THE RELATIONSHIP BETWEEN TIME CONCEPTUALIZATION AND TIME LANGUAGE IN YOUNG CHILDREN

by

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ABSTRACT

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This study examined the relationship between language and thought through the study of the child's development of the notion of time and the development of those aspects of language that express temporal relations (time language). Based upon Piaget's treatment of the development of time concepts, and psycholinguists' data of the development of time language, the study tested the following hypotheses: (1) Cognitive development precedes or is concomitant with linguistic development. Specifically children must acquire reversible operations before they can comprehend or produce tenses such as the present perfect and the past progressive, or can use correctly before and after in both positions in a sentence. (2) At later stages of conceptual development (ages 5-7), yet prior to the development of certain concrete operations (age 8), the child's language in and of itself will not be sufficient to advance him to the next stages of operational thinking.

Five groups of children, 12 nursery Ss, 29 kindergartners, 29 first graders, 30 second graders, and 30 9-, 10- and 11-year old children, were administered, individually, a series of time concept (both verbal and non-verbal) and time language tasks.

The language tasks consisted of: 9 syntax items which tested the following: present progressive, past, future, present perfect, past progressive and the conditional, and 7 vocabulary items which tested the following words: fast, slow, first, last, more(longer) time, less (shorter) time; 4 Before/after constructions (After X, Y; X before Y; [illegible] X; Before Y, X).

The time-concept measures included: a reversibility-time-seriation task, a Piaget-time concept task consisting of 5 situation; and a time concept attainment task based on a discrimination model. The latter task also included a verbal training procedure. The language productions of the children were recorded for all the concept measures.

The language measures used in this study indicated that speed words were the easiest whereas words dealing with duration were the most difficult. Tenses such as the present, past, future were mastered by more than 75% of the subjects whereas the past progressive was mastered by not more than 50% of the Ss. The language measures emphasized the importance of the context within which a lexical item is presented. Children may comprehend an item within one context but not within another. Analyses of the Piaget Time-Concept Tasks indicated that the order of difficulty of the items was similar to that of Piaget's and closely approximated scalability criterion. The children's explanations revealed that time space, distance and speed were confused, lending support to Piaget's conception of the child's development of time.

The overall relationship among the above measures indicated that reversibility operations precede developmentally the past progressive tense, and the before/after connectives when the order of events are

the reverse of the order in which the sentence is spoken. The relationship between the language measures and the concept measures were significantly correlated. However none of the correlations within each grade were significant nor were there any significant correlations between specific Piaget situations and vocabulary and syntax scores.

The language productions of the Ss revealed a relationship between correct score on the Piaget situation and type of cognitive explanation used. Language explanations given after the concept-attainment task and prior to verbal training indicated that there was a tendency for the younger Ss who were trainable to use the response patterns of the older Ss while there was a tendency for the older Ss who were not trainable to use the response patterns of the younger Ss.

The second hypothesis, that language was not a sufficient condition to advance operational thinking was confirmed. When the language was used appropriately it only acted as dependent variable, an expression of a cognitive structure already present.

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CHAPTER I

INTRODUCTION

This study examined the relationship between language and thought through the analysis of the child's development of the notion of time and the development of those aspects of language that express temporal relations (time language). There is a long history concerning the relationship between cognition and language. Chomsky (1966), in his history of linguistics, points out that the study of language has always contained some psychological assumptions. As early as the 17th century Descartes justified a failure to formulate rules of sentence construction because the "sequence of words in a sentence correspond directly to the flow of thought [p. 25]." In the mid-nineteenth century, J. S. Mill felt that "grammar...is the beginning of the analysis of the thinking process [in Chomsky, 1966, p. 95]." In the early part of the 20th century, some linguists rejected the notion that cognitive processes should be studied as part of linguistics (Bloomfield, 1933). Cognitivists, however, have always paid some attention to language development within their cognitive theories (Piaget, 1926; Vygotsky, 1962), although the last ten years represent the beginning of a major effort to explain language development and the role that cognition plays within language. (Piaget, 1963; Bruner, 1966; Beilin, 1969b). There are now several major theoretical views concerning the language/cognition relationship.

According to one view, the source of intellectual operations has its roots in the sensorimotor period, that is, the pre-language phase of development and both language and cognitive operations emerge from the

development of the symbolic function (Piaget, 1963; Sinclair-de-Zwart, 1968; Furth, 1969).

Language acquisition in this general position, is dependent upon the child's possessing of relevant cognitive structures (Piaget, 1963). Beilin (1969b) has shown that the child's ability to form plurals is related to his acquisition of number conceptualization. Similarly, research conducted with educable retarded children suggests that the ability to inflect is dependent on level of operational thought (Lovell, 1968). In addition, both Cromer (1968) and Slobin (1966) have found that although a child has been exposed to certain forms, structures and words with a high frequency, he fails to acquire them until he has reached a particular stage of cognitive development. Forms of the perfect tense were found throughout the mother's protocols, and although the child had a sufficient sentence span and the elements necessary to form the perfect tense he did not do this until after age 4;6 (Cromer, 1968). Similarly, Russian research has shown that the emergence of certain morphological categories can be explained in terms of conceptual difficulty. The conditional is late in emerging in the child's speech although its grammatical structure is exceedingly simple (Slobin, 1966).

While the processes of language and thought development may be synchronized after the sensorimotor period, the acquisition of language is not necessary or sufficient for the development of preoperational or concrete thought processes. Two different sources of evidence have been cited to support this view. One source derives from studies comparing deaf-mute children with normal-hearing children. These studies have shown that the deaf show only slight retardation in the acquisition of elementary operations (Furth, 1966). The second source stems

from studies which investigate the relationship between language development and the stages of operational thought. Inhelder et al. (1966) and Sinclair-de-Zwart (1968) studied children's verbal productions in relation to their ability to solve conservation tasks. They found that children who solved conservation problems used pairs of coordinated descriptions in the same sentence when describing a problem which varied in two dimensions (e.g., "he has more beads but they are smaller"); non-conservers lacked this linguistic form. Appropriate linguistic training did not improve conservation performance and only in the case where an intermediate stage had been reached was there progress to the next stage. Beilin (1969a), on the other hand, offers evidence that providing the non-conserving child with a verbal rule significantly improved conservation performance. However, he states that "it is questionable whether what is achieved is true conservation (Beilin, 1969a)."

Some developmental psycholinguists, particularly of the transformational school, have regarded language and thought processes as independent. However, they feel that the child is endowed with an innate structure, the "language acquisition device" which guides the first stages of linguistic development (McNeill, 1966). Only a minimal amount of exposure to speech is required for language to emerge (Miller and Chomsky, 1963). These linguists cite as evidence the seemingly wide discrepancy between the four-year-old child's inability to solve Piagetian type problems and the fact that by that age he has acquired all the complex rules of grammar (McNeill, 1966). They feel that to account for the rapid growth in grammatical competence they must appeal to some innate explanation. Thus, these linguistics would not concur with Piaget that certain intellectual operations obtained in the pre-language period are

necessary for the development of language. More recently, Bever (1970) argues that some substantive as well as formal universals (the latter had always been considered as part of an innate language structure) may reflect general cognitive structure as opposed to innate structure. He cites as an example, that the 'universality of the noun/verb distinction in language might be explained as the linguistic reflection of the general cognitive distinction between objects and the relations between objects. Thus, the concept 'noun' would not have to be taken as a linguistic universal but merely the linguistic expression of such a cognitive distinction [p. 172]." Bloom (1968) has emphasized that an account of the development of linguistic competence must incorporate the interaction between linguistic experience, non-linguistic experience and cognitive-perceptual organization.

The Russian school as represented by Vygotsky (1962) and Luria (1957) differs with the above viewpoints. They view language as the source for creating the possibility of the 'intelligent coordination of function' (Luria, 1957). According to their theory, thought and language evolve independently at first. Then, at the stage when the child begins to discover the symbolic functions of words (around 19-26 months of age) the developmental paths become interdependent. Highly differentiated logical categories emerge in the child's thinking as a function of his ability to develop more differentiated language (i.e., words). The 'word' in this case is the guiding function for the development of genuine concepts (Vygotsky, 1962).

