RAMIREZ, LOUISE McKIBBIN. Developmental Changes in Information Input Preference. (1977) Directed by: Dr. Mary Fulcher Geis. Pp. 26

Recent memory literature has demonstrated that children younger than about 6 years consistently perform more poorly with verbal material than with non-verbal (visual) material. Four-year-olds were less proficient at recognizing material presented verbally than material presented either visually or visually and verbally (Perlmutter & Meyers, 1975); three-year-olds showed poorer recall for verbal material than for pictoral material (Jones, 1973). The addition of non-verbal cues has been shown to increase retention of verbal material for young children but to have no effect on retention for 7-year-olds (Corsini, 1961). These studies support Bruner's (1964) and Piaget's (1952) theories that the child first develops the ability to represent information internally by visual representation and later the ability to represent information by verbal representation. This shift in mode of information representation is hypothesized to occur at about the age of 6 years. The present study was a further investigation of the proposed shift in mode of internal representation and was designed to assess the information input preference of 3-, 5-, and 8-year-olds.

It was hypothesized that a shift in preferred mode of information input would occur concurrent with the shift in internal representation, i.e., it was hypothesized that young children who supposedly represent the world internally by visual means would attend to visual information, whereas children over the age of 6 would attend to verbal information.

To test this hypothesis, 3-, 5-, and 8-year-olds were presented the task of performing simple motor behaviors such as clapping their hands. The task was complicated by the experimenter simultaneously giving

conflicting instructions verbally and visually. For example, the experimenter performed the action of touching her toes while telling the child to clap his or her hands. An observer recorded the child's behavior and reaction time.

It was found that, on the whole, the 8-year-olds tended to perform a greater number of verbally presented behaviors than either the 3- or the 5-year-olds. Eight-year-olds may prefer the verbal mode of information input, whereas the younger children may prefer the visual mode. On the other hand, the preference of the 8-year-olds for verbal or visual information was at the chance level. Three-year-olds may be limited to the use of the visual system, whereas the 8-year-olds may be able to use either the visual or the verbal system. Thus while supportive evidence was found for Piaget's (1952) theory that a change in internal representation occurs at about the age of 6 years, questions concerning the nature of that change remain unresolved.

DEVELOPMENTAL CHANGES IN INFORMATION INPUT PREFERENCE

by

Louise McKibbin Ramirez

A Thesis Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Greensboro
1977

Approved by

Mary Fulcher Ellis
Thesis Adviser

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

Thesis Adviser Mary Julia Ellis

Committee Members P. Scott Sommers

Audrey J. McCasper

10/7/77
Date of Acceptance by Committee

ACKNOWLEDGEMENTS

The author wishes to thank Mrs. Salmon of Young World Day Nursery, Rena Vaughn and Judy Stack of Mini-Schools, Sheila Green of Renee's Nursery, and Mr. David Kemp of Sedgefield Elementary School for the use of their facilities and children in this study. Thanks are also due to Mary Kay Reed for her assistance in running the subjects, and to Professors Scott Lawrence and Tony DeCasper for their suggestions in writing the thesis. The author is indebted to Dr. Mary Fulcher Geis for her encouragement and advice throughout the project.

DEDICATION

To Fernando, Dr. Robert Eason, and Dr. Mary Fulcher Geis,

who provided me with the

impetus and means to begin

and the

wisdom and curiosity to focus,

this thesis is fondly dedicated.

TABLE OF CONTENTS

Page

APPENDICES

LIST OF TABLES

CHAPTER I

INTRODUCTION

Recent memory data seem to support the theory that adults represent the external world internally by both visual and verbal systems (Craik & Lockhart, 1972; Paivio, 1969). Developmental studies suggest that the two systems, independent of one another, emerge at different times during the child's life (Jones, 1973).

The present study approaches the development of internal representation by assessing the child's preferred mode of information input. It will be argued that, if conflicting information is presented simultaneously in two forms, the child is more likely to process effectively the information that is presented in the form consistent with his current mode of representation. From the child's responses to conflicting information, it can be inferred which information he processed and therefore which might be the preferred mode of internal representation.

Adult Verbal and Visual Representation

Although controversy exists concerning the development of verbal representation (Bruner, 1964; Bruner, Oliver, & Greenfield, 1966; Piaget, 1952; Rohwer, 1970), it is acknowledged that the adult system of representation is at least partially verbal in nature.

