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ABSTRACT

In order to gain a greater understanding of the intellectual strengths and weaknesses of the young child, a test was developed (for which data collection is ongoing) to investigate a broad range of cognitive skills in the three- to five-year age range. The test covers skills within four main spheres--cognitively Directed Perception, Concepts and the Process of Verbal Coding, Problem-Solving Skills, and Spatial Representation. Each skill area is assessed by approximately 8 to 10 questions. A basic assumption of the test is that when a child passes or fails a particular question, he does so not because of the specific information involved, but because he has mastered, or failed to master, the skills or ability underlying that question. The test contains 240 items and is given in four half-hour testing sessions. The items designed to test any one skill are not administered together. The test is given in two forms, identical except for the order of the items. In Cognitively Directed Perception, one of the abilities sampled is Visual Search, the ability to scan a complex visual array to locate a particular object. In Concepts and Coding, concepts such as "not", "same", and "different" are tested. The range of skills in Problem Solving focus on why, how, and if. For Spatial Representation, spatial patterns must be reproduced. For scoring and interpretation, correctness of the response, form of the incorrect response, and reaction time will be considered. [Filmed from best available copy.] (KM)

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The Analysis of Cognitive Abilities in the Preschool Age*

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In recent years, we have witnessed renewed interest in the learning of the preschool age child. As is well-known, this interest was initially marked by an almost unbounded enthusiasm about the value of early education, particularly for those groups of children who were likely to experience difficulty in later academic work. When many initial efforts failed to yield significant results, signs of disillusionment arose and investigators began to deemphasize the early years in order to put greater effort toward the learning of the older child (see Silberman, 1970).

Unfortunately, much of this debate has had to proceed on the basis of inadequate information. Thus, while there has been great emphasis on the early years as a period of rapid learning and high modifiability (Bloom, 1964; Hunt, 1961), the actual skills and abilities of the young child have not been clearly established. The picture is even more complex than this, however, for in many studies where skills have been analyzed, the findings have been interpreted to indicate that the young child does not have those skills which might profit from exposure to formal educational efforts. This emphasis is seen most clearly in the work of Piaget (1959) where he states that the vast percentage of the young child's thinking and language is egocentric so that it is extremely rare to have any meaningful intellectual interchange at that age. This is not to deny that his thinking constantly develops; rather it tends to deny the possible value of structured intentional effort at education.

Questions about the learning skills and styles of the young child must be answered if we

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are to make judicious decisions about the feasibility and practicability of early education. Any decision, however, cannot be arrived at until we have a much wider understanding of the intellectual strengths and weaknesses of the young child. The work I am about to describe represents one of the efforts that is currently being developed in this area. It concerns an extensive test designed to tap a broad range of cognitive skills in the three to five year age range. Its major purposes are:

1. to define some of the major cognitive skills available in the preschool years,
2. to identify some of the major parameters that increase or decrease the complexity of some of the major cognitive tasks a young child might confront (e.g., the presence vs. the absence of concrete cues; the presence of conflicting cues, etc.),
3. to identify the skills that differentiate children who are likely to function effectively in the academic sphere from those who are likely to find difficulty in this sphere,
4. to determine the patterns of thinking that underlie incorrect responses (e.g., associational responses, irrelevant verbalization, etc.) in an effort to ascertain whether such patterns differ systematically
 - (a) among individuals
 - (b) among age groups
 - (c) according to the type of cognitive skill demanded

With these goals in mind, I would now like to describe the test that has been developed. We are just in the midst of data collection. Therefore, I will not be able to report conclusive findings although I will be able to offer some preliminary results that were obtained in the pilot

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work. The major thrust of the paper, however, will be directed towards elaborating upon the design of the test and upon the assumptions and ideas underlying the various items.

The test covers skills within four main spheres -- these are:

1. Cognitively Directed Perception
2. Concepts and the Process of Verbal Coding
3. Problem Solving Skills
4. Spatial Representation

In turn, within each of these areas, a number of separate abilities or skills have been delineated. As the test currently stands Cognitively Directed Perception samples 4 main skills, Concepts and Coding sample 15, Problem Solving samples 8, and Spatial Representation samples 4. Each of these skill areas is assessed by approximately eight to ten questions. A basic assumption of the test is that when a child passes (or fails) a particular question, he does so not because of the specific information involved, but rather because he has mastered (or failed to master) the skill or ability underlying that question. For example, a child may be asked a question where he must consider two attributes of an object (e.g., "find me a car that is little and green"). If he is able to succeed on this task, then it is hypothesized that he will be able to succeed on all comparable tasks, even though the information involved is different (e.g., "find me a doll that is sitting and smiling").

