73-2856

STEINBERG, Brenda Miriam, 1938-
A TRANSFORMATION IN THE CODING OF INFORMATION AND ITS RELATIONSHIP TO THE DEVELOPMENT OF SYMBOLIC PROCESSES AT AGE TWO.

The City University of New York, Ph.D., 1972
Psychology, experimental

University Microfilms, A XEROX Company, Ann Arbor, Michigan

A TRANSFORMATION IN THE CODING OF INFORMATION AND ITS RELATIONSHIP TO THE DEVELOPMENT OF SYMBOLIC PROCESSES AT AGE TWO

by

Brenda M. Steinberg

A dissertation submitted to the Graduate
Faculty in Developmental Psychology in
Partial fulfillment of the requirements
for the degree of Doctor of Philosophy,
The City University of New York

1972

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

June 7, 1972
date

Peter W. Carey
Chairman of Examining Committee

May 31, 1972
date

Walter Weiss
Executive Officer

Dr. Peter W. Carey

Dr. Joseph Glick

Dr. William King

Supervisory Committee

The City University of New York

ACKNOWLEDGEMENTS

This study would not have been possible without the amazing chain of mothers who enthusiastically spread the word about "this interesting memory study" for which one hundred and twenty two-year olds were needed. I am very grateful to the children themselves whose unfailing interest in the task kept me fascinated for the duration.

I owe especial thanks to Peter Carey for his interest, encouragement and thoughtful reading of each draft, to Hinde Sack for her never ending willingness to ponder over many theoretical and ephemeral problems, to Claudia Koonz for her painstaking reading of the manuscript and her incisive comments with regard to clarity of thought and organization, and to Arlene Amidon without whom a parsimonious design would have been impossible.

I would also like to thank Joe Glick for sharing his astute sense of meaningful emphasis, Bill King for his ever trenchant comments, and Ann Rees for her enduring interest and encouragement. I am truly indebted to Chip Elwell for his sense of humor and impeccable typing and proofing of the final manuscript.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

In an endeavor better to understand "the internal mechanisms of transformation between stimulus and response" (Inhelder, 1969, p. 337), Piaget and Inhelder have undertaken a number of experiments on the development of memory in children between the ages of three and twelve. Viewing cognition as integral to memory, they have concerned themselves with changes in the memory code over time as related to the evolution of thinking operations (Piaget, 1968).

Fundamental to their conceptualization of the problem has been a distinction between the operative and figurative components of cognitive functions. According to Piaget (1968, p. 14), "the operative component . . . consists of action 'schemes,' or representative 'schemes' (either operational or preoperational)." These schemes result primarily from the child's assimilation of reality. It is through their intercoordination that he "knows" and generalizes from reality. His knowledge of transformations and their results therefore depend upon these schemes. The figurative component consists of the means by which the child represents states of reality or specific configurations without reference to transformations (Inhelder, 1969). It is therefore a function of the child's accommodative processes. Perception, imitation, and mental images are its three manifestations and each is paralleled by a particular form of memory, respectively: recognition, reconstruction, and evocation (Piaget, 1968).

A child's performance on a memory task is thought by Piaget and Inhelder to be influenced by both figurative representation of the stimulus and the operative schemes through which he comprehends it. Changes in the child's replication of a stimulus are assumed to reflect an operative advance rather than a figurative fade.

The Genevan experiments designed to investigate the evolution of memory, utilize levels of cognitive development which have been postulated on the basis of many previous studies of children's understanding of numerosity, seriation, water levels, etc. A similar pattern has been followed in all of these experiments and so, for the purposes of exposition, I will simply describe the basic paradigm in their studies of memory for seriation. This choice will facilitate discussion of the contributions of Altemeyer et al (1969), Bresson (1970), Carey (1971), and Dahlem (1970, 1971) since they have all focussed on the seriation studies.

Typically, the child is shown a seriation of sticks which vary regularly from 9 to 15cm in length. He is told to observe them carefully. One week later he is asked to relate verbally, by gesture, or by drawing, what he was previously shown. Six to eight months later this procedure is followed once more, and, in some experiments, the child is presented with ten sticks and asked to reconstruct the original array. Seventy-four per cent of the children participating in these studies show progress in their ability to produce a seriated array over the six months period. During this time interval the child's memory of the stimulus appears to 'improve' coincident with an advance in his ability to seriate.

Inhelder (1969, p. 343) has explained these results as follows:

> It seems that memory images are linked to operational schemes and that these schemes control the images and dominate the model perceived. . . . The action schemes . . . constitute the code for memorizing; this code is modified during the interval and the modified version is used as a new code for the next evocation.

In a similar vein, Piaget (1968, p. 5) has enunciated the following:

> Now, in six months, in the case of seriation or ordering . . . this operational, or preoperational

> scheme of assimilation evolves. . . . The new scheme of the next level serves as the code for decoding the original memory. The final memory, then, is a decoding of a code which has changed, which is better structured than before, and which gives rise to a new image which symbolizes the current state of the operational schema, and not what it was at the time when the encoding was done.

With respect to the Genevan theory of memory development as exemplified by the preceding quotations, there is at least one major problem demanding clarification and several derivatives thereof. There is some ambiguity as to the exact nature of the relationship between memory and cognition specified by the model.

Voyat (1971) stating the problem from within a Piagetian context, has suggested that there are two possible hypotheses which might be inferred from the theory as stated. Memory, from the standpoint of the first hypothesis, is totally integrated with the cognitive schemes. Operative structures serve in perception and retrieval, and one cannot distinguish between memory and the whole of cognition. The general schemes become localized in specific situations and as they evolve so do their manifestations in memory. The alternate hypothesis is that memory exists independently of cognition but codes information on the basis of available cognitive schemes. The child uses schemes present in his repertoire at perception and again at retrieval, which are most situationally appropriate or dominant. Within this framework an interaction between cognition and memory is assumed but unity is not.

Bresson (1970) has expressed the same question with a view to the heuristics of memory study. Is memory, he asks, the coding functions which evolve with development or, is memory a mass of traces and an evolving coding function which acts as a filter?

Reference to the quotations from Piaget (1968) and Inhelder (1969) illuminate this problem. Inhelder (1969, p. 343), has stated that "the action schemes constitute the code for memorizing" and that this code is modified during the interval and presented in its new form at the next evocation. This statement lends support to the hypothesis that the coded memory traces are totally integrated with the cognitive schemes. Piaget (1968, p. 5), on the other hand, by asserting that the "new scheme of the next level serves as the code for decoding the original memory," is suggesting that the new scheme is functioning as a filter at retrieval.

It is obviously statements such as these which have given rise to the questions of Voyat (1971), Bresson (1970) and others (e.g. Carey, 1971; and Altemeyer et al, 1969). In addition, the Piagetian dialectic would seem to preclude the possibility of any memory traces; whereas the distinction between the figurative and operative aspects of memory introduces the possibility of encoding a reproductive image (trace),

> In the case of knowledge of the past . . . the figurative elements are no longer pliable at will (if they are changed at will this leads to deformations or errors) since the past has passed and cannot be transformed.
>
> (Piaget, Inhelder, and Sinclair, 1968, p. 160)

Perhaps the real solution to the problem lies in the Piagetian distinction between memory in the broad sense and memory in the narrow sense.

> The former consists of the conservation of 'schemes,' and it is essentially intelligence itself, to the extent that intelligence is used to reconstruct the past. The latter, which is brought into play in recognition, reconstruction, and evocation, is only the figurative aspect of the 'schemes.'
>
> (Piaget, 1968, p. 15)

One reading of this would suggest that memory in the broad sense consists of all schemes which have been conserved by the child and that these schemes filter or decode the images which refer to memory in the narrow sense. This would seen to be a reasonable hypothesis both in terms of a Piagetian theory and other current models of memory (e.g. Neisser, 1967). Moreover, as Carey (1971) has pointed out, the idea that all memory traces are modified with with each new level of cognitive development is somewhat less than parsimonious.

When we speak of coding and decoding it is incumbent upon us to consider the problem of what must remain invariant between t_1 and t_2 which admits of two different outputs. As Bresson (1970, trans. by Carey, p. 2) has noted, "What is entered in memory must be compatible with two coding functions. . . ."

If we step outside of our Piagetian framework for a moment we find that Bower (1967) has conceptualized the encoding of a stimulus in a learning experiment in a fashion which offers one possible solution to the problem. He has asserted that Ss encode a list of attributes which can refer to psychophysical properties or verbal labels (and, we might add to this list, a concept such as seriation). Memory for each attribute or component is retained or forgotten in an all-or-none fashion. Memory for the whole is determined by the number of component losses during the retention interval. And, the probability of a correct response is determined by the probability of a correct guess over the N-l forgotten components (l being the number of components retained). One may suppose that the attributes which are encoded by the child depend upon his operative schemes and that what he retains from t_1 to t_x must be the maximum number of attributes which allows for the "x" required outputs. The accuracy of the guessing at t_2 would then be determined by the remaining attributes as decoded by the newly evolved schemes.