Visual representation, on the other hand, is not as widely accepted. Evidence for visual representation in adults comes from memory studies

in which high imagery words, i.e., words rated as arousing a sensory experience such as mental pictures or mental sounds (Paivio, 1971), were better remembered than abstract words, i.e., words rated as not arousing a sensory experience. Such words as grass were remembered better than words like history. In another study (Bugelski, 1968) adults instructed to use imagery mnemonics recalled a greater number of words than adults instructed to use rhyme mnemonics or adults without mnemonic instruction.

Modeling studies (Bandura, 1965) indicate that behaviors can be acquired by merely observing the behaviors of others, with or without observation of consequences. Researchers concluded (Bandura, 1969, p. 133) that both visual and verbal representation are influential in this means of acquiring behaviors. Indeed, studies found (Gerst, 1969) that either induced verbal or induced visual encoding subsequently facilitated reproduction of observed behaviors.

Thus there does seem to be evidence that adults can represent information by visual as well as verbal means.

Development of Internal Representation Systems

Whether or not internal representations exist in infants and, if so, in what form, has not yet been determined. Recent research indicates (Eimas, Sigueland, Jusczyk, & Vigorito, 1971) that 1-month-old infants not only show interest in (as measured by increased sucking responses) repeated hearings of linguistic syllables but also can discriminate between them. Furthermore, imitation of both verbal and motor behaviors is evident (Parton, 1976) as early as the first year of life. An infant, in other words, can at least process visual and auditory information.

Investigations of cognitive development have led Piaget to conclude (1950, 1952) that cognitive development proceeds from a nonverbal, sensori-motor stage, through visual representation to verbal representation. In the first stage of development, from birth to about 2 years, the child learns by manipulation of the environment. In the sensori-motor period, according to Piaget, the meaning of and reference to any object are in terms of the action performed with that object. Bruner (1964; Bruner, Oliver, & Greenfield, 1966) refers to this period as the enactive stage, where the child learns and orders his world by means of acting upon it.

For both Piaget and Bruner, the child develops the ability to represent information internally by first imitating the action performed with an object when that object is not actually present. Through this deferred imitation the child comes to represent the external world internally. Bruner hypothesizes that later the child pictures the object in his mind, and a system of ikonic representation develops.

By about the age of 6 or 7 years, the child masters the system of verbal representation, where each object can be represented in the child's mind by a word.

Empirical Support

Empirical support for the hypothesis of the development of visual representation prior to verbal representation has come from memory studies: children younger than about 7 years consistently show better retention for visual than for verbal material. It has been demonstrated (Jones, 1973; Tversky, 1973) that when verbal and visual test conditions are balanced, pictoral material is better remembered by 3-year-olds than

verbal material. Others (Entwisle & Huggins, 1973; Perlmutter & Meyers, 1975) have shown that 4-year-olds were less proficient at recognizing material presented verbally than material presented either visually or verbally and visually. Earlier data (Rossi & Rossi, 1965) showed that recall of non-verbal materials, such as pictures of objects, was high in children from 2 to 5 years. Corsini (1969) found that preschool children's retention of simple commands was significantly improved by presenting non-verbal cues simultaneously with verbal instructions. Non-verbal cues had no effect upon the retention of 7-year-olds.

Children younger than about 6 have been labeled production deficient (e.g., Flavell, Beach, & Chinsky, 1966) for they consistently fail to use language spontaneously to aid in memory tasks. For example, if young children are given a list of words to learn, they will not rehearse between presentation and test trials, as do older children. There is evidence (Ryan, Flavell, & Hegion, 1972), however, that children as young as 3 and 4 years have some ability to use visual mediation.

Taken together these data suggest that the development of representational systems proceeds from visual to verbal systems, with the transition occurring at about the age of 6 years (Conrad, 1971; Pascual-Leone & Smith, 1969; White, 1965). Children seem to be able to process visual information efficiently before they are 7 years old, but they process verbal information efficiently only after the age of 7.

Parallel or Dominant Systems of Internal Representation

Bruner proposed that as language develops it becomes the most specialized system of symbolism and preferred by adults for representation.

Piaget, on the oth er hand, argues that the two systems are parallel (Piaget & Inhelder, 1966) and that both systems are essential in adult thought. Although visual representation develops prior to verbal representation, the former is seen by Piaget to complement the latter.

