Importance of the Skill: The second intellectual skill investigated in the present research was the ability to discriminate the equivalence and nonequivalence of mathematical sets. Interest in the development of such premathematical skills has generated research,discussion of a theoretical nature (vide Brainerd, 1973b; Brainerd, 1973c; Siegel, 1972b). Furthermore this numerical judgment operation evidences a close relationship to mathematical skills emphasized in the elementary years and hence constitutes an educationally relevant set of capabilities. "Sesame Street" for instance, has articulated much of its instruction to the objectives of basic counting skills and numerical magnitude judgments, since these skills are regarded by educators and psychologists as fundamental to the mastery of basic arithmetic operations.

Selected Research on Enumeration Skills: During recent years, psychological research has been directed at the sequence of the development of mathematical notions in young children. Much of this work has been concerned in the prerequisite skill components that comprise the ability to discriminate equivalence and nonequivalence. Siegel (1972b) examined the sequence of development of several magnitude concepts with children aged 3 years 0 months to 4 years 11 months and found that judgments of linear magnitude and the concept of "oneness" was much easier for children of this age to discriminate than nonlinear magnitude. The nonlinear magnitude discrimination task was significantly more difficult than the other tasks except for the oldest group of children. The author concluded therefore that children initially discriminate magnitude on the basis of relative length. In an earlier study, Siegel (1971) had found that the development of the concept of equivalence precedes the understanding of conservation of number.

Brainerd (1973b, 19733) proposes that set discrimination judgments are made through the process of ordination or ordering which he defines as "the construction of an ascending (or descending) asymmetrical quantitative relation among a group of mathematical entities" (Brainerd, 1973b, p. 231). He identifies counting as an operation of ordination (1973c), and furthermore maintains that a high level of proficiency in ordination skills is a "necessary precondition for arithmetic proficiency" (1973b, p. 273).

Research on counting skills in young children has also been conducted. Potter and Levy (1968) found that accurate counting required that children be able to point to each object to be counted once and only once. They asked children between 2.5 and 4 years of age to touch each picture in a set of pictures just once. Then children were requested to count six objects. Counting accurately and touching pictures only once were significantly related. Want, Resnick, and Boozer (1971), in a scalogram analysis of numerical operations, found that when counting is used as a strategy for comparing sets which are not arranged in 1:1 correspondence, judgements of more and less are prerequisite to judgements of same and different. However, when sets are arranged in 1:1 correspondence, judgments of same and different are lower on the learning hierarchy than judgments of more or less. In another study (Shannon, 1975) children's error rates in number judgments were significantly decreased following instruction in a systematic linear counting strategy.

It appears from this research that (1) children of preschool age evidence premathematical behaviors, (2) they can discriminate magnitude relationships, (3) linear arrangements are more easily discriminated than nonlinear ones, and (4) that counting strategies offer promise as an effective device for making set comparison judgments.

Regarding the developmental sequence of the concepts of "same", "more", and "less", relational concepts essential for judgments of magnitude, research has also been conducted. A study by Harasym, Boersma, and Mcquire (1971) indicates that knowledge of the meaning of terms such as more or less may be important in the acquisition of more advanced numerical operations and skills. These investigators assessed conservation in children in grades 1, 2, and 3 in rural county schools. They then used the semantic differential technique to establish the meaningfulness of the terms more and less. They found that children who were able to conserve had a greater understanding of relational terms, i.e. more and less than children who could not conserve. Donaldson and Balfour (1968) worked with three and four year olds and found that for the most part the children did not differentiate the concepts of "more" and "less" on a discrimination task even when they were quite able to count the number of objects in the sets. In another study (Palermo, 1973), children as old as seven were not able to differentiate those two terms. And in another (Palermo, 1974), results indicated that children acquire the concept of "more" prior to the concept of "less", and that children who do not understand the concept "less" treat it as a synonymy of "more". In a training study with preschoolers Epichard (1969) found the most efficient learning sequence for relational concepts with sets to be "equivalence", "greater than", and "less than".

Rationale for the Present Research: The operational definitions chosen for the research under consideration here were selected to be congruent with the concerns of previous literature in the area. The final target behavior to which the instructional design was directed involved the judgments more-same-less as compared to an outside standard within the confines of a three-way sorting task. A three-set discrimination has been previously shown to be the most difficult type of task in magnitude-comparison studies (Want, Resnick, & Boozer, 1971).

On the basis of previous research, prerequisite skills to the target behavior were identified as (1) counting skills applied to linear sets, (2) counting skills applied to nonlinear arrangements, (3) discrimination between equivalence or nonequivalence with a standard for comparison, (4) discrimination of "more" and "same", (5) discrimination of "less" and "same", and (6) the final three-way discrimination task. These skills identified as prerequisites to the final three-way discrimination tasks were organized into an eight-step task hierarchy (Appendix A). The order of organization of the components was consistent with previous research findings and was unified through a systematic counting strategy approach.

Preliminary evaluation of the constructed sequence and skill components indicated several possible problems. First, it was noted that children involved in pilot testing evidenced confusion with the meaning of the word "same". These young children tended to confine the label to those objects which were identical on all dimensions (e.g., shape, color, numerosity). To avoid confounding from this semantic problem, the term "as many", a concept with a more restricted meaning, was substituted during equivalence instruction. Second, it appeared that the children preferred to select matches on perceptual dimensions other than number, such as configuration or object similarity-difference. Therefore, a variety of objects in a variety of configurations and colors were systematically included. It was also discovered that reliance on a great deal of language instruction and assessment led to considerable nonresponding in this age group, and hence language was minimized and nonverbal motor tasks were primarily employed in the assessment procedure. Other studies (Braine, 1959; Siegel & Goldstein, 1969) have indicated that reliance on language in assessing quantitative concepts can prove to be misleading.

In summary, the enumeration skills selected for instruction and validation in the present study are consistent with prior research in the area. Furthermore, the acquisition of such skills are relevant for later mathematical instruction and hence have practical validity and relevance on an educational basis.

Question-Asking

The skill of question-asking was chosen on the basis of a number of practical, theoretical, empirical, and cultural considerations that differ from the selection basis employed for the other target skills.

Practical Considerations: Question-asking is regarded in many educational programs as an important "learning to learn" skill. It is widely regarded as a basic intellectual capability which the child can use to obtain information from his environment and assume a role in guiding his own learning (Henderson & Garcia, 1974; Henderson, 1975). The child who can ask a variety of types of questions can obtain information when he wants and needs it, rather than depending on a schedule for dispensing information controlled entirely by adults in the environment.

Theoretical Considerations: Psychologists and educators who are concerned with the linguistic and intellectual development of children assert that question-asking is of obvious importance in intellectual life (Cazden, 1970) and that question-asking is central to all problem-solving (Blank & Covington, 1965). Suchman (1964), who has spent many years developing procedures to teach inquiry processes affirms that:

> . . . a realistic approach to conceptual growth must allow the learner to gather and process data in accordance with his cognitive needs of the moment, and this suggests he should be utilizing some kind of inquiry (p. 68).

In pilot testing for an experiment on question-asking, Rosenthal, Zimmerman and During (1970) were able to elicit a much lower rate of question-asking from lower SES minority groups. In early studies of the language development of young children, McCarthy (1930) and Davis (1932) found that question-asking behavior develops at a faster rate for higher socio-economic status children than for children from lower socio-economic backgrounds. In a more recent study of culturally different children, Martin (1970) observed that "disadvanataged" black children performed at a "lower level" of question-asking than their more "advantage" white peers.

There are a number of possible interpretations for these findings. It has been argued that the typical testing or classroom situation in which an adult Anglo-American requires minority students to produce language responses results in the inhibition of the child's verbal behavior (Labov, 1972). Herbert (1970) demonstrated that the children in a tutoring relationship with younger children used more complex language productions than they used in the role of student in the classroom. Baratz and Baratz (1970) charged that much of the social science literature on the language of minority groups is flawed by ethnocentric bias. Nevertheless, if Papago children do use fewer and less complex questions than their middle-class Anglo counterparts then this fact may have implications for understanding the cummulative discrepancy in school performance between culturally diverse groups, and between more and less successful pupils within these groups.

The developmental literature also indicates that while questions of varied types may all play an important role in intellectual functioning and problem-solving, some categories of questions are later than others to emerge in children's linguistic repertoires, and probably call for a greater load of information and relationships than simpler question forms. Ausubel and Sullivan (1970) indicate that questions which come early in children's development call for the names of objects and persons, while <u>why</u> and <u>how</u> questions develop somewhat later. Piaget's (1955) developmental study of language of two six-year-old boys revealed a very low incidence of questions calling for explanations in the verbal production of these children. In discussing Isaac's study of questions involved in causal inquiry (Cazden (1970) argued that "By means of these questions, a disparity between our past experience and some present event becomes for the child (or the scientist) the growing point of his knowledge" (p. 213).

Since causal questions are generally considered to be of critical importance to the intellectual growth of young children, there is a need to identify instructional practices capable of facilitating the learning and performance of this capability.

Empirical Considerations: Considering the fact that question-asking skills have both theoretical and face validity as an important set of capabilities within the larger domain of inquiry skills, surprisingly little experimental research has been done on children's question-asking behavior. Most research on children's question-asking has been descriptive and normative in nature, with data coming from records of children's spontaneous speech, studies of induced questions, and studies of the kinds of questions used by children in the course of problem-solving (Berlyne, 1970).

Gall (1970) reviewed the educational research on question-asking, and concluded that most investigations have centered on teacher behavior and that the shaping of student questioning skills has been a neglected area of research. Examples of the approaches employed in research on teachers' questioning behavior include the use of The Taxonomy of Educational Objectives: The Cognitive Domain (Bloom et al, 1956) as the basis for classifying the questions which teachers direct to students (Mason & Clegg, 1970), and the use of question categories derived from Guilford's (1967) Structure of the Intellectual Model to study intellectual operations addressed in teachers' questions (Zimmerman & Bergan, 1971). In these and similar investigations there has been no attempt to determine the effect of teacher questioning on the learning or performance of students.

A few investigators have manipulated one or more independent variables, and observed the effects on question-asking and attendant behaviors.

Torrence (1970) investigated the effects of opportunity to manipulate objects on question-asking in young children and found that the opportunity to manipulate objects facilitated question-asking in six-year-olds. Working with sixth graders, Blank and Covington (1965) found that an autoinstructional program was effective in facilitating question-asking on criterion tests, promoting participation in class discussions, and that inducing question-asking appeared to facilitate problem-solving on a science achievement test. Berlyne and Frommer (1966) induced question-asking through the use of an orally related story, accompanied by pictures and a "magic trick" involving elements such as novelty, surprisingness, incongruity, uncertainty, and amount of information. They found that these elements increased the incidence of questions. They also discovered that third grade children asked more questions when they were provided with answers, but younger children were not similarly influenced by the provision of answers. The authors speculated that the potential reinforcement value of answers may not yet have been operative in the younger children.

There are four observational learning experiments which provide the more relevant prototype for the strategies employed in the present research. In one experiment Rosenthal, Zimmerman and Durning (1970) demonstrated that modeling procedures were effective in teaching children to discriminate and produce questions falling within several modeled categories, and that the behavior generalized to a new set of stimuli. Zimmerman and Pike (1972) employed modeling and verbal reinforcement procedures successfully to teach question-asking skills to lower SES Mexican-American children in a classroom prototype for small group instruction. The question-asking skill of Mexican-American children has also been positively affected through the influence of their mothers who were trained to use modeling, cueing, and reinforcement procedures to teach their children to use causal questions (Henderson & Garcia, 1974). Similar results have been achieved in a field experiment involving the use of native American paraprofessionals to train mothers on the Papago Reservation to teach inquiry skills to their children through the application of basic social learning principles (Henderson & Swanson, 1975).

These four observational learning experiments provided the basis for the instructional strategies employed in the video tapes validated in the first year of the present research (Henderson, Swanson, & Zimmerman, 1975) and served as the prototype for the development of the ancillary instruction under consideration here. It should be mentioned that while these investigations document the efficacy of social learning principles for teaching a class of rule governed behaviors, only the Henderson, Swanson, and Zimmerman study (1975) has attempted such instruction with children as young as those who participated in the present research.

Cultural Considerations: School officials on the Papago Reservation report that Papago children ask very few questions, at least in settings where they interact with or are observed by Anglos (Henderson & Swanson, 1975). The ethnographic literature on this group also emphasizes the anthropological observation that traditionally, direct question-asking was not a favored mode for obtaining information. The traditional, culturally preferred way of acquiring skills and information was through close observation and imitation (Joseph, Spicer, & Chesky, 1949). While more current ethnographic evidence is not available to indicate the extent to which this pattern may still hold, informal observation suggests that to a large extent this pattern persists today in interpersonal transactions within the Papago culture. However, past research on the Reservation suggests that many Papagos hope for their children to learn the skills which are considered important in the dominant society, while preserving valued aspects of traditional culture. A degree of cultural pluralism is an implicit goal of many Papagos (Swanson & Henderson, 1974). Moreover, many of the parents who have participated in our research training activities are explicit in their belief that in dealing with Anglo-dominated agencies on the Reservation, question-asking is a very important skill.

In view of these considerations, question-asking, more so perhaps than the skills involved in the other experiments, may have a specific value beyond the purpose of testing the efficiency of televised instructional sequences designed to influence the acquisition of rule-governed cognitive skills.

Conservation

Importance of Conservation of Number: Piaget (1952) has argued that conservation of number is a reflection of a child's conception of quantity and quantitative invariance. Piaget's study of children's intellectual development has revealed that young children are unable to appreciate some of the more subtle dimensions of numerosity such as the possibility that object configuration and amount are potentially separate stimulus dimensions. This ability to respond to stimuli on the basis of two dimensions simultaneously is the hallmark of logical thinking, according to Piaget, and is a mental skill which underlies logical thought operations in general and mathematical reasoning in particular.

From an empirical point of view, correlations, between conservation responding and children's mathematical achievment has been reasonably high and statistically significant (*r*'s = .50s; Goldschmid & Bentler, 1968). This evidence does indicate the importance of this skill in children's understanding of mathematics.

Pragmatically, conservation skills would be important because the failure to conserve reflects confounding in a child's thinking. If a child judges number on the basis of the size of the configuration, he is going to be wrong whenever the size stimulus cues are in contrast to the amount cues. Piaget's research indicates this confounding will occur for young children if they are left on their own to deduce this principle. As a result of this incapacity, elementary and preschool teaching materials and instructional programs often include a sequence on conservation of number. Perhaps for the same reason, the Board of Advisors for the Children's Television Workshop selected conservation of number as one of their instructional objectives (Bogatz & Ball, 1971). However, the statistical evidence compiled in the second year Educational Testing Service (ETS) report (Bogatz & Ball, 1971) indicated that the "Sesame Street" programming was not successful in teaching children this concept.

Selected Descriptive Research on Conservation: Conservation tasks have attracted voluminous research attention since Piaget noted that such tasks produce remarkably different performances prior to and following the attainment of concrete operational thought-performance differences that surprise and often mystify adults. While there are several types of conservation problems that have been examined (number, mass, weight, length, and volume) success on all is considered to result from the same psychological structural or schematic alterations that occur with the onset of concrete operational thought. Hence successful judgments on different conservation problems appear in the child's behavioral repertoire at approximately the same point in time. Piaget did note some separation in time for the acquisition of mass, weight, and volume conservation in that some conservation tasks appear a few years earlier developmentally than the others; he refers to this sequence of skill appearance as "horizontal decalage". The literature suggests that conservation of number is the earliest of the operations to appear developmentally (Brainerd & Brainerd, 1972; Reese & Lipsett, 1970).

According to Piagetian theory, prior to the attainment of operational thought the child is able to make quantity judgments on the basis of only one perceptual dimension. Hence, his judgments become inaccurate whenever transformations occur that yield perceptually conflicting information. After the attainment of operational thought, however, correct judgments are attainable, for the child is able to recognize the invariance of quantity despite the presence of confusing perceptual cues. With respect to conservation of number, a child in the concrete operations stage can correctly discriminate numerosity equivalence despite confounding length and number cues. The facts of conservation performance have been repeatedly confirmed in the research literature (Reese & Lipsett, 1970).

Pufall (1973) and associates (Pufall & Shaw, 1972; Pufall, Shaw, & Syrdal-Lasky, 1973) have done an extensive study with conservation of number with seven object configurations based on four conservation rules that systematically vary spatial properties in relation to number judgments.

According to the discussions in these studies Piaget sees the concept of lasting equivalence as proceeding through a series of stages. In Stage I judgment is based on global similarities with length being the relevant dimension for decision-making, irrespective of row density. In Stage II the "coordination of length and density with number appears to be intuitive, that is, based on the perceived correspondence of length and density" (Pufall & Shaw, 1972, p. 62). The child cannot see this correspondence after row transformation and vacilates between density and length as the relevant criteria. Then finally in Stage III, the child can finally understand the invariance of numerical equality in the face of perceptual transformations as he now can use both dimensions simultaneously. Unlike most conservation studies, in this one (Pufall & Shaw, 1972) transformations of shape were not made in the child's view. The findings were not as Piaget has hypothesized. In this research the youngest children initially vacilated between length and ensity; the middle-age children used length exclusively, while the oldest managed both dimensions. Length judgments, then, were typical of the middle age group -- not the youngest or oldest groups.

Rose (1973) did a similar study using the rules and configuration of the Pufall work. Criterion for mastery was based solely on performance, and transformations were not used. Both equality and inequality items were presented to the children. By including both types of items, Rose was able to evaluate the extent to which performance results from acquiescence rather than appropriate logical operations. She found that acquiescence clearly played a large role with three and four year olds while at age five failures were due to systematic misconceptions about length and number.

One point of her study was the the inadequacies of many conservation measures (such as limited sampling of conservation items and required verbalization) could be overcome by the systematic inclusion of both equality and inequality items.

Selected Training Research on Conservation: The problem of whether children can be trained to conserve, and if so, how, has attracted overwhelming attention from developmental psychologists. The results attained and the methods employed evidence great variety, but in sum the evidence indicates that training may be successful at age levels lower than proposed for the onset of concrete operations. Early training efforts which were often predicated on Piaget's equilibration model seldom met with much success, but more recent training studies have emanated from other theoretical traditions such as task analysis models (e.g., Kingsley & Hall, 1967), and perceptual discrimination models (e.g., Rosenthal & Zimmerman, 1972a; Siegler & Liebert, 1972), have reported some success in teaching children to conserve on a variety of stimulus dimensions. All of these studies have treated conservation response as a form of rule learning and have utilized a variety of methods to constrain the child's attention to the relevant quantity dimension to disregard the irrelevant stimulus configuration dimension. Much of this literature on the training of conservation in young children has been reviewed elsehwere (Brainerd, 1973c; Henderson, Zimmerman, Swanson, & Bergan, 1974; Zimmerman & Rosenthal, 1974b).

Halford and Fullerton (1970) used a unique discrimination task to induce conservation of number in six-year-old children. Using sets of dolls and beds placed in one to one correspondence, the children were trained to use the set of dolls as a standard with which to compare other sets of dolls that would also correspond numerically with the set of beds. The standard set was therefore used as a cue in discrimination learning, for each child had to discriminate between sets that varied in spacing, and number to find a set which matched the beds in number. The training procedure consisted of five individual sessions in which the subject practiced matching sets of beds and dolls, and while no direct feedback was provided, subjects were permitted to verify their responses through object manipulation. Following training both a similar task posttest and a delayed retention test with novel stimuli were administered. The results indicated that the method induced two thirds of the experimental subjects to "acquire conservation of a stable kind" (Halford & Fullerton, 1970, p. 211).