This assumption is naturally subject to qualification. Thus, if a child did not comprehend a particular word or phrase, he might well fail one item while succeeding on another. The possibility of this occurring will be lessened however, if the informational aspects of the items are kept to a minimum. Accordingly, the items are uniformly designed to employ simple,

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common materials that are familiar to all children both in terms of their sensori-motor experience and the specific verbal labels attached to these objects.

Though useful, these constraints do not settle the basic problem -- namely, by what principles does one determine the particular items that will be formulated to tap each skill area. This is a difficult question to answer, for so many factors came into play, including the theoretical work in this area (Vygotsky, 1962; Piaget, 1959), normative material obtained from tests such as the Stanford-Binet, and anecdotal reports on the skills of young children (Isaacs, 1930). The most central influence, however, was the experience gained through structured dialogues with preschool age children (Blank & Solomon, 1968, 1969). Based upon these interchanges, a framework was constructed to define some of the major cognitive skills developing in the 3 to 5 year age period (see Blank, 1970 for a fuller description of this framework).

At this point, it is perhaps best to exemplify the way in which one set of skills was defined since this will express much of the thinking behind the design of the test. For example, one of the higher level concepts that appears to become available to the preschool age child is the concept of not. By this, I do not refer to simple grammatical negation (e.g., "I don't want....") but rather to the use of not to modify a category (e.g., name some things you can travel in that are not cars). This latter use of not is vital to cognitive functioning for it allows the child to evaluate an object, not by itself, but by its relationship to a broader, but relevant framework. In this sense, the concept of not may offer the young child an entree into thinking about objects according to superordinate groupings.

The ease with which the child may accomplish a task involving this concept of not

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will, of course, depend upon a variety of factors. Based upon the pilot work, it appeared that the factors most likely to be significant were whether

(a) the objects under discussion actually were present or just raised through verbal problems

(b) the type of grouping that had to be negated (e.g., a single object, a cluster of items, etc.).

Accordingly, as shown in Table 1, and in line with Goal 2 above, a group of items were devised which reflect these characteristics. The items illustrated in that table represent only 6 of the 18 items that are actually in the test to assess the child's grasp of the concept.

This type of analysis was used in the construction of all the items in the test; that is a major skill was defined and items were constructed. In addition based upon the pilot results, two or three key factors likely to affect performance in this skill were defined and permutations of the items were devised in order to assess the importance of these factors. While the particular factors so assessed vary across the different skills, some of the most common ones are

(a) the presence or absence of concrete cues

(b) the effect of indirect verbal definitions as opposed to single labels (e.g., referring to an object as a "scissors" vs. referring to it as "something that cuts")

(c) the imposition of demands prior to the presentation of the material or after the withdrawal of the material (e.g., saying "look at these things carefully because I want you to remember them" vs. showing the same objects without any specific instructions and then asking the child to recall them after the objects have been withdrawn from view). This permits

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us to assess the strategies used by children in the absence of specific direction from the adult.

The test contains 240 items in all. The items are distributed into four separate testing sessions, with each session lasting approximately one half hour. The items designed to test any one skill are not administered together (in contrast to the procedure used in the Wechsler Intelligence Tests), but rather they are distributed across the days of the test. This procedure was established to maximize the child's interest and to lessen the risk of a block of failure, should the child be confronted with a particular kind of task that he is unable to handle. The test is given in two forms; the items in each form are identical but the order of the items varies. This enables us to determine whether variations in performance (e.g., improvement over time) in an area are due to the particular content of the item or to practice over days.

To convey a clearer picture of the test, it seems useful to present one item from each major sphere. Thus, in the sphere of Cognitively Directed Perception, one of the abilities sampled is Visual Search -- that is, the ability to scan a complex visual array for the purpose of locating a particular object. Figure 1 shows one item designed to test this ability. As in the case of the not items, the task is presented in a variety of permutations, given over a period of days. These are:

- 1) search guided by a physical model -- that is, an object is shown, it is withdrawn, the card is exposed, and the child is asked to find a picture of the object he has just seen

- 2) search guided by a verbally defined function -- the child is given a functional definition of an object (e.g., "something to cut with") and is asked to find a picture of this item

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3) search guided by a verbally defined function and an associated perceptual cue -- an item is shown (e.g., an egg) and the child is asked to find a picture of an object necessary to perform some activity with this item (e.g., "find me something to cook this in") (see Hooper, 1970 for related type of design).