Paivio, like Piaget, regards visual and verbal representation systems as parallel in adults. The two systems are described by Paivio (1971a, 1971b) as alternative symbol systems, chosen according to the nature of the to-be-remembered items. Imagery, while theoretically efficient for representation of concrete and spatial dimensions, is relatively less useful than verbalization for representation of abstract and sequential dimensions.

In summary, theoretical accounts of verbal and visual representation are in accord that visual representation develops prior to verbal representation. They disagree as to whether the result is one dominant system of representation or two systems of representation.

Present Study

The present approach to the problem of internal representation assumes that a transition in mode of representation necessitates a concurrent change in preferred mode of information input. Man's information-processing system is an efficient system. In order to minimally tax the system, the preferred mode of information input should correspond to the preferred mode of information representation. During the visual stage of representation, the child's behavior should be more efficiently controlled by visual stimuli. During the verbal stage, on the other hand, the child should rely on verbal and auditory means of gathering information

from the environment. Their behaviors should be more efficiently controlled by verbal information. The preferred mode of information input is thus hypothesized to provide another measure of cognitive transition.

In the present study, 3-, 5-, and 8-year-olds were given the task of performing simple behaviors such as touching their toes. This type of task had been used successfully by others (Corsini, 1970; Pascual-Leone & Smith, 1969; Strommen, 1973). It is advantageous in that monitoring memory by means of non-verbal behaviors eliminates the need for the child to produce a verbal response. Since theoretically the young child can only use visual representation efficiently, this procedure minimizes any difficulty the young child may have in responding.

The children received three different types of instructions concerning the behaviors they were to perform. In the visual instruction condition, the experimenter modeled the behavior without verbalizing the command. In the verbal instruction condition, the experimenter told the children what to do, without modeling the behavior. In the simultaneous instruction condition (visual and verbal instructions), the experimenter both modeled a behavior and said a command.

In the simultaneous instruction condition, the experimenter, on some trials, performed one action while verbally commanding a conflicting behavior. On the remaining trials the behavior performed and verbally commanded was identical.

It was not doubted that children aged 3, 5, and 8 could follow simple instructions, either visually or verbally presented. Luria (1962) emphasized that speech can initiate behavior in very young children.

Furthermore, imitation has been shown in children of less than a year. The visual and verbal conditions served as controls for the condition of major interest, the simultaneous instruction condition.

If a child is told verbally to perform one behavior and visually to perform an incompatible behavior, either his behavior will be controlled by one of the commands or no behavior will occur. For example, if a child is told to turn around but visually instructed to sit on the floor, he or she will respond by doing one of the behaviors or, if confused, remaining motionless. By observing which behavior is performed on the conflict trials, it is hypothesized that the mode of information input preferred by the child can be determined. If the preferred mode of information input does correspond to the mode of internal representation, and, if there is a change in internal representation at around the age of 6 as Piaget and Bruner hypothesize, then the 3-year-olds should perform the visually-presented behaviors and the 8-year-olds should perform the verbally-presented behaviors.

CHAPTER II

METHOD

Subjects

Thirty-six children, selected on the basis of age, were placed into one of three groups. The first group contained 12 3-year-olds ranging in age from 41 to 48 months, with a mean age of 44 months. The second group contained 12 5-year-olds ranging in age from 70 to 78 months, with a mean age of 74 months. The third group contained 12 8-year-olds ranging in age from 102 to 111 months, with a mean age of 105 months. An equal number of males and females was tested at each level. All children were taken from pre-schools and public schools in the Greensboro, North Carolina area.

Design

The basic design of the study consisted of three instructional conditions (visual, verbal, and simultaneous), each of which was administered to all children of the three age levels (3, 5, and 8).

Procedure

Each child was tested in each of the three instruction conditions, one condition per day, for 3 consecutive days. Each condition involved the performance of simple experimenter-demanded actions, such as touching toes and blinking eyes. A complete list of the actions is found in Appendix A. The simultaneous instruction condition was presented first to

each child; the order of the other two conditions was counterbalanced across children. The order of the actions within each condition, as well as the specific actions per condition, was randomized across children. The counterbalancing procedure is described in Appendix A.

Following the establishment of rapport, the experimenter (a female graduate student) took the child from the classroom to an adjoining room. The child was asked to point to the parts of the body referred to in the commands. Then he or she received the verbal instructions appropriate for the condition in which he was being tested. Exact instructions are found in Appendix B.

