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IMITATIVE MOTOR ACTIVITY, AND FEEDBACK
ON THE INDUCTION OF SERIATION.

The University of Arizona, Ph.D., 1976
Psychology, experimental

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THE RELATIVE INFLUENCE OF OBSERVATION, IMITATIVE
MOTOR ACTIVITY, AND FEEDBACK ON THE
INDUCTION OF SERIATION

by

Rosemary Anne Swanson

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

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THE UNIVERSITY OF ARIZONA

GRADUATE COLLEGE

I hereby recommend that this dissertation prepared under my
direction by Rosemary Anne Swanson

entitled The Relative Influence of Observation, Imitative
Motor Activity, and Feedback on the Induction of
Seriation

be accepted as fulfilling the dissertation requirement of the
degree of Doctor of Philosophy

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Rosemary Anne Severson

ACKNOWLEDGMENTS

I wish to express appreciation to Drs. John Bergan, Glen Nicholson, Sarah Dinham, and Ralph Wetzel for their advice and suggestions, and especially to Dr. Ronald Henderson, supervisor of this study, for his continual support and encouragement. Special thanks are also extended to Elaine Williams for her conscientious effort in conducting this study, and to the teachers and students at Happy Trails preschool in Tucson, Arizona, who gave so freely of their time. Particular attention is also extended to Jerry Swanson who was always supportive and never allowed me to lose my perspective.

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ABSTRACT

It is already clear that television is an influential agent in the socialization of children's affective, social, and cognitive development. However, it has not yet been determined which specific program variables included in a televised display are effective in facilitating the socialization process. One particular area of concern is how television can be employed in a constructive fashion with children to facilitate cognitive development and the acquisition of intellectual skills. The purpose of this study was to examine the role of modeling, activity, and feedback on the acquisition of a cognitive skill when those variables were included in a televised instructional sequence.

Two cognitive skills, seriation and conservation of number, were selected for study. Forty preschool subjects were randomly assigned to one of four treatment conditions in which the televised instructional display varied in regard to the skill depicted, and the provision of informative feedback for active responding. The first group viewed four tapes that modeled seriation behavior and received instructions to covertly rehearse the depicted behaviors. The second group viewed the same four tapes but rehearsed the behaviors overtly. The third group similarly viewed the seriation instruction and responded overtly, but in

addition they received feedback for those responses. The fourth group, which served as a control condition, viewed video tapes that modeled conservation of number.

It was found that modeling plus overt rehearsal and modeling plus overt rehearsal and feedback were both effective in facilitating the acquisition of seriation behavior. Modeling procedures alone were not effective in facilitating either seriation or conservation of number, and transfer effects between skills did not result. The research findings were discussed in relation to predictions from social learning theory and Piagetian cognitive-developmental theory.

CHAPTER 1

INTRODUCTION AND REVIEW OF THE LITERATURE

It is becoming increasingly clear that the television medium is an important and influential agent of socialization in our society. Children in the course of their development spend a great many hours viewing television programming that relates to their social, affective, and cognitive development. While the importance of television is accepted, the specifics of that contribution to children's behavior and development remains ambiguous despite considerable research attention.

Television's influence on affective and social development has attracted the attention of numerous investigators, and has been summarized in a number of sources (Comstock and Lindsey 1975; Friedrich and Stein 1975; Henderson, Zimmerman, Swanson, and Bergan 1974; Liebert, Neale, and Davidson 1973; Stein and Friedrich 1971). In addition, its effect on cognitive development has also attracted attention (Bogatz and Ball 1971). At least one television research project has undertaken the programmatic examination of television instructional principles in facilitating the acquisition of complex conceptual skills, including Piagetian concrete operational behaviors, in preschool

children (Henderson and Swanson 1975; Henderson, Swanson, and Zimmerman 1975; Henderson, Zimmerman, Swanson, and Bergan 1974; Swanson and Henderson 1976a, 1976b). However, in these studies, the independent variable of the television instructional content is a complex, multi-component, molar unit, and systematic examination of specific program variables that comprise that molar unit has not yet been undertaken.

One Piagetian behavior that has been successfully taught to preschool children via television programming is the concept of seriation (Henderson, Swanson, and Zimmerman 1975; Swanson and Henderson 1976a). Remarkable training results both of a statistical and practical magnitude were attained with this skill. However, the particular programming approach employed was a composite one that included linear sequencing, modeling, and active participation on the part of the subject. It is not possible to determine from these studies which specific programming provisions included in the molar instructional display contributed to the observed behavioral change. It does appear that seriation is a conceptual skill that lends itself to visual instruction and which may be induced through television instruction even in very young children. However, the isolation of individual instructional principles that caused that change still requires closer examination.

Theoretical Rationale

The rationale for this research has theoretical as well as practical implications for child development and televised educational programming. There are basically two areas of theoretical concern: (1) the systematic isolation of particularly critical variables included in a video model display that facilitate concept acquisition and inducement of concrete operational behavior, and (2) the determination of training implications for concrete operational behaviors as a reflection of developmental order or sequence.

According to Bandura's (1969, 1971) analysis of behavioral acquisition in an information processing model, there are four sets of processes which account for the learning and the performance of a novel behavior. The first two sets or processes (i.e., attentional and retentional processes) 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 will be overtly performed. The variables that are considered relevant to the acquisition phase of learning include those that affect the manner in which the observer will attend to a model display, code that display in some informative fashion, and be able to recall that constructed code at a later time to guide performance. However, to acquire a

behavior, the observer need not perform the behavior or respond in an active fashion, rather it is sufficient that he observe another person performing.

In terms of the acquisition of cognitive behavior in a social learning paradigm (Zimmerman and Rosenthal 1974b), the observer views a model performing according to a particular rule across instances or exemplars of that rule. From watching performance across a series of instances, the observer is able to abstract and code the relevant rule and use that code to guide subsequent behavior. In this theoretical analysis, it is not necessary for the observer to engage actively in the task in any way, nor is it necessary for the observer to receive any direct feedback. Observation and abstraction from the performance of another person is a sufficient condition to induce concept acquisition. One could predict from this theoretical perspective that modeling alone is adequate to induce a complex concept like seriation without the necessity of providing an opportunity for active responding or direct feedback.