In another study, Roll (1970) successfully trained conservation of number in preoperational children. He also used a doll and bed procedure in which the subject could manipulate the objects and verify his own judgments. Results favored the performance of the trained children and moreover, the children resisted a reversion to non-conserving responses even when encouraged to do so. While performance was markedly improved as a result of training, few conserving subjects were able to demonstrate verbal awareness of conservation principles. Since verbal instruction and explanation was not a part of the training procedure, this result does not seem particularly surprising.

Figurelli and Keller (1972) have used verbal rule instruction techniques in training conservation with children from a lower-socio-economic group as well as the more usual middle-class group. In this study the procedure involved demonstration of a conservation task as well as provision for corrective feedback and verbal explanation. Instruction covered the full range of conservation tasks including conservation of number. Following training all children were administered both a posttest and a transfer test. While middle-class children scored consistently higher than the lower-class children, training resulted in significantly higher posttest performances for both of the experimental groups. Both groups made equivalent gains from pre- to posttesting. And, as the authors point out:

> It is quite likely that training with this simple procedure results in acquisition that is separate and independent for each conservation concept -- and perhaps for each task within a given concept (p. 297).

It does not seem surprising that training effects in this study did not generalize across conservation tasks since the training itself was task specific and steps to facilitate transfer were not included.

Experiments in the training of conservation have also been done with a social-learning model for instruction. Rosenthal and Zimmerman (1972a) used modeling procedures in teaching preoperational children to conserve across a variety of tasks on the Bentler-Goldschmid Test. They concluded that these procedures were effective with children as young as four years if modeling segments were limited in the time and the breadth of target responses depicted. Not only have gains in conservation tasks been produced with a modeling procedure, but gains have been shown to transfer across conservation tasks and to be retained over a seven to ten day delay (Henderson, Zimmerman, Swanson, & Bergan, 1974). The use of modeling sequences with television instruction has also been an effective procedure for training conservation with very young children (Henderson, Zimmerman, Swanson, & Bergan, 1974).

It is interesting to note that investigators concerned with training conservation from the social learning paradigm define and teach the task as they would any rule-governed behavior. They accomplish this by varying nonrelevant aspects of the models performance while holding constant the essential aspects of the task. Moreover, a verbal rule is usually provided, and verbal explanation of the judgmental process is frequently offered. In some cases the verbal rule concerns reversibility phenomena and in other cases the application of counting strategies (Henderson, Zimmerman, Swanson, & Bergan, 1974), but the common element here is that the model can and does verbally mediate his performance and his decision making processes for the observer.

A problem is encountered in the assessment of conservation skills in that the usual criteria for success on the tasks involves not only a correct performance but additionally a correct verbal justification of that performance. Such criteria may place a heavy burden on the young child who has not attained great facility with the use of verbalization in general and the use of relational terms in particular. Siegel and Goldstein (1969) found that young children do not understand the meaning of the words "same" and in fact tend to respond to arrays with regard to the most recent stimulus word presented to them. In another study (LaPointe & O'Donnell, 1974) it was found that children younger than four did not understand the relation of "same" to "more", but their language comprehension did improve with age. Griffiths, Shanta, and Sigel (1967) also noted the difficulty preschool children experience with the word "same" and found that verbal pretraining was effective in inducing conservation judgments. Harasym, Boersma, and Maquire (1971) employed a semantic differential technique with conservation tasks and found that conserving children evidence greater understanding of relational terms than children who cannot conserve.

Research evidence has not clarified to date the precise role that language comprehension plays in the acquisition of conservation responses, and certainly not whether it is a reflection of logical processes or whether it is a facilitator of them. It is clear, however, that in many conservation studies, language and performance are confounded, particularly in the assessment of the child's grasp of the concept. It appears that in the operationalization of a conservation task an effort should be made to unconfound these verbal and performance capabilities as much as possible.

Braine (1959) has demonstrated with other concrete operational tasks that Piaget's age levels do not hold when nonverbal means of assessment are employed. He found that children could accomplish performance type tasks at much earlier ages. Brainerd (1973a) points out that the use of the performance plus judgment criteria is psychometrically unsound and increases the probability of committing a Type II error. Therefore, both in instruction and in the assessment of conservation behaviors, the dependence of performance on language must be carefully considered.

Rationale for the Present Research: In designing the program approach for the current work, procedures for both instruction and assessment were selected to be consistent with previous research in the area. Therefore, while a modeling procedure was adapted as the basic instructional paradigm, additional components were included that prior research had designated as beneficial. Examples of supplementary components to basic performance models included in the instructional content were:

(1) Verbal rule provision (Beilin, 1965)

(2) Pre-training on relational terms (Griffiths, Shanta, & Siegel, 1967), and

(3) Inclusion of equal and unequal stimulus arrays (Rose, 1973).

Modeled instances of conservation behaviors were arranged sequentially from simple stimulus arrays (three objects in linear configuration) to the more complex (six object arrays). But all exemplars were unified on the basis of a systematically presented counting strategy. Counting as a procedure for the solving of a conservation of number task proved to be an efficacious procedure during the collection of pilot data and resulted in positive results during the previous year's research (Henderson, Zimmerman, Swanson, & Bergan, 1974). Furthermore, LaPointe & O'Donnell (1974) indicated that counting was a supportive device in the solving of conservation problems for children under six.

In the assessment of conservation performance, the traditional judgment explanation criteria for success was discarded and the more psychometrically sound judgment -- only criterion was employed (Brainerd, in press; Brainerd & Hooper, 1975; Brainerd, 1973a).

METHODS

Subjects

The subjects who participated in the four experiments were three to five year old children attending three Head Start centers on the Papago Indian Reservation in Southern Arizona. Approximately one third of the children attended preschool at the San Xavier site in close proximity to Tucson, Arizona. Another third of the children attended the Sells preschool located a distance of seventy-five miles from the city; and the final third attended a preschool in Pisinimo, a remote reservation village more than 120 miles from the urban center. Children at all three sites were randomly assigned to one of the two experimental groups or the control group prior to each study, hence groups were reconstituted for each study conducted. The exact number of children available for study fluctuated for each experiment depending on current enrollment, prolonged absences, and attrition, but usually about fifteen children were available at the San Xavier site, fifteen at the Sells center, and fifteen at Pisinimo. All children were Papago Indians whose level of family income qualified them for participation in Head Start. While most of the children possessed at least minimal English, some were bilingual, and particularly at at the Pisinimo center, some children were exclusively Papago speaking.

Experimental Procedure

A small trailer housing the video tape equipment, teaching activities, and testing materials was located at each site. These trailers provided a controlled setting in which the children could view the teaching tapes, participate in ancillary instruction, and be administered the assessment instruments. Experimenters brought the children to the trailer facility for brief viewing sessions of the video cassettes (10-15 minues in duration), for brief instructional segments (10-15 minutes in duration), and for testing purposes (15 minutes at each sitting). During the course of any one study a child would participate in an experiment-related activity a maximum of approximately twelve times.

In order to retain continuity with the Head Start classrooms, which are staffed by Papago adults, same-ethnicity female experimenters were employed at each site. These women functioned not only as experimenters in showing the video segments, but were also trained in instruction and assessment procedures. This staffing selection was helpful in alleviating language difficulties since the experimenters were bilingual and could administer tests and give directions in the child's primary language. Also, the Papago experimenters were better able to gain the support of Head Start Papago staff than might otherwise have been possible if Anglo experimenters had been utilized.

In general, following random assignment to either the TV instruction condition, TV plus ancillary instruction condition, or placebo (control) condition each child was pretested individually on a criterion-referenced evaluation instrument specific to the skill under consideration. Any child receiving a mastery score on the pretest was eliminated from that particular experiment. Following the pretest, the experimentation began and in general the experimental procedure was as follows:

1. In the first experimental phase, children in the TV instruction condition were exposed to an instructional video tape as were children in the TV and ancillary instruction group. Children in the control condition viewed a placebo tape of equivalent duration that depicted either relevant cultural material or instruction in a nontarget skill.

2. In the second experimental phase, children in the TV plus instruction group received a lesson parallel to the video tape employed in the first phase. To control for amount of exposure, TV only subjects and control subjects were reexposed to the video tapes utilized in the first phase.

3. This two phase process was repeated until all the instructional tapes and their accompanying lessons had been utilized. All children experienced the experimental process individually and in randomly constituted dyads as detailed later. All children received approximately the same aount of exposure to the experimental situation.

Following participation in the final phase of experimentation all children were posttested on the same criterion - reference instrument employed during the pretest. Then, to assess whether skills acquired from instruction were durable, experimental and control children were administered a retention test, on the same instrument, seven-to-fourteen days after the completion of posttesting. Testing was conducted by a female experimenter who was unaware of the child's group membership and who had not functioned in any other experimental capacity with that particular child. Anytime a child participated in an activity in the trailer facility, a nutritious consumable noncontingent reinforcer was provided to create a positive valence toward the experimental situation and the experimenters.

Development Procedures

Behavioral Objectives: Prior to each study it was necessary to develop the relevant experimental materials, i.e. placebo tapes, evaluation instruments, teaching tapes, and ancillary instructional segments, that would adequately exemplify the skill under consideration within a linear programming format. This procedure involved a multistep process that could be responsive to 1) the findings available from other research efforts, 2) the results of pilot information, and 3) our experience with other skills during the course of this project.

The first step in the process involved defining the skill behaviorally in accord with other research efforts. This definition was stated in the form of a performance objectives for the terminal behavior. Second, necessary prerequisite behaviors to the terminal one were specified and cast into a task hierarchy (see Appendix A). These task hierarchies were primarily linear analyses that attempted to reflect all necessary intervening steps that would have to be taught to a naive subject before the terminal behavior could be reached. Third, a behavioral objective specifying the behavior, condition, and criterion was generated for each step in the task analysis (see Appendix B). This, then, became the blueprint for instruction and assessment instrument development. Once the task analysis was specified, it was necessary to pilot the hierarchy with the same age children. Since Papago subjects of equivalent age were not available, same-age preschool Anglo children were used for preliminary investigation of the procedures. Piloting had several purposes: 1) to check the sequence of skill placement in the hierarchy; 2) to evaluate a number of possible teaching strategies for effectiveness in modeling the skill; and 3) to generate possible verbal rule statements that would be communicable to preschoolers. Following this step the task analysis could be modified as necessary, a specific teaching strategy decided upon, and viable rule statement generated.

Evaluation Instruments: A second task in the development of material for the experimentation procedure involved the construction of assessment instruments to be used for the collection of pre- post- and retention data. Evaluation instruments must be carefully constructed if they are to be sensitive to changes in performance that result from experimental treatment. Crude instrumentation may not be sensitive to such change and may mask important results. While this point appears somewhat obvious, it has been noted by some investigators (i.e. Flavell, 1971; Brainerd, 1973a; Brainerd & Hooper, 1975) that measurement questions are not usually addressed in the concept development literature. Some of the psychometric issues to which recent attention has been directed are (1) the use of pass-fail scores in evaluation (Brainerd, in press), (2) the possible methodological difficulties involved with language comprehension when measuring concepts (LaPointe & O'Donnel, 1974), and (3) the use of the performance plus explanation criteria in concept assessment (Brainerd, 1973a). In order to avoid possible methodological problems in the assessment component of the present study, a systematic procedure for instrument development was utilized that was designed to yield reliable tests particularly sensitive to the target behavior selected.

The task analysis developed for each target skill served as a blue print for each evaluation instrument. The behavioral objectives which comprised the task hierarchy were used for test-item generation. Two items covering each objective were generated and sequenced from the most basic skill through the terminal behavior. This resulted in two parallel item sets that were divided into parallel test forms, both of which were administered during data collection phases. Multi-item parallel forms of this nature, as opposed to a one shot performance task, offers the psychometric advantage of the use of total score responses for each subject, and makes possible the use of accepted numerical procedures on the determination of instrument reliability. Brainerd (in press) points out that procedures that make use of all of a subject's responses should be more sensitive to statistical changes for such procedures are less susceptible to Type II error. Furthermore, tests structured so as to produce numerical measures of reliability better reveal the amount of error introduced into the analyses through the measurement process, than are uni-item pass-fail tasks.

Following test development, pilot data were gathered to refine language used in the instrument, to eliminate ambiguities, to decide on maximal test length, and to arrive at a clear testing procedure. It became evident after piloting, that tests utilizing a motor performance task rather than a verbal one were more efficient at (1) avoiding an acquiescent response, (2) maintaining the young child's attention, and (3) providing a positive experience both for the child who grasped the concept as well as for the one who did not.

Tape Development: The finalized task analysis also became the skeleton for tape development. Tape segments were prepared to reflect not only the specific skills presented in the hierarchy but their sequencing as well. Each step was modeled two or three times on the tape continuously before modeling of a subsequent step was initiated. In all segments, the verbal rule for the behavior and the strategies employed were held constant, while the stimuli employed and the situations were varied. Each testing segment included 1) the modeled behavior, 2) a statement of the relevant rule, and 3) positive feedback for correct modeled responses. In addition, brief segments were incorporated into the tapes in which an invitation to perform was extended to the child-observer. While materials were made available for the child to participate if he wished, no encouragement to do so outside of the video cue was provided. Approximately one participation cue per tape was incorporated.

All instructional segments on the television tapes were unified through the systematic inclusion of a problem-solving strategy for the particular task. These strategies were developed following pilot instruction and selected on the basis of efficiency in instruction with preschool children.

Ancillary Instruction: The task hierarchy also served to guide the design of the ancillary teaching strategies. The instructional objectives and their sequencing were designed to parallel to the television programs.

However, while the television instruction emphasized modeling of the conceptual behavior, the ancillary teaching emphasized the child's manipulation of the stimulus objects with guided practice to avoid error. In addition positive reinforcement was provided to the child for each correct response. While the support system was developed to provide the opportunity for active participation, differential feedback, and reinforcement for correct responding, the same modeling paradigm, the same task objectives, and the same sequencing were employed as on the instructional video tapes.

Training Procedures: The Papago women who functioned as experimenters for the studies were required to perform several tasks in the field. First, it was necessary that they display competent test administration skills across the four concept areas. Second, they had to be knowledgeable regarding experimental control procedures during their interactions with the children and during the presentation of the video tapes. Third, they had to be proficient as teachers within the supplementary instructional system. Since these women had little or no experience as teachers or experimenters, they were trained in the specific skills required to carry out their role in the field. A combination of discrimination training and micro-teaching was employed which utilized our video-tape capability. Each required performance (e.g., testing, teaching) was broken down into small segments and modeled on video-tape by graduate assistants proficient in experimental research. The first performance modeled on tape consisted of an overview of an entire performance, accompanied by written performance standards to function as an advance organizer. This was followed by more minute modeling segments which focused on only a small aspect of a desired performance. These model-segments were accompanied by simple performance checklists to direct the trainees attention to the relevant aspects of the modeled performance. Therefore the trainees were aware of performance standards while viewing the video segments and could utilize appropriate monitoring checklists at each phase of the training.

Modeled video segments were followed by extensive role-play sessions in which dyads of trainee-experimenters practiced the target behaviors until criterion performance was attained. These role-play sessions were supervised by the graduate assistants who provided feedback to the trainees for the purpose of avoiding errors in performance. Finally,each trainee was video taped as she performed the entire experimental-behavior sequence, and simultaneously her behavior was monitored and assessed by the other trainees. In this way each person was given the opportunity not only to perform, but to observe and evaluate her own performance. This combination of training techniques proved to be an efficient procedure that resulted criterion level performance by all the Papago experimenters.

Procedure for the Specific Skills

Seriation: For the purposes of this experiment seriation was defined as the ability to impose order on an unordered array of up to six three-dimensional objects. All prerequisite skills were organized into an eighteen step task hierarchy that proceeded from simple size discrimination through the terminal behavior. Essentially, this 18-step hierarchy was broken down into five basic phases: (1) Simple size discrimination with linear objects (Tape 1), (2) discrimination of ordered and unordered arrays of linear objects (Tape 2), (3) imposition of order on unordered arrays of three to six linear objects (Tape 3 & 4), (4) the placement of additional linear objects to an already ordered array (Tape 5), and finally (5) the size discrimination and order imposition applied to three-dimensional objects

(Tape 6). Each tape covered the objectives in a particular segment of the hierarchy, included multi-incident modeling of those objectives coupled with a verbal rule, verbal mediation, and reinforcement. Each tape lasted for approximately 10 minutes.

The entire population of children at the three Head Start centers was utilized for the seriation study, excluding children who were absent for extended period, who refused to participate, or who demonstrated mastery of the skill on pretest. The remaining children (N = 43) were randomly assigned to one of the three treatment groups. One group received television instruction and ancillary group instruction. Another received television instruction only, and the third viewed placebo tapes.

All children were pretested on the two parallel forms of the seriation criterion-referenced instrument. Order of test presentation was randomized for all children. Testing was conducted by same-ethnicity bilingual examiners who were naive to the group assignment of the subjects. The children were assessed on an individual basis.

Following the pretest phase children began the experimental phases. The TV-plus instruction group viewed Tapes one through six individually in the presence of ethnicity experimenters. These children then received supplementary instruction in randomly constituted dyads with the same experimenter. In total, each child in this group participated in seven ten-minute instructional segments.

The children in the TV-only condition group receive one viewing each of Tapes one through six on an individual basis. Then in dyads, they received an additional viewing of Tape 6. In total this amounted to seven 10-minute instructional segments.

The children in the control condition viewed six placebo tapes depicting traditional Papago skills and activities. These children viewed the six placebos individually, and viewed a repeat of the sixth placebo in randomly constituted dyads. Again, a total of seven 10-minute sessions results.

Following the experimental treatment phases, all children were posttested by examiners unaware of the children's experimental group. Retention testing was conducted seven to ten days after termination of posttesting. These assessments utilized the same criterion-referenced instrument employed in pretesting.

A summary of the experimental phases is depicted in Table 1.

TABLE 1

Seriation: Experimental Phases

	Experimental Phase									
Group	1	2	3	4	5	6	7	8	9	10
TV & Instruction	Pretest	Tape 1	Tape 2	Tape 3	Tape 4	Tape 5	Tape 6	Tape 6 (dyads)	Posttesting	Retention Test
TV Only	Pretest	Tape 1	Tape 2	Tape 3	Tape 4	Tape 5	Tape 6	Tape 6 (dyads)	Posttesting	Retention Test
Control	Pretest	Placebo 1	Placebo 2	Placebo 3	Placebo 4	Placebo 5	Placebo 6	Placebo 6 (dyads)	Posttesting	Retention Test

Enumeration: The terminal target behavior for this study was operationalized at the ability to discriminate on the basis of number, sets containing as many, more, or less objects than a comparison standard. All prerequisite skills to this three-way sorting task were incorporated into a 10-step hierarchy that proceeded from simple counting skills up to the terminal behavior. The hierarchy was broken into six segments for tape production purposes as follows: (1) counting linear manipulables with 1:1 correspondence (Tape 1), (2) counting figural materials in linear and nonlinear arrangements (Tape 2), (3) matching sets by number and discriminating "same" and "different" (Tape 3), (4) acquiring the concept of more (Tape 4), (5) acquiring the concept of less (Tape 5), and (6) finally discriminating sets as to more-same-less (Tape 6). Each tape was approximately ten minutes in length.

The entire population of children participating in this study was the same as for the Seriation Study (N = 44). The children were randomly assigned to one of three treatment groups. One group received television instruction and ancillary group instruction; another received television instruction only; and the final (control) group received televised instruction unrelated to the target skill. This procedure was followed to offer some relevant educational experience to the control group to honor the request of Head Start personnel that control group children would receive worthwhile instruction.

All children were pretested on two parallel forms of the enumeration criterion-referenced instrument in the same manner as for the Seriation Study. Each child was assessed by a same ethnicity examiner on an individual basis.