Bruner and his colleagues (1964) have attempted to support this view by demonstrating that improvement in language and "activation" of language habits can improve children's problem-solving ability. Using

a pretest, training, posttest paradigm, Frank (Bruner, 1964), and Nair (Bruner, 1964) demonstrated posttest improvements on conservation problems in children aged 5, 6, and 7 although not in children 4 years of age. Bruner (1964) attributes success to the fact that the child has been given an internalized verbal formula which he can use to overcome the enormous perceptual discrepancies which had previously hindered him. Beilin (1969a), in a somewhat similar position holds that language in this case acts as a linguistic algorithm even though the child lacks understanding of what he observes.

Watsonian behaviorists viewed thought as implicit speech. With sufficiently sensitive instruments they argued one should be able to detect some sort of muscular movement accompanying thinking. A more sophisticated view, and one which resembles the formulation of the Russian psychologists, has been proposed by modern behaviorists such as Kendler and Kendler (1959) and Reese (1962). The main point in this theory is that there is a transition period in which the child begins to make mediating responses to the stimulus presented to him. The most important mediating response is the word which becomes the guide in problem solving. Although children can label the cues before the transition period, they have, according to Reese, a mediational deficiency so that labeling is not brought to bear on problem solving.

In summary, there is one line of reasoning which makes the assumption that, although language and thought processes may evolve contemporaneously, language is not sufficient nor necessary for the evolution of thought processes. There is within this viewpoint a further division between the cognitivists and the psycholinguists of the transformational grammar group: the cognitivists maintain that oper-

ational structures are necessary for language development, whereas the transformational linguists insist on the importance of innate structure for language development. Although as indicated an increasing number of psycholinguists of this persuasion are modifying their position and are making an accomodation to the influence of cognitive processes. The other school of thought states that although language and thought processes are initially independent, there is a transition point after which language directs the function of thought development.

The investigation to be reported here attempted to provide further data relevant to these questions through the study of the relation between time language and time conceptualization. It was hypothesized, for example, that the concepts of order and duration are necessarily acquired before children can make effective use of those aspects of language dealing with time. By examining the process by which time concepts, on the one hand, and time language, on the other, develop, the study provides data relevant to the more general questions surrounding the relationship between language development and cognitive processes. Before specific relationships between these variables can be hypothesized, a discussion of the development of the child's notions of time and time language is necessary.

The most extensive research on the development of time concepts in young children has been conducted by Piaget (1954, 1955). He defines several operations that the child must attain before he possesses a systematic notion of time. These are: (1) the logical operation of seriation, (2) the logical operation of class inclusion, (3) the coordination of the two, and (4) a concept of speed. Once these four phases have been reached, the child is capable of discovering the

system of time measurement. In addition, Piaget delineates three development periods during which these time concepts are acquired: (1) the period of sensorimotor intelligence (0-2 years), (2) the preoperative stage (2-7 years), and (3) the period of concrete operations (reached about 7 years).

At the sensorimotor level there are six stages in the development of the temporal schemata. During the first two stages (0-4 months), the observer views the child's actions as being arranged into a temporal series. However, the child does not perceive any order since to him his actions are global and undifferentiated. During the third stage (4-8 months), the child is able to perceive a sequence of events, and probably has an elementary consciousness of a before and after relationship. For example, the child must understand that he needs to pull a chain before he can activate his rattle. In addition, he is beginning to form a memory for the very immediate past. During the fourth and fifth stages (8-18 months), the child becomes capable of retaining a series of events in which he did not directly intervene. He also attains the capacity to remember events for a longer period of time. In the final stage of sensorimotor development, the child becomes capable of objectifying the temporal schema on a representational basis and recalls even more remote past events.

In his research with the preoperational child Piaget has found that:

1. Children under 5 have difficulty in judging the equality of time or order in time when two objects are moved at different speeds or follow different paths. If the objects move at the same speed or cover the same distance, they can correctly judge the simultaneity of

start and stop.

2. Only 17% of Genevan children studied between the ages of 4 and 5 could judge equality of duration. Temporal duration was usually judged according to the content of the action, the quantity of work accomplished, or by the external relationship of the objects (in Fraisse, 1963).

3. In problems dealing with the coordination of order and duration it was found that even when children would admit to the simultaneity of starting and stopping, they would not admit equality of temporal duration. Even after children were capable of seriating successive intervals or levels, they were not capable of reconstituting these events if they had to deduce one temporal interval from antoher. Before the child could progress from a preoperational level to a concrete level of thought he had to be capable of taking order and duration into consideration simultaneously.

McCarthy (1955), commenting on Piaget's descriptions and explanations of the development of time concepts in the preoperative child asked: (1) whether the child's progression to more advanced stages in time concepts was accomplished at the same time that he began to use the past and future tenses in his speech; (2) whether the child has a "clear concept" of verbal terms such as before, after, faster, sooner, first, which are inherent in Piaget's method; (3) whether the time concept was inextricably bound up with the ability to express concepts verbally. These questions still have not been answered.

Cromer (1968), as part of a major longitudinal study analyzed the development of temporal referents in the spontaneous verbal productions of 2 children. The analysis of their speech samples made possible for

the formation of a preliminary order of the emergence of what can be differentiated as a time lexicon and a time syntax.[1] He found that with respect to time lexicon: (1) that words such as before, after, fast, quick were not used spontaneously in the child's speech until age 4;6: (2) that words such as before and after are used to relate two objects in space before they are used to relate two events in time. With respect to time syntax, he found that: (1) utterances classified as future (use of will + verb) do not appear until 3;6; (2) use of references to the past begin at 2;7 and show a slight increase with age; (3) it is not until about age 4;5 that the child is able to produce utterances in which the linguistic order does not perserve the real order in time; (4) the child does not begin to use the more complex tenses (perfect, progressive) and conditional statements until age 4;6. In fact, Cromer concluded that something seems to occur after age 4 or 4;6 which "seems to make possible a greatly expanded range of temporal reference and the relations between times [p. 165]."

A cognitive analysis of time syntax may indicate why some structures emerge later than others in the child's speech. The present perfect tense emerges late in the child's speech, although the components necessary for its use are available much earlier. The present perfect tense is defined as "taking something which has occurred in the past and making it particularly 'relevant' to the time of the utterance (Cromer, 1968, p. 117)." Compare the sentence "Have you written a letter?" which is in the present perfect and asks a question about the present time, and the sentence "Did you write the letter?" which is a question about some definite time in the past (Jespersen, 1929). The child, in the first sentence, must go from the present time (his situation) into the past

time and then back to the present. This process seems to be analogous to the operation of reversibility. Similarly, the ability to use after and before in both positions in a sentence seems to imply the same process. After, when used in the first position in a sentence retains the true order of events (After X,Y); however, when used in the middle position, the order of events is reversed (Y after X). The opposite is true for before (X before Y; Before Y,X). The past progressive (was + participle) seems to be tapping a different cognitive ability. The purpose of the progressive tense is not to "express duration in itself, but relative duration, compared with the shorter time occupied by some other action (Jespersen, 1929, p 278)." In the sentence, "He was writing when I entered the room," the child must deal with two intervals of time simultaneously.

Based upon Piaget's treatment of the development of time concepts, and psycholinguists' data of the development of time language, the study tested the following hypotheses:

(1) Cognitive development precedes or is concurrent with linguistic development. Children must acquire reversible operations before they can comprehend and produce tenses such as the perfect and past progressive, or can use correctly before and after in both positions in a sentence.

(2) At later stages of conceptual development (ages 5-7), yet prior to the development of certain concrete operations (age 8), the child's language in and of itself will not be sufficient to advance him to the next stages of operational thinking. Although the child may have demonstrated knowledge of time vocabulary and time syntax, these will not be sufficient for him to display a systematic conception of time, that is, the ability to coordinate order and duration.

CHAPTER II

METHOD

Three groups of children, kindergartners, first graders and second graders, were administered, individually, a series of time concept and language tasks. Both verbal and non-verbal time-concept tasks were included. The performance of all children on each test was first analyzed for developmental sequences. Then comparisons were made between scores on all tests in order to determine relationships among time-concept tasks and time-language tasks. Subsequently, two additional groups of children, aged 4 and 9-11, were given some of the cognitive and verbal tasks in order to provide baseline data on the language measures and an adequate ceiling on the time-concept tasks. The results of these supplementary studies are incorporated into the results of the main study.

Experimental Design

All the kindergarten, first and second grade Ss were given the same series of six language tasks and time-concept tasks during two testing sessions. Four-year-olds were given only the language tasks. The 9-11-year-old children were given only the concept tasks.