In the visual instruction condition, the experimenter modeled the six actions to be performed, without using verbal instructions about the actions. For example, the experimenter touched her toes without saying anything.

In the verbal instruction condition, the experimenter gave six commands verbally, without performing the actions.

In the simultaneous instruction condition, the experimenter performed one action such as turning around, while verbally commanding a conflicting behavior such as sitting on the floor. There were four of these test (T) trials. There were also six coordinated (C) trials in which the experimenter performed and commanded the same behavior. Although the commands and modeled actions varied, the order of presentation remained constant across children: C, C, T, C, T, C, C, T, C, T.

On each trial an assistant recorded reaction time, in seconds, from the first word of the command to the instant the child made body contact.

A detailed protocol of each child's responses to the commands, as well as his or her verbalizations, were recorded.

CHAPTER III

RESULTS

Information-Input Preference

A breakdown of the number of children at each age level performing 0, 1, 2, 3 or 4 verbally instructed behaviors, visually instructed behaviors or non-responses is found in Tables 1, 2, and 3, respectively. A 3 x 2 analysis of variance, with the between-subject factors of age (3, 5, 8) and sex, was performed on the number of verbally instructed behaviors performed by the children in the simultaneous instruction condition. This number was used as a measure of the children's preference for verbal information over visual information. A child's behavior was labeled as verbal when the behavior performed immediately followed a command that had been instructed verbally. Performance of visually presented behaviors was labeled as visual. Performance of additional behaviors per trial was not included in the scoring. The main effect of age was significant, F (1, 30) = 6.27, $p < .01$, indicating that the older children were more likely to perform behaviors presented verbally, whereas the younger children were more apt to perform behaviors presented visually. The mean numbers of verbal behaviors performed per child were .50, .83, and 2.17 for the 3-, 5-, and 8-year-old groups, respectively. A Newman-Keuls post hoc analysis ($p < .05$) revealed that the 8-year-old group differed significantly from the 5-year-old and the 3-year-old

Table 1

Number of Children At Age Levels Performing o, 1, 2, 3 or 4 Verbally Instructed Behaviors in the Simultaneous Instruction Condition

	Number of Behaviors				
Age Level	0	1	2	3	4
3	8	2	2	0	0
5	7	1	3	1	0
8	3	3	1	0	5

Table 2

Number of Children At Age Levels Performing 0, 1, 2, 3 or 4 Visually Instructed Behaviors in the Simultaneous Instruction Condition

	Number of Behaviors				
Age Level	0	1	2	3	4
3	1	1	1	2	7
5	0	1	3	1	7
8	5	0	1	3	3

Table 3

Number of Children At Age Levels Making 0, 1, 2, 3 or 4 Non-Responses in the Simultaneous Instruction Condition

	Number of Behaviors				
Age Level	0	1	2	3	4
3	10	1	0	0	1
5	12	0	0	0	0
8	12	0	0	0	0

groups, which did not differ significantly from each other. No other outcomes were significant.

Simultaneous Instruction Latency

A 3 x 2 x 2 analysis of variance, with the between-subject factors of age and sex and the within-subject factor of type of trial (test, coordinated), was conducted on the latency of performance in the simultaneous instruction condition. A significant effect was found for type of trial, F (1, 30) = 35.85, $p < .01$. For all children, latencies on the test trials (mean = 1.86 sec) were longer than those on the coordinated trials (mean = 1.46 sec). Neither the main effect of sex nor the main effect of age was significant. None of the interactions was significant.

Single Modality Presentation

A 3 x 2 x 2 analysis of variance, with the between-subject factors of age and sex and the within-subject factor of modality of instruction (verbal, visual), was performed on the number of behaviors correctly performed in the verbal only and visual only instruction conditions. The main effect of age was the only significant outcome, F (2, 30) = 3.63, $p < .05$. A Newman-Keuls post hoc analysis ($p < .05$) revealed that regardless of modality of instruction, the 3-year-old group, which tended to remain motionless on some trials, performed significantly fewer behaviors (mean = 5.42) than either the 5-year-old group (mean = 5.88) or the 8-year-old group (mean = 5.92). The 5- and 8-year groups did not differ significantly from each other.