On the other hand from a Piagetian perspective of the acquisition of concrete operational behaviors, observation alone would not be viewed as a sufficient condition to induce the concept of seriation. In this view the child must engage in manipulation to discover for himself the object relationships, the child must take an active part in the learning rather than being a passive receiver of information. Proponents of this

theoretical position do not predict that modeling alone would provide the optimal condition to induce concrete operational behavior in a preoperational child.

Both perspectives take into account imaginal coding as a component of cognitive behavior, but social learning proposes that the relevant code can result from the observation process, whereas the Piagetian position posits that imitative motor activity facilitates imagery.

It is probably impossible to make a direct, objective comparison of these two theoretical perspectives in terms of the processes that each propose to explain complex cognitive behavior. Both positions hypothesize covert, unobservable, internal behaviors as part of an explanation for cognitive development. It is virtually impossible to conceive of an experimental situation that could unequivocally support or refute these process propositions. However, it should be possible to compare components of conditions that result in optimal learning and evaluate those differential treatment results in terms of the theoretical predictions.

Extrapolating from the social learning position, if observation alone is sufficient to induce the acquisition of a complex rule, including concrete operational behavior, then modeling alone would produce optimal learning not to be exceeded by a condition that provides both modeling and imitative overt activity. However, to the extent that inclusion of active

responding and object manipulation enhances concept acquisition and results in additive gain then one must question the efficacy of an observation-process-only explanation for the facilitation of this important kind of conceptual development. One relevant theoretical question that requires attention, then, is the differential efficacy of providing modeling as compared to modeling plus active participation in inducing the acquisition of concrete operational behavior.

To further examine the variable of activity, one must separate the information function of activity, i.e., feedback for responding, from activity per se, because in a Piagetian analysis it is the activity and not feedback or reinforcement from others that is the important component.

Another theoretical issue is the importance and the position of seriation in the sequence of cognitive development. According to some researchers, seriation is an ordination problem and developmentally precedes cardination-type behaviors such as conservation of number (Brainerd 1973b, 1973d, 1973e). According to Brainerd (1973c, p. 366): "If we have two concrete-operational concepts A and B such that A invariably precedes B during the course of normal cognitive growth, A probably will prove easier to train than B in subjects who possess neither concept." Therefore, if seriation is the earliest of this set of behaviors to appear developmentally, it should prove easier to

train than a later appearing concrete operational behavior such as conservation of number.

One could also hypothesize that training in only one of those skills should facilitate transfer to the other, if in fact both skills represent the same developmental process as proposed in a Piagetian analysis. However, if the skills represent unrelated concepts, as would be predicted from a learning theory position, transfer would not be expected unless incorporated into the specific training procedures.

In summary the theoretical issues addressed in this study include:

1. An examination of the variable of subject activity in inducing concrete operational behavior.
2. An examination of the role of feedback when activity is involved in concept acquisition.
3. An examination of the differential training ease of seriation as compared to a later appearing concrete operational behavior, i.e., conservation of number.
4. The examination of possible transfer effects to the untrained but closely related alternative concrete operational behavior.

Practical Rationale

From a practical perspective the isolation of particular programming variables that are sufficiently efficacious to produce mastery learning has important implications for program and

instructional development. Television programming is an expensive proposition, particularly if undertaken at the local level; and local production probably results in the most flexible programming articulated to specific regional objectives. However, to undertake such programming one must have information as to which specific programming variables are essential to promote learning, which ones are irrelevant to acquisition, and how those variables interact in facilitating learning with regard to particular skills and with regard to particular groups of children. Such information cannot be acquired simply by inspection of products, but rather requires systematic research examination both in controlled and naturalistic settings to isolate the critical variables.

One characteristic of television instruction that has been subject to question is the presumed passive role of the viewer in the learning experience. However, television need not be an exclusively passive medium since provisions for viewer activity and involvement can be incorporated into the programming (Henderson and Swanson 1975). It is not clear, however, what the specific role of activity is and how much adult mediation and guidance must be supplemented to glean the most from the televised instructional display. Hence whether or not to provide for an activity dimension becomes an important programming variable which to date has not been specifically examined.

Therefore, a practical goal of this study was to compare instruction alone to instruction plus viewer activity to see if in fact differential treatment effects result with respect to induction of seriation. The findings should then hold implications for program design in this and similar conceptual behaviors.

Review of the Literature

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 the effects of televised violence on aggressive behavior in children (Barker and Ball 1969; Friedrich and Stein 1974, 1975; Greenberg, Erickson, and Valhos 1972; Surgeon General's Scientific Advisory Committee on Television and Social Behavior 1972). A number of laboratory investigations (vide Bandura, Ross, and Ross 1963; Kuhn, Madsen, and Becker 1967; Liebert and Baron 1972) have demonstrated that viewing filmed aggressive behavior increases the likelihood that the observer will carry out similar acts when given the opportunity. Supporting research under more naturalistic conditions (e.g., Chafee and McLeod 1971; Friedrich and Stein 1974), has tended to confirm these findings and to support the contention that the influence of viewing aggressive models is not confined to the brief experimental interludes of the psychological laboratory.

As well as investigating the effects of television on anti-social behavior, researchers have also become concerned with effects on pro-social affective behavior (Atkin and Greenberg 1976; Comstock and Lindsey 1975). Some children's television programs have been found to positively influence pro-social behavior (Stein and Friedrich 1971); and recent laboratory research has indicated that pro-social behaviors such as sharing can be significantly improved through exposure to specially prepared, brief, televised models (Liebert, Sprafkin, and Poulos 1975).

The potential of the medium exerting effects on some aspects of intellectual development has also been impressive. The generally favorable outcomes of the summative evaluation of "Sesame Street" (Bogatz and Ball 1971) and the results of a large number of other studies of instructional television (vide Chu and Schramm 1967; Leifer, Gordon, and Graves 1973) indicate that television is an effective medium for the direct teaching of at least some intellectual competencies. It has been demonstrated that programming of a "Sesame Street" variety can produce such outcomes as rote counting, identification and labeling of letters, simple discriminations of similarities and differences, and the use of some simple relational words; but this type of programming has evidenced considerably less success in facilitating more complex conceptual behaviors with disadvantaged preschool children (Bogatz and Ball 1971; Henderson and Swanson 1975).