Four testing sequences were devised in order to counterbalance the effects of testing order. In two of the four testing sequences cognitive (time-concept) tasks preceded language (time syntax and vocabulary) tasks. In the other two sequences, the tasks were presented in the opposite order. In addition, the effect of experience with the various tasks was controlled by alternating the tasks presented in sessions 1 and 2. Table 1 summarizes the testing sequences. No child was permitted to see

Insert Table 1 about here

two films in a row and each film was separated by an activity task.

Procedure

Each child was assigned a testing sequence as he entered the testing room. Appendix A summarizes the assignment of Ss by session, sequences, sex, E and grade. Each S was seen individually for two 30-minute sessions. No sessions were separated by a period of less than two days or more than five days. Each session was administered by a different E. A total of three Es, including the author were used in the study.[2]

The Ss were brought into the classroom individually by the E and seated in front of a chair approximately 5 feet away from a child's painting easel. Films were projected in this easel with a Kodak MFS-8 projector. For the non-film tasks, the S was seated behind a child's table across from the E.

Time Language Tasks

Time-Language Film. A time language film was constructed to measure the S's comprehension of time syntax and time vocabulary. (There were 9 syntax items and 7 vocabulary items which are discussed in detail below.) The original film consisted of 5 situations each of which depicted 2 cars racing each other. Within each block of four questions, the colors of the cars (black or white), and the position of the cars on the film (top or bottom) were randomly assigned. The test consisted of 21 questions, 16 vocabulary and syntax questions, and an additional 5 questions in which the Ss were asked to explain their choice of cars. To minimize chance effects, a syntactic structure or

vocabulary item was scored correct only if the child responded correctly to that item in both sessions. Only partial credit was given. The Ss were instructed to carefully watch the two cars racing because they would be asked some questions after each race. If the child requested, a race was reshown, or if it appeared to E that the child had not been watching the race from start to end, E replayed the film. Each race lasted about 6 seconds. In reporting the results of these language items, the numerals I and II are used only if the same language structures are repeated. The numeral I indicates that both position and speed cues could be incorporated to comprehend the language items; the numeral II indicates that only speed cues could be used. When no numeral is used both position and speed cues are available. The test questions and answer sheets are found in Appendix B.

(a) Time Syntax. There were a total of 9 syntax items designed to test the child's understanding of the following tenses: past, future, progressive, perfect, and conditional construction. Five of these items could be answered correctly by relying only on position cues, or position and speed cues. These items were: the present progressive (is + verb + ing); the past (verb + ed); future I (will + verb); conditional I (If. . ., then) and present perfect I (has + past tense of verb). Three items could be answered correctly only by relying on speed cues: future II (will + verb); conditional II (If. . ., then) and present perfect II (has + past tense of verb).[3] For example, in future I: "Which car will win?" the car that wins is ahead when the question is asked. In future II: "Which car will win?" both cars are stopped at the same point when the question is asked. Thus, the child must infer that the car going faster will win. The same holds true for

present perfect I and II, and conditional I and II. The past progressive is slightly different. The question: "Which car was winning when the bell rang?" is asked at the end of the race when both cars are at the same point. However, when the bell rings one car is clearly in front of the other car. In order to minimize the effects of memory, the situation is shown twice and only the second answer is scored.

(b) Time Vocabulary. There were seven vocabulary items designed to assess the child's comprehension of order (first, last); speed (fast, slow); duration (more or longer time I and II, less or shorter time). The difference between more time I and II is that in the former case, the car that took more (longer) time was ahead of the other car when the question was asked, whereas in the latter case the cars were at the same point when the question was asked.

Before/After. The connectives before and after may be used to denote spatial or temporal successions. If these items had been presented as part of the time vocabulary film, it would have been impossible to distinguish whether the child was responding to spatial or temporal cues. Consequently, the Before/After test was constructed to assess the S's understanding of these connectives when used to connect two points in time. Before and after may be used in two positions of the sentence. When after appears in the first position and before in the second, the sentence order depicts the true time sequence. However, when after appears in the second position, and before in the first, then the true time order of the sentence is reversed. Thus, there are a total of four time constructions: after x, y; x before y; and the reversed sequence, y after x; before y, x.

Each sequence of 4 constructions was randomized and repeated twice using different toys. The S was told that he was going to play some games with a hand puppet and some of the puppet's toys. He was then shown 8 miniature toys and asked to identify them. As the child identified the toys, the E placed them in a circle. After all the toys had been identified, the E asked the S to pretend he was the puppet and carry out his instructions. The S had to perform all the actions in a particular construction in the appropriate sequence in order to receive credit for an item. The following items were used:

(1) After the bunny picks up his skate, he picks up his guitar.
(2) The bunny picks up the telephone after he picks up his trumpet.
(3) Before the bunny picks up his book, he picks up the rolling pin.
(4) The bunny picks up his cup before he picks up the radio.
(5) Before the bunny picks up his trumpet, he picks up his skate.
(6) After the bunny picks up the sponge, he picks up his guitar.
(7) The bunny picks up his book, after he picks up the telephone.
(8) The bunny picks up the sponge before he picks up the radio.

The Before/After score is based on the S performing each type of construction correctly twice. Thus, 4 is the maximum score. The test instructions, questions and answer sheet are found in Appendix B.

Demonstration Vocabulary. This test was designed so that Ss would have a break between two films. There were 6 vocabulary items: faster, slower, first, last, more time, less time. The S was given two stuffed animals, a yellow and a blue puppy, and was asked to demonstrate the above concepts. The following questions were asked:

(1) Make the yellow dog go faster.

(2) Which dog ran for more time (repeated 3 times)?
(3) Make the yellow dog start first.
(4) Which dog ran for less time (repeated 3 times)?
(5) Make the yellow dog run slower then the blue dog.
(6) Make the two dogs run. Make the yellow dog stop last.

For the concepts more time and less time E illustrated the concept and asked S to choose between two alternatives. The item was repeated 3 times. The S was scored correct if he chose the correct item 2 out of 3 times. A six was the maximum score.[4]

Time Concept Measures

Reversibility Tasks. This task is adapted from Piaget's notions of reversibility. In the first reversibility task, the S was shown four hand-drawn pictures of a tree. Each picture depicted various stages of leaf growth. The S was asked to "Place the pictures in such a way that they show how one tree went from many leaves (in the spring) to no leaves (in winter)." The E who sat across from the S placed the spring picture (#1) in front of and to the left of the S. The other three pictures were placed in a fixed non-seriated order (#3, #4, #2) in front of the E, facing the child. After the child completed the task, the E collected the pictures, shuffled them, and placed the winter picture in front of and to the left of the S and again asked him to "Place the pictures in such a way that they show how the tree went from no leaves in the winter to many leaves in the spring." The other three pictures were placed in a fixed non-seriated order (#2, #1, #3) in front of the E facing the S. In task 2, the S was shown five black and white hand drawn pictures illustrating 5 stages of growth of a male: a baby, a preschool boy, an adolescent, a man and an old man. All the figures were of the same height. The S was again asked to take all the pictures and place them in such a way that they show how the little boy (#1) grew

up to become an old man. Picture #1 was placed in front of and to the left of the S, and the other pictures were placed in a fixed non-seriated order (#4, #5, #3, #2) in front of the E facing the S. In part 2, the S had to make believe and show how the old man became a little boy. A copy of the test question and answer sheet are found in Appendix B.

Pretest to Piaget Time Concepts. Before the actual Piaget Time-Concept tasks, all the Ss were given a pretest to ensure that they understood the terms: start at same time; stop at some time; travel for the same distance. The S was given two miniature toys and asked to demonstrate his knowledge of these concepts. For example, "Make the two cars travel for the same distance." If the S scored incorrectly on any of the items, the E demonstrated the concept until the S understood it. If after 3 attempts, the S could not understand these concepts he was eliminated. All the Ss scored correctly on the pretest the first time except 3 kindergartners who were given training. No S was eliminated because he could not pass the pretest items.

Piaget Time Concepts. A film was specifically devised to test the child's understanding of: order, simultaneity and duration.

> Situation I: Equality of Time. This situation serves as a warm-up or pretest item, since the questions and situations were similar throughout. A black car and white car raced on a parallel course across the screen. Before the race begins the cars are lined up behind a start line. The E states: "Watch these two cars race." The E then begins the race. Both cars started and stopped at the same time and traveled at the same speed. The E then asked the following questions:
>
> "Did the two cars start at the same time?"
>
> "Did the two cars stop at the same time?"
>
> "Did both cars travel for the same distance? If S looked confused he was asked: "Did one car go just as far as the other?"
>
> "Did one car travel for more (longer) time than the other car or did they travel for the same amount of time? How do you know?"