Following the pretest phase, children began the experimental phases. The TV and instruction group viewed a tape and the following day received supplementary instruction until a total of six 10-minute tapes and six equivalent lessons had been completed. Both tape viewing and supplementary instruction was conducted in randomly constituted dyads. The children in the television only condition also viewed the tapes in dyads but were exposed to each tape on two consecutive but separate occasions. The children in the control condition received two viewings, each, of seriation Tapes 1 to 6, also in dyads. Every child, therefore, was exposed to twelve 10-minute sessions in the experimental setting.

Posttesting followed the experimental phase and was conducted individually by examiners unaware of the children's treatment group identity. Retention testing was conducted seven to ten days following completion of the posttest phase on the same evaluation instruments.

A summary of the experimental phases is depicted in Table 2.

Conservation of Number: For the purpose of this study, the terminal behavior was two-fold; both the ability to solve conservation problems with equal number (6 object rows) and the ability to solve an unequal number conservation problem (5 and 6 object rows) were included. Prerequisite behaviors included: (1) Pretraining on the concept of same number and 1:1 correspondence (Tape 1), (2) conservation of equality following both row-compression and row-expansion transformations (Tape 2 & 3), and (3) conservation of inequality with compression and expansion transformations (Tape 4). Each tape was approximately 10 minutes in duration. In addition to the basic modeling of appropriate conservation judgments, verbal rule provision was included and a systematic counting strategy for judgment verification was always modeled.

TABLE 2

Enumeration: Experimental Phases

Group	Experimental Phase														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TV & Instruction	Pretest	Enumeration Tape 1	Lesson 1	Enumeration Tape 2	Lesson 2	Enumeration Tape 3	Lesson 3	Enumeration Tape 4	Lesson 4	Enumeration Tape 5	Lesson 5	Enumeration Tape 6	Lesson 6	Posttest	Retention Test
TV Only	Pretest	Enumeration Tape 1	Enumeration Tape 1	Enumeration Tape 2	Enumeration Tape 2	Enumeration Tape 3	Enumeration Tape 3	Enumeration Tape 4	Enumeration Tape 4	Enumeration Tape 5	Enumeration Tape 5	Enumeration Tape 6	Enumeration Tape 6	Posttest	Retention Test
Control	Pretest	Seriation Tape 1	Seriation Tape 1	Seriation Tape 2	Seriation Tape 2	Seriation Tape 3	Seriation Tape 3	Seriation Tape 4	Seriation Tape 4	Seriation Tape 5	Seriation Tape 5	Seriation Tape 6	Seriation Tape 6	Posttest	Retention Test

The entire population of children at the Head Start centers was randomly assigned to treatment groups, but children who displayed conserving behavior on pretest were eliminated from the sample. The total number involved was 43. One group received television instruction with ancillary support; another received television instruction only, and the control group viewed placebo tapes depicting contemporary Papago activities. All children were exposed to an equivalent number of experimental sessions (eight).

Children were pretested on two parallel forms of the conservation criterion-referenced instrument in the same manner as in the seriation and enumeration studies. In this case, however, since one test was harder than the other i.e. in the second test the conservation problems contained a greater number of stimuli, test administration proceeded in a fixed sequence. This was followed by the eight experimental phases summarized in Table 3, and then by posttest and retention test assessment.

Question-Asking: This skill did not lend itself to the task analysis approach of hierarchially sequenced prerequisited skills as had the other target behaviors. Therefore, tapes and instruction were constructed in a different manner. The goals were to influence both fluency and flexibility in the production of causal questions. Causal questions, defined as those beginning with the words "Why?", "How come?", or "What would happen if?" were incorporated into the content of the video tapes and ancillary instruction. These language behaviors were modeled repetitively with increasingly complex examples of the instructional tapes in the ancillary instruction but speed was emphasized more in the instructional production component.

TABLE 3

Conservation: Experimental Phases

Group	Experimental Phase										
	1	2	3	4	5	6	7	8	9	10	11
TV & Instruction	Pretest	Conservation Tape 1	Lesson 1	Conservation Tape 2	Lesson 2	Conservation Tape 3	Lesson 3	Conservation Tape 4	Lesson 4	Posttest	Retention Test
TV Only	Pretest	Conservation Tape 1	Conservation Tape 1	Conservation Tape 2	Conservation Tape 2	Conservation Tape 3	Conservation Tape 3	Conservation Tape 4	Conservation Tape 4	Posttest	Retention Test
Control	Pretest	Placebo Tape 1	Placebo Tape 1	Placebo Tape 2	Placebo Tape 2	Placebo Tape 3	Placebo Tape 3	Placebo Tape 4	Placebo Tape 4	Posttest	Retention Test

Again all children in the population were (N = 50) randomly assigned to treatment groups. The pretest consisted of only one assessment form in which each item consisted of a single stimulus manipulable (object or picture) to which the subject was directed to produce questions. Question production was coded as to initial question phrase employed to within a 30 second period for each stimulus item. Five coding categories were employed: (1) "why" questions, (2) "how come" questions, (3) "what would happen if" questions, (4) non-causal questions, and (5) statements. Answers to produced questions were not provided within the assessment procedure.

Following pretest, eight experimental phases were conducted. Children in the television and ancillary instruction group received an instructional tape and an accompanying lesson for a total of four tapes and four lessons. Children in the TV only group received two viewings each of the four tapes, and children in the control group received two viewings each of enumeration tapes 1 through 4. Following the eight experimental phases, posttesting was conducted with the same question production instrument and retention data was collected one week following the posttest.

The experimental phases were summarized in Table 4.

RESULTS

The results of the four experiments conducted during the year covered by this report will be presented in the order in which they were conducted.

TABLE 4

Question-Asking: Experimental Phases

Group	Experimental Phase										
	1	2	3	4	5	6	7	8	9	10	11
TV & Instruction	Pretest	Question-Asking Tape 1	Lesson 1	Question-Asking Tape 2	Lesson 2	Question-Asking Tape 3	Lesson 3	Question-Asking Tape 4	Lesson 4	Posttest	Retention Test
TV Only	Pretest	Question-Asking Tape 1	Question-Asking Tape 1	Question-Asking Tape 2	Question-Asking Tape 2	Question-Asking Tape 3	Question-Asking Tape 3	Question-Asking Tape 4	Question-Asking Tape 4	Posttest	Retention Test
Control	Pretest	Enumeration Tape 1	Enumeration Tape 1	Enumeration Tape 2	Enumeration Tape 2	Enumeration Tape 3	Enumeration Tape 3	Enumeration Tape 4	Enumeration Tape 4	Posttest	Retention Test

Seriation

Descriptive statistics for the seriation study are presented in Table 5. Reliability of the seriation measure, as determined by the Spearman-Brown split-half method ranged from .83 at pretesting to .96 at retention testing. It should be noted that while the total score for both test split-halves was used in the data analysis, the half-tests were administered three to four days apart. Therefore, the reliability is not only a measure of internal consistency but is additionally a measure of score stability over a short period of time.

TABLE 5

Seriation: Means and Standard Deviation for Pretest, Posttest and Retention Phases

	Pre		Post		Retention	
Group	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
TV & Instruction	25.50	12.55	69.69	33.11	68.63	33.19
TV Only	31.18	23.32	72.94	43.66	78.50	43.80
Control	16.45	6.89	27.91	17.54	33.82	24.69

Data were analyzed using a 3 (treatment groups) x 3 (trials) repeated-measures analysis of variance for unequal N. Age and sex factors were not included in the analysis since those factors had proved not to be statistically significant in an earlier experiment with a similar population and the same skill (Henderson, Zimmerman, Swanson, & Bergan, 1974). A summary of the analysis of variance is presented in Table 6.

Significant effects were obtained for groups (F = 5.909, df 2,40, p < .006), trials (F = 63.96, df 2,80, p < .000), and the groups x trials interaction ($F = 4.19$, df 4,80, $p < .004$). Newman-Keuls post-hoc analyses revealed (1) a significant difference ($p < .05$) between the control group and the experimental groups at both post and retention trials, (2) a significant difference between pre- and posttrials for the TV only condition, (3) a significant difference between pre- and posttrials for the TV and instruction condition, (4) no differences between pretest scores among the three groups, (5) no differences between pre-, post-, and retention-trials for the control group, (6) no differences between the experimental groups for post- and retention-trials, and (7) no significant differences between post- and retention-trials for either experimental groups.

Table 6

Summary of Analysis of
Variance for Seriation Study

Source	*df*	*MS*	*F*	*p*
Between Groups				
Treatment	2	12,794.63	5.9	.0059
Error	40	2,165.28		
Within Groups				
Trials	2	19,204.71	63.96	.0000
Group x Trials	4	1,260.84	4.20	.0042
Error	80	300.26		

These results are depicted in Figure 1.

Enumeration:

Descriptive statistics for the enumeration experiment are presented in Table 7. Reliability of the enumeration instrument ranged from .85 at pretest to .90 at posttest as communted by the split-half method corrected by the Spearman-Brown formula.

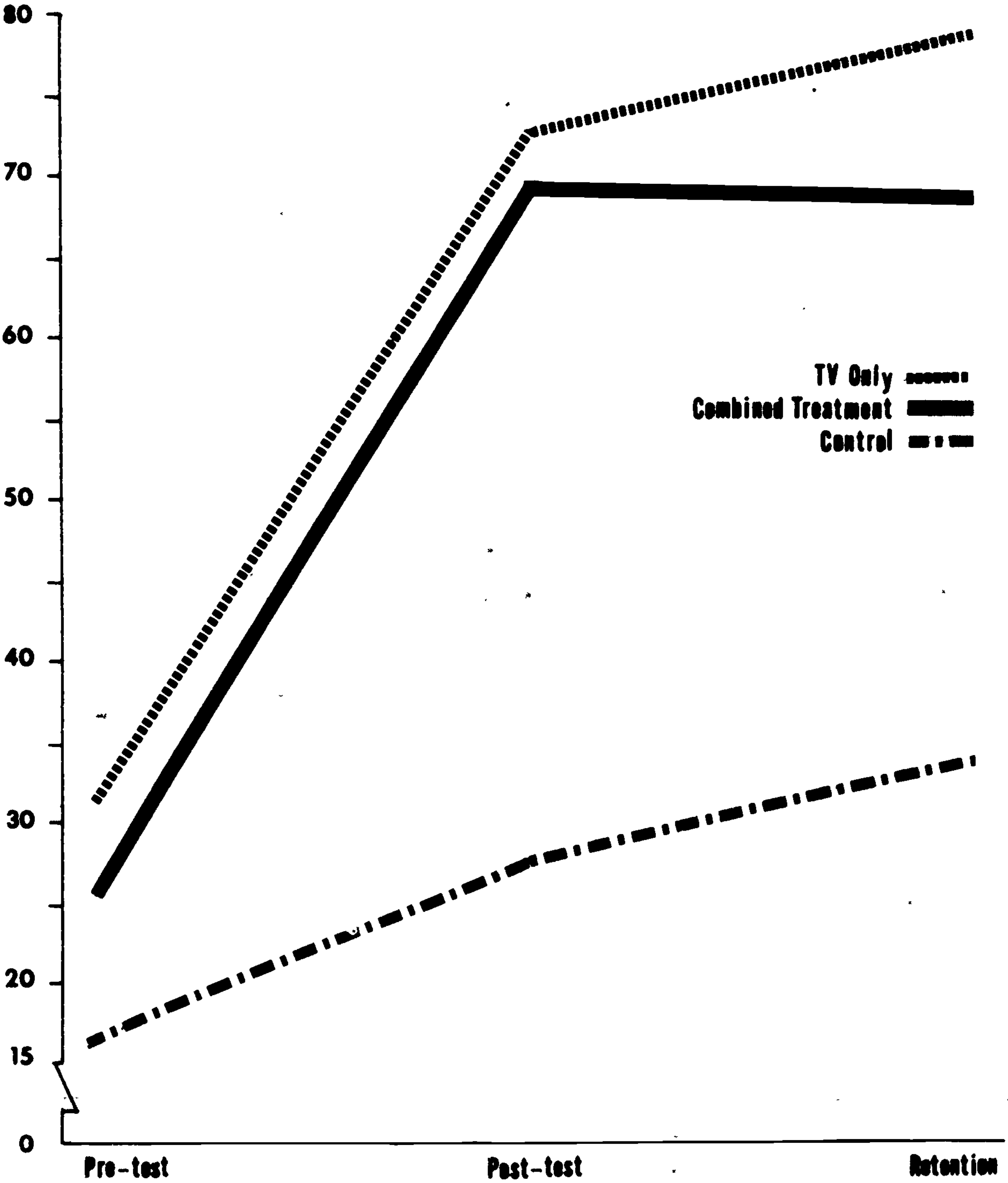


Fig. 1 Seration Means

TABLE 7

Enumeration: Means and Standard Deviation
for Pretest, Posttest, and Retention Phases

Group	Age	Pre		Post		Retention	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
TV & Instruction	Older	29.0	14.5	45.86	20.6	52.14	18.9
	Younger	22.2	10.9	38.60	12.1	51.00	11.3
TV Only	Older	19.5	13.6	44.10	15.3	50.50	17.4
	Younger	16.3	6.9	23.30	12.2	23.60	10.6
Control	Older	18.8	11.6	29.40	14.3	28.40	16.0
	Younger	10.8	4.9	12.60	8.5	17.10	6.7

Data were analyzed using a 3 (treatment group) x 2 (dichotomized age group) x 3 (trials) repeated measures analysis of variance for unequal N. Significant main effects were found for groups ($F = 5.75$, *df* 2,35, $p < .007$) and ($F = 7.72$, *df* 1,35, $p < .008$), and trials ($F = 39.58$, *df* 2,70, $p < .000$). Significant first order interactions were found for the groups x trials interaction ($F = 2.58$, *df* 4,70, $p < .05$) and the age x trials interaction ($F = 4.40$, *df* 2,70, $p < .02$). The summary of the analysis of the analysis of variance is present in Table 8.

Newman-Keuls post hoc procedures were utilized for a more specific analysis of the interaction effects, and the following results were revealed in combining across age groups: (1) The TV and instruction group made significant gains across trials and surpassed the controls at both post and retention trials. (2) The TV only group also made significant gains and surpassed the controls at retention; posttest that difference

TABLE 8

Summary of Analysis of Variance
for Enumeration Study

Source	*df*	*MS*	*F*	*p*
Between Groups				
Treatment	2	3,334.46	5.75	.0071
Age	1	4,472.96	7.72	.0086
Treatment x Age	2	177.56	1.00	NS
Error	35	5.79.42		
Within Groups				
Trials	2	2,774.01	39.58	.0000
Treatment x Trials	4	180.91	2.58	.0439
Age x Trials	2	308.38	4.40	.0156
Treatment x Age x Trials	4	131.38	1.87	NS
Error	70	70.08		

approached siginificance ($p < .10$). (3) There were no differences among the groups at pretest, and (4) the controls did not make any significant gains across testing points.

The samples were then dichotomized on the basis of age for closer analysis of the age interaction affects, with the following findings.

1. In the combined treatment group there was no significant difference between the two age groups across trials.

2. In the control group there was no significant difference between the age group across trials.

3. However, in the TV only group, while no significant difference was noted on pretest, the older children made significant pre- to post-gains ($p < .05$) and surpassed the younger children at both post and retention trials ($p < .05$).

Regarding the older group of children the following was revealed.

1. The combined treatment group made significant gains ($p < .05$) as did the TV only group, while no gains were noted for the controls.

2. The combined treatment group significantly surpassed the controls at retention ($p < .05$) and approached significantly better performance at posttesting ($p < .10$).

3. The difference between the TV only and control group approached significance on both post and retention trials ($p < .10$).

For the younger children, the pattern of results was somewhat different. In this case the combined treatment group surpassed the control on both post- and retention-trials ($p < .05$) while the TV only group did not. The difference between the combined treatment group and the TV only group at the retention-trial approached a significant advantage for the combined treatment group ($p < .10$).

These results are depicted in Figures 2 and 3.

Question-Asking

Descriptive statistics for the question-asking study are presented in Table 9. Reliability of the question-asking assessment instrument, as determined by the Spearman-Brown split half method was .99 at posttest, and .99 at retention testing. Scores on the instrument reflected the frequency with which the children produced causal questions. Data on flexibility was not used in the data analysis because of confounding that occurred during data collection.

Data were analyzed using a 3 (treatment) x 3 (trials) repeated-measures analysis of variance for unequal N. Age and sex factors were omitted from the design because those factors had not proved to be relevant in earlier studies of similar nature (Henderson & Swanson, 1974; Henderson, Zimmerman, Swanson, & Bergan, 1974; Henderson, Swanson, & Zimmerman, 1975). A summary of the analysis of variance is presented in Table 10.