One major research investigation has attained considerable success in teaching complex conceptual behaviors to preschool children with television including the operational behaviors of conservation and seriation (Henderson and Swanson 1975; Henderson, Swanson, and Zimmerman 1975; Henderson, Zimmerman, Swanson, and Bergan 1974; Swanson and Henderson 1976a, 1976b). The particular programming approach that proved successful in this series of investigations included the use of performance models who demonstrated the skill in question across instances of the concept when those instances increased gradually in stimulus complexity. Prerequisite behaviors to the target skill were hierarchically ordered and sequentially modeled. However, all successful instruction included the provision for active participation by the child viewers and virtually all children did engage in task-appropriate active responding (Henderson and Swanson 1975).

Seriation was one target skill that was successfully taught with this multi-component approach (Henderson and Swanson 1975; Henderson, Swanson, and Zimmerman 1975; Swanson and Henderson 1976a) but the effects of modeling and active participation were not separated in the complex instructional treatment employed in this research. It has not yet been determined if in fact observation alone is a sufficient condition to induce acquisition in this kind of complex conceptual behavior with very young children. It is clear that additional non-video activity

and feedback from a live model did not significantly enhance the effects of video-instruction alone (Henderson and Swanson 1975; Swanson and Henderson 1976a), but the specific contribution played by the television-provided response opportunity cannot be determined.

Therefore, while positive results of television instruction are indicated from the accumulation of research in the area, the specific effects of individual programming variables remains to be clearly delineated.

Empirical Evidence for the Efficacy of Modeling Procedures

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. It does seem clear that both implicitly as well as explicitly, modeling is involved in a visual medium such as television.

Initially investigations of the effects of vicarious processes focused on the development of a variety of affective, motor and self-regulatory behaviors (Bandura, Blanchard, and

Ritter 1968; Bandura and Kupers 1964; Bandura and Menlove 1968; Marshall and Hahn 1967), but more recent studies have shown that cognitive behaviors such as language responses can be transmitted and modified through observation of a model (Zimmerman and Rosenthal 1974b). There is evidence that children's verb tense and use of prepositions can be influenced through exposure to a model (Bandura and Harris 1966; Liebert, Odom, Hill, and Huff 1969; Odom, Liebert, and Hill 1968) and that children's sentence kernel structure as well can be modified through vicarious processes (Carroll, Rosenthal, and Brysch 1972; Rosenthal and 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's and Rosenthal's (1974b) review of research on children's learning of rule governed behaviors through observation as well as more recent research in this area have shown that modeling procedures have been effective with children on a wide variety of conceptual responses such as abstract classes for question-asking (Rosenthal and Zimmerman 1972b; Rosenthal, Zimmerman, and Durning 1970), question-asking skills (Henderson and Garcia 1973; Henderson and Swanson 1975; Zimmerman and Pike 1972), Piagetian conservation responses (Rosenthal and Zimmerman

1972a; Zimmerman and Rosenthal 1974a), geometric classification tasks (Denny and Acito 1974) and even creative responses (Zimmerman and Dialessi 1973). Evidence of significant retention of the vicariously learned response was found over as long a delay as a seven day period (Henderson and Swanson 1975; Swanson and Henderson 1976a, 1976b; Zimmerman and Bell 1972; Zimmerman and Rosenthal 1974a) and in all of these studies both acquisition and generalization were found.

The child observer in these studies was required to induce a particular property or rule from a highly diverse or complex modeling sequence and to generalize this property to a novel conceptual task. 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 and Rosenthal 1974b).

Furthermore, modeling has proved to be an efficacious procedure in field research as well as in controlled laboratory settings (Henderson and Garcia 1973; Henderson and Swanson 1974). The effects of vicarious instruction have been demonstrated so many times in both applied and laboratory learning experiments that it appeared to be a viable basis for developing an instructional format for the research undertaken here.

Empirical Evidence on Seriation

The ability to seriate was chosen for examination in this study because it is recognized as an important developmental skill that has attracted a great deal of attention by Piagetian researchers, because it is considered a difficult task for young children to accomplish, and because it has proved amenable to complex television instruction. As Siegel (1972, p. 135) pointed 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." Furthermore seriation has attracted research interest in terms of its sequential place in the development of concrete operational thought (Brainerd 1973d; Murray and Youniss 1968) 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). Since it is viewed as an important logical concept, it provides a relevant target skill on which to examine systematically specific facilitative training variables.

Seriation is defined as "an additive arrangement of asymmetrical transitive relations (Moore and 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 trial 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 and Piaget 1964). Similarly, Moore and Gallagher (1973) emphasized the necessity for a systematic strategy for comparison in order to demonstrate the concept of seriation.

Piaget broke the acquisition of the concept of seriation into two stages (Elkind 1964). The first involves the ability to make a simple size discrimination, the second involves the building of a "stairway" from a disarrayed set. This second stage has been further analyzed into three steps (Inhelder and Piaget 1964):

1. In the first step, the child puts the object 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 and 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 (Siegel 1972).

Other researchers (Gollin, Moody, and Schadler 1974; Moore and Gallagher 1973; Siegel 1972) have attempted to examine seriation concepts in less complex ways than through an ordering task. Siegel (1972) 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 positions 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; they found that identification could be learned by this age group. Again the ability to systematically order an array was not directly examined. Moore and Gallagher (1973) used a task which involved finding a preidentified 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 (1972) provided simplified verbal instruction and tangibly reinforced correct responses across trials. Gollin et al. (1974) trained children by using a reference point supplied either by an experimenter or by the subject, coupled with informative feedback. 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.

There are a few seriation training studies that have utilized social learning principles to successfully train children in a complete and systematic ordering task (Henderson and Swanson 1975; Henderson, Swanson, and Zimmerman 1975; Swanson and Henderson 1976a). A systematic strategy for imposing order was

modeled repetitively across instances of the task via television models, and children actively matched their responses to those they observed. This complex training procedure was very effective in facilitating the acquisition of seriation.

The empirical evidence suggests that seriation is trainable even in young children. However, research has not yet determined which training procedure is the most effective, nor what specific components of a training procedure produce successful results.

Empirical Evidence on Conservation of Number

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. There are several types of conservation problems that have been examined (number, mass, weight, length), but the literature suggests that of these conservation of number is the earliest of the operations to appear developmentally (Brainerd and Brainerd 1972; Reese and Lipsitt 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 equivalence of numerosity despite confounding length and number cues.