After situation I, the S was told that he would be asked the same kinds of questions again and again.

Before each race began, the S was instructed to watch the two cars. This served to focus the S's attention on the start line. The E did not begin the race until the S's attention was directed toward the start line.

> Situation II: Equality of Time. The two cars race along a parallel course. Both cars start and stop at the same time, but the black car travels faster and thus further. Thus, the simultaneity of the two cars must be deduced operationally from the equality of the two synchronous durations.
>
> Situation III: Inequality of Time (more). A black and white car start at the same time and race parallel across the screen. The black car travels further than the white car; the white car stops first. The S is asked the same questions as in situation I, but in addition is asked to identify the car that took more time; the car that stopped first; and his reasons for picking the cars that he did. In this situation, the concept "more time" is identical to "more distance" or "further."
>
> Situation IV: Inequality of Time (less). This situation is identical to situation III, except that the black car travels for a shorter time and covers less distance; the white car stops last. In this situation the concept "less time" is identical to "less distance."
>
> Situation V: Inequality of Time. The two cars race along a parallel course. The black car starts before the white car, and travels faster than the white car. Both cars travel the same distance. Thus, the inequality of the durations must be deduced from the speed of the car.

The situations were devised so that the S would be required to make a logical differentiation as opposed to a verbal one. According to Piaget, the predicted order of difficulty, from easiest to most difficult, would be situations I, III, IV, II and V.

All the Ss saw the races in the same fixed order. Two scoring procedures were used. In one procedure every item response was counted yielding a maximum score of 20. In the second procedure, a situation

was scored correct only if the S answered correctly 3 out of 4 items (criterion A) or 4 out of 4 items (criterion B). Thus 5 was the maximum total score. A copy of the test booklet is in Appendix B.

Time-Concept Attainment Task. A time-concept attainment task based on a discrimination model was devised in order to have a measure of time conceptualization which minimized the effects of language. In this concept attainment task, time, speed, distance and starting time were varied. Thus, it was comparable to a four cue-successive discrimination problem. A pilot study indicated that even when acquisition was continued for 60 trials, none of the Ss was able to learn that the task was based upon time. Consequently, a verbal training procedure was introduced to see whether the S could learn the required discrimination. A posttest (criterion) was given to measure the effects of training. Thus, the time-concept attainment task consisted of three sections: time-concept acquisition; concept training; criterion testing.

During the acquisition phase, the Ss were presented with 40 (4 blocks of 10) self-paced simultaneous discrimination problems. Half the Ss had to select the car that traveled for more time; the other half had to select the car that traveled for less time. In each block of 10 trials, starting time, speed, distance, color, and position of the correct car was randomly varied. No trial lasted for less then 4 1/2 seconds or more than 6 seconds. There was a 1 1/2 to 2 second difference between the times traveled by each of the two cars. These situations were similar to those presented in the Piaget time concept task and in the language tasks. After each selection of a car, the S was told whether he was right or wrong. At the end of the 40 trials, the S was asked why he had picked the cars he had. These responses were recorded

verbatim. Criterion was reached if the S scored correctly on 18 out of 20 trials within a 20 trial block. If the child did not attain criterion by the end of 40 trials, he was given concept training.

In the concept training phase, the S was first given the appropriate explanation for the correct car, that is, he was told whether the correct car was the car that took more time (or less time). Then the E and the S began a series of races, in which they repeated the various situations presented on the films. At the end of each race, the E explained who took more (or less time) and why. After this phase of the training the S and the E went back to their tables, and two miniature cars were taken out. Then the E and the S went through the various situations again using the cars. If the S could still not identify the car that took "more time", the E instructed the S to put his hands on the two cars while the E moved the cars. Thus, in a sense, the S could "feel" the time the cars traveled. There were 9 such training situations: 3 with the E and the S going across the room, 3 with the S's hands on the car, and 3 with the S just watching. A sample of the training procedure may be found in Appendix B. After these 9 trials, the first block of 10 trials of the film was presented. During these 10 training trials, the S not only received 100% reinforcement, but when he was incorrect, the E told him why and reminded him of the verbal rule. "No," he would say, "That's not right, it's the car that traveled for more time."

After the 10 training trials were completed, the criterion testing was begun. In this phase, the S received an entire series of 20 trials. The S was considered to have reached criterion if he scored correctly on 18 of the 20 trials. This could include the first 10 trials in the

training phase and the next 10 trials in the criterion phase. For a complete copy of the E's instructions and the S's answer sheet, see Appendix B.

Subjects

Main Study. Thirty children, 15 boys and 15 girls, were obtained from each of the kindergarten, first and second grade classes in one New York City elementary school to make a total of 90 subjects. The school was located in a middle-class neighborhood in Queens. All the subjects were white.

Of the 30 kindergarten children tested, one girl was dropped from the sample because of bilingualism in the home. Of the remaining 29 Ss in this grade the mean age for the boys was 5 years, 10 months, SD=3.21 months; and for the girls, 5 years, 10 months, SD=3.21 months. The mean age for the kindergarten sample was 5 years, 10 months; SD=3.25 months.

Ten Ss (5 girls and 5 boys) were drawn from each of the three first-grade classes. Of the 30 first graders tested, one girl had to be dropped from the sample because of bilingualism. In the final sample, the mean age for the boys was 7 years, 1 month, SD=1.59 months and for the girls, 7 years, 1 month, SD=3.15 months. The mean age for the first graders was 7 years, 1 month, SD=2.45 months.

For the second grade, the mean age for the boys was, 8 years, 0 months, SD=3.33 months, and for the girls, 8 years, 0 months, SD=3.24 months. The mean age for the second grade was 8 years, 0 months, SD=3.23 months. Twenty-four of the Ss were drawn from two second grade classes, and six were drawn from a third. There is a 15-month age difference between the kindergarten and the first grade classes and only

an 11-month difference between the first grade and the second grade. This is due to the fact that 22 of the kindergarten children were taken from the afternoon class which is the younger of the two kindergarten groups.

Since no standardized intelligence tests are administered in these schools, the kindergarten group was given the Peabody Picture Vocabulary Test (PPVT) after the second session. The median percentile score for the boys was 83; for the girls, 77; and for the entire sample, 81. For the first grade, the New York State Reading Readiness scores were available. The median percentile for the boys was 74, for the girls, 66, and for the entire sample, 70. The Metropolitan Reading Achievement Test was available for the second grade. The median age score for the boys was 3 years, 2 months; for the girls, 3 years, 4 months; and for the entire sample, 3 years, 3 months. The expected median for the second grade is 2 years, 7 months. Thus, we are dealing with a population whose standardized test performance is somewhat above average.

Supplementary Studies. The nursery Ss were 12 children, 6 boys and 2 girls, from a private nursery school, and 4 girls from a public nursery school. The schools were located in the same district as the school from the main sample. The mean age for the boys was 4 years, 0 months, SD=5.18 months; and for the girls, the mean age was 4 years, 6 months, SD=3.98 months. This difference is significant ($t=2.37$; $p < .05$). The median PPVT percentile scores which were obtained after testing were 71st percentile for the boys and 74th percentile for the girls. Thus, with respect to PPVT scores, the nursery school children performed slightly lower than the kindergarten group of the main study.

The older group of Ss consisted of 30 9-, 10-, and 11-year-old children attending a Vacation School Playground in Queens.[5] Each age group consisted of 5 boys and 5 girls. For the 3 groups the mean ages were respectively: 9 years, 5 months, SD=3.67 months; 10 years, 6 months, SD=3.71 months; 11 years, 4 months, SD=3.49 months. The PPVT median percentile scores for each of the groups were respectively: 73 percentile, 81 percentile, 90 percentile. The combined median for all three groups was 82 percentile. The older group seems to be comparable in PPVT scores to the kindergartners.

CHAPTER III

RESULTS

The main purpose of this study was to examine the relationship between time conceptualization and time language. A secondary aim was to look at the developmental trends within and between these two areas. For these analyses two kinds of data were utilized. One was the number of correct language and/or concept responses; the other was the categorization of the reports.

Intratest Comparisons

Time Language Measures

The time language tasks were broken down into 3 subdivisions: time vocabulary, time syntax, and the time connectives, before and after.