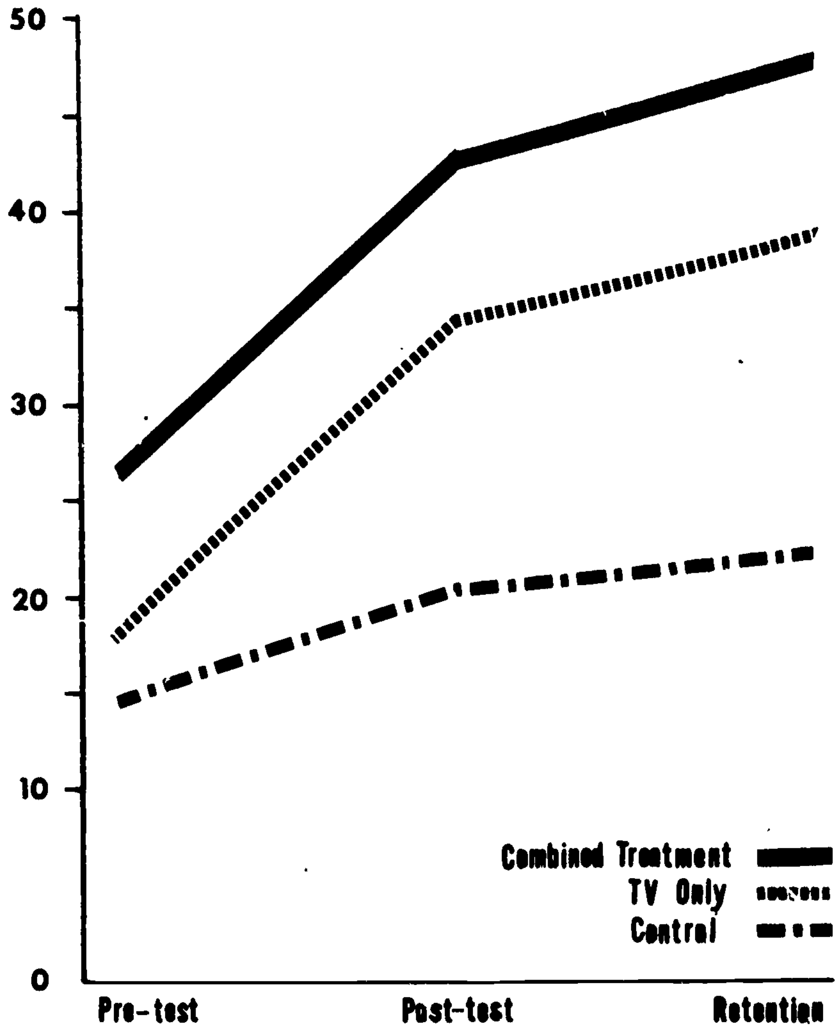


Fig. 2 Enumeration Means For Combined Age Groups

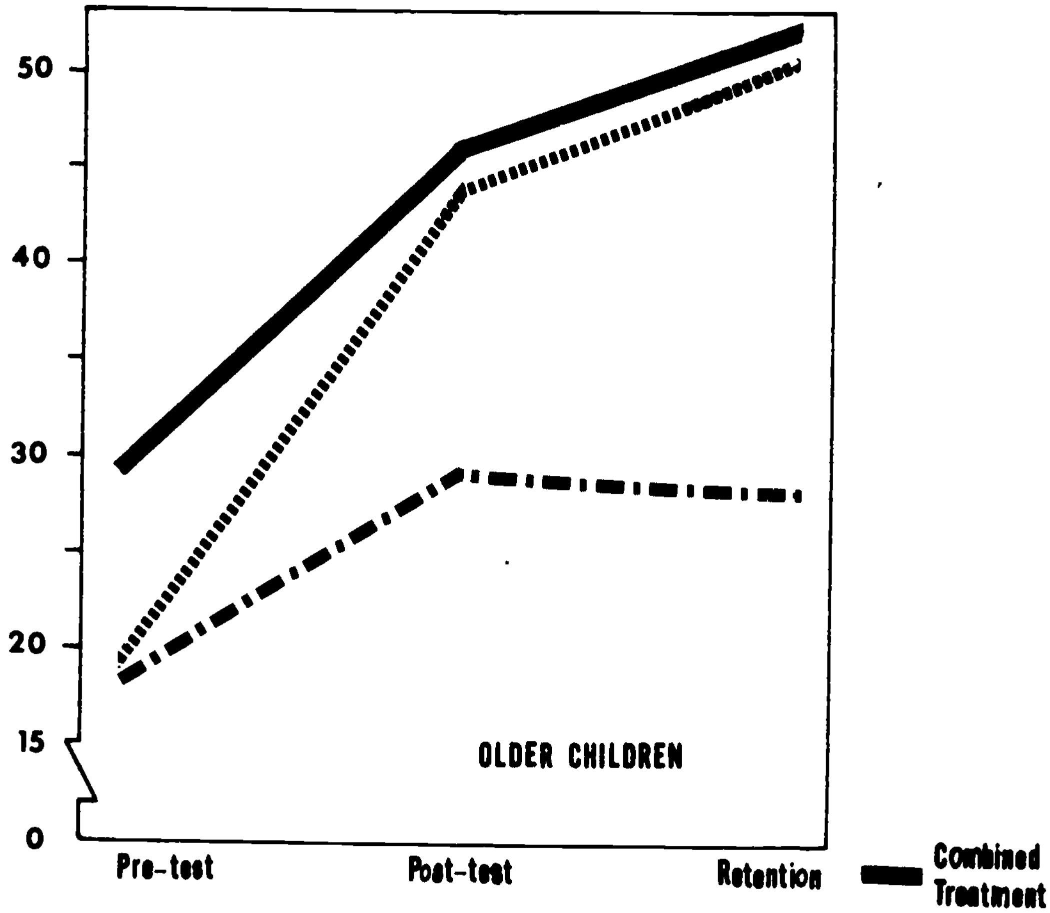


Fig. 3 Enumeration Means For Dichotomized Age Groups

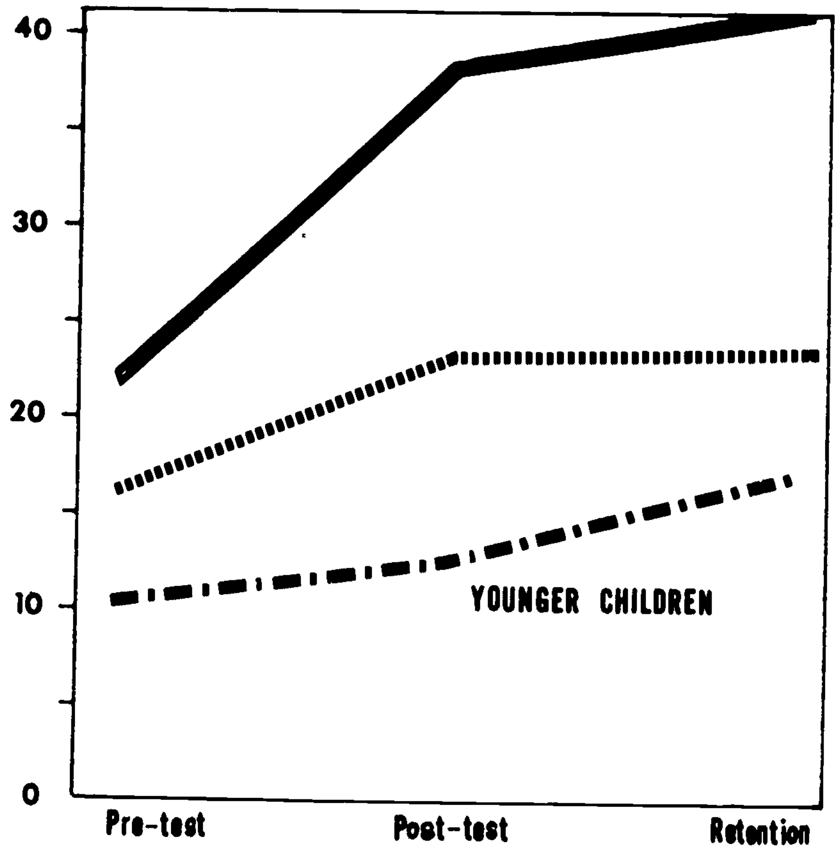


TABLE 9

Question-Asking: Means and Standard Deviations for pretest, posttest, and retention phases

	Pre		Post		Retention	
Group	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
TV and Instruction	1.76	3.65	82.7	47.88	93.7	54.2
TV Only	3.13	4.29	29.73	31.2	19.4	19.7
Control	2.0	2.11	2.0	3.21	2.5	3.3

TABLE 10

Summary of Analysis of Variance for Question-Asking

Source	*df*	*MS*	*F*	*p*
Between Groups				
Treatment	2	45,422.68	34.27	.000
Error	47	1,325.42		
Within Groups				
Trials	2	21,500.54	48.75	.000
Groups x Trials	4	12,027.17	27.27	.000
Error	94	441.07		

Significant effects were found for groups ($F = 34.27$ df 2,47, $p < .000$) for trials ($F = 48.75$ df 2,94, $p < .000$) and for the groups x trials interaction ($F = 27.27$ df 4,94, $p < .000$). Further examination of the data with Newman Keuls post-hoc procedures revealed the following findings.

1. The TV plus instruction group was superior to both the TV only group and the control group at both post and retention phases ($p < .01$).

2. The TV plus instruction group made significant gains from the pre- to posttesting and from the pre- to retention-testing ($p < .01$).

3. The TV only group performed significantly better than the controls at posttesting ($p < .05$) but not at retention.

4. The TV only group did make significant gains from pre- to posttesting ($p < .05$), and the gain from pre- to retention- approached significance ($p < .05$).

5. There was no change across trials for the controls.

6. The groups did not differ significantly at pretest.

Results of the study are depicted in Figure 4.

Conservation of Number

Descriptive statistics for the conservation study are presented in Table 11. Reliability of the conservation measure (split-half reliability corrected by the Spearman-Brown formula was .95 at pretest, .93 at posttest and .98 at retention. While the test halves were parallel in terms of concepts covered by the items, the second half was more difficult in that more stimuli were employed in the conservation items.

Data were analyzed using a 3 (treatment groups) x 2 (dichotomized age groups) x 3 (trials) repeated measures analysis of variance for unequal N. A summary of the analysis of variance is reported in Table 12.

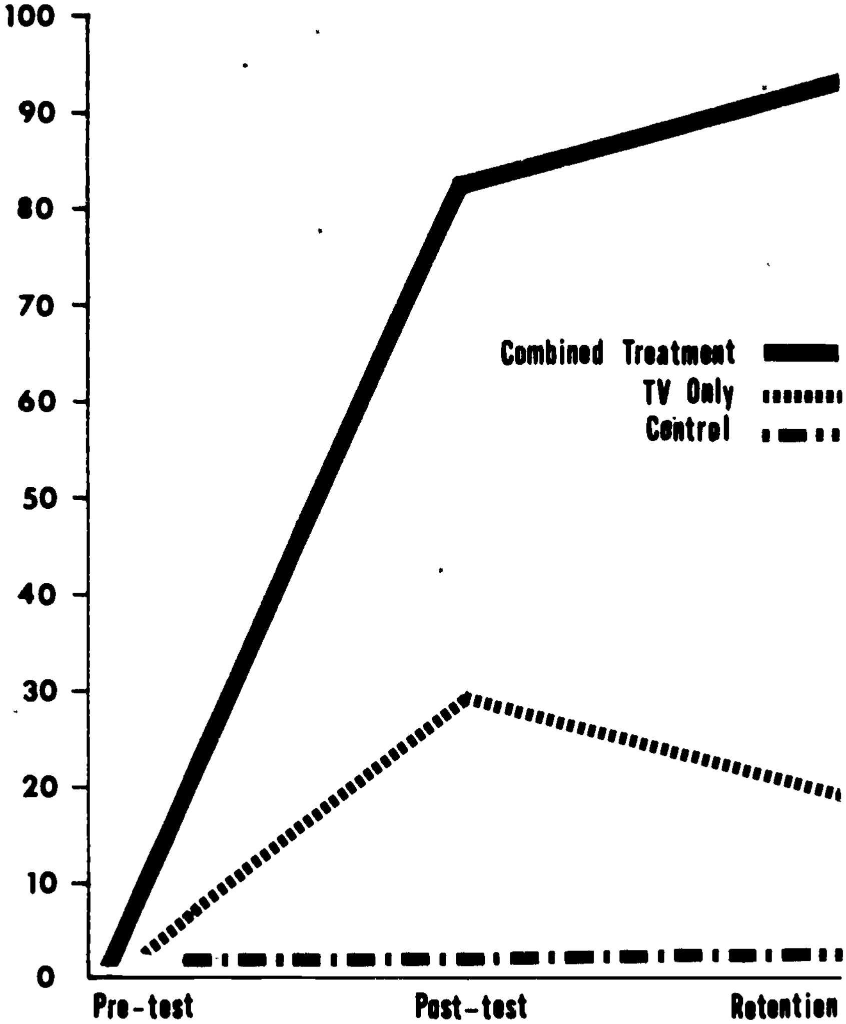


Fig. 4 Question - Asking Means

TABLE 11

Conservation: Means and Standard Deviations for Pretest, Posttest and Retention Phases

Group	Age	Pre $\bar{X}$	Pre SD	Post $\bar{X}$	Post SD	Retention $\bar{X}$	Retention SD
TV & Instruction	Older	2.00	2.94	26.22	11.68	24.22	12.59
	Younger	.80	.98	12.40	12.35	13.20	13.77
TV Only	Older	2.00	3.38	17.71	15.43	18.85	16.21
	Younger	1.00	2.00	2.25	2.73	1.50	1.66
Control	Older	2.00	2.31	.67	1.49	2.33	2.13
	Younger	2.25	3.80	2.75	4.68	4.25	8.27

TABLE 12

Summary of Analysis of Variance for Conservation Study

Source	*df*	*MS*	*F*	*p*
Between Groups				
Treatment	2	1,202.09	6.38	.005
Age	1	1,184.24	6.29	.016
Treatment x Age	2	464.73	2.47	NS
Error	37	188.40		
Within Groups				
Trials	2	1,082.46	23.75	.000
Treatment x Trials	4	345.69	7.59	.000
Age x Trials	2	237.21	2.12	NS
Error	74	45.57		

Significant main effects were found for groups ($F = 6.38$, df 2,37, $p < .005$) age ($F = 6.29$, df 1,37, $p < .016$) and for trials ($F = 23.75$, df 2,74 $p < .000$). Significant first order interactions were also found for the groups x trials ($F = 7.59$, df 4,74, $p < .000$) and the age x trials interaction ($F = 5.21$, df 2,74, $p < .008$) Newman-Keuls post-hoc procedures were employed to further inspect the data and to examine the interaction effects.

For the pooled age groups significant effects were only noted for the combined treatment group over the others. (1) The combined treatment group made significant gains from pre to post ($p < .01$); neither of the other groups gained significantly. (2) The combined treatment group surpassed the controls at both post and retention ($p < .01$). (3) The combined tratment group also significantly surpassed the TV only group at both post and retention ($p < .05$). (4) No other significant differences were detected.

A different pattern of differences is noted for the older group of children. (1) The children in the combined treatment group made significant pre-, post-gains ($p < .01$) as did the children in the TV only group ($p < .05$), while no gain across trial. was noted for the controls. (2) The combined treatment group surpassed the controls on both post and retention trials ($p < .01$). (3) The TV only children also performed significantly better than the controls at those two testing points ($p < .05$). (4) No difference between the two treatment groups was statistically significant, and (5) there was no different between the groups on pretest.

For the younger children, in contrast, there were no statistical differences between any of the groups on any of the trials.

These results are presented in Figures 5 and 6.

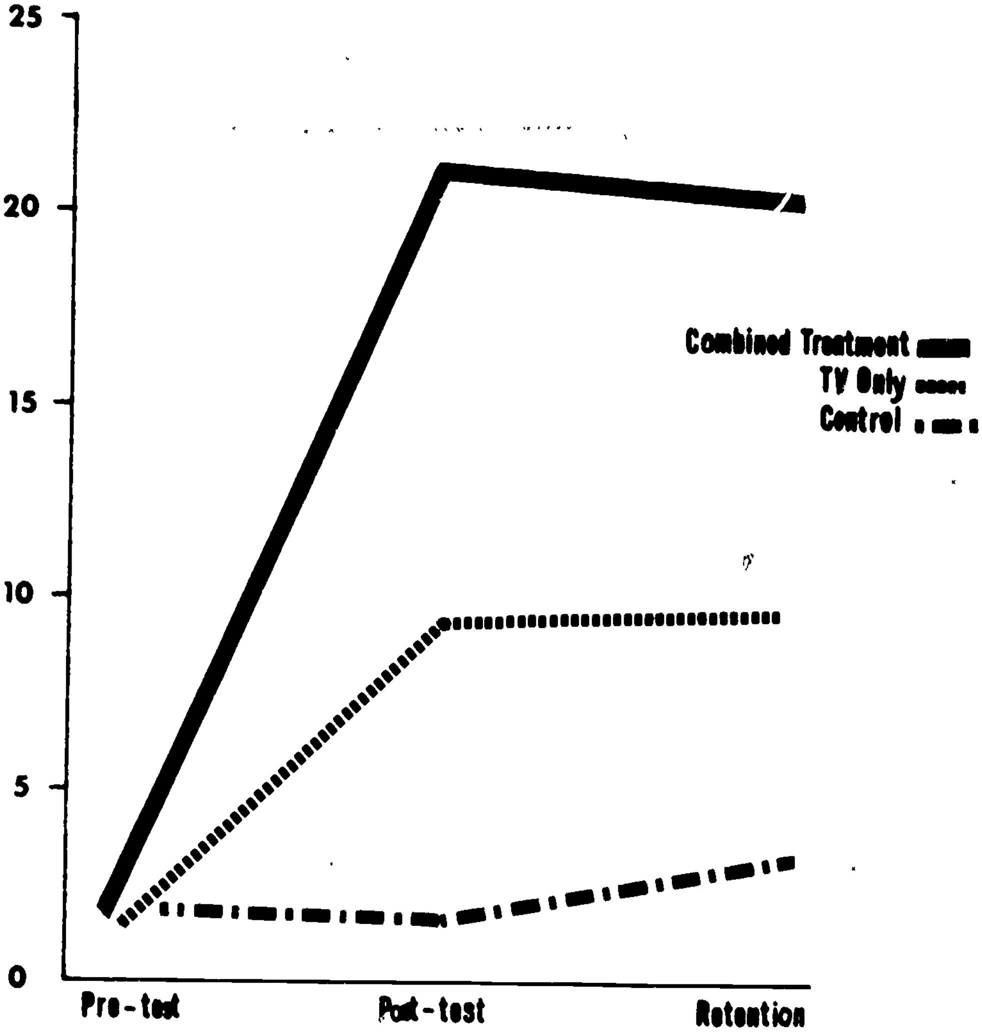


Fig. 5 Conservation Means For Combined Age Groups

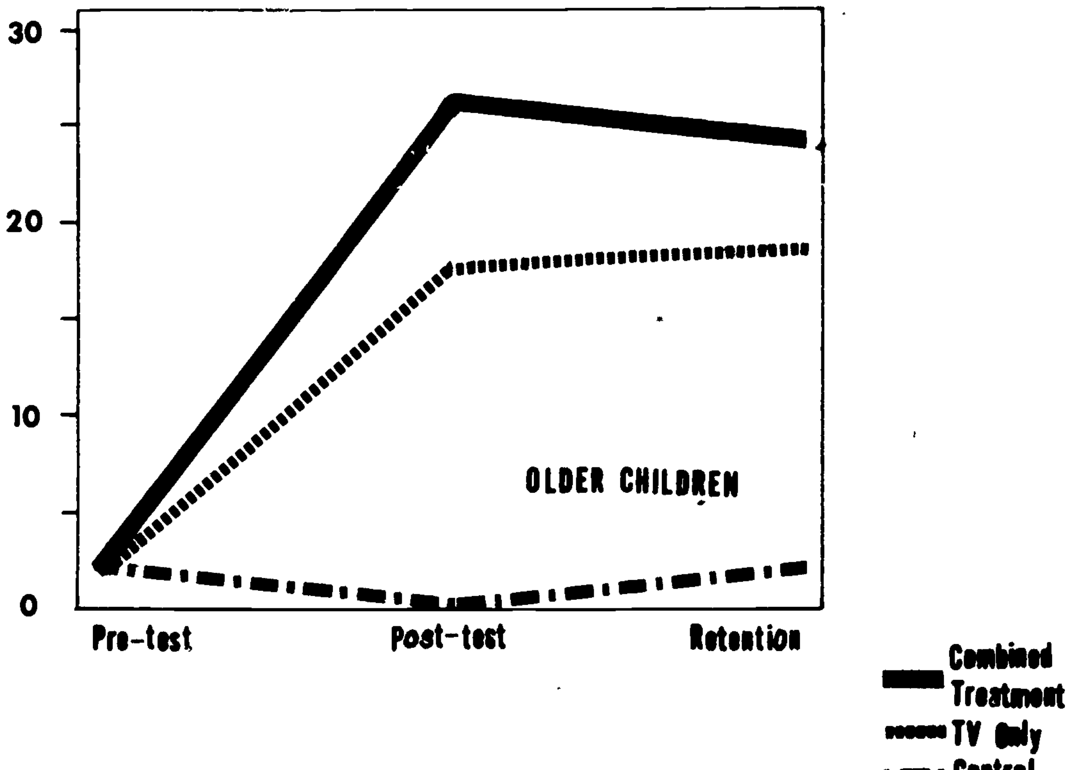
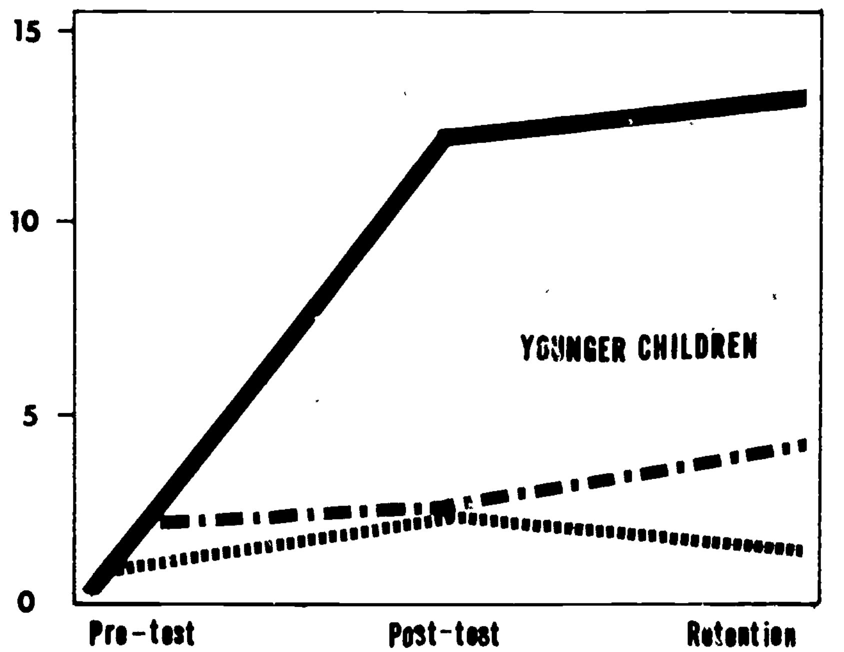


Fig. 6 Conservation Means For Dichotomized Age Groups



DISCUSSION

The overall results of this series of experiments clearly demonstrate that this year's effort was successful in devising instructional strategies both for television programming and ancillary support which can markedly influence the development of rule-governed cognitive skills. Each of the four studies conducted resulted in performance gains of both statistical significance and practical magnitude. Even more noteworthy than the fact that the experimental treatments produced significant effects in all four skill areas was the evidence that a given set of instructional procedures produced diverse patterns of outcomes for different conceptual tasks. The target skills involved in this year's experiments seem to have both unique and shared properties which must be explored in order to fully appreciate the implications of this research for psychological theory and educational practice. In order to explore the possible interpretations of these differential patterns of effects we shall first turn our attention to the findings of the separate experiments and then to the broader implications.