Altemeyer et al. (1969) have carried out a number of experiments which suggest that children in the seriation studies may, at the younger levels, encode the attributes stick and upright plus some markers as to the relationship between individual sticks. In the Altemeyer studies some subjects were presented with the task of remembering a seriation (replication of the Genevan groups); others were shown nonseriated arrays to remember, and still others were not shown any stimuli at t_1. Ss who had been shown the nonseriated array at t_1 were found to "improve" in the same direction as those who had been shown seriations. But, Ss who were simply asked to draw a stick picture at t_2 did not create designs which in any way resembled seriations. Dahlem (1969) who also had one group of Ss which did not see the original display found that only 3.7% of them made configurations bearing any relation to stimuli shown her other groups. One of the most important conclusions to be drawn from these studies is that the results achieved by Piaget and Inhelder were not altogether artifactual as regards memory. Subjects in these experiments are apparently remembering something. There is an invariant between t_1 and t_2 in the seriation studies' upright sticks.

We assume, on the basis of the Genevan seriation studies that the older child who produces a seriation has the concept of seriation. He has effectively encoded this concept as one attribute or chunk. Johnson (1970) has defined a chunk as "any response set or sequence which is represented in memory by a single code" (p. 173).

How are we to explain the behavior of the younger child who reproduces a seriation of three, four, or five sticks but not of ten? Blackstock (1971) found that with an increase in age there is an increase in the number of sticks which children can successfully seriate. Is the child encoding a conceptual chunk in one instance and not another? This is a possible but not likely explanation. Miller (1956) noted that when there is no single device, or chunk available to an S, the items in an array will occupy as many slots as there are items. Blackstock's (1971) findings would seem to suggest that young children do indeed encode each attribute separately and that limits in their channel capacity determine how many sticks they are able to remember. The work of Atkinson et al. (1964), Hansen (1965), and Calfee (1970) has demonstrated that the younger the child, the more problematic an increase in memory load.

Following Bresson (1970) and Carey (1971), one must in some manner specify the relationship between the stimulus and the code. Let us consider Bresson's formulation (1970, p. 2):

> Let us say that a code is defined by a function that maps one set onto another set . . . what is essential . . . is to determine the structures that are established between the two languages by the coding function; (which relations between words remain invariant when we pass from one language to another,) from one code to another, by means of a coding function? . . . The stimulus is in language 1, and the memory is in language 2. The coding function acts as a filter that preserved only part of the information in language 1. Later, when one is going to reproduce the remembered stimulus, one carries out inverse coding--a decoding--that utilizes the same function, or, if the subject himself has changed, a different function.

Johnson (1970), writing from a slightly different perspective, has made assertions regarding the relationship between the stimulus and the code which seem worthwhile considering in this context. He suggests that a code is a memorial representation and that because it is a representation of information and not the information itself, the two must be logically distinct. One implication of this for Johnson is that the variables which influence the acquisition and retention of the code may be quite different from those influencing the acquisition and retention of the information itself.

The relevance of this for developmental memory experiments is that performance difficulties encountered by young children may relate in some cases to comprehension of the data and in others to problems of encoding it. Although from a Piagetian point of view the child's cognitive schemes are thought to determine both the child's response to the data and the encoding process, it would seem to be an error not to distinguish between the two. Appropriate modes of retrieval at t_2 depend upon the correct coding of a matchable invariant and the relationship between the child's current means of representing things with the one he possessed at t_1.

Neisser (1968, p. 13) made reference to the latter problem when he suggested that the infantile amnesia to which Freud referred was

> . . . a necessary consequence of the discontinuities in cognitive functioning which accompany growth into adulthood . . . the cognitive accommodations which must accompany these transitions seem to make the past inaccessible.

The development of cognitive schemes involves three kinds of change in Neisser's view. The first is absorption of early schemes by later ones and results in the disappearance of the early ones. The second is displacement whereby the two schemes, new and old, exist side by side and each assimilates experience differently. And, the third is integration which involves a marriage of the two schemes and preserves the integrity of the older one.

Obviously, where memory is involved, the relationship between the new and old schemes will determine the retrievability of the information stored at t_1. In addition, the manner in which a child internally represents things to himself will be a factor in this matching process. It is difficult to specify the relationship between operative schemes and representational ability and between coding and representation. If the coding is a function of the operative scheme acting as a filter on the information, what does this tell us about whether something is encoded as an image, a label, an abstraction, a movement, or a concept? Where does the development of representation as reflected in the various forms of symbolization fit into all of this?

Corsini's (1971) statements below exemplify the relevant American view of the relationship between memory development and representational development.

> Memory development is the development of representational abilities, it is the development of the propensity to represent; it is the development of

> familiarity with different stimulus representation modes; it is the development of a general information base; and it is, perhaps most importantly the development of a cognitive operative system.
>
> (Corsini, 1971, pp. 10-11)

Much of the American research to study these developments has been initiated or inspired by Flavell and his associates (Flavell, Beach, and Chinsky, 1966; Keeney, Cannizzo, and Flavell, 1968; Moley, Olson, Halwes and Flavell, 1969; Corsini, 1969, 1970, 1971) and their main concern has been with development in the ability to use mnemonic mediators as memory aids. The core problem has been whether children who fail to use mediational devices are failing in the utilization of mediators (mediational deficiency) or in the production of mediators (production deficiency). In general these researchers have found that the primary deficiency among young children is in the production of mediators since when taught to use them they are often successful. However, this seems to depend on the task, the age of the children, and the nature of the instructions. This line of study differs significantly from that of the Genevans since it concentrates on cognitive activities which are deliberately undertaken by the children and not on the evolution of cognitive schemes. Furth (1969, p. 95) has undertaken the awesome task of relating knower, the known, and representation, from within a Piagetian framework:

> Schemes or operations form the internal knowing structures; an internal act of knowing can be said to derive from the active structures, and the concept of known things is shown as a final result in the field of knowing proper.
>
> . . . In distinction from the construction of the known thing which stays internal to the knowing activity, the symbol is constructed by means of the scheme of knowing in order to make present, to represent the known thing in a field that is different, not only from the original thing but also different from the field of operativity. . . . Only by having an aspect external to operativity can the symbol fulfill its function of representation, of making something else present in a new medium.

The ability to represent things, "in a field that is different not only from the original thing but also different from the field of operativity," develops, according to Piaget, during the second year of life. Prior to that time cues or indices which are not differentiated from the things they signify exist as extensions of perception. Once the semiotic process develops, it leads to the production of signs and symbols which are separate from their significates. They are not simple extensions of perception and require evocation. It is the development of simultaneous differentiation and coordination between the significants and the significates which for Piaget signals the beginning of representation:

> The first differentiations are provided by imitation and the mental image derived from it, both of which extend accommodation to external objects. The meanings of the symbols, on the other hand, come by way of assimilation, which is the dominating factor in play. . . . Having progressively separated at the

> sensory-motor level and so developed as to be capable of going beyond the immediate present. The constitution of the symbolic function is only possible as a result of this union between actual or mental imitation of an absent model and the 'meanings' provided by various forms of assimilation. Then it is that language, a system of collective signs, becomes possible, and through the set of individual symbols and of these signs the sensory-motor schemas can be transformed into concepts or integrate new concepts.
>
> (Piaget, 1962, p. 3)

The two year old child is in the process of developing several means of representing things. Imitation, mental imagery, dreams, drawings, make-believe, and language all begin to emerge at the same time. All of these symbolic processes enable the child to move away from the immediate in time and space and to manipulate and coordinate his knowledge of the world. The child now possesses the operative schemes and figurative schemas necessary for the development of memory from the Piagetian point of view.

We know from studies on the development of perception in early infancy as diverse as those of Fantz (1964, 1966), Kagan (1967), Lewis et al. (1966, 1969) and Charlesworth (1968, 1969), that some form of memory exists from early infancy. However, early responses suggestive of memory are all related to the kinds of cues and indices which according to Piaget fall under the rubric of "recognitive assimilation," a sensory-motor phenomenon. They do not therefore belong to representation proper; they do not provide for a separation between significates and what they represent.