Pufall and associates (Pufall and Shaw 1972; Pufall, Shaw, and Syrdal-Lasky 1973) have done an extensive study of conservation of number with seven object configurations based on four conservation rules that systematically vary spatial properties in relation to number judgments. Unlike most conservation studies, though, transformations of shape were not made in the child's view. In this research the youngest children initially vacillated between length and density; the middle-age children used length exclusively, while only the oldest managed both dimensions to reach correct conclusions.

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 that 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.

The problem of whether non-conserving 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 emanating from other theoretical traditions such as task analysis models (e.g., Kingsley and Hall 1967), and perceptual discrimination models (e.g., Rosenthal and Zimmerman 1972a; Siegler and Liebert 1972), have reported some success in teaching children to conserve on a variety of stimulus dimensions. All of these studies have treated conservation responses as a form of rule learning and have utilized a variety of methods to constrain the child's attention to the relevant quantity dimension and to disregard the irrelevant stimulus configuration dimension. Much of this literature on the training of conservation in young children has been reviewed elsewhere (Brainerd 1973c; Henderson, Zimmerman, Swanson, and Bergan 1974; Zimmerman and Rosenthal 1974b).

Halford and Fullerton (1970) used a discrimination procedure 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 and 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.

Figurelli and Keller (1972) have used verbal rule instruction techniques in training conservation with children from a lower-socioeconomic 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 Figurelli and Keller (1972, p. 297) pointed 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." 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) and Zimmerman and Rosenthal (1974a)

used modeling procedures in teaching preoperational children to conserve across a variety of tasks. 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 10 day delay (Henderson, Zimmerman, Swanson, and Bergan 1974). The use of modeling sequences with television instruction has also been an effective procedure for training conservation with very young children (Henderson and Swanson 1975; Henderson, Zimmerman, Swanson, and Bergan 1974; Swanson and Henderson 1976b). But these modeling studies were confounded with an activity component because children engaged in an immediate matching response.

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 and Swanson 1975; Henderson, Zimmerman, Swanson, and Bergan 1974,

Swanson and Henderson 1976b) 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 word "same" and in fact tend to respond to arrays with regard to the most recent stimulus word presented to them. In another study (LaPointe and 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, Shantz, 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 McGuire (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. 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) pointed 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 heavy dependence on verbal facility should be eliminated.

Empirical Evidence on the Role of Activity and Feedback

The additive role of activity in conceptual learning is not entirely clear from research on concrete operational target behaviors. Training studies on seriation behavior invariably contain an active response component of some kind on the part of the subject (vide Gollin et al. 1974; Siegel 1972). The one training study that employed modeling as a treatment variable also contained an activity dimension (Henderson, Swanson, and

Zimmerman 1975). Hence, the specific causal role of activity in relation to the acquisition of seriation is not at all clear.

Evidence from modeling studies on other conceptual behaviors does not help a great deal to clarify the issue. McLaughlin and Brinley (1973) used both modeling and practice conditions to train children on a multiple classification task. While modeling was effective in altering performance on a duplicate task, the investigators were unable to detect significant differences between the effects of practice and the effects of a model. The authors suggested that it is older children who are most likely to benefit from modeling in conceptual problems. Furthermore, there was no support that modeling was an effective procedure in facilitating abstraction to a novel but related task for the youngest group of children (second graders). According to a social learning analysis of rule acquisition (Liebert and Swensen 1971a, 1971b) the observer does not simply match a performance in learning rules, but rather abstracts the rules which can then guide behavior with novel stimuli but on a same rule governed task. This generalization to a new task from a rule abstraction process can not be unequivocally supported by the McLaughlin and Brinley (1973) experiment though it does lend some support to that possibility.

In many other modeling studies that have dealt with conceptual rules other than those related to language and syntax, the specifics of the paradigm complicate the issue as well.

Typically the child observes a model performing a rule-governed behavior and then immediately makes an overt response on exactly the same task as used in training as either an immediate posttest or as part of the treatment condition. This active responding occurs prior to an examination of rule-governed behavior on any kind of generalization or transfer task (vide Zimmerman and Bell 1972; Zimmerman and Rosenthal 1974a). It is difficult to determine, therefore, whether it was the modeling display or the overt matching response that facilitated rule abstraction. This specific contribution of modeling and overt responding cannot be unequivocally separated despite cumulative support for the efficacy of modeling (Zimmerman and Rosenthal 1974b).

The issue is further complicated by the fact that theoretically seriation is not viewed in the same manner as other kinds of conceptual behavior. It is a concrete operational behavior that is a hallmark of developmental change from the pre-operational to concrete operational stage of logical thinking in children (Inhelder and Piaget 1964). It may be an overgeneralization to assume that processes successful in inducing other kinds of rules in children (e.g., language rules) are the same processes that induce concrete operational behavior in the pre-operational child. Since Piaget maintained (Flavell 1963) that the child's activity is critical in that particular change it becomes important to separate observationally induced behavioral change from change that includes an activity dimension. One

modeling study on a concrete operational behavior, i.e., conservation, included active subject responding on the same stimuli as part of the treatment process even though posttesting included different stimuli (Zimmerman and Rosenthal 1974a).

Imagery is a related issue when considering subject activity. Both social learning theory and Piagetian theory propose imaginal coding as having an influence in guiding behavior. Some sort of coding is the supposed process by which an observer retains information included in a model display to be used for later response production (Bandura 1969). In Piaget's theory imagery coding is also important and is the result of internalized overt motor activity (Piaget and Inhelder 1971). Furthermore it is proposed that images are first internalized through imitative motor activity (Brainerd and Heuvel 1974). In fact, Brainerd and Heuvel (1974, p. 99) referred to the successful training procedure in inducing concrete operational concepts of conservation, transitivity, and class inclusion as "imitative motor training techniques" or "operational practice." These investigators found that imitative motor activity was more effective than nonmotoric imitation and discrimination training in training children to recognize and produce geometric shapes, and furthermore that the capacity to represent geometric images was positively correlated with the ability to perform concrete operational behaviors.

This theoretical issue indicates that subject activity, then, is an important variable to consider in examining movement from the preoperational to the concrete operational stage of development. If so, any training or concept induction approach utilizing modeling principles must certainly control for the influence of overt activity on concept acquisition if they wish to attribute change to observation alone. It appears that this has not been clearly separated and examined in such training studies.