Seriation

The most notable results of instruction in this cognitive capability is the surprising parallel between this year's study and that conducted last year which utilized only the vicarious process (Henderson, Swanson, & Zimmerman, in press). Despite the fact that the task was operationalized in a manner designed to make it more difficult than in the previous year's work (e.g., adding objects to an array, extension to three-dimensional objects), the pattern of gains for the experimental group that received only

TV instruction as well as the magnitude of those gains are strikingly similar for both years. During the first year 96% of the children exposed to the instruction TV tapes made performance gains, in the second year 94% exposed to the same tapes made gains. While the statistical significance of year's outcomes taken separately are impressive, the replication of effects is even more so.

Another interesting result which we did not predict was the lack of advantage displayed by the treatment group that received ancillary instructional support. The percentage of children making gains with the combined approach was very similar to the TV-only children (91%). Even though children in the combined treatment group had the opportunity to practice the skill in an error-free instructional setting and were reinforced for that performance, they failed to display a greater proficiency in the skill than children who had only observed the skill performed vicariously.

With this particular skill the vicarious process alone appears to be a sufficient instructional process, while object manipulation and reinforcement did not produce an additive effect. It is not possible to identify from this study the respective contributions of the several aspects of the observed stimulus display (e.g., multiple-models; rule provision, verbal mediation), but it is clear that the total vicarious presentation was highly effective.

This pattern of results did not occur with any of the other skills examined during this project and yet the subject population, instructional content and teaching paradigms for all the skills were very similar. This fact suggests that it is the skill itself that accounts for differences in results.

By definition television is a visual media, and by extension television instruction is predicated on visual teaching. Despite the inclusion of other instructional stimuli (e.g., auditory instructions) television's visual component is its most salient characteristic. Seriation performance appears to be a visual skill, at least as it was operationalized here. A child can view the solution to an ordering problem whether or not he attends to and/or understands the verbal mediation accompanying that solution. Furthermore, the final solution to the seriation problem results in a very clear perceptual image (cue) that can be utilized as a distinct template for a match. Regardless of the stimuli employed, the resulting perceptual configuration is the same; irrespective of the type and number of stimuli employed. In none of the other skills considered here is there such a clear-cut visual cue for the correct solution and for some tasks the perceptual cues are actually misleading (e.g., conservation).

Bandura (1969), has hypothesized that observational learning is effective because the observer can code, either through imagery or verbalization, the information presented vicariously for use at a later time. He further hypothesized that imaginal coding is a more primitive form of coding hence more prevalent at early age levels. It may be then that instruction which is based on very clear visual perceptual cues facilitates imaginal coding and hence skill acquisition at early age levels. To extrapolate further, perhaps skills which are conducive to clear visual instruction will lend themselves better to the television media at least at these young ages. An important question to which research could be directed is the role of visual cues in promoting concept acquisition, especially in relation to television programming.

Question-Asking

The results of the question-asking study were very different from those of the seriation experiment. In this case the television -- only treatment had a statistically significant effect but the combined treatment group evidenced a highly significant additive effect. Those children who were exposed to practice and feedback as well as reinforcement for correct responding far surpassed the children only exposed to the vicarious process. Ninety-four percent of the children in the combined treatment group made impressive gains in fluency of production of causal questions as compared to 53% for the television instruction only group. Previous studies (Henderson & Garcia, 1973; Henderson & Swanson, 1974; Henderson, Swanson, & Zimmerman, 1975) indicate that causal-questions production can be induced through a modeling procedure, but only in one of those studies (Henderson, Swanson, & Zimmerman, 1975) was there an absence of direct reinforcement to the subject. Only modeling of the skill and vicarious reinforcement to the model was included. In that study causal question production was significantly enhanced by modeling alone. In the current study the provision of reinforcement and practice, however, was more effective than modeling alone.

The much higher scores attained by the children in the combined treatment group may have resulted from a differential emphasis on fluency in the teaching segments as compared to the video tapes. While the video instructional segments presented multiple question productions per stimulus presented, speed of production was not strongly cued. In the ancillary lessons, however, speed was cued and was reinforced. This may account then for some of the discrepancy in group performance.

At least two important questions remain unanswered following the present study. First, the group of children in the TV only condition did not produce as many causal questions as similar children exposed to the same tapes in our previous study (Henderson, Swanson, & Zimmerman, 1975) even though they were exposed to twice much teaching time. The reason for that is not clear, but one possibility is that the use of a delayed posttest this year as compared with an immediate posttest last year. A delayed posttest is a more stringent test and significant results were still obtained for this group.

A second question concerns the extent to which modeling can affect not only the <u>form</u> but the <u>subject matter</u> of children's question production as well. Informal evidence suggests that this type of instruction does result in individualized and interesting content in question production, but this specific effect still requires investigation.

Enumeration

The results of the enumeration study were quite different from the outcomes of the seriation and question-asking studies.

When we inspect the results of treatment without considering the age factor, the results appear clearly supportive of the original hypothesis i.e., the combined treatment performs best, the single treatment group produces an intermediate level of performance, and the controls produce the poorest performance.

However, with age taken into account an entirely different picture of the data emerges. For the older children, the vicarious process alone produces a level of performance almost identical to the performance of the combined treatment group; the children learned just as effectively by observing as by performing and receiving reinforcement. Such is not the case with younger children. The younger children were only able to perform on the eneumeration tasks if they had experienced the ancillary as well as the vicarious instruction. Younger children exposed only to the televised instruction did not benefit significantly from the instruction. This differential effect of treatment with respect to age holds important implications for instructional programming for very young children and is certainly distinct from the implications of the seriation study.

There are many possible reasons that the visual presentation was not effective with the younger children. One reason could be the interference of salient perceptual cues in the visual display unrelated to numerosity, e.g., color, shape, configuration. Another possibility is the necessary reliance on language and specifically on relational language terms which young children experience difficulty e.g., some, more, less. Questions of this nature need further research before specific solutions can be proposed.

A methodological problem encountered in this experiment is one which may arise whenever research is conducted on behavior categories which are also valued and specifically taught in the child's natural environment. Much of the visual material displayed in the Head Start classrooms was concerned with numerosity, number, and counting. While no direct instruction involving the concepts appeared to be occurring at the time we were conducting our study, the materials and the concepts were obviously displayed. The question of concern, then, is whether pretesting on a skill where materials are available sensitizes the subject to those materials in his environment. Figure 2 shows a rise in performance of the control group pre- to retention-testing. While this rise did not come close to attaining statistical significance, it suggests the possibility that a sensitization to number stimuli from the pretest experience may influence performance.

Conservation

The results for the concservation study are very similar to those encountered with enumeration. The combined treatment proved superior to both the vicarious process alone and to the control. Here again, though, the age factor is in evidence with both treatments being considerable more effective with the older children. There was no statisitcal difference between the treatment types for this age group and both far surpassed the control group. It is interesting, however, that in this case it was not possible to detect any statistical difference among any of the groups of younger children. One must assume that neither treatment was powerful enough to produce a statistically significant increment in performance for the younger children.

The results obtained for the vicarious process alone in this skill area compares similarly with those obtained for enumeration, i.e., effective for older children, not effective for younger children. It is interesting to note that as well as sharing similar results, both these skills involved (1) problems of numerosity, (2) employed relational language terms, (3) utilized a counting strategy for correct judgment verification, and (4) the correct solution was only possible if visual perceptual cues or dimensions were overridden. Considering the great similarities in the two tasks, it does seem surprising that the pattern of results are so analogous.

Implications

The results of the four studies undertaken during the year reported here clearly demonstrate that carefully programmed television presentations can markedly influence complex cognitive capabilities in preschool children.

When examined more closely, however, our results indicate that sequentially structured television instruction based on social learning principles is differentially effective for different cognitive tasks and for different age groups. The contrasting outcomes of the seriation experiment as compared with the enumeration and conservation studies are particularly interesting.

The markedly different patterns of results for these studies call into question the assumption that seriation and conservation are both representations of operativity, and that experiences that influence the development of one capability may be assumed to influence the other in a like manner. With a skill in which the perceptual cues are clear and noncontradictory, televised modeling of the rules and strategies which constitute the skill may be sufficient to teach the concept. Seriation is such a task, and our results showed that television alone was no less effective an instructional tool than television supplemental by direct instruction which provided the opportunity for error-free manipulation and reinforcement. The vicarious influences of television modeling were effective for both younger and older Head Start children.

This was not the case with enumeration and conservation skills. These two skills share a number of component capabilities, and the outcomes seemed to show a gradient o- age-related additive value attributable to direct instruction designed to supplement the television presentations. Television alone was an effective instructional agent for the older chiledren, but the younger children benefited to a significant degree only when the television treatment was supplemented by direct ancillary instruction by an adult. Neither television alone nor television plus ancillary instruction was effective in teaching conservation to the younger children, although a nonsignificant trend parallel to the enumeration results for the combined treatment is evident. Only the combined treatment showed significant effects on conservation, and then only for the older children.

The shared properties of enumeration and conservation which may account for the differences between the outcomes of these experiments and the seriation study have already been mentioned. One of the characteristics which seems to distinguish conservation from enumeration might be the degree to which salient perceptual cues may distract from or even be incongruent with the criterial attributes of a target concept. Inspection of the tasks that define enumeration and conservation suggest to us that the discrepancy between perceptual cues and a correct solution is greater for conservation than for enumeration.

One important implication of these results is that a single approach to programming may not be equally effective for the teaching of all kinds of conceptual rules. It is also clear that for some kinds of concepts direct instruction may be necessary to supplement televised instruction for young children. Our ancillary instruction provided for guided manipulation, feedback, and reinforcment, but at present we have no way of knowing the respective contributions of these elements to the outcomes that were noted. We are not ready to concede that conservation, as measured by stringent criteria, cannot be taught to children as young as those at the lower end of the age range in our sample, but it is clear that even the careful programming which we employed was not sufficient to influence conservation in the youngest of our children. A major difficulty seems to lie in the meaning attributed to the word "same" appears to be the salient stimulus for the younger children. This possibility will be explored in our next year's work.

The applicability of these findings have yet to be demonstrated for broadcast television. Broadcasters might well argue that differential programming approaches for child audiences of different ages, for example, would be impractical. If there is substance to such an argument, it may well be substance of a fleeting nature. In a recent assessment of the state of research on Television and Human Behavior, George Comstock and George Lindsey asserted that it is not at all far-feteched to assume that television may, in the not too distant future, cease to exist as we know it. With fuller utilization of cable television and the feasibility of low-cost video playback units, a much more diverse and individualized set of television offerings may become available (Comstock & Lindsey, 1975). It appears that in a matter of two or three years video-disk playback units for homes and school may be available at a cost of about $500.00 per unit. Prerecorded disks will very likely cost little more than good quality stereo records on today's market. Such an advent would make it quite practical for schools, and even for parents, to purchase video instructional materials suited to the developmental status of children of different ages and individual characteristics. The findings of the present research certainly have implications for the development of both video instructional materials and ancillary support systems which should be devised to accompany video instruction for those skills and at those ages for which vicarious learning processes may not be sufficient.

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FOOTNOTE

1. This project was supported in part by Grant No. OCD-CB-479-Cl from the Children's Bureau.

APPENDICES

APPENDIX A

TASK ANALYSIS

SERIATION: TASK ANALYSIS

Given 5-6 flat squares of varying sizes, child can impose order

Given 3-4 flat squares of varying sizes, child can impose order

Given 5-6 cylinders of varying heights, child can impose order

Given 3-4 cylinders of varying heights, child can impose order

Given 5-6 flat squares of varying sizes, child can select the largest

Given 3-4 flat squares of varying sizes, child can select the largest

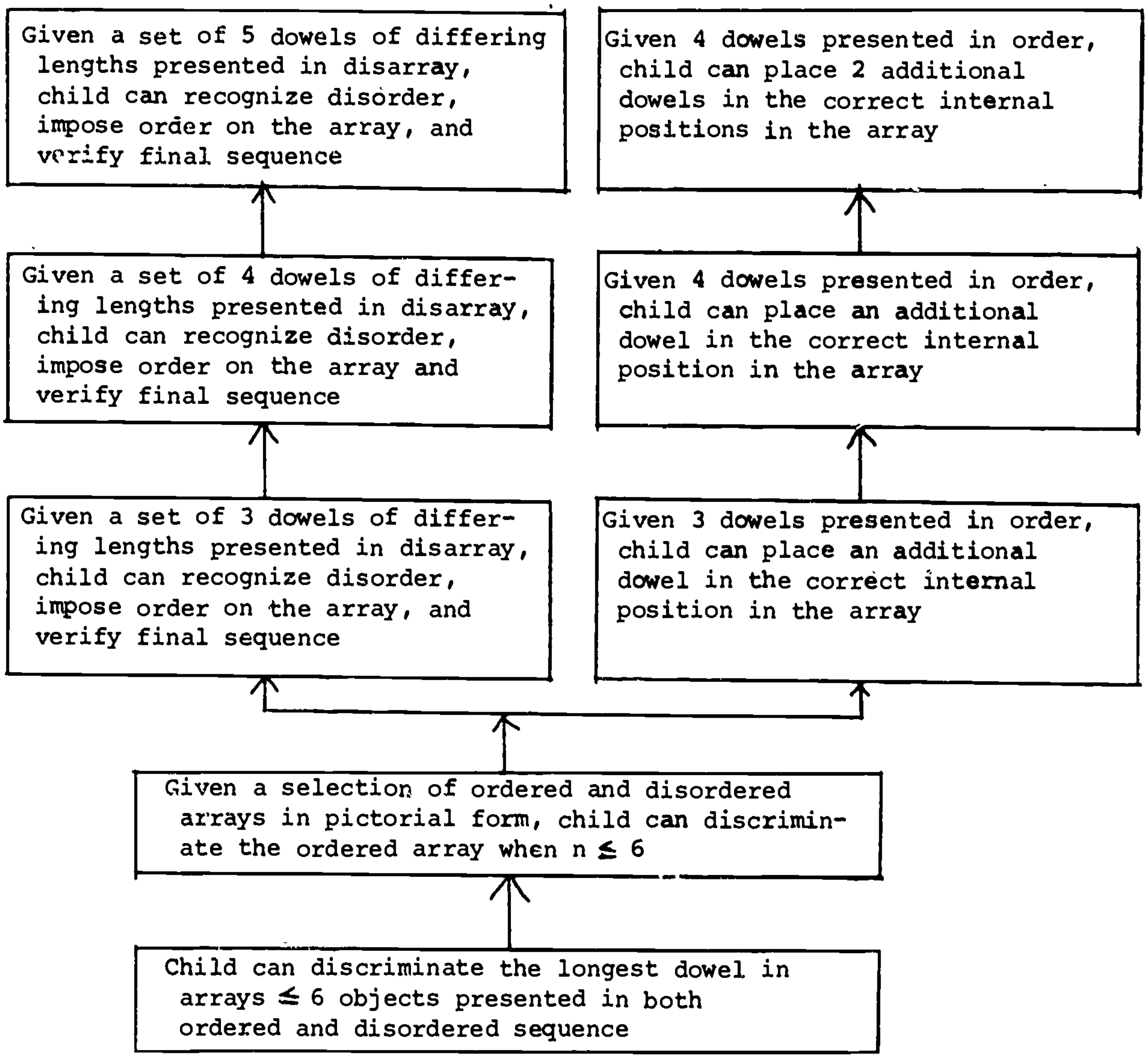
Given 5-6 cylinders of varying heights, child can select the tallest

Given 3-4 cylinders of varying heights, child can select the tallest

Given a set of 6 dowels of differing lengths presented in disarray, child can recognize disorder, impose order on the array, and verify final sequence

Given 4 dowels presented in order, child can place 3 additional dowels in the correct internal positions in the array

Seriation: Task Analysis continued



ENUMERATION: Counting and Differentiation of Sets

Task Analysis

8. Child can differentiate sets as to more, same, and fewer, in a 3-way sorting task.
→ a. when objects are not the same
→ b. when objects are the same

↑

7. Child can differentiate sets as to fewer and same in a 2-way sorting task.
→ a. when objects are not the same
→ b. when objects are the same

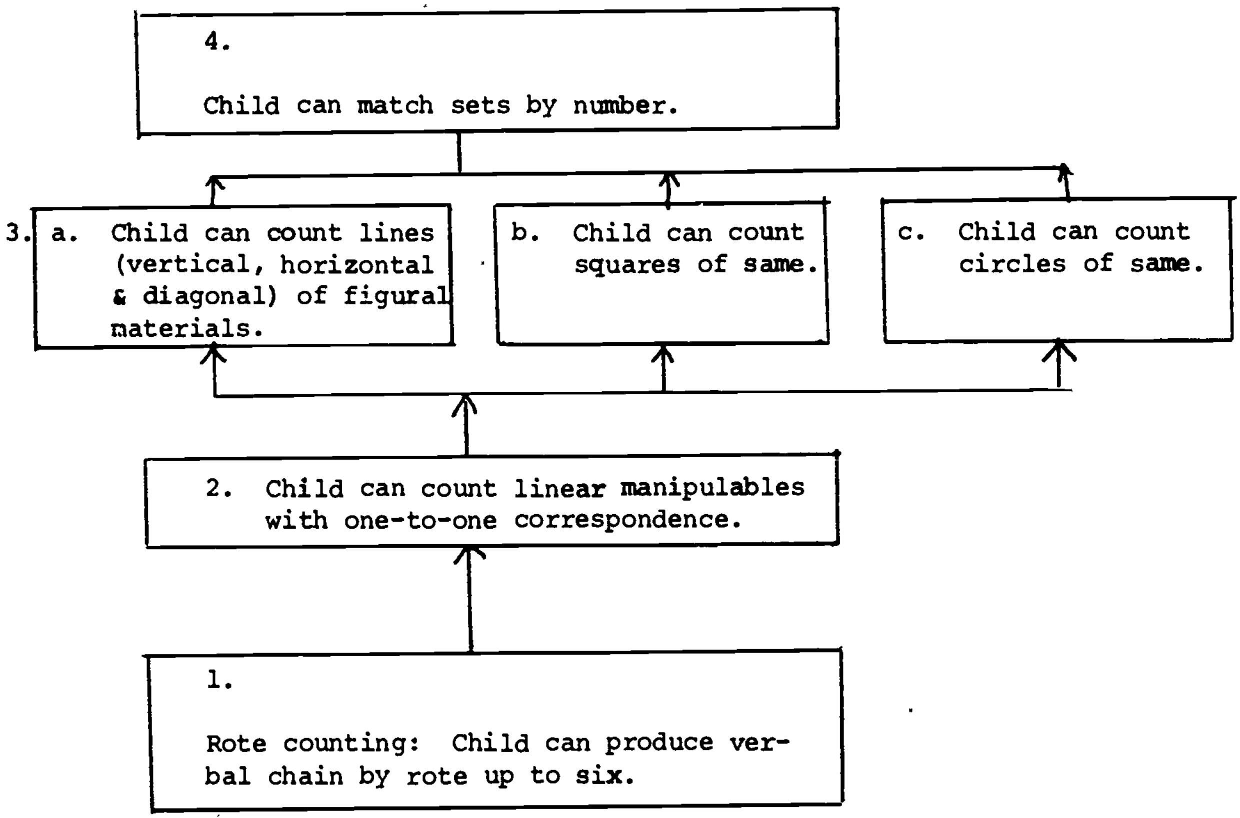
↑

6. Child can differentiate sets as to more and same in a 2-way sorting task
→ a. when objects depicted are not the same
→ b. when objects depicted are the same

↑

5. Child can differentiate sets as to same & different in a 2-way sorting task
→ a. when objects depicted are not the same
→ b. when objects depicted are the same

ENUMERATION: Task Analysis continued



QUESTION ASKING:
Fluency and Flexibility with Causal Forms

TASK ANALYSIS

5) Production of 3 or more causal questions utilizing 3 different question forms to one presentation of a pictorial stimulus

Stage IV:
Combination of fluency and flexibility in question production

4) Production of 3 or more causal questions of any form to a pictorial stimulus items

Stage III:
Fluency in question production

3) Production of a causal question of each form to a series of 3 pictorial stimulus items

Stage II:
Flexibility in question form

2) Production of one causal question to a pictorial stimulus form

Stage I:
Question production

1) Production of one causal question to a stimulus object

TASK ANALYSIS:

CONSERVATION OF NUMBER

Stage III: True Conservation of Number

- Child can identify numerically unequal configuration of 3 and 4; 5 and 6 objects when linear arrangements are expanded.
- Child can identify numerically equal configurations of 3, 4, 5, and 6 objects when linear arrangements are expanded.
- Child can identify numerically equal configurations of 3, 4, 5, and 6 objects when linear arrangements are compressed.