Although Piaget and Inhelder (1969) place the formation of all symbolic processes at the same age, they do suggest that some forms of imagery precede others. Reproductive (static) images are considered more primitive and emerge prior to anticipatory images. The former are copy images formed through accommodation and partaking mainly of the figurative aspect of memory. The latter are images which refer to movements and transformations and rely upon the operative aspect of memory. At the extreme of this view we find the following:

> With reference to the relations between images and thought it is probable that the last word has yet to be said, for if one accepts the proposed distinction between the operative and figurative aspects . . . it follows that images are at once necessary to represent states but insufficient to understand transformations. . . .
>
> (Piaget and Inhelder, 1969, pp. 140-41)

The necessary conclusion is that a simple reproductive image of a stimulus must necessarily precede an understanding of a transformation of that stimulus. A child at the early stages of symbolic development would therefore be encoding an image of a stimulus in his memory. A child at a later stage, who can comprehend the possibility of transformation might encode a concept of the stimulus. Or, if the latter has encoded an image also, it would be possible for him to retrieve this image when shown the original stimulus in a modified form. The child who can only deal with a reproductive image, on the other hand, would not respond to any modifications of the stimulus.

Piaget has averred that once abstract signs and symbols develop, a child is able to form concepts. The development of the semiotic process, therefore, not only initiates representation but also conceptualization. The child who has reached this stage of development advances from responding to the uniqueness of a stimulus to responding to each stimulus as an instance of a class of stimuli. Each progression relies on a further evolution of the child's operative schemes and his memory and, in turn, contributes to the further development of these processes. "The ability to recognize some event as an instance of a previously acquired concept is presumably some function of memory" (Bransford, 1969, p. 18). The child who sees a dog as a member of a class is able to, and eventually impelled to, encode or decode in terms of the concept "dog" rather than the specific dog.

The chronological distinction between reproductive and anticipatory images implies that conceptualization must necessarily follow the earliest forms of symbolic development.

This bears some relation to the progression postulated by Bruner (1966). Bruner has placed the emergence of imagery or ikonic representation at the end of the first year. The early images, in his view, are closely related to perception and share some of the characteristics of infant perception. Of note are the lack of transformability ("stuckness") and concreteness. Both of these characteristics are reminiscent of the reproductive image as described by Piaget and Inhelder (1969). Other forms of symbolic development, like language, develop somewhat later than imagery according to Bruner (1966, p. 28) and "rest upon the prior base established by imagery."

Despite the apparent similarity between Piaget & Inhelder's (1969) and Bruner's (1966) theories of symbolic development, there is a fundamental difference implied by their varying usage of the term symbolic or semiotic. According to Piaget, once there is a differentiation between the signifier and the signified, the semiotic function has made its appearance. The later symbolic developments include mental imagery and they rest upon the prior base established by imitation. Imitation leads to deferred imitation which leads to internalized imitation. Mental imagery is not an extension of perception but of imitation in the Piagetian scheme, and does not develop prior to the symbolic function, but rather depends upon that function. Neisser (1966) has also affirmed that Bruner's distinction between ikonic and symbolic is invalid in view of the prevailing psychological convention which considers images symbols. However, if Bruner is accurately describing reality when he avows that children represent things ikonically before they represent things with other kinds of symbols, it seems unreasonable to disagree with him on purely terminological grounds. Moreover, there may not be an essential difference between assuming that reproductive images (copy images) occur before anticipatory images (transformational images) and asserting that ikonic encoding precedes symbolic encoding.

It is my intention in this study to transcend these semantic arguments and ascertain experimentally the mode of the code. If two year old children are representing things to themselves by means of images they will respond differently to a transformed stimulus than if they are representing things by means of a more abstract symbol. The purpose of this study is to investigate transformation in the encoding of information at age two and its relationship to the development of symbolic processes.

The problem is to find the task most suitable to assess this relationship. As was stated several pages ago, on the basis of Piaget's (1962) description of the emergence of the semiotic process, one may conclude that some time after one and one half years of age the ability to symbolize and eventually to conceptualize emerges. According to Piaget and Inhelder (1969) a child's performance on a memory task is determined both by his figurative representation of the stimulus and the operative schemes through which he comprehends it. At the earliest stages of semiotic development the child is thought to be relying primarily upon the figurative component since the early images appear to be static reproductive images and do not enable the child to comprehend transformations in the stimulus. At a slightly later stage, after further operative development has occurred, the child is able to relate to transformations and to utilize a variety of symbols.

It follows from the above that two kinds of developments in memory occur during the third year of life as a result of cognitive advance. There is first a change in what the child responds to in the stimulus, and second a change in the coding process. With regard to the former, it seems probable that a two year old would respond primarily to the outward appearance of things such as size, form, and color. The three year old, on the other hand, if Piaget is correct in his assumptions about the development of conceptualization, should be competent to respond to some conceptual aspects of stimuli as well. One might assume that a two year old asked to discriminate between a toy horse, cow and pig, would do so on the basis of color, or size, whereas a three year old might make his discrimination on the basis of class membership.

The second change to which we have referred is the change in the coding process. There are two rather attractive hypotheses with respect to coding which it is helpful to consider. One is that children encode a figurative representation of the stimulus and decode on the basis of their operative schemes and the specific task requirements. Since at acquisition there is often no way of knowing what the retrieval requirements will be it is most efficient to encode the least amount of information compatible with the immediate memory requirements--a reproductive image. Decoding then, can coincide with any number of conceptual categories if the child's level of operative development is sufficiently high.

The other hypothesis is that if the child perceives the information conceptually to begin with, it is parsimonious and logical for him to encode the concept in memory. In the Genevan seriation experiments, for example, a child who understands the concept of seriation is assumed to perceive a seriation, and encode a symbol representing the concept of seriation, rather than attempting to represent all of the individual relationships between sticks.

Whichever of the two views is correct there remains the question of determining whether the same causal relationship exists at all stages of development. The purpose of this study is to investigate the relationship between operative development and changes in the coding process between age two and age three.

If we are to assess the influence of operative development at age three on the coding of information we must find a memory task which enables us to view changes in the code. If we present a child with an object to remember and then test for retention of the instance and also for retention of the concept to which the instance refers we should be able to note the age at which children can relate to both. Consideration of the literature on children's memory makes it obvious that the task must be quite simple in terms of memory load, or performance differences between the different age groups will derive from differences in channel capacity rather than cognitive growth (Atkinson, et al., 1964). The obvious choice, then, on the basis of the requirement for simple assessment of retention and coding is a discrimination learning task.

Following Flavell (1970) it was considered wise to use stimuli (in this case farm animals) which were all familiar to the children and which children between 2 and 3 can commonly name. The basic task was simply for each child to discriminate one of the animals from the other two on a reliable basis for

5 consecutive trials. Ability to perform this task indicates that the child has developed some memory skills but the question of what he has encoded if he is successful can only be asserted on the basis of theory. In this case it seems reasonable that a child who can recognize the cow as the animal which he has previously discriminated when he is shown that same cow again has encoded at least a figurative representation or image.

We next inquire as to how we can assess whether he has related to the concept or meaning category of the stimulus. Or, for that matter (following Bressen, 1970), whether he has encoded a symbol, image or other invariant which permits a response to more than one figural representation of the stimulus. The obvious way to answer this question is to present the child with a stimulus which has undergone a perceptual transformation and see if he can still recognize it. If he can, we may then assume that he has decoded in a manner sufficiently abstract to permit response to change and that he is therefore decoding conceptually.

The task for this study was determined on the basis of the foregoing discussion to be a simple discrimination task with a retention test utilizing the original stimulus items and a transfer test utilizing pictorial representations of the original. Therefore for the purposes of this study a perceptual response with imagistic coding is operationally defined as the inability of a child to recognize a learned discriminative stimulus once it has been perceptually transformed (i.e., fail the transfer test). And, conceptual response with abstract symbolic coding is operationally defined as the ability of a child to recognize a perceptually changed stimulus (i.e., pass the transfer test).

This study was undertaken with three main hypotheses in mind:

If Piaget and Inhelder (1969) are correct in their theory that the development of cognitive schemes determines the way in which information is coded, then, we should be able to find evidence for this in the performance of 24-36 month old children on a memory task designed to assess changes in coding.

If the critical and cognitive developments between 24 and 36 months of age involve the emergence of the abilities to symbolize and to conceptualize, we should be able to see manifestations of these developments in differences in the coding of information by the younger and older children.

and

If these cognitive developments appear to influence the comprehension and coding of information but not retention we may assume this to be evidence in support of the position that the coding function, not the memory traces, evolve with cognitive development.

Specific Predictions With Regard to Actual Performance

1. Children between the ages of 24 and 27 months are in an early stage of symbolic development which enables them to represent things internally by means of mental images. These images are static reproductive images, however, and do not permit the child to comprehend transformations (Piaget and Inhelder, 1969). On the basis of this it was predicted that children in this age group will be successful in passing the retention test but not the transfer test.

2. Children over thirty-two months of age, as a result of further development of the semiotic function, are able to respond to a changed stimulus. Attainment of a new level of operative development results in new schemes for decoding information. In this case a representational scheme which permits the child to decode a meaning category rather than a set of perceptual attributes. On the basis of this it was predicted that children in this group will be successful with both the retention and transfer tests.