If one examines the role of activity in concept acquisition, one must further isolate the influence of feedback as a result of the activity from activity itself. Both video modeling studies of seriation have included the activity and feedback component. In the first, the television model and the experimenter provided positive social reinforcement for the child's active response which was invariably the correct one (Henderson, Swanson, and Zimmerman 1975). In the second one, reinforcing feedback was only delivered by the television model (Henderson and Swanson 1975), but activity itself was not separated from the informative function provided by the feedback variable.

In a modeling study of conservation behavior (Zimmerman and Rosenthal 1974a), the modeling condition was compared with modeling plus corrective feedback and corrective feedback alone. Both groups that were exposed to a correction component exceeded the model only condition with the combined treatment group performing at the highest level. Bandura (1969, 1971) indicated

that feedback is not a necessary condition for learning to occur, but in addition to isolating the activity dimension from the modeling influence, it seems advisable to separate the feedback variable with respect to activity as well.

Statement of the Problem

This body of empirical evidence has bearing on this research in a variety of ways, and suggests a number of research questions to be addressed. While a modeling paradigm as a conceptual learning facilitator is well substantiated empirically and has proved amenable to adaptation for television instruction, it still remains necessary to separate a pure modeling display from the role of activity. The first question addressed in this study was to determine whether or not the separation of observational learning from imitative motor activity results in differential efficacy for inducing rule abstraction.

A second question addressed concerned whether there is a supplemental effect of feedback when activity is included in inducing concept acquisition. It is still necessary to separate the role of activity itself from the informative properties of feedback for the activity.

The third question considered concerned the nature of the relationship between seriation and other concrete operational behaviors, and specifically whether or not vertical transfer occurs to those other behaviors following training in seriation only. Transfer to the next behavior in the sequence, i.e., transitivity,

is examined as well as transfer to the more complex concept of number conservation. In addition, transfer to seriation and transitivity following training in conservation of number is also examined. This research question, therefore, is directed at illuminating the specificity of training effects with regard to this class of concrete operational behaviors.

A fourth and final research question concerned the relative training ease of seriation and conservation when both utilize the same training procedures, i.e., modeling. This involves the comparison of mastery attainment of the conceptual behaviors following a duplicate amount of training through observational learning alone.

Objectives of the Research

1. To determine the differential effectiveness of modeling procedures, modeling plus activity and modeling plus activity and feedback in facilitating acquisition of seriation behavior.
2. To determine the effectiveness of modeling procedures in facilitating the acquisition of conservation of number.
3. To determine transfer effects of training in seriation to transitivity and conservation of number.
4. To determine transfer effects of training in conservation of number to seriation and transitivity.

5. To determine the differential training ease of seriation and conservation when both are based on the same training procedures .

CHAPTER 2

METHOD

Subjects

The subjects who participated in this research study were preschool children ($n = 40$) who attended a private day care center servicing a predominately Anglo middle-class population in Tucson, Arizona. The subject group consisted of 20 girls and 20 boys ranging in age from 3 years, 0 months to 4 years, 2 months with a mean age of 3 years, 6 months. Subjects were randomly assigned to one of four treatment groups, three of which received televised instruction in the concept of seriation while the fourth received similar televised instruction depicting the concept of conservation of number.

Procedure

Materials and Scoring

The televised modeling instruction for seriation consisted of four 10-minute tapes that depicted increasingly complex instances of seriating behavior. These tapes were slight alterations of training tapes used in earlier experiments (Henderson and Swanson 1975). Each tape consisted of a series of

related segments demonstrating seriation across varied models and stimuli. In each segment a model performed some aspect of seriation and received reinforcement for correct responding. Every segment was parallel in this respect, and parallel in that the relevant rule was held constant while all non-relevant dimensions were systematically varied. A systematic strategy of ordering by progressively selecting the longest element from a disarrayed set, removing it, adding the next longest and so on, until an ordered array was completed, was consistently modeled on every tape segment. Twice per tape, the video image was frozen for 30 seconds so that children in the activity treatment groups could match the modeled responses.

The televised conservation modeling also consisted of four 10-minute tapes produced in the same manner as those for seriation. Here the relevant strategy consistently modeled was the application of a counting strategy to decide numerical equivalence or non-equivalence before and after perceptual transformation. Again the irrelevant dimensions were systematically varied while the relevant rule was held constant across segments. Each model performed the conservation task and received feedback for that performance. The scenery, characters, backgrounds, format, and the use of interspersed music to maintain attention was the same on both seriation and conservation tapes.

For each concept, an evaluation performance task was developed to assess the behavioral objectives depicted on the video

tapes. Two items were generated for each behavioral objective so that split-half reliability could be ascertained. The instruments were refined variations of reliable tasks (r 's $> .90$) used in earlier studies on the same behaviors (Henderson and Swanson 1975).

The seriation assessment instrument consisted of 12 test items, four of which required the child to make size discriminations, and eight of which required the child to seriate a disarrayed set comprised of from four to six stimulus items. One point was given for each correct size discrimination while three points were given for a seriation performance. Size discrimination was weighted with a lower value since it was viewed as prerequisite to seriation rather than as an index of seriation behavior. In addition, since the simplest level of seriation task (i.e., ordering three linear objects) was not included between the pre-requisite skill of size discrimination and a complex seriation performance, the complex tasks were weighted more heavily. In order to systematically order a four object array, three size discrimination judgments are required, hence the assignment of a three point value for assessment items requiring at least that complex a task. To be considered an acceptable seriation performance, the subject not only had to order the array, but must have ordered it in a systematic manner rather than through a trial and error approach. Only performance of the conceptual behavior was considered; verbal justification was

not included to avoid a confounding of performance with language facility. Stimulus objects utilized in assessment consisted of two and three dimensional objects other than the specific ones included in the video display.

The conservation assessment instrument consisted of eight items. Two items required the child to match a stimulus array in terms of number, four required equivalence conservation, and two assessed non-equivalence. The matching items received one point while the conservation items received two points. Again the differential weighting reflected the view that matching constituted a pre-requisite skill to actual conservation which is a more difficult task. Performance alone without verbal justification was the relevant criteria for success.