Verbal and Visual Instructional Latency

A 3 x 2 x 2 analysis of variance, with the between-subject factors of age and sex and the within-subject factor of instructional condition (verbal, visual), was performed on the latency of performance in the verbal only and visual only instruction conditions. A significant difference in latency was found, F (1, 30) = 18.40, $p < .05$, between the verbal only (mean = 1.68 sec) and visual only (mean = 1.40 sec) instruction conditions. For children of all ages, verbal latencies were longer than visual latencies. No other significant effects were found.

Reaction Time Reliability

Reliability of the observers' recording of the children's reaction times was assessed on 87 trials. After a brief training session, two observers recorded reaction times of within .2 sec on 68 trials (78%) and reaction times of within .3 sec on 81 trials (93%).

Instructional Bias

Three independent judges were asked to estimate the instruction condition (either verbal only or simultaneous) and the age of the child (3, 5 or 8) in randomized recordings of the experimenter's voice made during the verbal only and the simultaneous instruction conditions for children of all ages. Estimations of instruction condition ranged from 40% to 70% correct (mean = 57%). Estimations of age of child ranged from 10% to 60% correct (mean = 37%). These estimations, at or below the level of chance, give evidence that the experimenter's voice was comparable across age levels and instruction conditions.

CHAPTER IV

DISCUSSION

Results of this experiment indicate that 8-year-olds in a situation of conflict between verbal and visual stimuli responded to a greater number of verbal stimuli than either the 3- or the 5-year-olds in the same conflict situation. This increase in the number of responses to verbal stimuli is consistent with the hypothesis that a developmental change in preferred mode of information input occurs at about the age of 6 years.

Younger children in the single instruction (control) conditions, however, responded correctly to fewer instructions (both verbal and visual) than did the older children. This finding suggests that an age-related change in preferred mode of information input was not the sole factor responsible for the difference in the number of verbally instructed behaviors performed in the simultaneous (experimental) condition. Rather, factors such as inattention to commands, inability to perform the commanded behaviors, or failure to comprehend the command may have contributed to the difference between the 3- and 8-year-old groups.

Evidence indicates, however, that inattention, evident during the control conditions of the 3-year-olds, was not present in the experimental condition. Individual protocols indicate that on one particular day, four of the 3-year-olds remained motionless following at least one of the experimenter's commands. Testing on that day occurred between lunch and nap time, a time of general confusion in a nursery school. It would

seem that the children were either not looking at the motion or not listening to the instruction presented by the experimenter. With the exception of only one coordinated trial and five test trials in the simultaneous condition, however, either a visual or a verbal response was made by all children. In the visual only and verbal only instruction conditions, the 3-year-olds responded to 136 out of 144 instructions (94%); in the simultaneous instruction condition, on the other hand, they responded to 47 out of 48 instructions (97%). Thus while an inattention factor may have contributed to the 3-year-olds not performing as many responses as the 8-year-olds in the control conditions, it does not seem to have been the major determinant of the number of responses made by the 3-year-old group in the experimental condition.

A second reason for arguing that the number of verbal behaviors performed by the 3- and 8-year-old groups in the simultaneous condition reflects a change in information preference and not other factors is the magnitude of difference between means in the two conditions. In the experimental condition the magnitude of difference between the mean number of verbal behaviors performed by the 3- and 8-year-old groups is relatively large (.50 vs. 2.17, or 12% vs. 54%), whereas the difference between the mean number of behaviors performed in the control conditions is relatively small (5.42 vs. 5.92, or 90% vs. 99%). It seems reasonable to conclude that, although other factors may be present in the experimental condition, a change from visual to verbal preference is the major determinant of the change in the number of verbally commanded behaviors performed.

It should be noted that the magnitude of difference in the experimental condition occurs despite the large percentage (46%) of visually presented behaviors performed by the older children. This may be due to a relatively large sample of 8-year-olds who have not made the shift, to a strong sensitivity of the 8-year-olds to visual stimuli despite the recent shift to predominantly verbal information, or to the ability of the 8-year-olds to use both the visual and verbal systems. Piaget (1952) and Paivio (1971) hypothesize that adults have alternative or dual systems of processing, wherein the verbal and visual modes of representation are parallel. The finding that preference for verbal or visual instruction may be at chance level provides evidence for the dual processing theory. Children younger than about 6 years may be more limited to the visual system of representation, whereas children older than about 6 years may be able to use both visual and verbal systems. The transition at age 6 may be the emergence of the verbal system which parallels, rather than dominates, the visual system.