3. Children in the middle group, 28-31 months, may be considered transitional children and their behavior is best described by the model developed by Flavell and Wohlwill (1969), who are concerned with the influence of performance considerations on children undergoing change. It was

therefore predicted that some of these children will be successful with the transfer task and others will not. Performance on the two converging operations instituted to assess conceptual and symbolic development is expected to be predictive of ability to pass the transfer test.

4. On the basis of the hypothesis that cognitive developments influence coding but not retention it is predicted that there will be no differences in retention based on age or differences in performance on the two converging operations.

CHAPTER II

METHODOLOGY

Subjects

The subjects in this study were children from middle class homes who were between the ages of 24 and 36 months. They came from two communities: New York City and The Hamptons on Long Island. A Chi-square test has shown that there is no difference between the two groups in their performance on the transfer task. And, t tests have shown them to be homogeneous with respect to the scores obtained on the tasks utilized to measure level of symbolic development.

The names of the children were obtained through the aid of cooperative playschool teachers and mothers. In all cases the permission of the mother was a prerequisite for testing the child. Each child was tested individually in a quiet room. Often, the mother was present but sat at a distance and only in a very few circumstances was encouraged to communicate with the child. A small percentage of the children initially approached were rejected for the study because they responded randomly to the discrimination task during both the demonstration and learning trials. Only two children refused to participate in the study and only one of the mothers approached declined to allow her child to be a subject.

A total of 120 children participated in the study and they were divided into three age groups: 24-27 months, 28-31 months, and 32-36 months. At each of these age levels there were four experimental groups with ten children apiece. This yields forty Ss per age level and the over all total of 120.

Materials

The materials for the memory task consisted of: three rubber animals (cow, horse, and pig), each of which was placed on a plastic stand with an inverted box under it 1/4 inch deep; three colored drawings of the animals of approximately the same dimensions, also on plastic stands; and, raisins. The small boxes under the stands were just large enough to comfortably conceal raisins.

The materials for the two tasks chosen to assess the children's level of symbolic development were: The Stanford-Binet Form L-M Picture Vocabulary Test, which consists of a small book of line drawings of familiar objects, and the Object-Picture Test which consists of a 3x3 grid of small colored drawings with nine small matching objects. The latter is a test which was created for this study, and it was designed to assess the ability of young children to match pictures with the objects they were drawn to represent. The grid of pictures was pasted to the top of a set of plastic boxes similar in dimensions to the ones used in the memory task.

Design

Subjects in three age groups were tested under four experimental conditions:

Experimental Group 1 (A): Train...Retention test

Experimental Group 2 (B): Train...Transfer test

Experimental Group 3 (C): Train...45-minute delay... Retention test

Experimental Group 4 (D): Train...45-minute delay... Transfer test

In addition to the primary task several controls were instituted on the basis of the cautions enumerated by Carey (1971) in his discussion of the Genevan experiments. Subjects initially tested under the immediate time contingency were all given a second test after 45 minutes; Ss in A were given a transfer test at t_2 and Ss in B were divided into two groups one-half of which received a second transfer test and one-half a retention test at t_2. After all retention and transfer tests had been administered, each subject was given the Picture-vocabulary and Object-Picture Tests and asked to label the three animals used in the criterion task.

Procedure

Each child was individually tested in a quiet location. In many of the cases the mother was present and sat unobtrusively outside the child's direct vision. The mother, or in some cases, the teacher, participated in the study only during the warm up period during which time she helped E and the child get to know one another. E and S sat opposite each other with a small table between them. The stimuli were placed on the table between E and S as they were needed.

E began the test session by offering S a raisin to eat, and by eating one herself if S hesitated. (Permission had been obtained from the mother prior to this.) Once S had eaten the raisin; the horse, cow, and pig were placed on the table in front of him or her. A second raisin was removed from the box and S was told, "Watch very carefully now, because I'm going to hide this raisin and see if you can find it." The raisin was then placed under a previously determined animal with S watching. S was then asked, "Find the raisin. Show me the one with the raisin," and then encouraged to look under the animal. Success in finding the raisin was followed by praise and encouragement to eat it. Failure led to encouragement to look under the other two animals until the raisin was located and in this case, also, success in finding the raisin was responded to with verbal praise. The "open" demonstration procedure during which the child watched while the raisin was hidden was repeated three times.

This procedure was followed by "closed" training trials which were different from the former in that a cardboard barrier was placed between E and S while the raisin was being hidden. Many of the children had to be restrained from removing the cardboard or attempting to peek around it for one or two trials. The few children who manifested this behavior most strongly or persistently had difficulty with the learning task. They seemed to be directing their energies to removing the cardboard rather than figuring out where the raisin was. One or two of these children were among the random responders who were ultimately dropped from the study. When a child reached the criterion of five consecutive errorless "closed" trials, his or her training was completed. For both the demonstration and training trials the animals were randomly rearranged during each intertrial interval. This was done with the child watching and occurred prior to the placement of the barrier and the hiding of the raisin.

After the training was completed:

_S_s in A (immediate retention condition) were immediately given a retention test. This consisted of three additional but unrewarded trials with the identical animals. On the first of these trials, _S_ was asked to "tell me which one had the raisins before; which one had all the raisins." Between each trial _S_ was asked to go and touch the door or get something from the other side of the room. He was then asked to see if he could "still tell me which one had the raisins." This procedure was carried out in this fashion because pilot work with two year olds showed that unrewarded trials are perceived as error trials unless some additional activity is requested at each interval. Telling the children that they will not be receiving raisins was only minimally helpful alone, but done in conjunction with preventing the children from looking under the animals and the intertrial activities, it seemed to minimize their sense of error. The criterion of two out of three correct performances on test trials was instituted to minimize the possibility of chance success or failure.

_S_s in B were shown three pictures of the animals in place of the original stimuli. The three-trial procedure with intertrial activities was the same as for A.

_S_s in C were encouraged to become involved in a variety of gross motor activities for a period of 45 minutes. _E_ busied herself in another part of the house or school or left the premises during that time. At the end of the forty-five minute period these Ss were presented with the original stimulus animals and requested to tell "which one had the raisins before," as were the other groups of Ss. They were then given the same retention test as the Ss in A.

Ss in D were encouraged to become involved in a variety of gross motor activities as were those in C. They were then given the same transfer test as the Ss in B.

After the delayed retention or transfer test each subject was shown the picture-vocabulary cards and asked before each picture, "What's this?" This was followed by the Object-Picture test. The latter involved placing a grid of nine colored pictures in front of the child, handing him the matching toys one by one, and requesting in each case that he "find the one that's the same. Find the picture that looks like this."

Finally, each child was asked to name each of the small animals.

CHAPTER III

RESULTS

Fidelity to the factorial design of this experiment (there are two time conditions, two experimental conditions, and three ages, with no replications) requires some form of multiple contingency analysis. Anovar not being applicable to frequency data, a possible Chi square analogue was sought. Sutcliffe (1957) has fortunately developed a method of partitioning Chi square (with appropriate degrees of freedom) into additive independent components based on the different sources of variation. His approach enables one to examine both main effects and interactions between factors, and proves to be a more economical and powerful approach to the data of this study than a set of individual Chi square tests. Table 1 summarizes the results of this analysis. Factor A is success or failure (the only random variable and for the purposes of this study a dummy variable); Factor B is time (immediate or delay); Factor C is condition (retention or transfer); Factor D is age (level 1, 24-27 months; level 2, 28-31 months; and level 3, 32-36 months).

TABLE 1

Partitioning of Chi Square and Degrees of Freedom for Performance on the Criterial Task

Source of Variation		d.f.	Chi square
AB	Time	1	0.00
AC	Condition	1	24.54***
AD	Age	2	23.08***
ABC	Time x Condition	1	.36
ACD	Condition x Age	2	13.92***
ABD	Time x Age	2	.22
ABCD	Time x Condition x Age	2	3.65
Total		11	65.77

*p < .05
**p < .01
***p < .001

Because Factor A is a dummy variable, AB, AC, and AD are the main effects for time, condition, and age, and by the same token, ABC, ACD, and ABD are first order interactions. Reference to Table 1 shows that time is not a significant main effect but experimental condition and age are both significant with P of less than .001. A glance at the data in

Table 2 makes the direction of the differences clear. Fifty-six children, 93% of those tested under the retention condition, passed; whereas, only 32, 53% of the children tested under the transfer condition, passed. As to age, Table 2 indicates that twenty of the children at age level 1 passed (50%), twenty-nine children at age level 2 passed (73%), and thirty-nine children at age level 3 passed (98%). Individual Chi square comparisons show that each of these age groups differs significantly from the next group. If condition is held constant, the young group differs from the middle group with a $p < .05$ and the middle group differs from the old group with a $p < .01$. If we look at the transfer condition alone we find that both differences are significant at the .01 level of confidence.