The transitivity task utilized to assess transfer of training effects consisted of only three performance items consisting of three two-dimensional linear objects. For each item, the three linear objects were graded in height in one-eighth inch increments. Two of the objects were permanently attached to a board, and the child was directed to place the third in its appropriate position according to order of size. The height differences and spacing of the individual elements was such that height differences were not readily perceptible from simple visual inspection but rather required two separate measurement comparisons and a subsequent inference regarding the relationship among all three. For example, if the fixed items were A and C, and the

free item (B) was intermediately sized, the child had to determine that $A > B$ and that $B > C$ and then infer the appropriate position in which to place B such that it would be simultaneously smaller than one object and larger than the other. Of the three items, on the first $A < B < C$ and B was the free item; on the second $A > B > C$ and B was the free item; and on the third $A > B > C$ and C was the free item. A child had to make the correct placement on all three to be classified as performing a transitivity operation. This task required that the child know a general rule for order of size but prohibited the use of the ordering strategy modeled on the seriation tapes.

Treatment Variations

Following random assignment to treatment group, all children were pretested individually on both the seriation and conservation performance assessment instruments. Each child was then exposed, on an individual basis, to the four training tapes on consecutive days. Delayed posttesting was then conducted 3-4 days following the final tape viewing in the same manner as the pretesting. Retention testing was conducted 10-14 days after posttesting. At that time the transitivity instrument was administered to all children.

Modeling and covert rehearsal. The children ($n = 10$) in the seriation modeling and covert rehearsal group viewed all four of the seriation tapes. However, twice per tape, the video was

frozen for 30 seconds to allow for covert rehearsal. This involved the experimenter instructing the child to close his eyes and "picture yourself doing what [TV character] just did." To insure that each child understood this direction, one practice session was conducted prior to any tape exposure. Each child in this condition participated in eight such covert rehearsals during the course of the experiment. No feedback (for this rehearsal task) was provided either from the television characters or from the experimenter.

Modeling plus overt rehearsal. Subjects in this condition ($n = 10$) viewed the same seriation tapes as those in the covert rehearsal condition. When the tapes were frozen, however, the subject was instructed to "do what the [TV character] just did" and was provided with duplicate stimulus items as those utilized by the video model. Again, feedback was not provided by the television or the experimenter for that overt response. Eight opportunities for a matching active response were provided during the course of the experiment.

Modeling plus overt rehearsal and feedback. Subjects in this condition ($n = 10$) received precisely the same instructions and experience as those in the modeling plus overt rehearsal group with the exception that the experimenter did provide brief informative feedback concerning the correctness of the matching response.

Conservation modeling. Children in the last condition (n = 10) viewed the four conservation training tapes. This was strictly an observational learning approach to concept induction and neither opportunity for matching responses nor feedback was included. Conservation training served as a placebo instruction with which to compare seriation training, since the conservation treatment was of equal duration but depicted a concept other than seriation.

CHAPTER 3

RESULTS

The data for the seriation experiment were analyzed using a 4 (treatment groups) x 3 (trials) repeated measures analysis of variance for equal n's. Descriptive statistics for seriation are presented in Table 1; a summary of the analysis of variance is presented in Table 2.

Significant effects were found for groups ($F = 6.12$, $df\ 3, 36$, $p < .005$), for trials ($F = 37.96$, $df\ 2, 72$, $p < .001$), and for the groups x trials interaction ($F = 3.32$, $df\ 6, 72$, $p < .01$). The trials effect was still significant ($p < .001$) when Box's correction was employed (Myers 1972).

Newman-Keuls post-hoc comparisons were utilized to examine more specific effects (Myers 1972). Pairwise comparisons indicated no significant differences among the groups on pretest, no significant gain for the control group or the modeling plus covert rehearsal group, and no significant difference between the control and modeling plus covert rehearsal condition. The modeling plus overt rehearsal condition did lead to significant pre to post and pre to retention trials ($p < .01$), and a significant advantage over the controls at both post ($p < .05$) and retention

Table 1. Seriation: Means and Standard Deviations for Pretest, Posttest, and Retention Trials

Group	Pre		Post		Retention	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Modeling and Covert Rehearsal	2.8	1.4	9.0	4.7	9.5	6.8
Modeling and Overt Rehearsal	4.3	1.8	13.6	8.5	15.2	8.9
Modeling + Overt Rehearsal and Feedback	3.7	.5	17.3	8.7	17.6	11.2
Control (Conservation-Training)	3.3	.8	5.7	2.8	5.9	2.5

Table 2. Seriation: Summary of Analysis of Variance

Source	df	MS	F	P
Between Groups				
Treatment	3	389.63	6.12	< .005
Error	36	63.69		
Within Groups				
Trials	2	900.75	37.96	< .001
Groups x Trials	6	78.78	3.32	< .01
Error	72	23.73		

($p < .01$) was found. The difference between modeling plus overt rehearsal and modeling plus covert rehearsal approached a statistically significant advantage for the former at retention ($p < .10$). The modeling plus overt rehearsal and feedback group also produced a statistically significant gain from pre to post and pre to retention trials ($p < .01$) surpassing both the control ($p < .01$) and the modeling plus covert rehearsal group ($p < .05$) at both post and retention. The modeling plus overt rehearsal condition and the modeling plus overt rehearsal and feedback did not differ significantly from one another, and neither demonstrated any significant change from post to retention trials. These results are depicted in Figure 1.

The data on the conservation dependent measure was similarly analyzed using a 4 (treatment group) $\times$ 3 (trials) repeated measures analysis of variance for equal n's. Descriptive statistics for conservation are presented in Table 3; a summary of the analysis of variance is presented in Table 4.

The group effect was not significant ($F = 1.59$, df 3, 36); the trials effect was marginally significant ($F = 3.72$, df 2, 72, $p < .05$) and the group $\times$ trials interaction was not significant ($F = 2.16$, df 6, 72). The trials effect was not statistically significant when the more conservative Box's correction (Myers 1972) was employed. Newman-Keuls post-hoc comparisons revealed no differences among any of the groups on any of the trials.