These variations are included in an effort to determine whether difficulties in isolating parts of a field depend upon a) perceptual complexity of the field itself, b) the need to use verbal information to guide a perceptual analysis, or c) the need to interpret perceptual cues, rather than to use them simply as direct models (as, for example, occurs in the first permutation).

The second major sphere that is assessed is Concepts and Coding. The Not example above represents one of the skills tested in this sphere. Another skill that is sampled is the concept of "same" and "different." This skill is included not because of its proven importance in the general assessment of intelligence, but rather because it is deemed central to the long-standing issue of the relationship between the word and its referent. Specialists in the area of language development have consistently emphasized the way in which the child binds the word to its referent (e.g., once he learns to label a particular object he will object vehemently if one suggests, in some way, that the label is arbitrary and could be changed). This binding process seems to have important ramifications for the way in which the child will perceive material. In particular, what seems to occur is that

- 1) similar items with different labels lose their similarity (e.g., a house and a garage are almost never seen as alike once their differentiating labels are acquired)
- 2) different items with the same label lose their distinctiveness (e.g., so many

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different kinds of animals are called "dogs" that the child overgeneralizes this label to many four-legged furry animals)

In order to begin to test this process more adequately, we have constructed a series of items which contain pairs of objects -- each pair either a) shares a common label (e.g., cup -- cup) or is designated by different labels (e.g., truck -- bus), or b) shares many physical characteristics (e.g., color, size, texture) or is marked by very different characteristics (e.g., a red paper cup without a handle vs. a blue glass cup with a handle).

Figure 2 depicts two such items. The questions put to the child in each case are -- How are these things alike? and How are these things different? Among the findings that are expected are:

- 1) even when the perceptual impression is one of difference the presence of a common label will help the child report similarities while the absence of a common label will interfere with the awareness of similarities;

- 2) when the perceptual impression is one of similarity, the presence of a common label will make it difficult for the children to report a difference while the presence of different labels will facilitate the awareness of differences.

The third sphere that is assessed is that of Problem Solving. The range of skills in this sphere focus on questions represented best by the terms "why" "how" and "if." One skill tested is that involving imagery where hypothetical changes are proposed relative to an item or a set of items. For example, a child may be shown a vertical stack of colored blocks. The examiner points to the block on the bottom and asks "if I took this one away, what would

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happen?" From the pilot work, this sphere appears to tap some of the striking differences between children who perform well in the cognitive setting and those who do not. At first, it may appear that the differences are caused by the complexity of the language (e.g., possible failure to comprehend the "if" formulation). Further analysis suggests, however, that the major factor is not the question alone, but the relationship of the question to the context. In particular, three features seem central: these refer to whether the question refers to a situation 1) which is unusual vs. one which is common; 2) which contains a limited number of stimuli vs. one which contains a complex array; 3) where an action has been performed that the child has observed vs. a situation where no action has been observed.

Because of the importance of these factors, the identical question can be exceedingly difficult or remarkably simple for the young child. For example, in a naturalistic situation, the child might be asked the question, "Why is it light in this room?" A correct answer would be almost certain if the conditions had been such that initially the room a) had been dark (a relatively unusual occurrence in the school); b) contained relatively few objects in view (limited stimuli) and c) was lighted by the teacher turning a switch which the child could observe (action observed). On the other hand, a correct answer is much more doubtful if the child walks into a room where a) a light is coming in through the windows; b) many objects are present and c) no action was performed to change the state of the lighting. This example is, of course, somewhat extreme since in any two natural settings, it is unlikely that all three parameters would be so dramatically opposed. It was included here merely to highlight the importance of contextual variables in affecting children's problem solving performance and to illustrate the fact that it is rarely valuable in a cognitive setting to consider linguistic parameters apart from any other factors.