The ABC interaction yielded a very small Chi square, .36, indicating that the time factor did not assist or hinder the subjects under either the retention or the transfer condition. ACD was significant with a $p < .001$, which is not surprising considering the differences between the different age groups as regards success on the transfer test. Inspection of Table 2 indicates that retention could not possibly discriminate between children of different ages.

TABLE 2

Number of Children in Each Age Group Passing the Criterial Task under each Experimental Condition

	Immediate		Delay			
	Reten-tion	Trans-fer	Reten-tion	Trans-fer		
	A	B	C	D	Total	N
Age 1	9	1	9	1	20	40
Age 2	10	4	8	7	29	40
Age 3	10	10	10	9	39	40
Total	29	15	27	17	88	
N	30	30	30	30		120

The ABD first order interaction did not reach significance. Perusal of Table 2 makes it clear that there was practically no variation in performance between the two time conditions at any age. ABCD, the interaction which takes into account all three factors, was also not significant. When all factors are taken into account the resulting second order interaction does not reach significance. We may conclude, therefore, that the hypothesis that children in the middle age group would perform with more frequent success on the transfer test under the immediate than under the delayed condition has been disconfirmed. There is no age for which performance under a particular experimental condition, at a particular time, was significantly better or worse than all other possible combinations of age, condition and time.

The major outcome of the primary analysis is therefore, that with age there is improved performance on the transfer test but not on the retention test. Two year old children who can retain a discrimination for one minute can retain that discrimination for 45 minutes whether the recognition task utilizes the same stimulus or a variation of that stimulus.

The fact that the youngest group differs significantly from the middle group in its success with the transfer test, and that the latter differs significantly from the oldest group, suggests that there is an age of transition during which some children can transfer and others cannot.

In order to shed some light on the reasons for this we must refer to the performance of the children on the two tasks introduced for the purpose of assessing level of symbolic development. Table 3 shows the correlations between the performance of children on the Picture Vocabulary Test and

TABLE 3

Point Biserial Correlations Between Performances on the Picture Vocabulary Test and the Transfer Test for Each Age Group[a]

Group	Pass		Fail		rpb
	# Ss	mean # words	# Ss	mean # words	
24-27 months	2	8.0	18	7.39	.045
28-31 months	11	13.64	9	10.22	.480*
32-36 months	19	13.11	1	12.95	.317

*$p < .05$
**$p \leq .01$
***$p \leq .001$

[a]Correlations were not computed for success and failure on the retention test since it was apparent from observation of the data that there could be no significant differences.

the transfer task broken down by age. Table 4 shows the correlations between the performance of children on the object-picture Matching Test and the Transfer Test.

The point biserial correlation which according to Ferguson (1966, pp. 240-41) "can always be interpreted as a measure of the degree to which the continuous variable differentiates, or discriminates, between the two categories of the dichotomous

TABLE 4

Point Biserial Correlations Between Performances on the Object-Picture Test and the Transfer Test for Each Group[a]

	Pass		Fail		
Group	# Ss	mean # matches	# Ss	mean # matches	rpb
24-27 months	2	8.5	18	2.2	.557**
28-31 months	11	8.1	9	4.1	.569**
32-36 months	19	8.4	1	7	.251

*p <.05
**p <.01
***p <.001

[a]Correlations were not computed for success and failure on the retention test since it was apparent from observation of the data that there could be no significant differences.

variable" is the statistic. Tables 3 and 4 therefore, describe the degree to which the two converging operations reliably distinguish between children who pass or fail the transfer test. It is readily apparent that the Object-Picture Test is the more predictive of the two at each age level. The correlation between age in months and Object-Picture Matching score is .63081 (p .001). Lack of ability of the Picture-

Vocabulary Test to differentiate between success and failure for the youngest and oldest age groups results from the fact that so very few Ss behaved differently from their age cohorts.

As noted earlier, each age group differs significantly from each of the other two with regard to performance on the transfer test. At this point it is reasonable to ask whether each age group also differs with respect to performance on the two converging operations from the two other groups. A comparison between the mean scores on the Picture-Vocabulary Test for the two youngest groups yields a t of 5.44 ($p < .001$) and for the middle with the oldest group a t of 1.19 (n.s.). A t test comparing the youngest with the middle groups performance on the Object-Picture Test was significant with a $p < .001$ and a test comparing the oldest groups was significant with a $p < .05$. The differences between the three age groups reflected in performance on the two converging tasks thus closely approximates differences between the groups in transfer test performance.

The Genevan memory studies have generated some discussion as to whether children truly remember anything from t_1 and whether additional experiences with the stimuli influence their responses (Dahlem, 1968, 1969; Carey, 1971). In order to control for both the possibility that children who cannot perform the transfer task may fail because they do not remember the discriminative stimulus and for the influence of more than one test trial a number of controls were instituted. Subjects in Group A (immediate retention condition) were given a transfer test after 45 minutes as were half the subjects in Group B (immediate transfer condition). This provides us with three delayed transfer groups for comparison: one which has previously been given a retention test (A), one which was previously given a transfer test (B), and one which received no previous test (D).

Perusal of the data in Table 5 readily indicates that at no age level was there a difference between performances under any of the delayed transfer conditions. The same conclusion may be reached about the two retention conditions depicted in Table 6. This table represents a comparison between subjects in Group B (immediate transfer condition) who were given a delayed retention test and subjects in Group C who were not tested prior to the delayed retention test. The Chi squares did not reach significance at any age level.

When subjects in Group B (immediate transfer condition) were given transfer tests after a delay, their later performance was not found to differ significantly from their early performance. This confirms the nonsignificant ABD first

TABLE 5

Contingency Table Comparing Success and Failure on the Transfer Test Under Each of the Delay Conditions at Each Age Level

	Pass	Fail	N	
24-27 months				
A Delay (follows Retention Test)	1	9	10	
B Delay (follows Transfer Test)	1	4	5	2 df
D Delay (follows no test)	1	9	10	
	3	22	25	
		x^2 =	.2823	ns
28-31 months				
A Delay (follows Retention Test)	6	4	10	
B Delay (follows Transfer Test)	3	2	5	
D Delay (follows no test)	7	3	10	2 df
	16	9	25	
		x^2 =	.2603	ns
32-36 months				
A Delay (follows Retention Test)	9	1	10	
B Delay (follows Transfer Test)	5	0	5	
D Delay (follows no test)	9	1	10	2 df
		x^2 =	.5433	ns

order interaction in the multiple contingency analysis. It disconfirms the hypothesis that subjects succeed more often

TABLE 6

Contingency Table Comparing Success and Failure on the Retention Test Under the Two Delay Conditions at Each Age Level

	Pass	Fail	N	
24-27 months				
B Delay (follows Transfer Test	4	1	5	
C Delay (follows no test)	9	1	10	
	13	2	15	1 df
		x^2 = .2882		ns
28-31 months				
B Delay (follows Transfer Test)	5	0	5	
C Delay (follows no test)	8	2	10	
	13	2	15	1 df
		x^2 = 1.1535		ns
32-36 months				
B Delay (follows Transfer Test)	5	0	5	
C Delay (follows no test)	10	0	10	
	15	0	15	1 df
		x^2 = 0.00		ns

with the transfer task after a delay than they do under the immediate time condition.

TABLE 7

Contingency Table Comparing the Performance of Children in Group B (Immediate Transfer Condition) on the Immediate Transfer Test with Their Own Performance on the Delayed Transfer Test

		Pass	Fail	N	
24-27 months					
R	t_1	0	5	5	1 df
R	t_2	1	4	5	x^2 = .111 ns
		1	9	10	
28-31 months					
R	t_1	1	4	5	1 df
R	t_2	3	2	5	x^2 = 1.666 ns
		4	6	10	
32-36 months					
R	t_1	5	0	5	1 df
R	t_2	5	0	5	x^2 = 0.00 ns
		10	0	10	

The final task of each subject in this study was to name the three animals used in the discrimination task. The ability to name increasing numbers of animals (0,1,2, or 3) did not correlate with success on the transfer test for any age group. However, the ability to name the discriminative stimulus (the animal that a particular child was taught to discriminate) did apparently assist some children in performing the transfer task. Examination of Table 8 shows that although some children who could name the discriminative stimulus failed the transfer test, and naming is thus not predictive of success, inability to name was unquestionably predictive of failure.

TABLE 8

Contingency Table of Children's Ability to Pass the Transfer Test as Related to Their Ability to Correctly Name the Discriminative Stimulus

	Pass	Fail	N	
Ss who named the DS correctly upon request	28	16	44	
Ss who did not name the DS correctly upon request	4	12	16	1 df
				$x^2 = 6.113^*$
N	32	28	60	

$^*p < .05$

CHAPTER V

DISCUSSION

It is clear from the multiple contingency analysis of the data that beyond 28 months, but not before, children in this study were able to respond with recognition to a previously discriminated stimulus in the face of perceptual transformation. Children below 28 months easily remembered and recognized a re-presented stimulus, but they did not transfer their recognition response to an altered version.