Stage II: Conservation of Number with Subject Involvement

- Child can construct numerical match, transform the linear arrangement by expansion, and judge the equality.
- Child can construct numerical match, transform the linear arrangement by compression, and judge the equality.
- Child can select numerically matched configurations, difering in overall length, through comparison to a child-constructed standard using rows of 3, 4, 5, and 6 objects.

Stage I: Construction of Matches

- Child can construct linear arrangements numerically matched with standards containing 3, 4, 5, and 6 objects.
  - → Verification of choice w/standard
  - → Choice of others matching standard
  - → Initial construction of a standard

APPENDIX B

BEHAVIORAL OBJECTIVES

BEHAVIORAL OBJECTIVES: SERIATION

1. Child can discriminate the longest dowel in arrays of ≤ 6 objects presented in both ordered and disordered sequence.

2. Given a selection of ordered and disordered arrays in pictoral form, child can discriminate the ordered array when $n \leq 6$.

3. Given a set of three dowels of differing length presented in disarray, child can recognize disorder, impose order on the array, and verify final sequence.

4. Given a set of four dowels of differing lengths presented in disarray, child can recognize disorder, impose order on the array, and verify final sequence.

5. Given a set of five dowels of differing lengths presented in disarray, child can recognize disorder, impose order on the array, and verify final sequence.

6. Given a set of six dowels of differing lengths presented in disarray, child can recognize disorder, impose order on the array, and verify final sequence.

7. Given 3-4 cylinders of varying heights, child can discriminate the tallest.

8. Given 5-6 cylinders of varying heights, child can discriminate the tallest.

9. Given 3-4 flat squares of varying sizes, child can discriminate the largest.

10. Given 5-6 flat squares of varying sizes, child can discriminate the largest.

11. Given 3-4 cylinders of varying heights, child can impose order.

12. Given 5-6 cylinders of varying heights, child can impose order.

13. Given 3-4 flat squares of varying sizes, child can impose order.

14. Given 5-6 flat squares of varying sizes, child can impose order.

15. Given three dowels presented in order, child can place an additional dowel in the correct internal position in the array.

16. Given four dowels presented in order, child can place an additional dowel in the correct internal position in the array.

17. Given four dowels presented in order, child can place two additional dowels in the correct internal positions in the array.

18. Given four dowels presented in order, child can place three additional dowels in the correct internal positions in the array.

ENUMERATION:
Counting and Differentiation of Sets

BEHAVIORAL OBJECTIVES

1. Given a verbal direction the child can produce the verbal chain of numbers 1 through 6 with 100% accuracy.

2. Given a linear arrangement of up to six manipulable objects, the child can count them with one to one correspondence with 100% accuracy.

3. a) Given a linear arrangement of up to six items in pictorial form child can count them with 100% accuracy.

   b) Given a non linear arrangement of up to six items in pictorial form, child can count them with 100% accuracy.

   c) Given a circular arrangement of up to six items in pictorial form, child can count them with 100% accuracy.

4. Given a row arrangement of manipulable objects, child can construct another row matching in number.

5. Given a series of sets in a two-way sorting task, child can differentiate "same" and "different" with respect to number.

6. Given a two-way sorting task with a series of sets, child can differentiate them as to "same" and "more".

7. Given a two-way sorting task with a series of sets, child can differentiate them as to "same" and "less".

8. Given a three-way sorting task with a series of sets, child can differentiate them as to "more", "less", and "same".

QUESTION ASKING:
Fluency and Flexibility with Causal Forms

BEHAVIORAL OBJECTIVES

1. Given a manipulable object the child can produce at least one causal question within a 30 second interval.

2. Given a pictoral stimulus object the child can produce at least one causal question within a 30 second interval.

3. Given a series of 3 pictoral stimuli presented one at a time, the child can produce one question each of the 3 causal forms (why, how come, what would happen if).

4. Given a single pictorial stimulus item the child can produce 3 or more causal questions.

5. Given a single pictoral stimulus item the child can produce 3 or more causal questions that utilize 3 different question forms.

BEHAVIORAL OBJECTIVES

CONSERVATION OF NUMBER

1. Given a standard containing 3 linearly arranged objects, child can construct a numerically matched set.

    a. Child can select from among other sets of 3 objects the one which numerically matches the standard.

2. Given a standard containing 4 linearly arranged objects, child can construct a numerically matched set.

    a. Child can select from among other sets of 4 objects the one which numerically matches the standard.

3. Given a standard containing 5 linearly arranged objects, child can construct a numerically matched set.

    a. Child can select from among other sets of 5 objects the one which numerically matches the standard.

4. Given a standard containing 6 linearly arranged objects, child can construct a numerically matched set.

    a. Child can select from among other sets of 6 objects, the one which numerically matches the standard.

5. Given 2 sets each containing 3 linearly arranged objects equally spaced, child can transform one row by compression and correctly judge the numerical equality of the sets before and after transformation.

6. Given 2 sets each containing 4 linearly arranged objects equally spaced, child can transform one row by compression and correctly judge the numerical equality of the sets before and after transformation.

7. Given 2 sets each containing 5 linearly arranged objects equally spaced, child can transform one row by compression and correctly judge the numerical equality of the sets before and after transformation.

8. Given 2 sets each containing 6 linearly arranged objects equally spaced, child can transform one row by compression and correctly judge the numerical equality of the sets before and after transformation.

9. Given 2 sets each containing 3 linearly arranged objects equally spaced, child can transform one row by expansion and correctly judge the numerical equality of the sets before and after transformation.

10. Given 2 sets each containing 4 linearly arranged objects equally spaced, child can transform one row by expansion and correctly judge the numerical equality of the sets before and after transformation.

11. Given 2 sets each containing 5 linearly arranged objects equally spaced, child can transform one row by expansion and correctly judge the numerical equality of the sets before and after transformation.

12. Given 2 sets each containing 6 linearly arranged objects equally spaced, child can transform one row by expansion and correctly judge the numerical equality of the sets before and after transformation.

13. Given 2 sets each containing 3 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by compression.

14. Given 2 sets each containing 4 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by compression.

15. Given 2 sets each containing 5 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by compression.

16. Given 2 sets each containing 6 linearly arranged objects, child can correctly judge numerical equality after E transforms the array by compression.

17. Given 2 sets each containing 3 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by expansion.

18. Given 2 sets each containing 4 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by expansion.

19. Given 2 sets each containing 5 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by expansion.

20. Given 2 sets each containing 6 linearly arranged objects, child can correctly judge numerical equality after E transforms one array by expansion.

21. Given 2 linear sets containing 3 and 4 objects, child can correctly judge numerical inequality and indicate which set has more, following a transformation.

$$\begin{array}{lcl} 0\ 0\ 0 & & 0\ 0\ 0 \\ 0\ 0\ 0\ 0 & \longrightarrow & 0000 \end{array}$$

22. Given 2 linear stts containing 5 and 6 objects, child can correctly judge numerical inequality and indicate which set has more, following a transformation.

$$\begin{array}{lcl} 0\ 0\ 0\ 0\ 0 & & 0\ 0\ 0\ 0\ 0 \\ 0\ 0\ 0\ 0\ 0\ 0 & \longrightarrow & 00000 \end{array}$$

APPENDIX C

INSTRUMENTS

Name ______________________

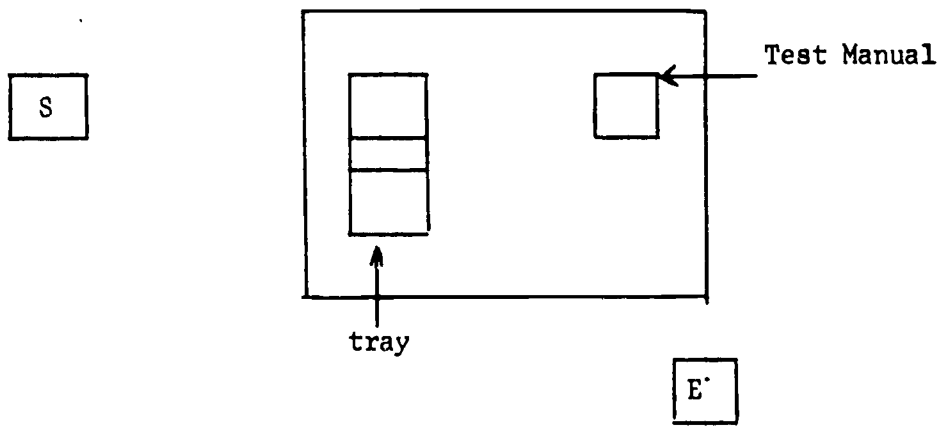
Date ______________________

Test ______________________

SERIATION: TEST I

A. Initiation*

Child should be seated at table with the stimulus objects arranged in the following manner:

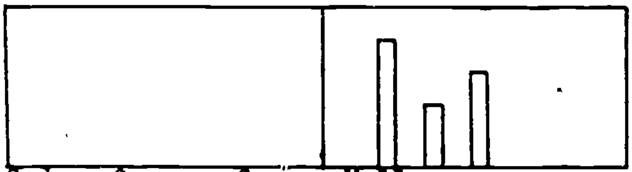


WE ARE GOING TO PLAY A GAME WITH THE THINGS I HAVE HERE. LISTEN CAREFULLY AND YOU WILL LEARN HOW TO PLAY THE GAME. AFTER WE ARE ALL DONE YOU CAN HAVE A TREAT, OK? LET'S PLAY.

*Note any unusual or unexpected events that occur during the testing situation. Anything that deviates from standard procedures should be noted.

B. Size Discrimination

1. Present child with 3 sticks on one side of tray.

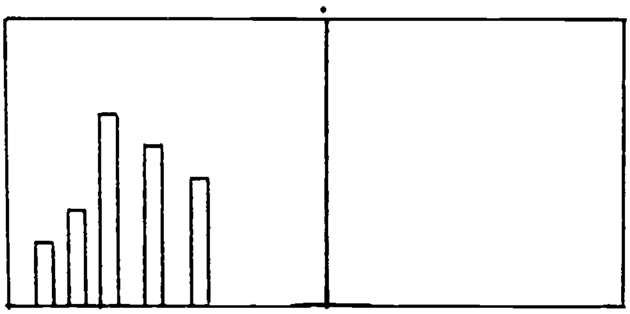


Code: Orange, Green, Yellow

LOOK AT THESE THREE STICKS HERE (point). FIND THE LONGEST AND PUT IT OVER HERE (point to other side of tray).

Answer

2. Present child with 5 sticks on one side of tray.



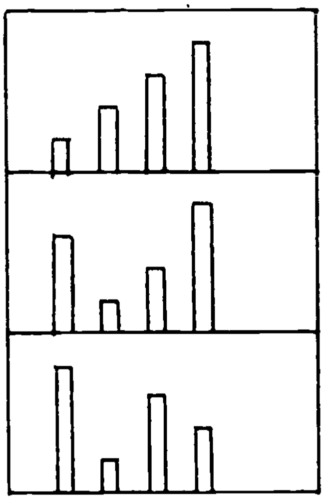
Code: Blue, Green, Red, Orange, Yellow

LOOK AT THESE FIVE STICKS HERE (point). FIND THE LONGEST STICK AND PUT IT OVER HERE (point to other side of tray).

Answer

C. Recognition of Order

3. Present child with pictorial array #1.

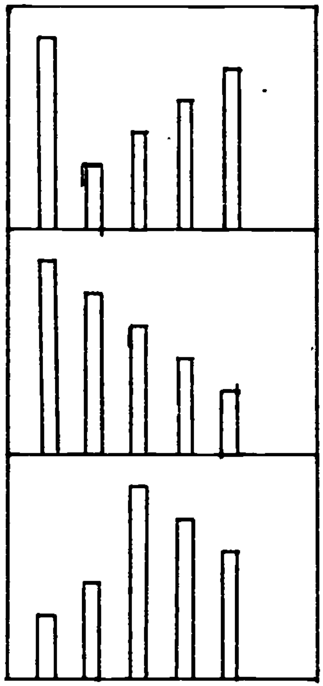


LOOK AT THE THREE SETS (point 1-2-3). THERE ARE STICKS IN EACH SET. POINT TO THE SET WITH STICKS IN THE RIGHT ORDER FROM THE LONGEST TO THE SHORTEST.

Answer

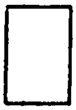
HOW DO YOU KNOW?

4. Present child with pictorial array #2.



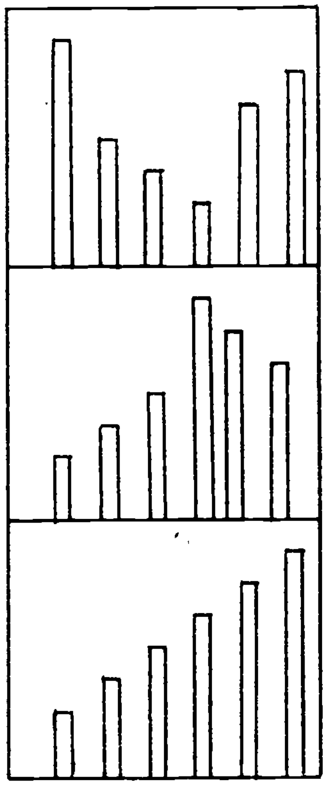
LOOK AT THE THREE SETS (point 1-2-3). THERE ARE STICKS IN EACH SET. POINT TO THE SET WITH STICKS IN THE RIGHT ORDER FROM THE LONGEST TO THE SHORTEST.

Answer



HOW DO YOU KNOW?

5. Present child with pictorial array #3.



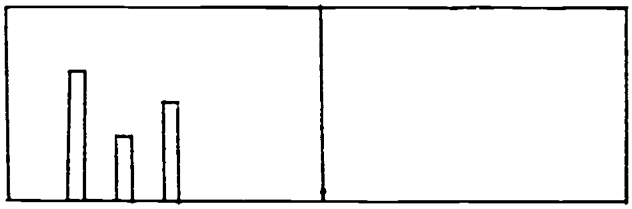
LOOK AT THE THREE SETS (point 1-2-3). THERE ARE STICKS IN EACH SET. POINT TO THE SET WITH STICKS IN THE RIGHT ORDER FROM THE LONGEST TO THE SHORTEST.

Answer

HOW DO YOU KNOW?

D. Imposition of Order

6. Present child with 3 stick array.



Code: Orange, Green, Yellow

LOOK AT THESE THREE STICKS. THEY ARE NOT IN ORDER. PUT THEM OVER HERE (point to the other side of tray). IN THE RIGHT ORDER FROM LONGEST TO SHORTEST.

Strategy ________

Answer ☐

Time ____________

When child is finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", go on to next item.

If child says "no", say:

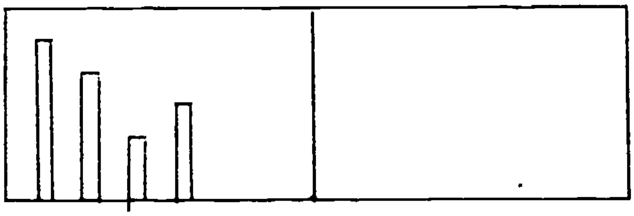
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point to the other side of tray).

Strategy ________

Answer ☐

Time ____________

7. Present child with 4 sticks array.



Code: Red, Orange, Purple, Blue

LOOK AT THESE FOUR STICKS. THEY ARE NOT IN ORDER. PUT THEM OVER HERE (Point to other side of tray) IN THE RIGHT ORDER FROM LONGEST TO SHORTEST.

Strategy _______

Answer ☐

Time _________

When child is finished, say:

Are THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", go on to the next item.

If child says "no", say:

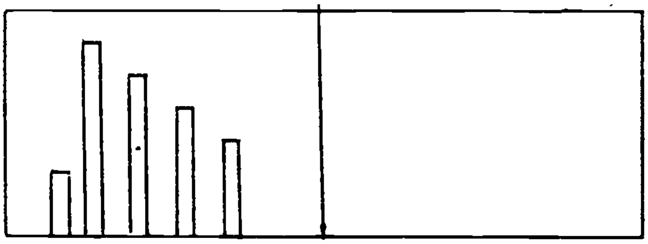
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point to other side of tray).

Strategy _______

Answer ☐

Time _________

8. Present child with 5 sticks array.



Code: White, Yellow Purple, Blue, Green

LOOK AT THESE FIVE STICKS. THEY ARE NOT IN ORDER. PUT THEM OVER HERE (point) IN THE RIGHT ORDER FROM LONGEST TO SHORTEST.

Strategy ______

Answer ☐

Time ________

When child is finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", go on to the next item.

If child says "no", say:

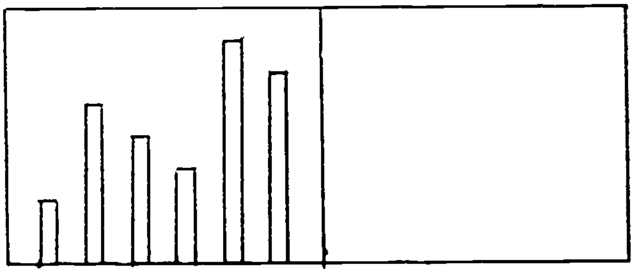
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ______

Answer ☐

Time ________

9. Present child with six sticks array.



Code: Purple, Yellow, een, Blue, Red, Orange

LOOK AT THESE SIX STICKS. THEY ARE NOT IN ORDER. PUT THEM OVER HERE (point) IN THE RIGHT ORDER FROM LONGEST TO SHORTEST.

Strategy ________

Answer ☐

Time ________

When child is finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes" go on to the next item.