It was not necessary to employ statistical procedures to examine transfer effects between conservation and seriation

Figure 1. Seriation Means

Table 3. Conservation: Means and Standard Deviations for Pretest, Posttest, and Retention Trials

Group	Pre		Post		Retention	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Seriation Training (Model + Covert)	1.7	2.0	1.4	.8	2.6	1.2
Seriation Training (Model + Overt)	1.7	1.6	2.3	2.4	2.3	2.8
Seriation Training (Model + Overt + Feedback)	2.2	2.1	2.4	1.5	2.0	.8
Conservation Training	1.9	2.0	4.8	4.4	4.5	4.9

Table 4. Conservation: Summary of Analysis Variance

Source	df	MS	F	P
Between Groups				
Treatment	3	21.3	1.59	NS
Error	36			
Within Groups				
Trials	2	11.28	3.72	<.05
Groups x Trials	6	6.55	2.16	NS
Error	72			

because not a single child gained on the untrained target skill in any of the groups. Similarly it was not necessary to further examine transfer to the transitivity task, since no one successfully completed this task either.

Comparison of the proportion of subjects attaining mastery in the modeling only treatments for both conservation and seriation was unnecessary since only one child in either group met the predetermined level for mastery (80% of a total score).

The assessment of reliability on the dependent measures of seriation and conservation presented some difficulties because variability on many of the trials, including all pretest trials, was very low and the range of scores was very restricted. Therefore, computing a Pearson product-moment correlation on separate trial data with such limited variability and restricted range would not have accurately reflected the consistency in the data. Therefore, test-retest reliability was assessed by correlating post and retention scores. Test-retest reliability for the seriation instrument was measured at .83; for conservation, the test-retest reliability was measured at .77.

CHAPTER 4

DISCUSSION

The results of the study undertaken here are clear and unambiguous with reference to the differential effectiveness of the training procedures with these skills and with this particular population of preschool children. While the precise theoretical ramifications are not as unequivocal, these results do raise a number of important questions and provide implications for future study that could serve to clarify some of the remaining ambiguity centered around this issue.

In regard to the conservation training, observation of conserving models was not effective as a procedure to facilitate the acquisition of conservation of number in children this young. This is not particularly surprising, since even studies that have employed more powerful training procedures (vide Figurelli and Keller 1972; Halford and Fullerton 1970; Roll 1970; Zimmerman and Rosenthal 1974a) have invariably utilized an older target population. In addition these results are consistent with other video based instructional studies (Swanson and Henderson 1976b) that were unsuccessful in inducing conservation in children this age even when additional directed participation was

included in the treatment approach. It is clear from the literature (Brainerd 1973c) that conservation can be trained in children of preoperational age, but apparently not with strict observational procedures with children this young.

Another objective addressed in this study was the examination of any transfer of training effects across the three target skills of seriation, conservation, and transitivity. Again the results are unequivocal in that not a single subject acquired one of the transfer skills even when mastery was attained on the trained target concept.

With respect to the transitivity task, no subject was able to produce an acceptable performance. It may have simply been much too difficult a task for this age level. Children who had received seriation training and had succeeded in a seriation performance appeared to attempt a solution to the transitivity problem through the use of a visual comparison strategy rather than through a series of separate measurement comparisons. A visual strategy was consistent with their seriation training but was not helpful with the more difficult transitivity task since length differences between the stimulus objects were not readily perceptible from visual inspection. Hence, since no one employed a measurement strategy, no one successfully completed the task.

Similarly no child trained on seriation was able to conserve; the opposite was also true. This is not particularly surprising since the two tasks are very different in terms of

perceptual characteristics, relevant rule, and problem-solving strategy. The lack of transfer noted in this study is entirely consistent with a social learning theory point of view which would not predict transfer across rules when training is targeted at the abstraction of only one of those rules. Transfer across stimuli, that is generalization, would be anticipated; but transfer to a different rule-governed performance would not be expected unless such a process had been specifically included in the training process. What is clear from the results reported here, is that training in rule-governed behavior is a very specific induction procedure no doubt requiring extensive training across concepts if wide generalization is desired.

Another issue proposed for examination in this study was the investigation of the relative task difficulty of conservation and seriation when only observational procedures are employed in training. Since observation alone was clearly not an effective procedure with either skill, and since only one subject mastered the target skill in each of these training conditions, such a comparison was not possible. From these data, the skills appear to be of equal difficulty to induce with observational training for such young children.

The results of the training in seriation, which was the major thrust of the study, are by far the most interesting and the clearest. While observation alone did not yield any significant gains, both modeling plus activity and modeling plus

activity and feedback led to impressive gains that were durable over a two week period. Both of the activity groups surpassed the controls, and while they did not differ significantly from each other, only the modeling plus activity and feedback condition displayed a significant advantage over modeling alone. It does seem evident that active motor involvement on the part of the subject played an important and perhaps critical role in assuring concept attainment.

While there is little doubt that activity proved to be crucial to concept acquisition, a specific causal process explanation for the additive effect is still not revealed. A number of possible theoretical explanations may be offered to account for the importance of this variable.

First of all, one could argue that activity is an important dimension not specifically because the learner is active in the acquisition process, but rather because actively engaging in the production of a response permits the learner to receive feedback from the environment as to the correctness of his own response. In this study, while the addition of feedback from the experimenter did not result in a significantly better performance, experimenter feedback may have been redundant in serving an informative function. Subjects did have a frozen video image with which their own responses could be compared and accuracy verified whether or not the experimenter supplied outside verification. Activity may merely have offered an opportunity for the subject

to validate his own performance. Proponents of an operant position have called attention to the role of activity and feedback in response acquisition, as well as the reinforcing effects of confirmation (Skinner 1968). Social learning theorists (Bandura 1969, 1971) have also emphasized the role of feedback and reinforcement contingencies on the performance of acquired responses. Both would no doubt predict that the reinforcing function of feedback would lead to a more proficient performance on a task such as this.

There are some problems, however, with both of these explanations regarding the role of activity in this particular study. As for an operant explanation, it seems very doubtful that the subject would have had time to both make the appropriate response and verify that performance with the video image in the brief 30 second interval provided him. Informal observation of children during the treatment phase indicated that the allowable response time interval was barely sufficient to respond, and frequently the subjects did not complete the full performance before the stimuli were removed. Hence, only children in the activity plus feedback condition consistently had a verification of their response and they did not demonstrate a significant increment over those who were active but did not receive such feedback. Knowledge of results, therefore, does not appear to be a particularly viable explanation for the results indicated here.