Performance on a memory task is determined by both the child's figurative representation of the stimulus and the operative schemes through which he comprehends it, according to Piaget and Inhelder (1969). If we accept their theory, the ability to respond to a changed stimulus would be assumed to depend upon the operative development of the child. Thus, the 24-27 month old child who responds to the form of the discriminative stimulus rather than the meaning category apparently lacks the operative schemes necessary to a conceptual response.

Elkind (1969) has asserted that there is an essential difference between the Piagetian and discriminative response versions of a concept. Piaget, he suggests, is concerned with variation within things, and S-R theorists are typically concerned with variation between things. Both principals, from his point of view, are required for full conceptualization. Although he has not considered the question of chronological priority, we may propose one on the basis of the children's performance differences in this study. The 24-27 month old children readily discriminated between a cow, a horse, and a pig, but they did not relate to the within-class identity of an animal and its picture. The ability to deal with between-things variation is thus seemingly more precocious than cognizance of within-things variation.

On the other hand, if we apply Elkind's (1969) standard for full conceptualization (response to both the intensive and extensive content of a concept) to the performance of the younger children in this study, we must conclude that they are not responding conceptually to the discrimination problem. Moreover, it also appears that the code into which the information has been translated is very specific to the stimulus situation.

Piaget and Inhelder (1969, p. 140) have proposed that if we accept their distinction between the operative and figurative aspects of cognition and memory, "it follows that images are at once necessary to represent states but insufficient to understand transformations." It proceeds logically from this that the two year old child is encoding and decoding an image of the stimulus since he is unable to relate to change. He must be encoding something, because he is successful in recognizing the discriminative stimulus after a period of a few seconds or 45 minutes, as long as it remains unchanged.

If he is encoding an image he fits Bruner's (1966, p. 26) description of the child who has progressed from enactive to ikonic encoding. "It is as if the young child, having achieved a perceptual world that is no longer directly linked to action, now deals with the surface of things rather than with deeper structures based on invariant features." He is also similar to the high imagery children described by Kuhlman (1969, p. 1115) who find conceptualization difficult if not impossible because "to grasp a meaning category and recognize new instances of it a child must often shift away from the more obvious appearance of objects and focus on less observable aspects," and he is incapable of this. It is evident that the young two year olds in this study responded to perceptual rather than conceptual characteristics of the stimulus and encoded images rather than abstract symbols.

If we reflect on the question of what invariants must exist between t_1 (training) and t_2 (testing), which has been raised by Bresson (1970), one conclusion is that for the two year old it is so specific as to prevent more than one output. A second condition which must be met is that it contains sufficient information to insure recognition of the original. An invariant which is both a representation of the original and enables response to a changed stimulus may be an image or a more abstract symbol.

Two tasks were used in this study in the hopes of converging on these developments, the Picture Vocabulary test and the Object Picture test. On the basis of the performance of the 24-27 month olds on these two tests, it is possible to assert that they were significantly behind the older children in both these areas. They were only able to name a mean of 7.7 vocabulary words and matched a mode of 0 objects with the appropriate pictures.

Once the children reached the age of 32 months they reliably passed the transfer test with the same ease as the retention test. They appeared to relate to the discrimination problem in a manner distinct from that of the younger children. We can infer from their recognition of the transformed stimulus that they responded to the intensive as well as extensive meanings of the concept. For them, a picture of a horse was equivalent in its relationship to pictures of a cow and pig, as was the toy horse in its relationship to the toy cow and pig.

The children in the 32-36 month age group were able at t_2 to respond to the drawings with the same recognition with which the younger children responded to the original stimuli. This suggests that they encoded an invariant which their operative schemes could decode in more than one manner at t_2. One possibility is that they too encoded a figurative image of the stimulus which they could then read out in terms of the percept or the concept. A second possibility is that they encoded an abstract symbol which represented the concept.

Reference to the Picture-Vocabulary and Object-Picture tests reveals significant progress over the performance of the children in the younger groups. These children were able to name a mean of 12.9 words and match a mode of 9 objects. It seems reasonable to infer on the basis of their performance on the transfer test as well as on the two converging operations that they have reached a new stage of conceptual and symbolic development.

The middle age group of children between 27 and 31 months performed on the transfer task and the two converging tasks on a level intermediate between the two other age groups.

Both the performances of individuals and the overall behavior of the group leaves me with the distinct impression that this is a transitional stage of "emerging schemas" (Bruner, 1969), or "unstable structures" (Voyat, 1971).

Flavell and Wohlwill (1969) have formulated a model for the analysis of stages of intellectual development which accounts for the probabilistic character of responses during transitional periods. They begin by distinguishing between "two determinants of the child's performance in a cognitive task: A, the rules, structures, or 'mental operations' embodied in the task, and B, the actual mechanisms required for processing the input and output" (p. 98). They then specify the performance of a particular child in a particular performance situation on the basis of his cognitive competence and the probability that he can manifest that competence under particular performance conditions. They hypothesize that transition from one stage to another occurs in four phases. The first phase is one in which the child lacks the cognitive structures necessary to the next stage. The second is a phase in which the structures are beginning to emerge but performance contingencies dominate the child's behavior. Next is a phase in which the new structures are entirely formed but they are becoming consolidated. During this phase they begin to take precedence over performance variables. And finally, the fourth or terminal phase arrives in which the child reliably performs at a new level.

Although I have distinguished between 3 not 4 phases in the present study, it is obvious from examination of the data that children between the ages of 28 and 31 months are in a transitional phase of symbolic and conceptual development. Those who seemed advanced with respect to performance on the vocabulary or matching tests in some cases failed the transfer test due to performance variables.

If, following Johnson (1970) we distinguish between factors influencing the acquisition of the information in the stimulus from factors influencing encoding of the information we have more than one structural development to consider. A child in a transitional stage may have developed conceptually to the point where he is capable of responding to the meaning of the stimulus, but he may be immature in his ability to decode it symbolically. An example of such a problem appears in the case of the children who knew the name of the animal to be discriminated, but failed to use the name to represent it. Examination of the data pertaining to labeling reveals that inability to name the discriminative stimulus was a very high predictor of failure on the transfer test. This suggests the possibility that many successful labelers use the name as a mnemonic code in the memory process. However, the fact that one third of the namers failed the transfer test implies that although a name is a potential mediator it does not always function in that capacity. A number of children in transitional stages manifest either the "production deficiency" or the "mediational deficiency" to which Flavell (1970) has referred.

A second possibility exists that a child has developed symbolically to the level required by the task, but due to a lag in operative development does not relate to the stimuli conceptually. An example of such a situation would be a child who knows close to the 12 vocabulary words characteristic of success on the transfer test but is not able to match the pictures with the objects. There are a handful of children who did function in that manner.

Returning more closely to Flavell and Wohlwill's (1969) paradigm we must also consider the probability that some children possess the competence for representing concepts symbolically but they are not able to do this in a particular performance situation. In the present experiment, the placing of the raisin under a toy animal was so potent as to force the image of the toy in the child's memory even though under less demanding conditions he would have been capable of responding differently. Voyat (1971) has hypothesized that children in transition have more than one scheme at their disposal, and that they choose one most dominant at a given moment. Although it makes sense to conclude that a vertical transition between stages must follow a particular order, individual differences are likely to play a significant role in effecting a child's transition from one stage to another.

One of the hypotheses which I entertained before I carried out this experiment was that children in transition might perform better on the transfer test after a delay than under the immediate condition. This was postulated on the assumption that information is recoded between primary and long-term memory after consolidation has occurred. The data did not support this at all conclusively. A few children did perform better when retested after a delay, and there were overall a few more successes on transfer among subjects in Group D than in Group B, but the differences did not reach significance.

Finally, I would like to consider the following questions which have been touched upon incidentally in this discussion but not responded to directly. The overwhelming success of the children on the retention test confirms the findings of Atkinson, Hansen, and Bernbach (1964; and Hansen, 1965), who studied forgetting in children 4, 5, and 10 years of age, and of Belmont (Belmont and Butterfield, 1969), who studied the ability to remember positions of lights in children from 8 to 20. Their studies plus many others reviewed by Belmont and Butterfield (1969) designed to assess differences in acquisition, retention, and retrieval as they correlate to differences in intellectual development, indicate that retention is independent of intelligence. Acquisition and retrieval strategies reliably reflect age and IQ, but retention does not. The same is true in the present study where ability to pass the transfer test was age and stage dependent, but there is no systematic way of predicting failure on the retention test. Very few of the children at any level failed it.