Time Vocabulary. The intent of the vocabulary tasks was to determine whether there were any developmental differences in the child's time vocabulary, and if such differences did exist, whether there was an order of emergence of time-related words. There were seven time words divided into three categories: order (first, last); speed (fast, slow); and, duration (more time, longer time, shorter time). The means and standard deviations of vocabulary scores by grade and sex are presented in Table 2. The table indicates an increase

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Insert Table 2 about here

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in scores up to the first grade and then a slight drop in the second. A sex by grade analysis of variance revealed that grade was the only significant effect ($F=5.00$; $df=3,92$; $p < .01$). The Newman-Keuls test

for simple effects (Winer, p. 80) indicated that the only significant difference was between the nursery group and the first graders ($p < .05$).

In order to discover any developmental trends for the vocabulary items the percentage of Ss passing each item was computed and a test of independent proportions ($\underline{z}$) was conducted (Table 3). The analyses

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Insert Table 3 about here

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indicate that the percentage of kindergartners passing each of the items (except for longer time I) is higher than the nursery group. However, none of the differences between the two groups was significant. A developmental trend seemed to be emerging for first but the only significant difference was between the nursery group and the second grade ($\underline{z}=1.97$; $p < .05$). The word last was significantly more difficult for the nursery group, kindergartners and second graders than it was for the first grade. This U-shaped relationship also held true for longer (more) time I. The first graders also did significantly better than the nursery group and the second graders on the word shorter (less time). Comprehension of the word last proved to be easier than first in all four grades. Shorter (less) time was easier than longer (more) time I and II. The table also indicates that by the nursery years most of the children demonstrate comprehension of speed words.

Time syntax. The intent of the syntax items was to see whether there were any developmental trends in the emergence of these items. There were nine time-syntax constructions divided into two categories: the simple tenses, present, past, future, and the complex tenses, present perfect, conditional, and the past progressive. Moreover, the future, conditional and present perfect were further subdivided into

two types of sentences. Constructions labelled I could be comprehended correctly on the basis of speed and position cues, and those labelled II could be comprehended correctly only on the basis of speed cues. Means and standard deviations of the nine syntax items are presented by grade and sex in Table 4. A sex by grade analysis of variance

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Insert Table 4 about here

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revealed that grade was the only significant effect ($F=5.33$; $p < .01$). The Newman-Keuls test for simple effects (Winer, p. 80) revealed that only the differences between the nursery group and the second grade were significant ($p < .05$).

The percentage of Ss passing each syntax item and tests of independent proportions (z) were computed (Table 5). On the whole, the

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Insert Table 5 about here

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kindergartners did better than the nursery group but the only difference which was significant was on future I ($z=2.67$; $p < .01$). The first and second graders also performed significantly better than the nursery group on this item ($z=2.67$; $z=3.18$ respectively; $p < .01$). The five questions which could be answered on the basis of speed and/or position cues (present progressive, past tense, future I, present perfect I, and conditional I) were answered correctly by at least 90% of the kindergartners, first and second graders, whereas the three syntactic questions which could only be answered correctly by making inferences from the speed of the cars (future II, present perfect II and conditional II) were answered correctly by not more than 50% of these Ss. Of these items future II and present perfect II are the only items showing a

developmental trend. Significant differences were found only for present perfect II, and that was between the nursery group and the second graders ($\underline{z}$=2.17; $p < .05$). A developmental trend also seems to be emerging for the past progressive tense. The difference between the nursery group and the second grade, and the kindergarten and the second grade was significant ($\underline{z}$=2.01; and $\underline{z}$=2.26, respectively; $p < .05$). In the past progressive tense the Ss had to deal with two durations of time simultaneously.

Although the nursery Ss scored higher on conditional II, the difference between the nursery group and the other grades was not significant. The correct response for this item was the "black car." A possible explanation for the high nursery group score is that these Ss showed a color preference. Seventy per cent of the total nursery groups' responses were "the black car." In contrast, an analysis of a random sample of 12 second graders' response sheets recorded that this group used the response "the black car" only 58% of the time. It is not uncommon to find certain response sets when testing young Ss.

The relationship between vocabulary and syntax scores was examined by computing Pearson product-moment correlations. The correlations are fair, although the only significant correlation is for the second grade ($\underline{r}$=.39; $p < .05$). The correlations for the nursery group, kindergartners and first gradee are respectively: $\underline{r}$=.25; $\underline{r}$=.17; and $\underline{r}$=.22.

Before/After. There were two categories on the Before/After test. In the first category, the order in which the sentence was spoken was equal to the order in time (OS=OT); in the second category, the order in which the sentence was spoken was the reverse of the order in time (OS≠OT). Table 6 presents the percentage of Ss passing each item on

Insert Table 6 about here

the Before/After Test by category, concept, and grade. The percentages indicate that by 4;6 (nursery group) more than 65% of the Ss have mastered the connectives before and after in relating two events in time when OS=OT. Less than 35% of the nursery Ss have mastered these connectives when OS≠OT. For the other groups, it appears that before (OS≠OT) is mastered earlier than after (OS≠OT). By Kindergarten, 70% of the Ss have mastered the concept before; it is not until the second grade that 70% of the Ss have mastered after. A grade by concept analysis revealed that a significant developmental trend existed for before when OS≠OT (χ^2=12.00; df=3; $p < .01$), and for after when OS≠OT (χ^2=8.36; df=3; $p < .05$). For the concept before, tests of independent proportions revealed that there were significant differences between the nursery group and the kindergartners (Z=1.98; $p < .05$); the nursery group and the first graders (Z=1.98; $p < .05$); and the nursery group and the second graders (Z=3.08; $p < .01$). For the concept after, the only significant differences were between the nursery group and the second graders (Fisher's exact p = .03) and the kindergartners and the second graders (Z=2.47; $p < .01$).

McNemar's test for the significance of changes (Siegel, p.66) was conducted within each grade to examine further before/after differences (Table 7). The results indicated that for the nursery group before and

Insert Table 7 about here

after is equally difficult whereas for the kindergartners after is more difficult than before in both the reversed (χ^2=5.06; $p < .05$) and

nonreversed situations ($\chi^2=4.16$; $p < .05$). Neither the first nor second grade show any significant differences with respect to these connectives.

It was hypothesized that concept reversibility would be related to before/after reversibility (OS≠OT) as well as to syntax. Also, it was assumed that before and after (OS=OT) as time-related connectives would be related to time vocabulary. Therefore, it was expected that there would be a positive relationship between before and after reversibility and syntax, and between before/after (OS=OT) and vocabulary. Point-biserial correlations were computed to see if there was any such relationship (Table 8). This analysis revealed that the only

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Insert Table 8 about here

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significant relationship was in the kindergarten grade. However, since 32 correlations were computed for this analysis alone, the relationship between before/after reversibility and vocabulary is attributed to chance.

Summary

To summarize, the most important results of the analysis of the language measures are:

(1) The main effect of grade was significant for the vocabulary scores. The first grade, but not the second grade did better than the nursery group. There were no significant differences among the other grades.

(2) Vocabulary items dealing with speed were the easiest, while those dealing with duration the most difficult.

(3) The main effect of grade was significant for the syntax scores, with the only significant difference between the nursery group and the second graders.

(4) By the kindergarten grade, a comprehensive knowledge of the present progressive, the past, future I and conditional I had been acquired by at least 75% of the Ss, but as late as the second grade less than 55% had comprehensive knowledge of the past progressive, future II, conditional II and present perfect II. The latter three required the S to incorporate a concept of speed into his judgments.

(5) The kindergartners found before easier than after whether the sentences were reversed or not.

Time Concept Measures

Two measures were used to measure time operativity. One measure was a replication of some of Piaget's time conceptualization tasks; the other, was a nonverbal time-concept attainment task which included a verbal training procedure. A time-seriation reversibility task was also given to all Ss.