Similarly, the social learning explanation with regard to feedback is weak. Vicarious reinforcement and feedback was provided for every modeled response on the video tape; in fact approximately 40 incidences of vicarious reinforcement were included in the instructional display. Since vicarious reinforcement has been demonstrated to be as effective as direct reinforcement in many modeling studies (Flanders 1968), one would doubt that the opportunity for at most eight additional confirmations would affect performance to any degree. The modeling-only subjects also viewed the vicarious reinforcement incidents and yet their performance was not significantly affected. It therefore is doubtful that the differences among the three treatment groups can be attributed to the performance process, but would rather seem to reside in the actual acquisition process.

There are two explanations for the importance of activity that emphasized the skill acquisition process. One explanation comes from a structuralist orientation, the other from social learning theory, and both are equally viable process explanations for these results.

In a Piagetian analysis, activity on the part of a child is a critical aspect of learning or developing cognitive processes (Flavell 1963). One possible reason is that the subject's motor involvement facilitates imagery; success at imagery tasks has been found to correlate with performance of concrete

operational tasks such as seriation (Brainerd and Heuvel 1974). Active matched responding then serves to generate an imaginal code conducive to appropriate responding on the conceptual task. It is the process of acting that is important in this view rather than the product of the action. This explanation is consistent with the results observed here in that activity did result in a superior performance not exceeded by the addition of feedback for the products of activity.

Social learning theory also posits the importance of imaginal coding in behavioral acquisition, but for different reasons. At least two sub-processes, attention and retention, are essential to the acquisition of a novel behavior in a social learning analysis. If a child anticipates having to make a matched response, he may very well attend much better to a modeled exemplar of that task to assist his own responding. Hence activity directions, like the ones employed in this study, may serve to direct and maintain attention to relevant aspects of a vicarious presentation. Additionally, the accomplishment of a matched response may provide a very salient visual image that could be coded and retained to guide subsequent behavior. Certainly, real stimulus objects arranged directly in front of the subject would be perceptually more powerful than a black and white video image, 10 feet away. So therefore, while both Piagetian and social learning theorists view activity as relevant to imaginal coding and subsequent concept attainment, the

structuralist perspective stresses the motor or kinetic aspects of activity, while the other offers an explanation in terms of the attentional and representation effects that occur when activity is involved and a product of that activity made available for coding.

The results of this study do not yield a clear definitive statement as to which of these sets of hypothetical processes is responsible for the demonstrated gain in performance when activity is included. They do clearly reveal that observation alone is not sufficient for concept inducement; the learner needs to be involved in the process for maximal benefit. Whether or not activity plays a lesser role with increased exposure to vicarious exemplars, or whether the advantage for activity decreases with increasing age are important questions that still remain for investigation.

From a practical orientation as well as a theoretical perspective it does seem abundantly clear that the more environmental factors that can be included in instruction designed to support concept attainment, the more powerful the induction procedure. Hence the least powerful in terms of environmental support, modeling alone, yields the lowest performance, the most powerful, coupling vicarious as well as direct influence results in the highest yield.

APPENDIX A
ASSESSMENT INSTRUMENTS

Seriation Assessment Instrument

Test Form 1

A. Initiation

WE ARE GOING TO PLAY A GAME WITH THE THINGS I HAVE HERE.
LISTEN CAREFULLY, AND YOU WILL LEARN HOW TO PLAY THE GAME.
LET'S PLAY.

B. Imposition of order

1. (Present the child with five sticks on one side of board)

Code: blue, green, red, orange, yellow

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

Answer

2. (Present the child with five stick 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.

Answer

3. (Present child with six stick array)

Code: purple, yellow, green, 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.

Answer

C. Generalization

(Remove stimulus board and use table with tape down the middle)

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

4. (Present child with five cans standing up on one 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

5. (Place four cans on table)

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

Answer

6. (Place six cans on table)

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

Answer

D. Termination

YOU PLAYED THE GAME SO WELL. NOW YOU CAN GO BACK.

Test Form 2

A. Initiation

WE ARE GOING TO PLAY A GAME WITH THE THINGS I HAVE HERE.
LISTEN CAREFULLY, AND YOU WILL LEARN HOW TO PLAY THE GAME.
LET'S PLAY.

B. Imposition of order

1. (Present the child with five poles on one side of board)

LOOK AT THESE FIVE POLES HERE (point). FIND THE LONGEST POLE
AND PUT IT OVER HERE (point to other side of board).

Answer

2. (Present child with four pole array)

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

Answer

3. (Present child with six pole array)

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

Answer ☐

C. Generalization

(Remove stimulus board and use table with tape down the middle)

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

4. (Present child with four cans standing up on one side of table)

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

Answer ☐

5. (Place six cans on table)

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

Answer

6. (Place five cans on table)

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

Answer

D. Termination

YOU PLAYED THE GAME SO WELL. YOU CAN GO BACK NOW.

Conservation Assessment Instrument

A. Matching

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

X X X

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

2. Make a row of five red chips, equidistant apart:

X X X X X

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

B. Conservation

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

X X X
O O O

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 looks like this:

X X X
OOO

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.

4. Make a row of three red chips and a row of four white chips.

X X X
O O O O

HERE IS A ROW OF RED CHIPS. HERE IS A ROW OF WHITE CHIPS. THE WHITE ROW HAS MORE (do not point). NOW WATCH. Compress white row so array looks like this:

X X X
OOOO

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.

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

X X X X X
O O O O O

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 looks like this:

X X X X X
.OOOOO

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.

6. Make a row of five red chips and a row of four white chips:

X X X X X
O O O O

HERE IS A ROW OF RED CHIPS. HERE IS A ROW OF WHITE CHIPS. THE RED ROW HAS MORE (do not point). NOW WATCH. Compress red row so array looks like this:

XXXXX
O O O O

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.

7. Make a row of six red chips and a corresponding row of six white chips:

X X X X X X
O O O O O O

HERE IS A ROW OF RED CHIPS. HERE IS A ROW OF WHITE CHIPS. BOTH ROWS HAVE THE SAME NUMBER. NOW WATCH. Compress the white row so array looks like this:

X X X X X X
O O O O O O

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.

8. Make a row of seven red chips and a corresponding row of seven white chips:

X X X X X X X
O O O O O O O

HERE IS A ROW OF RED CHIPS. HERE IS A ROW OF
WHITE CHIPS. BOTH ROWS HAVE THE SAME NUMBER.
NOW WATCH: Compress the red row so array
looks like this:

XXXXXXX
O O O O O O O

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 _____

THANK YOU. YOU PLAYED THE GAME SO WELL.

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