On the basis of the independence of retention from intellectual development, I would like to assert that cognitive schemes serve as filters at acquisition and retrieval, but do not have a role in retention. At the beginning of my introduction I raised what seemed, at the time, to be an imponderable question when following the lead of Altemeyer et al. (1969), Bresson (1970), Carey (1971), and Voyat (1971) I inquired whether the coding devices (filters) or the traces evolve with cognitive development. If, as has been suggested by this study, developments in cognition result in changes in acquisition and retrieval but not retention, one may conclude, along with Piaget (1968), that the schemes of intelligence (memory in the broad sense) do in fact structure and code the images which compose memory in the narrow sense. That is, according to this view, development of the cognitive schemes determines the manner in which information is processed during acquisition and retrieval. That, when Piaget refers to memory in the broad sense as the whole of intelligence operating upon memory in the narrow sense, he is in reality referring to his more fundamental distinction between the operative and figurative aspects of memory and their interaction. In the present study, a new level of operative development enabled the older children to mentally transform the original figurative representation of the stimulus in order to match it with a new stimulus, different in appearance.

The subjects in this study were divided according to age. Since the differences between the age groups were significant with respect to success on the transfer test our discussion of memory development has been related to age differences. However, the qualitative character of the change which occurs and the correlation of success on the transfer test with performance on the two converging operations suggests the possibility of a stage interpretation of the data. Piaget has devoted little attention to cognitive developments which occur during the third year of life, but the work of Voyat (1969) on identity and Bever (1970) on perceptual strategies suggests that fundamental changes may be occurring at that time. If the findings of this study are supported and elaborated by further work with two year olds we may find that significant structural developments occur at about two and one half. We will then be able to state with confidence that the change manifested in this study is stage rather than merely age dependent.

BIBLIOGRAPHY

Altemeyer, R. A., Fuldon, D., & Berney, K. M. Long-term memory improvement: confirmation of a finding by Piaget. Child development, 1969, 40, 845-858.

Atkinson, R., Hansen, D. N., & Bernback, H. A. Short-term memory in young children. Psychonomic science, 1964, 1, 255-256.

Bartlett, F. C. Remembering. Cambridge: Cambridge University Press, 1967 (originally published, 1932).

Beilin, H. Stimulus and cognitive transformation in conservation. In D. Elkind & J. H. Flavell (Eds.), Studies in cognitive development. New York: Oxford Press, 1969.

Belmont, J. M., & Butterfield, E. C. The relation of short-term memory to development and intelligence. In S. Lipsitt and H. Reese (Eds.), Advances in child development and behavior. New York: Academic Press, 1969.

Bernback, H. A. The effects of labels on short-term memory for colors with nursery school children. Psychonomic science, 1967, 7, 149-150.

Bever, T. G. The comprehension and memory of sentences with temporal relations. In G. B. Flords d'Arcais and W.J.M. Levelt (Eds.), Advances in Psycholinguistics. Amsterdam: North Holland, 1970.

Blackstock, E. Recognition and reconstruction memory for seriation in four and five year olds. Paper presented at the meeting of the Society for Research in Child Development, Minneapolis, April, 1971.

Blake, J. An investigation of speed and strategy in the visual information processing of children and adults using backward masking. Unpublished doctoral dissertation, The City University of New York, 1971.

Bower, G. A multi-component theory of the memory trace. In K. W. Spence and J. T. Spence (Eds.), The psychology of learning and motivation. New York: Academic Press, 1967.

Bransford, J. The problem of conceptual abstraction: Implications for theories of memory and learning. Unpublished manuscript, University of Minnesota, 1969.

Bresson, . Excerpt from discussion of Piaget memory presentation. P. Carey (Trans.), mimeograph, New York, 1970.

Bruner, J. The course of cognitive growth. The American psychologist, 1964, 19, 1-15.

Bruner, J. Eye, hand, and mind. In D. Elkind & J. Flavell (Eds.), Studies in cognitive development. New York: Oxford Press, 1969.

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

Calfee, R. C. Short-term recognition memory in children. Child development, 1970, 1, 145-164.

Carey, P. W. An information processing interpretation of Piaget's memory experiments. Paper presented at the meeting of the Society for Research in Child Development, Minneapolis, April, 1971.

Charlesworth, W. R. Cognition in infancy: Where do we stand in the mid-sixties. Merrill-Palmer quarterly, 1968, 14, 25-46.

Charlesworth, W. R. The role of surprise in cognitive development. In D. Elkind & J. Flavell (Eds.), Studies in cognitive development. New York: Oxford University Press, 1969.

Corsini, D. A., Pick, A. D., & Flavell, J. H. Production of nonverbal mediators in young children. Child development, 1968, 39, 53-68.

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

Corsini, D. A. What is memory development the development of? Paper presented at the meeting of the Society for Research in Child Development, Minneapolis, April, 1971.

Daehler, M. W., Horowitz, A. B., Wynns, F. C., & Flavell, J. H. Verbal and nonverbal rehearsal in children's recall. Child development, 1969, 40, 443-452.

Dahlem, N. W. Reconstitutive memory in kindergarten children. Psychonomic science, 1968, 13.

Dahlem, N. W. Reconstitutive memory in kindergarten children revisited. Psychonomic science, 1969, 17.

Elkind, D. Conservation and concept formation. In D. Elkind & J. H. Flavell (Eds.), Studies in cognitive development. New York: Oxford Press, 1969.

Fantz, R. L. Visual experience in infants: decreased attention to familiar patterns relative to novel ones. Science, 1964, 146, 668-670.

Fantz, R. L. Pattern discrimination and selective attention as determinants of perceptual development from birth. In Perceptual development in children. New York: International Universities Press, 1966.

Ferguson, G. A. Statistical analysis in psychology and education. New York: McGraw Hill, 1966.

Flavell, J. H. Developmental studies of mediated memory. Mimeographed draft of manuscript to appear in Advances in child development and behavior. New York: Academic Press, vol. 5, 1970.

Flavell, J. H., & Wohlwill, J. F. Formal and functional aspects of cognitive development. In D. Elkind and J. H. Flavell (Eds.), Studies in cognitive development. New York: Oxford Press, 1969.

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.

Furth, H. Piaget and knowledge. New Jersey: Prentice Hall, 1969.

Hagen, J. W. Some thoughts on how children learn to remember. Paper presented at the Society of Research in Child Development, Minneapolis, April, 1971.

Hagen, J. W., & Kingsley, P. R. Labeling effects in short-term memory. Child development, 1968, 39, 113-121

Hansen, D. N. Short-term memory and presentation rates with young children. Psychonomic science, 1965, 3, 253-254.

Inhelder, B. Memory and intelligence in the child. In D. Elkind & J. Flavell (Eds.), Studies in cognitive development. New York: Oxford University Press, 1969.

Johnson, N. F. The role of chunking and organization in the process of recall. In G. H. Bower (Ed.), The psychology of learning and motivation, vol. 4. New York: Academic Press, 1970.

Kagan, J. The growth of the "face" schema: theoretical significance and methodological issues. In J. Hellmuth (Ed.), Exceptional child, vol. 1. New York: Bruner/Mazel, 1967.

Kuhlman Hollenberg, C. Functions of visual imagery in the learning and concept formation of children. Child development, 1970, 41, 1003-1016

Lewis, M., Kagan, J., Campbell, H., & Kalafat, J. The cardiac response as a correlate of attention in infants. Child development, 1966, 37, 63-71.

Lewis, M., Kagan, J., & Kalafat, J. Patterns of fixation in the young infant. Child development, 1966, 37, 332-341.

Lewis, M., Goldberg, S., & Campbell, H. A developmental study of information processing within the first three years of life: Response decrement to a redundant signal. Monograph of the Society for Research in Child Development, 1969, 133.

Miller, G. A. The magical number seven plus or minus two: some limits on our capacity for processing information. Psychological review, 1963, 81-97.

Moley, B. E., Olson, F. A., Halwer, T. G., & Flavell, J. H. Production deficiency in young children's clustered recall. Developmental psychology, 1969, 1.

Neisser, U. Cultural and cognitive discontinuity. In T. Gladwin & W. Sturtevant (Eds.), Anthropology and human behavior. Anthropological Society of Washington, D.C., 1962.

Neisser, U. Cognitive psychology. New York: Appleton Century Crofts, 1967.

Piaget, J. _Play, dreams and imitation_. New York: Norton, 1962 (orig. 1951).

Piaget, J. _Origins of intelligence in children_. New York: Norton, 1963 (orig. 1952).

Piaget, J. _On the development of memory and identity_. Boston: Clark University Press, 1968.

Piaget, J., & Inhelder, B. Mental images. In F. Fraisse & J. Piaget (Eds.), _Intelligence_. Vol. 7. New York: Basic Books, 1969.

Piaget, J., Inhelder, B., & Sinclair, H. Memoire et intelligence. In H. Furth, _Piaget and knowledge_. New Jersey: Prentice Hall, 1969.

Piaget, J., & Voyat, G. Recherche sur l'identite d'un corps en developpement et sur celle du mouvement transitif. _Epistemologie et psychologie de l'identite_, 1968, 24, 1-82.