Piaget time-concept tasks. The Piaget task consisted of 5 situations: (I) Time equality: times and speed were equal (warm-up item). (II) Time equality: times were equal; speed was varied. (III) Time inequality (more time): times were unequal; distances were varied. The car that went further took more time. (IV) Time inequality (less time): same as situation III, except that the car that took less time traveled for a shorter distance. (V) Time inequality: times were unequal; speed was varied but distances were equal. The slower car took more time. Within each situation the S was asked 4 questions to make a total of 20 items. Two methods of scoring were used. In the first method, each item was scored right or wrong yielding a total possible

score of 20 items correct. In the second method, each situation was scored correct or incorrect. Two criteria were used for these analyses: criterion A, a less stringent criterion, indicates that a child was scored correct on a particular situation if he answered three out of the four items correctly; criterion B, which is the more stringent criterion, indicates that a child was scored correct on a particular situation if he answered all four questions correctly. Since, in analyzing Piaget-type problems, it is more meaningful to judge whether a child responded consistently to all contexts in which the concept appears the majority of the analyses were conducted using the second scoring procedure. The first scoring procedure was only used in testing for sex and overall grade differences. Table 9 gives the means and standard deviations for each situation by grade and sex.[6] A sex by

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Insert Table 9 about here

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grade analysis of variance was conducted on the total score. Grade was the only significant main effect ($F=35.33$; $df=3,110$; $p<.001$). The Newman-Keuls test for main effects was conducted and significant differences were found between kindergartners and the first graders, the kindergartners and the second graders, and the kindergartners and the older group ($p<.01$ for all three analyses). Significant differences were also found between the first graders and the older group, and the second grade and the older group ($p<.01$ for both analyses). There was no significant difference between the first and second graders.

The percentage of Ss giving a correct situation response was computed for each situation by grade. Table 10 gives the percentage

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Insert Table 10 about here

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of Ss obtaining a correct situation score for criterion A and the overall χ^2s for each item. Significant developmental differences were found for situations II (χ^2=52.94; df=3; $p < .001$); III (χ^2=18.53; df=3; $p < .001$); IV (χ^2=23.43; df=3; $p < .001$); and V (χ^2=37.29; df=3; $p < .001$). Less than 55% of the kindergartners scored correctly on situation III and IV whereas over 95% of the older group did. For situation II significant developmental differences were found between the kindergartners and the first graders ($\bar{z}$=2.18; $p < .05$); the kindergartners and the older group ($\bar{z}$=3.89; $p < .01$); the first graders and the older group ($\bar{z}$=2.06; $p < .05$); and the second graders and the older group ($\bar{z}$=2.43; $p < .05$). For situation IV significant developmental differences were found between the kindergartners and the first graders ($\bar{z}$=2.99; $p < .01$); the kindergartners and the older group ($\bar{z}$=3.84; $p < .01$); and, the second graders and the older group ($\bar{z}$=2.15; $p < .01$). Even more pronounced differences are found for situations II and V, the only items involving a coordination of time and speed. For situation II less than 5% of the kindergartners attained criterion A whereas more than 90% of the older Ss did. Significant developmental differences were found between: the kindergartners and the first graders ($\bar{z}$=2.43; $p < .05$); the kindergartners and the second graders ($\bar{z}$=2.61; $p < .01$); the kindergartners and the older group ($\bar{z}$=6.65; $p < .001$); the first graders and the older group ($\bar{z}$=4.68; $p < .001$); and the second graders and the older group ($\bar{z}$=4.56; $p < .001$). On situation V only 20% of the kindergartners had attained criterion A whereas over 95% of the older Ss had. Significant developmental differences were found between the

following groups: the kindergartners and first graders ($\underline{Z}$=2.43; $p < .05$): the kindergartners and the second graders ($\underline{Z}$=3.54; $p < .01$); the kindergartners and the older group ($\underline{Z}$=5.68, $p < .01$); the first graders and the older group ($\underline{Z}$=3.44; $p < .01$); the second graders and the older group ($\underline{Z}$=2.43; $p < .05$).

Significant developmental differences were less pronounced when criterion B was used to calculate the percentage of Ss scoring correctly on each situation (Table 11). Situation I (χ^2=11.60; $\underline{df}$=3; $p < .01$),

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Insert Table 11 about here

II (χ^2=5.90; $\underline{df}$=1; $p < .05$), III (χ^2=26.14; $\underline{df}$=3; $p < .001$), and IV (χ^2=8.61; $\underline{df}$=3; $p < .05$) all showed significant developmental trends. On situation I, 69% of the kindergartners scored correctly while 100% of the older group obtained perfect scores. The per cent kindergartners scoring correctly on this situation is much lower than would have been expected according to Piaget since no time operativity was required for this item. Significant developmental differences for this item were found between the kindergartners and the older group (Fisher's exact $p < .002$); and the second garders and the older group (Fisher's exact $p < .005$). Significant developmental differences were also found for situations III where less than 20% of the kindergartners scored correctly and more than 75% of the older group did. Significant differences were found for situation III between the kindergartners and the older group ($\underline{Z}$=4.31; $p < .001$); the first grade and the older group ($\underline{Z}$=3.77; $p < .001$); and the second grade and the older group ($\underline{Z}$=2.62; $p < .01$). On situation IV, 10% of the kindergartners scored correctly whereas 63% of the older group did. The differences between the kindergartners

and the first grade ($\underline{z}$=2.14; $p < .05$), the kindergartners and the second grade ($\underline{z}$=2.56; $p < .01$), and the kindergartners and the older group ($\underline{z}$=3.94; $p < .001$), were significant. Differences between the first grade and the older group approached significance ($\underline{z}$=1.95; $p < .10$). For situation II, none of the kindergartners, first or second graders demonstrated operativity, that is, scored correctly on all four items, while 53% of older group did. It had been expected that some of the second graders would have demonstrated operativity. The difference between the younger grades and the older group was significant (χ^2=5.90; df=1; $p < .05$). Only 3% of the kindergartners demonstrated operativity with respect to situation V whereas 20% of the older group did. The developmental differences for situation V were not statistically significant.

In order to determine whether these items were scalable and the differences reproducible, Green's Index of Consistency was the measure of scalability used (Green, 1956). The data from all 118 Ss for the 5 situations were pooled. Using criterion A, the reproducibility score was .94, and the index of consistency was .44. Using criterion B, the reproducibility score was .95, and the consistency index was .46. Green suggests an index of .50 as the criterion for scalability. According to Piaget (1954), situation I should have been the easiest, III and IV should have been about equally difficult and situation II the most difficult. Situation V, the time inequality situation, was added by the present author. It is quite possible that greater scalability was not obtained because situation III and IV were of similar difficulty as were situation II and V. Combining three levels would have left too few tasks to scale according to this method.

Time-concept attainment task. There were three phases to the time-concept attainment task: 40 concept-attainment trials; verbal training on the time concepts (including 10 film trials); and, criterion testing. Table 12 gives the mean scores for the total concept-attainment trials, total training trials, and criterion trials.[7] None of

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Insert Table 12 about here

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the Ss attained criterion during the concept-attainment phase of this task. A concept by grade analysis of variance of the total number of concept-attainment trials reveals a significant concept effect (F=22.11; df=1,110; $p < .001$). "Less time" was significantly harder to acquire than "more time." A similar analysis was conducted on the 10 training trials with grade the only significant effect (F=21.23; df=3,110; $p < .001$). The Newman-Keuls test revealed that the differences between the kindergarten and the older group, the first grade and the older group, and the second grade and the older group were significant ($p < .01$). The older group regardless of concept benefitted the most during training.

Two types of analyses were conducted to examine the effects of verbal training. The first analysis compares the mean number of correct trials during criterion testing; the second analysis compares the percentage of Ss attaining criterion after verbal training.

A concept by grade analysis for the mean number of correct trials during criterion testing revealed a significant concept effect (F=5.43; df=1,110; $p < .05$) and a significant grade effect (F=28.17; df=3,110; $p < .001$). "Less time" was significantly more difficult to train than "more time." Significant grade differences (Newman-Keuls test) were

found between the kindergartners and the first graders, the kindergartners and the second graders, and kindergartners and the older group ($p < .01$ for each analysis); first graders and the older group; and, the second graders and the older group ($p < .05$ for latter 2 analyses).

The percentage of Ss attaining criterion after verbal training was calculated. None of the kindergartners attained criterion whereas 17% of the first graders, 23% of the second graders, and 80% of the older group did. The difference between the kindergartners and the combined first and second graders was significant ($\underline{Z}=2.63$; $p < .01$) as was the difference between the kindergartners and the older group ($\underline{Z}=6.26$; $p < .001$), the first graders and the older group ($\underline{Z}=4.83$; $p < .001$), and the second graders and the older group ($\underline{Z}=4.73$; $p < .001$).