If child says "no", say:

TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ________

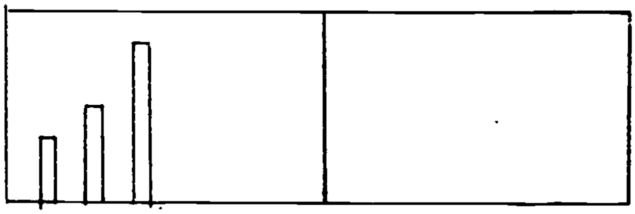
Answer ☐

Time ________

E. Adding to the Array

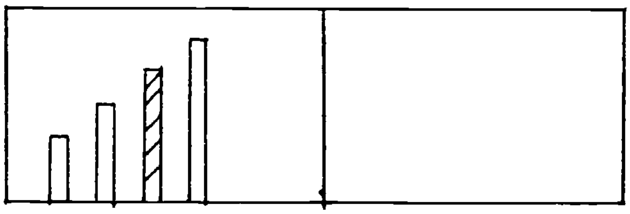
NOW WE ARE GOING TO PLAY A NEW GAME. I'LL TAKE A TURN FIRST. WATCH ME.

Place array on board.



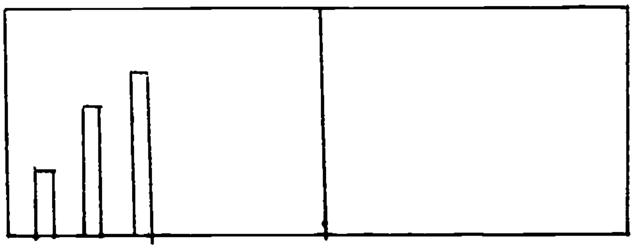
Code: Blue, Green, (Yellow), Orange

HERE ARE THREE STICKS. THEY ARE IN ORDER FROM LONGEST TO SHORTEST. HERE IS AN EXTRA STICK. I AM GOING TO PUT IT WHERE IT FITS (place extra stick in array).



NOW, THEY ARE IN ORDER FROM LONGEST TO SHORTEST (remove sticks from board).

10. Present child with 3 object array and 1 extra.



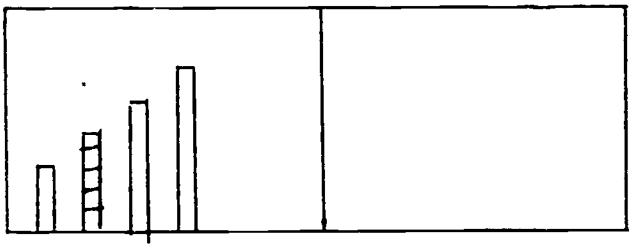
Code: Green, (Yellow), Orange, Red

NOW IT'S HOUR TURN. HERE ARE THREE STICKS. THEY ARE IN ORDER FROM LONGEST TO SHORTEST. HERE IS AN EXTRA STICK (hand to child). PUT IT WHERE IT FITS.

Strategy ______

Answer ☐

Time ______

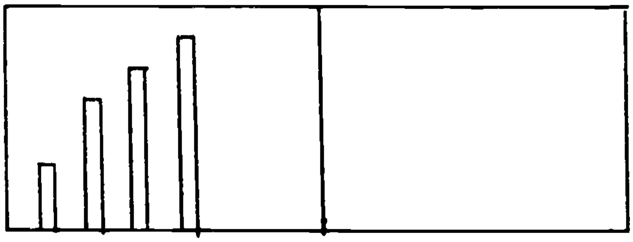


When child is finished, say:

ARE THEY IN ORDER FROM LONGEST TO SHORTEST?

Judgement ☐

11. Present child with 4 object array and 1 extra.



Code: Purple, (Blue), Green, Yellow, Orange

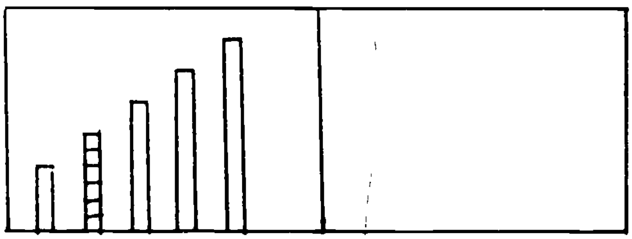
HERE ARE FOUR STICKS. THEY ARE IN ORDER FROM LONGEST TO SHORTEST.

HERE IS AN EXTRA STICK (hand to child). PUT IT WHERE IT FITS.

Strategy ______

Answer

Time ________

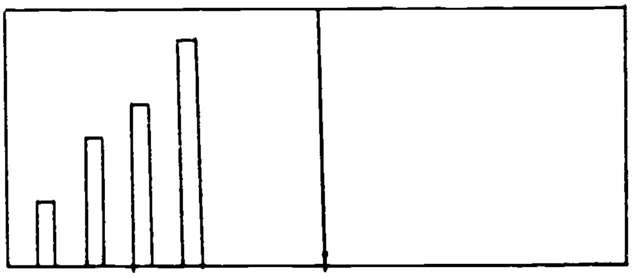


When completed, say:

ARE THEY IN ORDER FROM LONGEST TO SHORTEST?

Judgement

12. Present child with 4 object array and 2 extras.



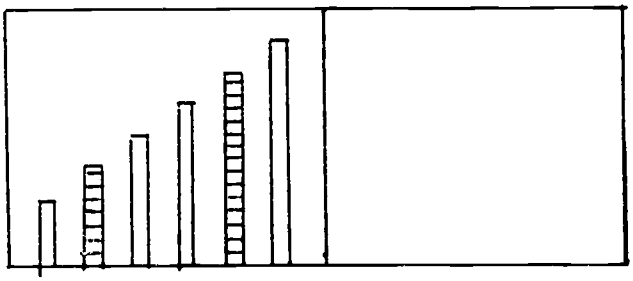
Code: Purple, (Blue), Green, Yellow, (Orange), Red

HERE ARE FOUR STICKS. THEY ARE IN ORDER FROM LONGEST TO SHORTEST. HERE ARE SOME EXTRA STICKS (hand to child). PUT THEM WHERE THEY FIT.

Strategy ________

Answer □

Time ____________

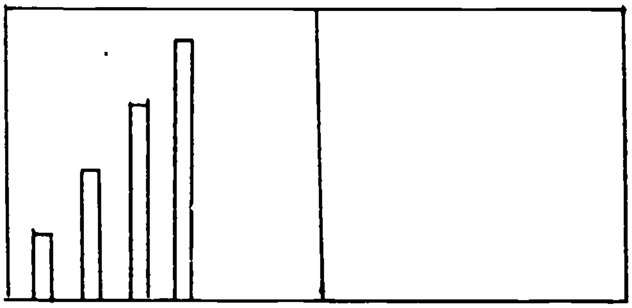


When completed say:

ARE THEY IN ORDER FROM LONGEST TO SHORTEST?

Judgement □

13. Present child with 4 object array and 3 extras.



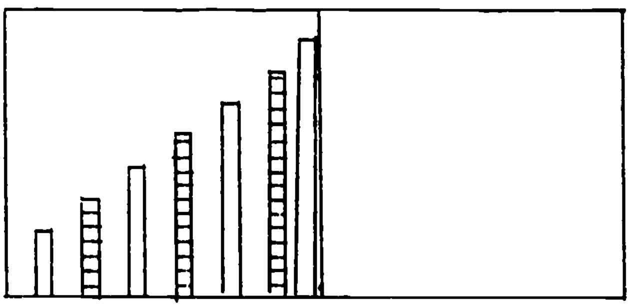
Code: White, (Purple), Blue, (Green), Yellow, (Orange), Red

HERE ARE FOUR STICKS. THEY ARE IN ORDER FROM LONGEST TO SHORTEST. HERE ARE SOME EXTRA STICKS (hand to child). PUT THEM WHERE THEY FIT.

Strategy________

Answer ☐

Time__________



When completed say:

ARE THEY IN ORDER FROM LONGEST TO SHORTEST?

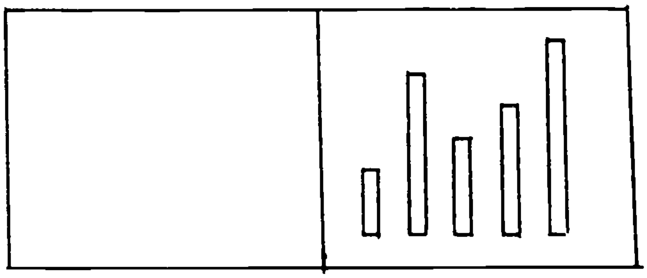
Judgement ☐

F. Generalization

Remove stimulus board and place teaching board face down on table with edge toward the subject.

14. NOW WE ARE GOING TO PLAY WITH SOME MORE OF THE THINGS I HAVE HERE.

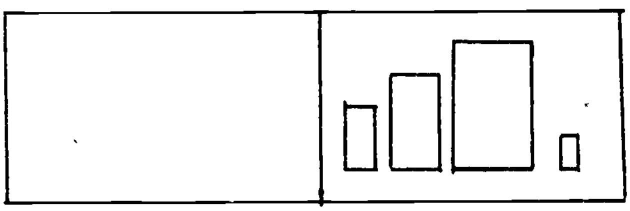
Present child with 5 cans standing up on right side of table.



LOOK AT THESE FIVE CANS. FIND THE BIGGEST CAN AND PUT IT OVER HERE (point to the other side of table)

Answer ☐

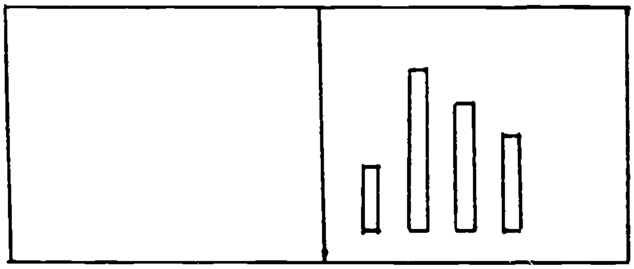
15. Place flat squares on table.



LOOK AT THESE FOUR SQUARES. FIND THE BIGGEST SQUARE AND PUT IT OVER HERE (point to the other side of table).

Answer ☐

16. Place 4 cans on table.



LOOK AT THESE FOUR CANS. THEY ARE NOT IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST. PUT THEM OVER HERE IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST (point).

Strategy ________

Answer ☐

Time ________

When finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ________

If child says "yes", go on to the next item.

If child says "no", say:

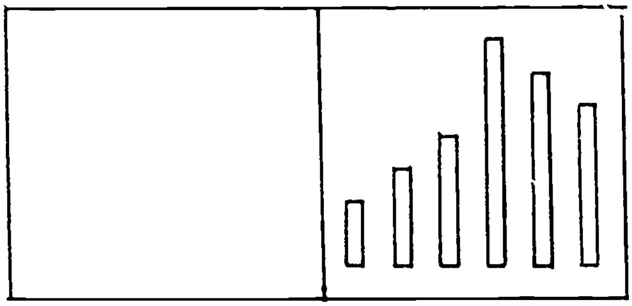
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ________

Answer ☐

Time ________

17. Place 6 cans on table.



LOOK AT THESE SIX CANS. THEY ARE NOT IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST. PUT THEM OVER HERE IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST (point).

Strategy ______

Answer ☐

Time ______

When finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", go on to next item.

If child says "no", say:

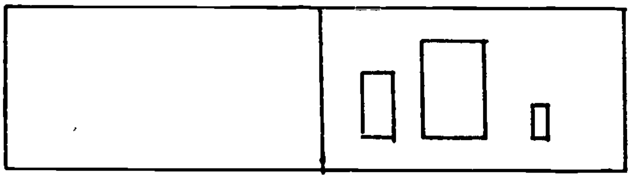
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ______

Answer ☐

Time ______

18. Place 3 flat squares on table.



LOOK AT THESE THREE SQUARES. THEY ARE NOT IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST. PUT THEM OVER HERE (point) IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST.

Strategy ________

Answer ☐

Time ________

When finished, say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", go on to next item.

If child says "no", say:

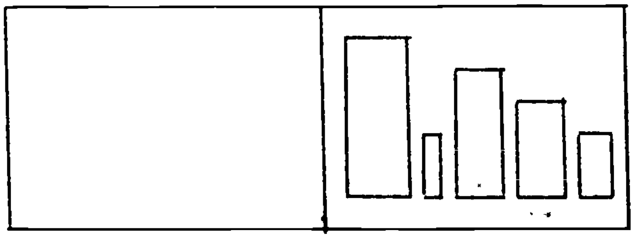
TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ________

Answer ☐

Time ________

19. Place 5 flat squares on table.



LOOK AT THESE FIVE SQUARES. THEY ARE NOT IN THE RIGHT ORDER FROM THE BIGGEST TO THE SMALLEST. PUT THEM OVER HERE IN THE RIGHT ORDER FROM BIGGEST TO SMALLEST (point).

Strategy ________

Answer ☐

Time ________

When finished say:

ARE THEY IN THE RIGHT ORDER?

Judgement ☐

If child says "yes", terminate test.

If child says "no", say:

TRY AGAIN. PUT THEM OVER HERE IN THE RIGHT ORDER (point).

Strategy ________

Answ r ☐

Time ________

G. Termination

YOU HAVE PLAYED THE GAME SO WELL. YOU CAN HAVE A TREAT FOR PLAYING SO WELL.

Deliver reinforcer.

Total Score ________

ENUMERATION TEST I

Name of Child: ______________________________

Name of Tester ______________________________

Date: ______________________________

Language: Papago: ____________ English ____________

Check One: 1. Pre ____________

2. Post ____________

3. Retention ________

Site: ______________________________

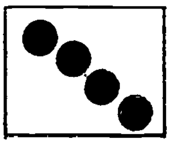
Introduction: WE ARE TO PLAY A GAME WITH ALL THE THINGS I HAVE HERE. IT' A COUNTING GAME. WHEN WE ARE ALL THROUGH PLAYING THE GAME YOU CAN HAVE A TREAT, OKAY? LET'S PLAY.

Mark right or wrong

1. (Make a line of 5 chips) COUNT THESE CHIPS AND TELL ME HOW MANY THERE ARE. GO SLOW AND POINT.

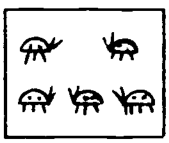
1. A. ☐

2. (Name), COUNT THE SPOTS ON THIS CARD. COUNT THE SPOTS IN THIS SET FOR ME GO SLOW AND POINT.



2. A ☐

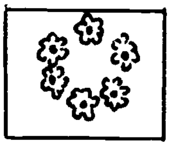
3. (Name), COUNT THE BUGS IN **THIS** SET. GO SLOW AND COUNT.



3. A ☐

Mark right or wrong

4. (Name), COUNT THE FLOWERS IN THIS SET. GO SLOW AND POINT.



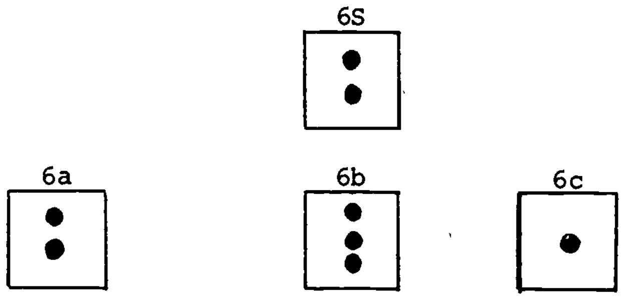
4. A [ ]

5. (Put out a row of 3 chips in a line). (Name), HERE IS A ROW OF CHIPS. YOU MAKE A ROW WITH AS MANY CHIPS.

5. A [ ]

Write code of card child chose

6. (Use cards: 1 for examiner and 3 for child. Place cards for child in a row in front of him.)



(Name), HERE ARE SOME SETS FOR YOU, AND HERE IS A SET FOR ME. MY SET HAS 2 SPOTS. GIVE ME YOUR SET THAT HAS 2 SPOTS. GIVE ME THE ONE WITH 2.

6.

A

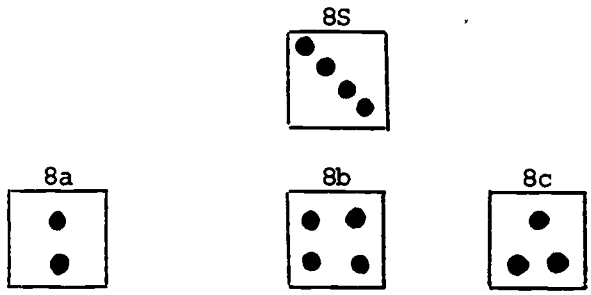
7. (Replace card for child. Remove your card from sight.) NOW (Name), GIVE ME THE SET WITH 3 SPOTS. GIVE ME THE ONE WITH 3.

7.

A

Write code of card child chose

8. (Use cards: 1 for examiner and 3 for child, same arrangement as for previous item.)



(Name), HERE ARE SOME SETS FOR YOU. AND HERE IS A SET FOR ME. MY SET HAS 4 SPOTS. GIVE ME YOUR SET THAT HAS 4 SPOTS. GIVE ME THE ONE WITH 4.

8. ______

A ______

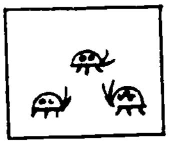
9. (Replace card for child. Remove your card from sight.) NOW, (Name), GIVE ME THE SET WITH 2 SPOTS. GIVE ME THE ONE WITH 2.

9. ______

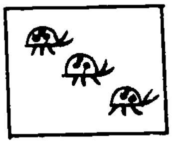
A ______

Demonstration Item: Use 1-way Sorting Board.

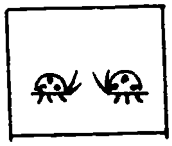
HERE IS A BOARD FOR OUR GAME. IT HAS HOOKS ON IT. THE SETS FIT ON THE HOOKS. WATCH (demonstrate hooking set on a cup hook.) WE ARE GOING TO PLAY WITH THIS BOARD.



Demo standard



Demo 1



Demo 2

THIS IS MY SET. I AM GOING TO PUT IT HERE (slip demo standard into position).

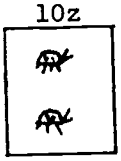
WATCH ME. HERE IS ANOTHER SET (demo 1). DOES IT HAVE AS MANY BUGS AS THIS ONE? LET'S COUNT 1-213 IN THIS SET...AND 1-2-3 IN THIS SET. YES, THERE ARE AS MANY, SO I'LL PUT IT ON THE HOOK.

NOW, HERE IS ANOTHER SET (demo 2). LET'S COUNT IT 1-2. OH, NO, THAT IS NOT AS MANY SO WE'LL PUT IT OVER HERE (place face down at edge of table).

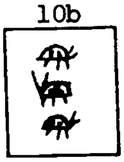
10. NOW IT'S YOUR TURN (remove samples but leave standard in place). (Place in front of child a row of response cards).

Write code of hooked sets
A. ____
A. ____
A. ____
A. ____

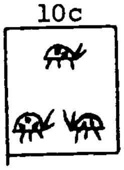
10z



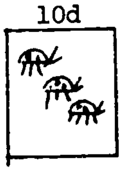
10b



10c

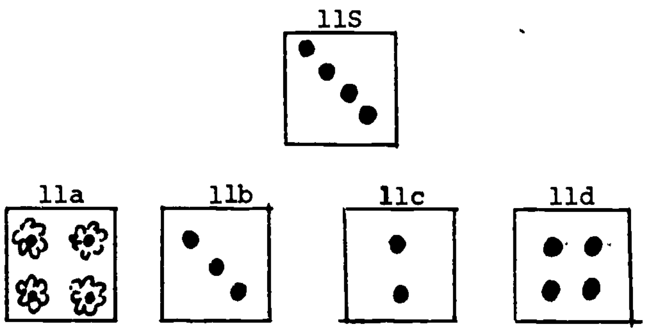


10d



HERE ARE SOME SETS FOR YOU. PUT THE ONES THAT HAVE AS MANY ON THE HOOKS. HOOK THE ONES THAT HAVE AS MANY.