Rossi, L., & Rossi, S. I. Concept utilization, serial order, and recall in nursery-school children. _Child development_, 1965, 36,

Ryan, S. M., Hegion, A. G., & Flavell, H. J. Nonverbal mnemonic mediation in preschool children. _Child development_, 1970, 41, 539-549.

Schachtel, E. On memory and childhood amnesia. _Psychiatry_, 1947, 10, 1-26.

Sinclair, H. The transition from sensory-motor behavior to symbolic activity. _Interchange_, 1970, 1, 119-126.

Sutcliffe, J. P. A general method of analysis of frequency data for multiple classification designs. _Psychology bulletin_, 1957, 54, 134-137.

Voyat, G. Studies on the development of identity cited in J. Piaget, _On the development of memory and identity_. Boston: Clark University Press, 1969.

Voyat, G. Mental imagery and memory. Paper presented at the Graduate Center of the City University of New York, New York, 1971.

APPENDIX

Raw Data for All Subjects Classified According to Age (24-27 months, 28-31 months, 32-36 months) and Experimental Group (A: Immediate Retention, B: Immediate Transfer, C: Delayed Retention, D: Delayed Transfer)

Subject	Age (monthly)	Pass/Fail Retention	Picture Vocabulary Score	Object Picture Score	No. Animals Labeled	Labels Discrim. Stimulus	Delayed Retention	Delayed Transfer	Urban or Suburban
24-27 Experimental Group A (Immediate Retention)									
1 Maggie	27	pass	12	9	3	*		+pass	S
2 Missy	27	pass	2	0	0			fail	S
3 Rachel	26	pass	6	0	0			fail	U
4 Michael	24	pass	0	0	0			fail	S
5 David	24	pass	6	0	1			fail	S
6 Marcia	24	pass	12	0	1			fail	S
7 Noah	24	pass	9	0	1	*		fail	U
8 Jason	26	pass	10	9	3	*		fail	U
9 Mathew	24	pass	5	0	3	*		fail	U
10 John	26	fail	5	0	0			fail	S

24-27 Experimental Group B (Immediate Transfer)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
11 Blair	26	pass	12	9	3	*	pass		U
12 Rachel	26	fail	8	0	2	*	fail		S
13 Edith	25	fail	7	0	2		pass		
14 Laura	24	fail	12	4	1	*	pass		S
15 Richard	24	fail	9	1	3	*	pass		S
16 Stevie	24	fail	11	0	2			fail	U
17 Jason	27	fail	0	0	0			fail	U
18 Elizabeth	24	fail	1	1	1			fail	S
19 Andy	24	fail	10	9	3	*		fail	U
20 Jenny	27	fail	13	8	1			pass	S

24-27 Experimental Group C (Delayed Retention)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
21 Doug	26	pass	14	9	3	*			S
22 Joanna	24	pass	11	9	2	*			U
23 Kathy	24	pass	16	0	3	*			U
24 Andy	27	pass	12	0	2	*			U
25 Mathew	27	pass	2	3	0				S
26 Jennifer	24	pass	1	0	0				U
27 Steven	24	pass	4	0	0				S
28 Joanna	26	pass	11	9	3	*			U
29 Niko	25	pass	10	0	3	*			S
30 Arthur	24	fail	10	0	2	*			U

24-27 Experimental Group D (Delayed Transfer)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
31 Maomi	25	pass	4	8	0				U
32 Alexander	26	fail	10	2	1				S
33 Adam	26	fail	7	1	1	*			S
34 Jenny	26	fail	0	5	0				U
35 Cory	26	fail	10	7	2				S
36 Sara	27	fail	9	2	3	*			S
37 Greg	25	fail	7	0	3	*			U
38 Laurie	27	fail	9	0	2	*			U
39 David	27	fail	0	0	0				S
40 Josh	25	fail	10	0	2	*			U

28-31 Experimental Group A (Immediate Retention)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
41 Louis	30	pass	12	7	2			pass	S
42 Remy	31	pass	8	8	2	*		pass	U
43 Kity	28	pass	13	9	2	*		pass	U
44 Merel	31	pass	13	9	3	*		pass	U
45 Michelle	28	pass	12	9	3	*		pass	S
46 Melissa	31	pass	13	9	3	*		pass	S
47 Steven	31	pass	11	9	2	*		fail	U
48 Boo	28	pass	13	2	3	*		fail	U
49 Brian	31	pass	8	0	3	*		fail	S
50 Andrew	29	pass	14	7	3	*		fail	U

		28-31	Experimental Group B (Immediate Transfer)						
Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
51 Dee	31	pass	16	9	3	*	pass		S
52 Rachel	28	pass	15	7	3	*	pass		S
53 Greg	31	fail	12	9	2	*	pass		U
54 Liz	30	fail	12	0	2		pass		U
55 Tory	31	pass	13	9	2		pass		U
56 Kate	28	pass	14	9	3	*		pass	S
57 Andy	29	fail	3	0	0			fail	S
58 Greg	30	fail	14	2	0			pass	S
59 May	29	fail	14	5	3	*		fail	U
60 James	29	fail	14	9	2	*		pass	U

28-31 Experimental Group C (Delayed Retention)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
61 Tommy	28	pass	16	9	2	*			S
62 Amanda	29	pass	15	9	3	*			U
63 Amon	30	pass	16	9	3	*			S
64 Juan	30	pass	11	9	2	*			U
65 Dora	28	pass	13	8	0				S
66 Susan	30	pass	15	9	3	*			U
67 Barbara	31	pass	14	9	1	*			U
68 Diane	31	pass	10	8	2	*			U
69 Maye	31	fail	10	9	2				S
70 Henry	30	fail	11	7	2				S

28-31 Experimental Group D (Delayed Transfer)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
71 Karl	28	pass	10	3	3	*			U
72 Terry	30	pass	13	9	3	*			S
73 Jenny	28	pass	16	9	3	*			S
74 Carrie	29	pass	9	7	1				S
75 Oliver	30	pass	14	9	2	*			S
76 Ben	31	pass	15	9	3	*			S
77 Jeff	31	pass	15	9	3	*			U
78 Sarah	28	fail	5	0	2	*			S
79 Mark	29	fail	7	3	2	*			S
80 Kristin	30	fail	11	9	3	*			U

32-35 Experimental Group A (Immediate Retention)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
81 William	35	pass	9	9	3	*		pass	S
82 Deane	33	pass	15	9	3	*		pass	U
83 Christain	32	pass	9	2	3	*		fail	S
84 Brian	36	pass	12	7	1	*		pass	S
85 Mathew	35	pass	13	8	3	*		pass	U
86 Ian	35	pass	12	9	2			pass	S
87 Natasha	33	pass	16	9	3	*		pass	U
88 Robbie	35	pass	15	9	3	*		pass	U
89 Jessie	33	pass	16	9	3	*		pass	S
90 Rolf	33	pass	15	9	3	*		pass	U

32-35 Experimental Group B (Immediate Transfer)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
91 Jossien	33	pass	16	9	3	*	pass		U
92 Brent	36	pass	13	9	3	*	pass		S
93 Steve	35	pass	13	9	1	*	pass		U
94 Cindy	33	pass	8	9	3	*	pass		S
95 Jacob	34	pass	13	9	3	*	pass		U
96 Dana	36	pass	14	9	2			pass	U
97 John	34	pass	14	9	3	*		pass	S
98 Wilma	36	pass	11	9	3	*		pass	S
99 Shayn	32	pass	10	7	1	*		pass	U
100 Evon	33	pass	13	6	3	*		pass	S

32-35 Experimental Group C (Delayed Retention

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
101 Beth	36	pass	13	9	3	*			S
102 Kevin	34	pass	15	9	3	*			S
103 Christie	36	pass	10	9	1				S
104 Jennifer	32	pass	7	6	0	*			S
105 Kim	33	pass	11	8	2				S
106 Dean	35	pass	15	7	3	*			U
107 Henry	33	pass	13	9	3	*			U
108 Ben	32	pass	15	9	2	*			U
109 Josh	32	pass	16	9	3	*			U
110 Orin	33	pass	13	9	2	*			U

32-35 Experimental Group D (Delayed Transfer)

Subject	Age	P/F	PV	OP	L	LDS	DR	DT	U/S
111 Dana	31	pass	15	5	2	*			S
112 Michelle	34	pass	11	9	1	*			S
113 Amy	36	pass	17	9	2	*			S
114 Emily	32	pass	13	8	2	*			S
115 Ben	36	pass	13	9	3	*			S
116 Julliet	32	pass	13	9	2	*			U
117 Michael	33	pass	15	9	3	*			U
118 Erica	36	pass	15	7	3	*			U
119 Greg	32	pass	12	9	2	*			U
120 Kyle	34	fail	10	7	1	*			U