Reversibility task. There were 2 reversibility tasks. On each task the S could score either 0, 1, or 2. A zero score meant the S could not seriate in either direction; a score of 1 meant he could seriate in one direction, and a score of 2 indicates that he could seriate in both directions and had attained reversibility. The scores on the two tasks were combined, and three stages were formed: A total score of 0, or 1, on the two tasks combined indicated no reversibility; a score of 2, or 3 indicated that an intermediate stage had been attained, and a score of 4 indicated reversibility. Table 13 presents the

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percentage of Ss attaining reversibility by grade. The percentages indicate a developmental trend in the increase of Ss attaining reversibility. At the nursery level, none of the Ss have reversibility whereas by the second grade there is no child who has not attained some level

of reversibility. The differences between the nursery group and the kindergartners is significant ($\bar{z}$=2.94; $p < .01$) as is the difference between the kindergartners and the first graders, and the kindergartners and the second graders ($\bar{z}$=2.94; $p < .01$; and $\bar{z}$=4.16; $p < .01$, respectively). The difference between the first and second grade is not significant. Moreover, whereas 83% of the second graders had attained reversibility only 20% of the kindergartners had attained reversibility. This difference is statistically significant ($\bar{z}$=4.82; $p < .01$) as is the difference between the kindergartners and the first grade ($\bar{z}$=3.95; $p < .01$).

Summary

The main findings on the time concept measures were:

(1) A significant developmental trend was obtained on the Piaget time concept measures. However, by second grade no child has attained time operativity on the Piagetian tasks (i.e., all four items correct on situation II).

(2) None of the Ss were able to attain the time concepts on the basis of time after 40 time-concept-attainment trials. More was an easier concept to attain than less. The first, second, and older groups profited significantly more than the kindergartners from verbal training as indicated by the percentage of Ss attaining criterion after training, and the mean number of correct responses during criterion training.

(3) The time-seriation data reveal that by the second grade there is no child who does not have some degree of reversible operations whereas almost half the kindergartners show no degree of reversibility, and that 85% of the second graders show

total reversibility and only 20% of the kindergartners demonstrate this. None of the nursery Ss had attained any level of reversibility whereas all of the older Ss attained total reversibility. Thus, there is a very distinct developmental trend in acquiring reversible operations, when such reversibility is defined as a time-seriation task.

Intertest Comparisons

The main purpose of this study was to examine the relationship between the development of the child's notion of time and the development of his time-language. This section will be divided into three parts in order to examine: (1) the relationship between all the language scores and the Piaget time-concept scores; (2) the relationship between all the language scores and reversibility; and (3) the relationship between the language task and the time concept-attainment task.

The Relationship Between Language Development and Piaget-Time Concepts

Since there were two concept scores available, the total number of items correct and total number of situations correct, two separate analyses were conducted to determine the overall relationship between the Piaget time-concept scores and the total language score. In the first analysis the Piaget items (maximum score is 20) were correlated with the combined vocabulary and syntax scores (maximum score is 15). The overall Pearson correlation was statistically significant ($r=.57$; $p<.01$). However, since the grade span covered three years, it would be expected that the kindergartners would do more poorly than the older Ss (grades one and two). When individual correlations were conducted within each of the three grades, only the correlation for the

kindergarten grade was significant (K:r=.36; $p < .05$). The correlation for the first grade was r=.18, and for the second grade it was r=.28. Thus, although the correlations within each grade were low, the overall correlation indicates a very strong developmental trend for these measures.

In the second analysis, correlations were computed on Piaget-situation scores with language scores. Contingency tables were set up and analyses were conducted using the 50th percentile as a cut-off point for the language and Piaget situation scores. Table 14 represents the relationship between the Piaget situations (criterion A) and the

Insert Table 14 about here

language scores when both measures are divided at the 50th percentile. Table 15 represents this relationship using criterion B. None of these

Insert Table 15 about here

relationships were significant (Fisher's exact $p > .05$).

In the original hypothesis it was felt that some of the Piaget situations especially those requiring operativity (situations II and V) would show a relationship to syntactic development. Point-biserial correlations were conducted with each of the Piaget situations (criterion A and B) and the total syntax score (Table 16). None of the

Insert Table 16 about here

correlations was significant. Also in attempting to determine whether the child's vocabulary was related to his score on any of the Piagetian situations, point-biserial correlations were conducted with each of the

situations (criterion A and B) and total vocabulary scores (Table 17). The only significant correlation was in the kindergarten, situation V,

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Insert Table 17 about here

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criterion A ($r=.39$; $p < .05$). However, since 30 point-biserial correlations were computed on this analysis alone, it is to be expected that the significant correlation is due to chance.

The Relationship between the Complex Tenses and Reversibility

One of the original hypotheses was that reversibility would be related to the complex tenses. The Ss were divided into two groups: reversers (scores of 1 or 2) and non-reversers (scores of 0). Their performance on each of the complex tenses was analyzed.[8] Table 18

Insert Table 18 about here

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shows the number of Ss who fell into each of the categories. Although there is a trend from no reversibility to total reversibility, this trend is not significantly related to the development of the complex tenses (Fisher's exact $p > .05$). However, it should be noted that by the second grade only about half of the Ss had obtained correct scores on the past progressive and present perfect II and one-third on conditional II. These data seem to indicate that the concept of reversibility is attained prior to these complex tenses.

It was also hypothesized that time-concept reversibility may be related to time-language reversibility. That is, the ability to carry out specific actions in their true time order even though the order of events may be presented in reverse order (e.g., y after x; before y, x) is dependent upon the ability to reverse. Contingency tables were

set up to see if there was such a relationship (Table 19). None of these relationships proved to be significant.

Insert Table 19 about here

Since solving Piaget-type problems (especially situations II and V) provides another measure of reversibility, the relationship between language reversibility and correct responses to the Piaget-type situations was examined. Tables 20, 21, and 22 present respectively the

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Insert Tables 20, 21, and 22 about here

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proportion of kindergartners, first graders and second graders giving correct responses to each Piaget situation as a function of language reversibility. None of these relationships was significant.

The Relationship Between Language Scores and Time Trainability

About 17% of the first graders and 23% of the second graders reached criterion after verbal training on the time-concept-attainment task. The relationship between language scores and reaching criterion after verbal training was examined (Table 23). None of the point-biserial

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Insert Table 23 about here

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correlations was significant.

Summary

The main findings concerning the relationship between time-language and time-operativity indicated that:

(1) The overall correlation between language scores and Piaget scores was significant although the individual correlation within each grade was low.

(2) There were no significant correlations between specific Piaget situations and vocabulary or syntax scores.

(3) There was no relationship between reversibility and the complex tenses nor concept reversibility and language reversibility, although it appears that concept reversibility is mastered prior to these tenses.

(4) There was no relationship between vocabulary or syntax scores and ability to reach criterion after verbal training on the concept attainment task.

The Relationship Between Time Language Production and Time Cognition

At the end of each of the five Piaget situations (question 4), the child was asked: 'Which car took more time (or less time)? or 'Which car traveled for a longer time (or shorter time)?' and/or 'Did the two cars travel for the same amount of time?' After the child picked one of the cars, he was asked: 'How do you know that car took more time (or less time, or the same amount of time)?' In addition, after completing the 40 acquisition trials and prior to concept training in the time-concept-attainment task, each S was asked: 'Why did you pick those cars?' Each of the verbal responses was recorded and subsequently classified by two raters into twelve categories. The first 6 categories were derived from Piaget's (1955; 1969) descriptions of the children's responses to his time experiments. Category 9 is merely a combination of any of the first 6 categories. Category 11 and 12 were derived from what is know about children's problem solving techniques. Disagreements between the two raters were discussed. If after discussion the raters were still in disagreement, the responses were categorized as "Ambiguous". The twelve categories were as follows:

(1) Perceptual. The S must use some perceptual properties in giving his response. For example, he uses positional relationships such as: ahead, behind, further, as far as, under. He uses some kind of placement in space that is dependent upon perception, such as: "This one is there and that one is there." A response is also classified as perceptual if the child is simply reporting what he has seen without making any further temporal inferences or comparisons.

(2) Spatial order. The S's answer must imply some type of numerical order in space such as: first, second, last. The S must make some comparison of the cars in relation to each other, but some numerical order concept must be included.

(3) Temporal order. The S must position or numerically order two cars in relation to one another in terms of time rather than space. For example, "This car stopped first", implies a temporal order as opposed to a spatial order. A point in time must be indicated.

(4) Speed. The S uses some form of speed as an explanation. For example, It went fast (or faster, slower, the same speed)."