A second finding of this study was that latencies on test trials were significantly longer than latencies on coordinated trials in the experimental condition for children at all age levels. This result implies that neither the 8-year-olds nor the 3-year-olds were attending to only one mode of information input; rather, all children were sensitive to the conflict situation and responded selectively to the stimuli. In addition, response latencies to verbal commands, which were significantly longer than response latencies to visual commands for all children, did not differ for 3- and 8-year-olds. This suggests that 3-year-olds

may be as efficient, in some respects, at processing verbal information as 8-year-olds. If this is the case, the development of greater efficiency with the verbal mode of information input cannot be responsible for the change.

Although this experiment provides additional support for the theory that a change in internal representation occurs, the source or the transition and the extent of its effects are unexplored. It may be the case that the change reflects a programmed or maturational development occurring at about the age of 5 or 6. School age may in fact have been determined by the internal change in representation which concurrently facilitates reading acquisition and enables the child's functioning in the predominantly verbal environment of school. On the other hand, a range of experiences during some critical period may be necessary for the shift to occur. Perhaps mothers who provide their children with a verbal commentary of the environment provide them also with the experiences necessary for likewise monitoring and representing verbally the events around them. Finally, it is quite possible that mere entrance into school provides practice and experiences in a predominantly verbal environment and results in the child's attending and responding to verbal stimuli.

This transition in preferred mode of information input may be related to school learning. The experimenter observed that children in the 3-year-old group who preferred verbal information tended to be described as "smart" by their teachers. Children in the 8-year-old group who preferred visual information tended to be rated as "slow" by their teachers. It

may be that this change, whether programmed or learned, is essential for efficient functioning in school. In a predominantly verbal environment, children must attend to verbal information. Failure to do so hinders academic progress for it decreases the chance that pertinent information will be received. It seems possible that some of the problems subsumed under the rubric of learning disability may in fact be related to mode of information input and internal representation.

In summary, this study provides supportive evidence for the theory that a transition in internal systems of representation occurs at about the age of 6 years. However, data support two alternative conceptions of that transition. Eight-year-olds performed a significantly greater number of verbally instructed behaviors than either the 3- or the 5-year-olds. Eight-year-olds may prefer the verbal mode of information input, whereas 3-year-olds may prefer the visual mode of information input. On the other hand, the preference of 8-year-olds for verbal or visual information was at the level of chance. Three-year-olds may be more limited to the use of visual information input and internal representation, whereas the 8-year-olds may be able to use both visual and verbal information input and systems of internal representation.

BIBLIOGRAPHY

Bandura, A. Vicarious processes: A case of no trial learning. In L. Berkowitz (Ed.), Advances in experimental social psychology (Vol. 2). New York: Academic Press, 1965.

Bandura, A. Principles of behavior modification. New York: Holt, Rinehard, & Winston, 1969.

Bruner, J. S. The course of cognitive growth. American Psychologist, 1969, 19, 1-15.

Bruner, J. S., Oliver, R. R., & Greenfield, P. M. Studies in cognitive growth. New York: Wiley, 1966.

Bugelski, B. R. Images as mediators in one trial paired-associate learning. Journal of Experimental Psychology, 1968, 77, 328-334.

Conrad, R. The relation of speech to thought. Developmental Psychology, 1971, 5, 398-405.

Corsini, D. The effect of nonverbal cues on the retention of kindergarten children. Child Development, 1969, 40, 599-607.

Corsini, D. Effect of type of redundancy in retention in preschool children. Psychonomic Science, 1970, 19, 117-118.

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Eimas, P., Sigueland, E., Jusczyk, P., & Vigorito, J. Speech perception in infants. Science, 1971, 171, 303-306.

Entwisle, D., & Huggins, W. Iconic memory in children. Child Development, 1973, 44, 392-394.

Flavell, J. H., Beach, D. R., & Chinsky, J. M. Spontaneous verbal rehearsal in a memory task as a function of age. Child Development, 1966, 37, 283-299.

Jones, H. R. The use of visual and verbal memory processes by 3-year-old children. Journal of Experimental Child Psychology, 1973, 15, 340-351.

Luria, A. R. The genesis of voluntary movements. In N. O'Connor (Ed.), Recent soviet psychology. New York: Holt, Rinehart, & Winston, 1971.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971.