The fourth sphere assessed in the test is Spatial Representation. In this area, the children are asked to reproduce spatial patterns of varying types (e.g., geometric forms such as a square; a sequence of colors, etc.). Motor skill is kept to a minimum by avoiding any need to draw and relying instead on preformed materials which the child must place into an organization (e.g., discs, sticks, blocks, etc.). A sample skill in this sphere might be the reproduction of complex sequences such as copying a row of discs where the discs are alternately red or yellow. The permutations in this task, and on all the tasks in this sphere are different from those in the three spheres outlined above. In particular, the permutations here are based upon a systematic set of techniques designed to simplify the items in those cases where a child fails. This procedure was selected since this sphere lends itself to more careful control than do the other areas. Thus, the most complex demand presented to the child is one where he is shown a two dimensional (pictured) model of an object or design, the model is withdrawn and then the child is asked to reproduce it from memory with three dimensional materials. The first simplification following this is to have the two-dimensional model in front of the child; the next is to present a three dimensional model identical to the one he is to make, and the last simplification is to actually construct the model in front of the child and then have him make his model following this.

An issue of central concern in a test with such a broad array of skills is the method of interpreting the results. Any answer to this problem hinges, in large measure, on the method of scoring -- that is, on the way in which the children's responses are assessed. Currently, we are working on three major parameters. These are:

1. the correctness of the response -- this is based on a three point scale of correct, part correct and incorrect. This is only a gross assessment but it permits us to gain an overview

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of the skills that may be strong or weak in a child, an age group, or any other particular subgroup (e.g., sex, socio-economic background, etc.).

2. the form of the incorrect response. For this purpose we have devised a series of analyses to permit us to code any incorrect response. Three main types of analysis cover the entire test, in that any items analyzed falls into one of these three patterns. One such pattern is presented in Table 2. In general, it proceeds from higher level, albeit incorrect, performance to lower level performance. This particular analysis is applicable to the majority of items -- and it is particularly suited to items where the child must produce a verbal response. Table 3 shows the pattern that has been devised for the analysis of errors on the spatial representational items (see Haworth, for a similar analysis). The third analysis, which has been developed, is designed mainly for multiple choice items (e.g., those tasks where the child, given 5 items, is asked to select a particular one on the basis of some concept or principle); it is designed to indicate whether there were particular preferences in the choice of objects when an incorrect choice was made.

The analysis of the errors is vital for any future effort at diagnostic teaching in that the paths open to the teacher vary significantly as a function of the error that has been committed (e.g., if asked "why did the knife cut better than the spoon?" a child who says "because it's longer" (termed an associational error) must be responded to differently from a child who says "I saw one like that in the store, "). What we are particular / interested in at this point is to determine whether particular groups of children establish different but consistent error patterns (e.g., do the errors of hyperactive children take a different form than do the errors of withdrawn children?).

3. Reaction time is the third measure of assessment. It refers to the length of time it takes a child to offer a response (and, in a few tasks, such as reproduction of forms, it refers to the length of time a child works on a problem). This measure can serve a variety of purposes. First, the speed of response has received particular attention in research on children's learning since it is deemed to be a measure of impulsivity -- reflectivity (Kagan, 1965). Our own work has suggested that this latter continuum might be modified to include a distinction among children who are slow to respond. Thus, while some of these children are reflective and use the time to ponder over the material, others are withdrawn, non-responsive children who avoid the tasks. If these patterns of reaction are an important feature of the child's interaction with his environment, then we should be able to see relatively consistent patterns of reaction time across the four days of the test. Any such pattern of reaction might well interact with skill attainment in that the children may show different patterns of response to items where they are successful and to those where they fail.

Another possible application of the reaction time measure is the assessment of task difficulty. Resenberg (1970) in analyzing the referential function of language discusses this use of reaction time. For example, he suggests that in situations where the listener must carefully evaluate the information he is receiving and attempts to do so, his latency will be slow; on the other hand, if he makes no such effort, his latency will be much faster. We may find an analogous pattern in our results in that in the initial acquisition of a skill, the reaction times may be much more than when the skill has been securely established. For example, 3 year olds may pass the search item as effectively as 4 year olds, but they may take a much longer time to do so since the task demands much more of them than it does of

the older child (just as having to read a set of words for an adult can be almost an effortless task while it is arduous for the first grader).