11. LET'S DO THAT AGAIN (remove standard and replace with another). MY SET HAS 4 SPOTS. HERE ARE SOME SETS FOR YOU. PUT THE ONES THAT HAVE AS MANY ON THE HOOKS. HOOK THE ONES THAT HAVE AS MANY (place in row in front of child.)



Write code of hooked sets.

A. ____

A. ____

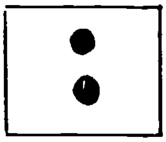
A. ____

A. ____

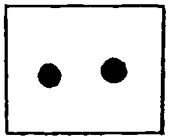
Comments if any:

Demonstration Item: Use "More" (+) Sorting Board.

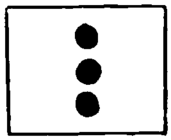
NOW THE GAME IS GETTING HARDER. WATCH ME FIRST. HERE IS MY SET (demo standard).



Demo Standard



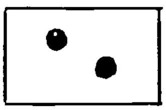
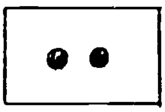
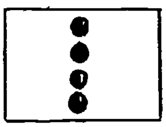
Demo 1



Demo 2

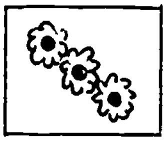
IT HAS 1-2 SPOTS (slip set into standard position). NOW LET's LOOK AT THIS ONE (demo 1). IT HAS 1-2 SPOTS. IT HAS AS MANY SO WE'LL HOOK IT HERE (place in "as many" column). LET'S TAKE ANOTHER ONE (demo 2). IT HAS 1-2-3. THAT IS MORE SO WE HOOK IT HERE. OKAY. (Remove all but standard.)

Write code of hooked sets

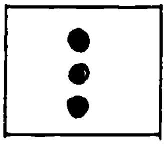
		As many	More
12. NOW YOU TRY WITH YOUR SETS. HOOK THE SETS THAT HAVE AS MANY HERE (point). HOOK THE SETS WITH MORE HERE (point).			
a. (hand child 12a)		A. ____	A. ____
b. (hand child 12b)		A. ____	A. ____
c. (hand child 12c)		A. ____	A. ____

	Write code of hooked sets	
	As many	More
13. LET'S TRY IT WITH SOME OTHERS (remove all sets; replace standard).		
a. (hand child 13a)	A.___	A.___
b. (hand child 13b)	A.___	A.___
c. (hand child 13C)	A.___	A.___

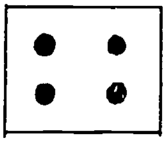
13S



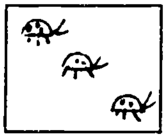
a. (hand child 13a)



b. (hand child 13b)



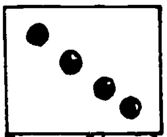
c. (hand child 13C)

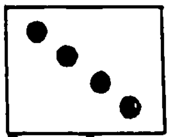


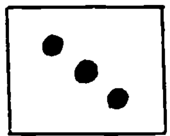
Comments if any:

Demonstration Item: Use "Less" (-) Board.

LET'S DO IT IN A LITTLE DIFFERENT WAY THIS TIME. WATCH ME FIRST, HERE IS MY SET (demo standard). IT HAS 1-2-3-4 SPOTS (Slip set into standard position). NOW LET'S LOOK AT THIS ONE (demo 1). IT HAS 1-2-3-4 ALSO, SO WE'LL HOOK IT HERE (place in "as many" column). LET'S TAKE ANOTHER ONE (demo 2). IT HAS 1-2-3. THAT IS LESS SO WE HOOK IT HERE. OKAY. (Remove all but standard).


Demo Standard


Demo 1

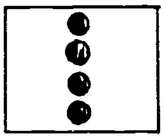

Demo 2

Write code of hooked set

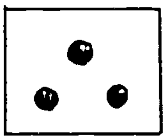
Less As Many

14. NOW YOU TRY WITH YOUR SETS. HOOK THE SETS THAT HAVE AS MANY HERE (point). HOOK THE SETS WITH LESS HERE (point).

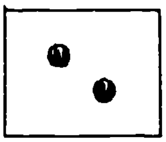
a. (hand child 14A) A. ___ A. ___

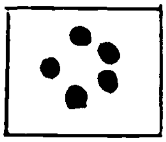
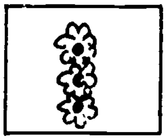
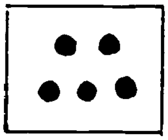
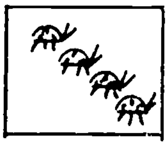


b. (hand child 14B A. ___ A. ___



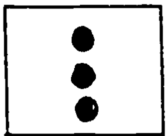
c. (hand child 14C) A. ___ A. ___

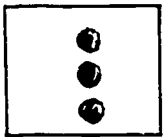


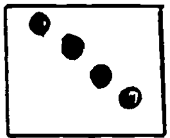
	Write code of hooked sets	
	Less	As Many
15. LET'S TRY AGAIN (Remove all sets; replace standard).  HOOK THE SETS WITH AS MANY HERE (point). HOOK THE SETS WITH LESS HERE (point).		
a. (hand child 14A). 	A. ___	A. ___
b. (hand child 14B). 	A. ___	A. ___
c. (hand child 14C). 	A. ___	A. ___

Demonstration Item: Use 3-way Sorting Board.

NOW THE GAME IS GETTING EVEN HARDER. WATCH ME FIRST. HERE IS MY SET (demo standard). IT HAS 1-2-3 (slip set into standard position).


Demo Standard

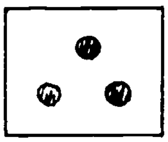
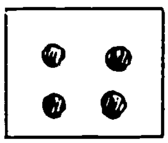
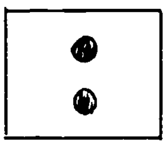
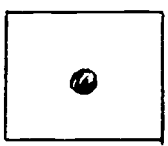
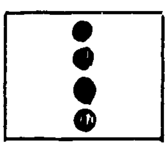

Demo 1


Demo 2


Demo 3

NOW LET'S LOOK AT THIS ONE (demo 1). IT HAS 1-2-3 ALSO. IT HAS AS MANY SO WE'LL HOOK IT HERE (place in same column). LET'S TAKE ANOTHER ONE (demo 2). IT HAS 1-2-3-4. THAT IS MORE SO WE HOOK IT HERE. LET'S LOOK AT ANOTHER ONE (demo 3). IT HAS 1-2. THAT IS LESS SO WE'LL HOOK IT HERE. OKAY. (remove all but standard).

16. NOW YOU TRY WITH YOUR SETS. HANG THE SETS THAT HAVE AS MANY HERE. HANG THE SETS WITH MORE HERE. HANGE THE SETS WITH LESS HERE.

	Write code of ooked Set		
	L	AS	M
a. (hand child 16A) 	A.___	A.___	A.___
b. (hand child 16B) 	A.___	A.___	A.___
c. (hand child 16C) 	A.___	A.___	A.___
d. (hand child 16D) 	A.___	A.___	A.___
e. (hand child 16E) 	A.___	A.___	A.___

Termination

YOU PLAYED THE GAME SO WELL. HERE IS A TREAT FOR PLAYING SO WELL.

Total Score

QUESTION PRODUCTION TEST

Name of Child: ______________________________

Name of Tester: ______________________________

Date: ______________________________

Check one. 1. Pre ______________

2. Post ______________

3. Retention ______________

Site: ______________________________

QUESTION PRODUCTION TASK

A. Initiation:

TODAY WE ARE GOING TO PLAY A QUESTION GAME. I'M GOING TO ASK YOU A QUESTION ABOUT THIS PICTURE (present stimuli demonstration item #1). LISTEN CAREFULLY, THIS IS A QUESTION (pause).

"HOW COME . . . .?" (pause)

I ASKED YOU A QUESTION. NOW YOU ASK ME A QUESTION ABOUT THIS PICTURE (present stimuli demonstration item #2. Wait for response. If no answer continue with test.).

B. Generation of Questions to Objects

General directions.

NOW, (NAME), FOR MY PART OF THE GAME, I'M GOING TO SHOW YOU SOME TOYS. YOU ASK AS MANY QUESTIONS AS YOU CAN ABOUT THE TOYS (pause). I AM NOT GOING TO ANSWER YOUR QUESTIONS: YOU JUST ASK ME AS MANY AS YOU CAN.

1. Item 1: The stop watch. Place watch in hand of child.

(NAME), HERE IS A WATCH. YOU ASK AS MANY QUESTIONS AS YOU CAN ABOUT THE WATCH.

Code each produced utterance: allow 30 seconds of response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____

Wait 15 seconds: If no response, repeat directons.

Wait another 15 seconds: use a non-cueing utterance such as "okay", remove item and go on with the test.

2. Item 2: Contraption #1

(NAME), HERE IS A SPECIAL TOY. YOU ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THE TOY.

Code each produced utterance: allow 30 seconds of response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

3. Item 3: Contraption #2

(NAME), HERE IS ANOTHER SPECIAL TOY. YOU ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THE TOY.

Code each produced utterance: allow 30 seconds of response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

4. Item 4: Contraption #3

(NAME), HERE IS ANOTHER SPECIAL TOY. YOU ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THE TOY.

Code each produ

1. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ N/R_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

C. Generation to Pictorial Items.

General directions: Place pile of stimulus pictures on table in a stack. Pictures should be:

a. face down

b. in order

c. at the side, so that one at a time they can be placed directly in front of child.

(NAME), NOW I'M GOING TO SHOW YOU SOME PICTURES. YOU ASK ME AS MANY QUESTOONS AS YOU CAN ABOUT THE PICTURES. I AM NOT GOING TO ANSWER YOUR QUESTIONS: YOU JUST ASK ME AS MANY QUESTIONS YS YOU CAN.

5. Item 5: Present stimulus picture #1.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

6. Item 6: Present stimulus picture #2

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produ ed utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still nor response continue with test.

7. Item 7: Present stimulus picture #3.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

8. Item 8: Present stimulus picture #4.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

9. Item 9: Present stimulus picture #5.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions

Wait another 15 seconds: If there is still no response continue with test.

10. Item 10: Present stimulus picture #6.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

11. Item 11: Present stimulus picture #7.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

12. Item 12: Present stimulus picture #8.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

13. Item 13: Present stimulus picture #9.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

14. Item 14: Present stimulus picture #10.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

15. Item 15: Present stimulus picture #11.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response continue with test.

16. Item 16: Present stimulus picture #12.

(NAME), ASK ME AS MANY QUESTIONS AS YOU CAN ABOUT THIS PICTURE.

Code each produced utterance: Allow 30 seconds response time.

1. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
2. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
3. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
4. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
5. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____
6. Why_____ HC_____ WWHI_____ NC_____ S_____ NR_____

Wait 15 seconds: If no response, repeat directions.

Wait another 15 seconds: If there is still no response terminate the test.

D. Termination

YOU PLAYED THE GAME SO WELL. HERE IS YOUR TREAT FOR PLAYING SO WELL.

Total Score: ________

CONSERVATION OF NUMBER TEST
Form I

NAME ______________________

DATE ______________________

EXPERIMENTER ______________

SITE: _____________________

TEST: Pre _________________

Post ______________________

Retention _________________

1. Make a row of 3 red chips, equidistant apart:

X X X

HERE IS A ROW OF CHIPS. THERE ARE 1-2-3. 3 CHIPS.

YOU MAKE A ROW WITH AS MANY. MAKE A ROW HERE (point)

WITH THE SAME NUMBER.

Place box of white chips in front of child

Right ____

Wrong ____

NR ______

Pick up all chips; remove red ones; return white ones to box.

1. Make a row of 5 red chips, equidistant apart:

X X X X X

HERE IS A ROW OF CHIPS. THERE ARE 1-2-3-4-5. 5 CHIPS.

YOU MAKE A ROW WITH AS MANY. MAKE A ROW HERE (point)

WITH THE SAME NUMBER.

Place box of white chips in front of child.

Right ____

Wrong ____

NR ______

Remove all stimuli from table.

Demonstration item: use magnet board, red circles, white circles.

HERE IS A BOARD FOR OUR GAME. THIS IS A SPECIAL BOARD. SO THINGS WILL STICK TO IT. WATCH (demonstrate sticking a red circle on lower surface).

NOW, HERE ARE SOME RED BALLS (place 2 red balls on top row):

X X

THERE ARE 1-2. 2 RED BALLS. NOW I WILL MAKE A ROW WITH THE SAME NUMBER OF WHITE BALLS AS THERE ARE RED BALLS.

Make a row of white balls underneath red balls:

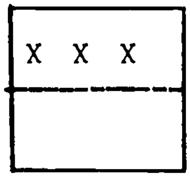
X X
0 0

NOW THERE IS A WHITE BALL FOR EACH RED BALL. THEY HAVE THE SAME NUMBER.

Remove all balls.

3. NOW IT IS YOUR TURN.

Place 3 red balls on top row equally spread over top surface so entire area is covered:



HERE IS A ROW OF RED BALLS. MAKE A ROW THAT HAS THE SAME NUMBER.

Place box of white balls in front of child.

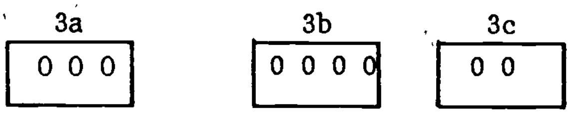
Right ____

Wrong ____

NR ____

After response:

Place row of 3 cards directly in front of child:



HERE ARE SOME SETS OF WHITE BALLS. POINT TO THE SET THAT HAS THE SAME NUMBER OF WHITE BALLS AS THESE RED BALLS.

3a ____

3b ____

3c ____

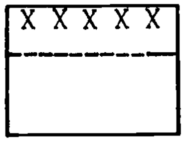
NR ____

Remove objects and cards, leave board in place.

4. LET'S DO THAT AGAIN.

Place 5 red balls across top row spread apart so that

they completely cover the top row:



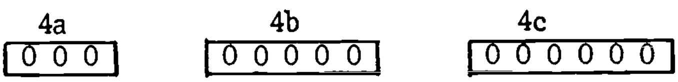
HERE IS A ROW OF RED BALLS. MAKE A ROW OF WHITE BALLS Right ____

HAT HAS THE SAME NUMBER. Wrong ____

Place box of white balls in front of child. NR ______

After response:

Place row of 3 cards directly in front of child:



HERE ARE SOME SETS OF WHITE BALLS. POINT TO THE SET 4a ______

THAT HAS THE SAME NUMBER OF WHITE BALLS AS THESE RED 4b ______

BALLS. 4c ______

NR ______

Remove all stimuli.

5. NOW, LET'S PLAY WITH SOME OTHER THINGS.

Make a row of 3 red chips and a row of 3 white chips equidistant apart but spread out enough so they can be pushed together:

```
X X X
0 0 0
```

HERE IS THE RED ROW (sweep hand).

HERE IS THE WHITE ROW (sweep hand).

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____

More_____

NR_______

If more: POINT TO THE ROW WITH MORE.

Red _____

White____

NR_______

After response:

Now, (NAME), PUSH THE WHITE CHIPS TOGETHER.

Assist child to compress row:

```
X X X
 000
```

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____

More_____

NR_______

If more: POINT TO THE ROW WITH MORE

Red______

White____

NR_______

Pick up all chips.

6. Make a row of 5 red chips and a row of 5 white chips equidistant apart but spread out enough so they can be pushed together:

```
X X X X X
0 0 0 0 0
```

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____
More_____
NR_____

If more: POINT TO THE ROW WITH MORE.

Red_____
White_____
NR_____

After response:

NOW, (NAME), PUSH THE WHITE CHIPS TOGETHER.

Assist child to compress:

```
X X X X X
 00000
```

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____
More_____
NR_____

If more: POINT TO THE ROW WITH MORE.

Red_____
White_____
NR_____

Pick up all chips.

7. Make a row of 3 red chips and a row of 3 white chips equidistant but closer together than before so that it resembles a compressed condition.

XXX
000

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____
More_____
NR_______

If more: POINT TO THE ROW WITH MORE.

Red______
White____
NR_______

After response:

NOW, (NAME), SPREAD THE WHITE ROW APART.

Assist child to spread row:

XXX
0 0 0

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_____
More_____
NR_______

If more: POINT TO THE ROW WITH MORE

Red______
White____
NR_______

Pick up all the chips.

8. Make a row of 5 red chips and a row of 5 white chips, equidistant apart but in compressed condition:

XXXXX
00000

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same_______
More_______
NR_______

If more: POINT TO THE ROW WITH MORE.

Red_______
White_______
NR_______

After response:

NOW, (NAME), SPREAD THE WHITE ROW APART.

Assist child to spread row:

XXXXX

0 0 0 0 0

DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS OR DOES ONE ROW HAVE MORE?

Same_______
More_______
NR_______

If more: POINT TO THE ROW WITH MORE.

Red_______
White_______
NR_______

Pick up all chips.

9. Make a row of 3 red chips and a corresponding row of 3 white chips.

```
X X X
0 0 0
```

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIP .

THERE ARE AS MANY RED CHIPS AS WHITE CHIPS. THEY HAVE THE SAME NUMBER.

NOW WATCH. Compress white row so array looks like this:

```
X X X
 000
```

NOW, (NAME), DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS,	Same_____
OR DOES ONE ROW HAVE MORE?	More_____
	NR_______
If more: POINT TO THE ROW WITH MORE.	Red______
	White____
	NR_______

Pick up all chips.

10. Make a row of 5 red chips and a corresponding row of

5 white chips:

X X X X X
0 0 0 0 0

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

THERE ARE AS MANY RED CHIPS AS WHITE CHIPS.

THEY HAVE THE SAME NUMBER.

NOW WATCH. Compress white row so array locks like this:

X X X X X
00000

NOW, (NAME), DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS Same______

OR DOES ONE ROW HAVE MORE? More______

NR______

If more: POINT TO THE ROW WITH MORE. Red______

White______

NR______

Pick up all chips.

11. Make a row of 3 red chips and a corresponding row of 3 white chips:

```
 X X X
 0 0 0
```

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

BOTH ROWS HAVE THE <u>SAME NUMBER</u>.

NOW WATCH. Spread the white row so array looks like this:

```
  X X X
 0  0  0
```

NOW, (NAME), DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same________

More________

NR________

If more: POINT TO THE ROW WITH MORE

Red________

White________

NR________

Pick up all chips.

12. Make a row of 5 red chips and a corresponding row of 5 white chips:

```
  X X X X X
  0 0 0 0 0
```

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

BOTH ROWS HAVE THE SAME NUMBER.

NOW WATCH. Spread white row so array looks like this:

```
  X X X X X
0  0  0  0  0
```

NOW, (NAME), DO BOTH ROWS HAVE THE SAME NUMBER OF CHIPS, OR DOES ONE ROW HAVE MORE?

Same______

More______

NR______

If more: POINT TO THE ROW WITH MORE.

Red______

White______

NR______

Pick up all chips.

13. Make 2 rows of chips: red row with 4 chips; white row with 3.

```
X X X X
0 0 0
```

HERE IS A ROW OF RED CHIPS.

HERE IS A ROW OF WHITE CHIPS.

THE ROWS DO NOT HAVE THE SAME NUMBER. THIS ROW HAS MORE (point).

NOW WATCH. Spread white row and compress red row, so array looks like this:

```
   XXXX
 0   0   0
```

NOW, (NAME), DOES ONE ROW HAVE MORE CHIPS OR DO THEY HAVE THE SAME?

Same_______

More_______

NR_______

If more: POINT TO THE ROW WITH MORE.

Red_______

White_______

NR_______

Pick up all chips.

YOU PLAYED THE GAME SO WELL. HERE IS YOUR TREAT.