Paivio, A. Imagery and language. In S. J. Segal (Ed.), Imagery and current cognitive approaches. New York: Academic Press, 1971.

Parton, D. Learning to imitate in infancy. Child Development, 1976, 47, 14-31.

Pascual-Leone, J., & Smith, J. The encoding and decoding of symbols by children. Journal of Experimental Child Psychology, 1969, 8, 326-355.

Perlmutter, M., & Meyers, N. A. Young children's coding and storage of visual and verbal material. Child Development, 1975, 46, 215-218.

Piaget, J. Origins of intelligence. New York: International University Press, 1952.

Piaget, J. Psychology of intelligence. New York: Harcourt, Brace & Co., 1950.

Piaget, J., & Inhelder, B. Mental imagery in the child. New York: Basic Books, 1971.

Rohwer, W. Images and pictures in children's learning: Research results and educational implications. Psychological Bulletin, 1970, 73, 393-403.

Rossi, E. L., & Rossi, S. I. Concept utilization, serial order and recall in nursery children. Child Development, 1965, 36, 771-778.

Ryan, S., Flavell, J. H., & Hegion, A. Non-verbal mnemonic mediation in preschool children. Child Development, 1970, 41, 539-550.

Strommen, E. A. Verbal self-regulation in a children's game: Impulsive errors in Simon Says. Child Development, 1973, 44, 849-853.

Tversky, B. Pictures and verbal encoding in preschool children. Developmental Psychology, 1973, 8, 149-153.

White, S. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt & C. C. Spiker (Eds.), Advances in child development and behavior (Vol. 1). New York: Academic Press, 1963.

Wolf, T., & Cheyne, J. Persistance of effects of live behavioral, televised behavioral and live verbal models on resistance to deviation. Child Development, 1972, 43, 1429-1436.

Appendix A

Commands and Randomization Procedure

All children received the simultaneous condition first. The verbal only and visual only instruction conditions were counterbalanced for order across children. Commands were first randomized across conditions, then counterbalanced for order within each condition.

Commands and Conflict Actions

1. Shake your head (touch your eyes)
2. Jump on floor (rub your hands)
3. Blink your eyes (hands on hips)
4. Sit on floor (pull your hair)
5. Pull your ear (jump on floor)
6. Touch your nose (stomp your feet)
7. Scratch your tum (shake your head)
8. Rub your hands (kick your feet)
9. Kick your foot (touch shoulder)
10. Step on floor (blink your eyes)
11. Clap your hands (scratch your head)
12. Touch your eyes (hands on knees)
13. Touch your tum (sit on floor)
14. Jump on floor (touch your toes)
15. Hands on hips (shake a foot)
16. Shake your hand (turn your head)
17. Stick out tongue (clap your hands)
18. Pull your hair (turn around)
19. Stomp your feet (tickle tummy)
20. Turn around (touch your nose)
21. Touch your ear (kick your feet)
22. Wave good-bye (blink your eyes)

Randomization Procedure

First Condition	Second Condition	Third Condition
Simultaneous Condition Commands 1-10	Verbal Condition Commands 6-16	Visual Condition Commands 12-22
	Visual Condition Commands 6-16	Verbal Condition Commands 12-22
	Verbal Condition Commands 12-22	Visual Condition Commands 6-16
	Visual Condition Commands 12-22	Verbal Condition Commands 6-16
Simultaneous Condition Commands 6-16	Verbal Condition Commands 1-10	Visual Condition Commands 12-22
	Visual Condition Commands 1-10	Verbal Condition Commands 12-22
	Verbal Condition Commands 12-22	Visual Condition Commands 1-10
	Visual Condition Commands 12-22	Verbal Condition Commands 1-10
Simultaneous Condition Commands 12-22	Verbal Condition Commands 1-10	Visual Condition Commands 6-16
	Visual Condition Commands 1-10	Verbal Condition Commands 6-16
	Verbal Condition Commands 6-16	Visual Condition Commands 1-10
	Visual Condition Commands 6-16	Verbal Condition Commands 1-10

Appendix B

Instructions

Simultaneous Instruction Condition

We're going to play a game. I'm going to be the leader. See if you can follow the leader. OK? Get ready!

Verbal Instruction Condition

We're going to play a game. I'm going to be the leader. See if you can do all the things I say. OK? Get ready!

Visual Instruction Condition

We're going to play a game. I'm going to be the leader. See if you can do all the things I do. OK? Get ready!