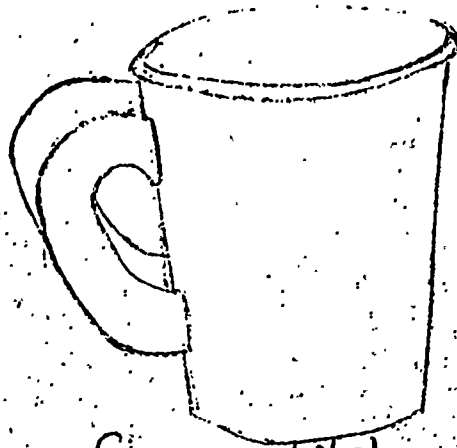
At this point we are directly in the midst of the data collection and therefore I cannot present any firm results. However, I thought it would be worthwhile to point up some findings from the pilot study in order to indicate some of the expected results. Table 4 presents some of these findings and for most part, I believe they are self-explanatory. I would, however, like to emphasize one feature that seems of particular relevance to issues in compensatory preschool education. As shown in the first four tasks outlined in Table 4, there are almost no differences between the lower class and middle class children on skills which require the child to produce relevant verbal associations to material (e.g., labeling objects, completing a sentence, etc.).

Marked differences occur, however, when the child must independently impose an organization on material (e.g., sequencing pictures into a story), evaluate material according to a broad, rather than a specific constraint (the "not" item), and in general, use the immediately presented material not as a sufficient unit but merely as a beginning point of reference through which he can evoke relevant, but not present, ideas. Results such as these seem to have relevance to the major controversy about language acquisition and language usage among children from disadvantaged backgrounds. Thus, if these results are maintained in our new series of tests, they would suggest that it is not only valueless, but actually unnecessary to develop compensatory programs geared to an undifferentiated press for the enhancement of language. Instead, they suggest the need for much more delineated programs

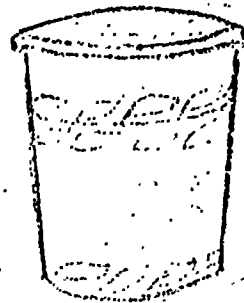
where the child is helped to learn how to bring to bear the language he processes in coping with relatively complex problem situations. Any generalization, such as this, must be taken with extreme caution; for the results are far from final. They are presented here only to illustrate the ways in which these findings might serve in the development of curricula for the young child.

References

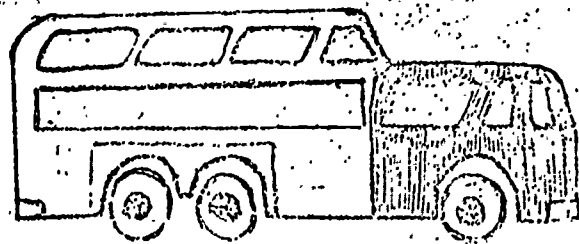
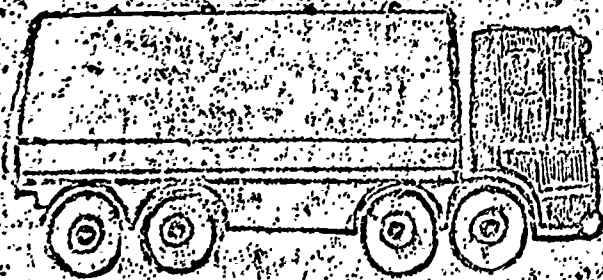
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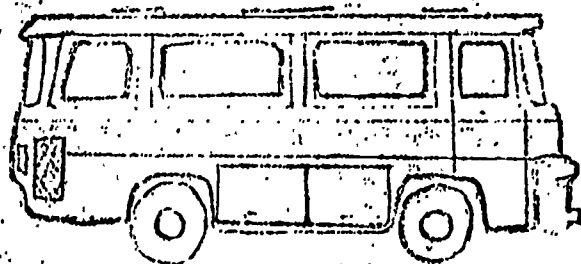
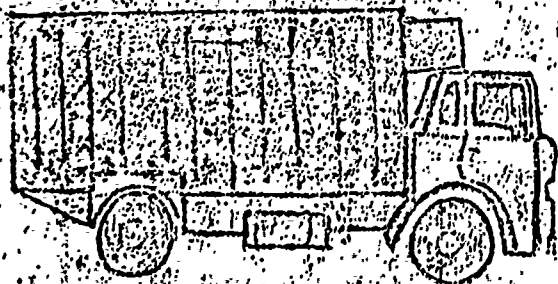
Minimum Difference - Common Label



Maximum Difference - Common Label



Minimum Difference - No Common Label



Maximum Difference - No Common Label

Figure 2. Sample Materials for "Same-Different" Question

TABLE 2 - ANALYSIS OF RESPONSES FOR
QUESTION TYPE-RATIONALE FOR OBSERVATION,
BEHAVIOR AND EVENTS

Question: Picture of a smiling vs. a non-smiling girl--"This girl is happy
and this one is not. How do I know which one is happy?"

that is

CORRECT	DIRECTLY NOTES RELEVANT CHARACTERISTIC. "She's smiling."
PART CORRECT	GIVES RELEVANT CHARACTERISTIC WITHOUT CLEAR SPECIFICATION. "She looks happy." "Because her face."
INCORRECT DIVERGENCE	DESCRIBING VALID BUT NOT FOCAL ATTRIBUTE "She's not crying." - <i>another context correct</i>
ASSOCIATED BUT TANGENTIAL CHARACTERISTIC	GIVES CHARACTERISTIC WHICH IS ASSOCIATED BUT NOT TO THE STIMULUS. "She has nice pants."
AMBIGUOUS	UNFOCUSED RESPONSE WHICH CANNOT BE ASSESSED WITHOUT CLARIFICATION. "I can see." (This response is prompted.)
MATCH	REPEATS DESCRIPTION. "She's happy."
OPPOSITE MATCH	REPEATS DESCRIPTION - MODIFIED FOR OPPOSITE PAIR. "She's not happy."
IRRELEVANT	STATES SOME CONTEXTUAL ASSOCIATION TO THE MATERIAL. "She got hair like my mommy."
"DON'T KNOW" (VERBAL)	
NO RESPONSE	
NON-WORK	
DON'T KNOW (GESTURE OR SHRUG)	

TABLE 3 - ANALYSIS OF RESPONSES FOR REPRODUCTION OF GEOMETRIC FORMS




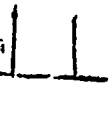



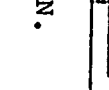
CORRECT	CORRECT FORM.	
PART CORRECT	SIMILAR TO FIGURE BUT WITH A MINOR MISTAKE.	
INCORRECT ROTATION OR REVERSAL	ROTATION OF WHOLE. ANY CHANGE IN ORIENTATION INCLUDING MIRROR IMAGE.	
ROTATION OR PARTS/WRONG ORDER	ONE OF THE PARTS IS IN WRONG ORIENTATION.	
OMISSION	INCOMPLETE, LEAVES OUT A PART OF FIGURE.	
DISTORTION	RETENTION OF SOME PARTS. SOME BASIC SIMILARITY.	
USED EXTRA	PLACES ADDITIONAL PIECES THAT ARE PROVIDED.	
RANDOM	PLACES STICKS ON TOP OF EACH OTHER OR IN RANDOM PATTERN.	
"DON'T KNOW" (VERBAL)		
NO RESPONSE		
NON-WORK		
DON'T KNOW (GESTURE OR SHRUG)		

TABLE 4 - PARTIAL SUMMARY OF THE INITIAL TEST RESULTS

% who succeeded (approximately 8 to 10 S's per group)

Task	SE	MC	LC	MC	LC	MC	LC
	Age	3	3	4	4	5	5
Concept labeling		90	88	98	95	100	98
Separation of Word and Referent		95	100	95	95	100	95
Description of Pictured Events		77	70	84	78	94	95
Completion of Verbal Sequences		79	67	89	85	79	87
Negation Specific		100	95	100	95	95	90
Constraints of Group		44	15	61	20	79	50
Pictorial Sequences		00	00	44	7	80	23
Rationale for Coding		38	05	61	20	85	30
Separation of Word from its Context		76	05	78	22	70	55

EXAMPLE TEST ITEMS OF RESULTS DESCRIBED IN TABLE 4

1. Concepts label - "What is this" - referring to a cup, car, pencil, scissors.
2. Separation of Word and Referent - Look at this. Don't tell me its name now. Later, when I take it away, tell me.
3. Description of Pictured Events - Tell me what's happening in the picture ("boy riding a bicycle")
4. Completion of Verbal Sequences - Finish the sentence
"Every morning I go to _____"
5. Negation - Specific - "Get me something that is not a car."
- Constraints on the group - "Get me something different that writes that is not a pencil."
6. Pictorial Sequences - "Put these pictures together to tell a story."
7. Rationale for Coding - "Why do we call this a buttonhole and not a keyhole?"
8. Separation of Word from its Context - "I'll say something loud and you whisper it to me."