(5) Duration. The S uses some reference to time intervals, such as, more time, less time, the same amount of time. On a time continuum, the S is referring to some extension in time rather than an end point.

(6) Coordination of Start and Stop. The S's explanation shows that he can dissociate spatial succession from temporal succession. For example, "When one car stopped, the other was still going (more time)" or "They both started and stopped at the same time (same time)."

(7) (8) Guessing and Don't Know. The S states that he doesn't know the answer or the S is obviously guessing For example, "I think it at home" implies S had no understanding of the question and just gave a response. These two categories were classified separately and then pooled into one category.

(9) Combination. If a S's explanation uses two or more of the first six categories in his explanation, his explanation was categorized as "combination". In the appendices the numbers alongside the responses classified as "combination" indicate which of the categories the S was using.

(10) Ambiguous. If the raters were in total disagreement as to how an explanation should be classified, the explanation was categorized as "ambiguous." Disagreement between the raters arose most often when the raters were deciding whether the S's response should be classified as spatial or temporal order. For example, the word before may be classified as spatial if it indicates "in front of" or temporal if it indicates

"earlier." The concept "head start" is another example. The child could mean that one car started an inch before the other car (spatial) or several seconds before the other car (temporal). If the child gives no other clues, the response was classified as "ambiguous."

(11) Alternation. The S uses some color or position sequence, such as: black car, black car, white car, white car; or top car, bottom car, top car, bottom car.

(12) Hypothesis Testing. The S makes up hypotheses about which car he thought was correct. For example, "Sometimes I thought it was the fast one, then I thought it might be the one that's behind, then I thought it might be..."

Appendices C through G give the protocols of all the Ss by category and age for each of the five Piaget situations respectively. Appendices H and I give the actual protocols by category and age of the children's explanations after completing the 40 concept-attainment trials.

Two types of comparisons were made: One analysis compares the differences in type of judgment made by the younger group and the older group. The younger groups (Grades K, 1st and 2nd) were pooled and the older groups (ages 9, 10, and 11) were pooled for these analyses. The other analysis compare the types of judgment used by the Ss who scored correctly on a particular situation (criterion B) as opposed to those who scored incorrectly; or those Ss who were trainable on the time-concept-attainment tasks as opposed to those who were not. Each of these analyses was done separately for each of the two age groups. Percentage scores in each of the categories were calculated and tests of independent proportions (Z) were computed.

Time Language Production and Piaget Time Concepts

The percentages for each type of explanation were computed as a function of situation and age group within each of the categories (Table 24). Significant age differences were found in the use of category 6, coordination of start and stop; category 3, temporal order;

Insert Table 24 about here

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and category 6, coordination of start and stop. In situation II, the only appropriate explanation is: "The cars took the same amount of time because they started and stopped at the same time." Such an explanation would be classified as category 6. For that situation, none of the younger Ss' responses indicated a coordination of start and stop, whereas 30% of the older Ss' responses were classified in that category. The difference is highly significant ($\bar{z}$=4.91; $p < .001$).

Situations III and IV were identical except that situation III asked the question "Which car traveled for more (longer) time" and situation IV asked: "Which car traveled for less (shorter) time." The most appropriate response would have been some variation of "That car took more time because it kept on going when the other car had stopped (category 6)" or "That car took less time because it stopped first (category 3)." Both these responses could be interchanged for more or less. Thus, responses classified as category 3 or 6 would have been the most appropriate. For situation IV, 10% of the older Ss used category 6, whereas none of the younger Ss used this category. This difference is significant (Fisher's exact $p = .02$). On the other hand, 13.63% of the younger Ss used category 4 speed whereas none of the older Ss were classified in this category. This difference was also significant (Fisher's exact $p = .02$). On situation III, the significant difference between the older and younger Ss occurred in category 3, temporal order. Almost 37% of the older Ss used this type of judgment whereas only about 6% of the younger Ss did. This difference is significant ($\bar{z}$=3.99; $p < .01$). The older group's use of a less sophisticated type of

explanation might be due to the nature of the situation. In situation III "more time" was equal to "more distance." In situation IV "less time" was equal to "less distance." Thus, the Ss could get this problem correct by relying on perceptual cues or temporal order cues. It is interesting to note that for situations III and IV more than 40% of the responses for both groups fall into category 1, perceptual.

In situation V, the S had to rely on speed and duration cues in order to obtain the correct response. Both cars started and stopped at different times, but covered the same distance. Thus, the car that traveled slower took more time because the cars traveled the same distance. An appropriate explanation requires reliance on speed, perceptual and durational cues. Thirty per cent of the older Ss used such a combination of cues whereas only 10% of the younger Ss did. This difference was significant ($\bar{z}$=2.33; $p < .05$). On the other hand, about 31% of the younger Ss relied on temporal order cues ("This car stopped first") and only 3% of the older Ss used such cues. This difference is also significant ($\bar{z}$=2.81; $p < .01$). Clearly the younger Ss were not incorporating any notion of speed into their explanations.

In order to further examine the relationship between language production and Piaget time-operativity, comparisons were made between the type of explanations used by those Ss who scored correctly on a particular situation (criterion B) versus those who scored incorrectly. This type of analysis was conducted separately for each of the two groups. There was a significant relationship between type of explanation and correct score for situations I, III, and IV for the younger group (Table 25). In situation I, the cars started and stopped at the same time, and traveled at the same speed. Category 6 is the only

appropriate explanation. Fifty-five per cent of the Ss who scored correctly used this type of judgment whereas none of Ss who scored

Insert Table 25 about here

incorrectly gave this explanation. This difference is significant ($Z=3.06$; $p < .01$). It is interesting to note that there were 5 younger Ss who had available the appropriate verbal algorithm for coordination of start and stop but only used it in situation I when no logical operations were involved. No test of independent proportions were conducted for situation II since none of the Ss scored correctly. The majority of these Ss used perceptual cues (37%) or temporal order cues (28%) as explanations.

For situation III, almost 17% of the Ss who scored correctly used temporal order as an explanation, whereas less than 2% of the Ss who scored incorrectly used this explanation. Such a relationship also holds true for situation IV, where almost 19% of the Ss who scored correctly used category III and 3% who scored incorrectly used a temporal order explanation. Nevertheless the majority of the Ss, whether correct or incorrect, relied on perceptual cues.

For the older Ss, there was no relationship between type of explanation used and score on the Piaget tasks except for situation II (Table 26). Fifty per cent of the Ss who scored correctly used category

Insert Table 26 about here

6 whereas 7% (N=1) who scored incorectly used this category. This difference is significant ($Z=2.13$; $p < .05$). Thus, it appears that there is more of a relationship between type of explanation used and correct

situation score for the younger Ss than for the older Ss.

Explanation Given After Forty Acquisition Trials

Initial analyses revealed that there were no significant differences between type of explanations given by those Ss who were given concept-attainment trials of "more time" and those given concept-attainment trials of "less time." Thus, these explanations were pooled. Table 27 compares the judgments used by the younger and older groups

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Insert Table 27 about here

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after 40 acquisition trials. This table indicates that the older Ss' use of perceptual cues decreases significantly. Thirty-five per cent of the younger subjects (31 out of 88 Ss) used perceptual cues in their explanations, whereas only 6% of the older Ss (2 out of 30 Ss) did. This difference is significant ($\bar{z}$2.79; $p < .01$). On the other hand, the older Ss use a combination of cues (category 9) significantly more than the younger Ss. Almost 47% of the older Ss gave this type of explanation, whereas only 20% of the younger Ss did. This difference was also significant ($\bar{z}$=2.27; $p < .05$).

The data were further divided according to whether the Ss were trainable or not (Table 28). The data for the younger group reveal

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Insert Table 28 about here

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that if the S was trainable, he was more likely to use a combination of cues (category 9) than if he was not. Fifty per cent of the Ss who were trainable gave explanations classified in category 9, whereas only 18% of the untrainable Ss did. This difference is significant ($\bar{z}$=2.27; $p < .05$).

The data for the older group revealed that there were significant differences in the use of perceptual cues. The Ss who gave perceptual explanations were untrainable. Two of the six untrainable Ss used perceptual cues. None of the trainable Ss used such cues. This difference is significant ($\bar{z}$=2.02; $p < .05$). The main differences between the older and younger groups were in category 1 (perceptual) and category 9 (combination of temporal cues). The younger Ss who were trainable were more likely to use the response patterns of the older Ss. On the other hand, the older Ss who were untrainable were more likely to use the response patterns (perceptual) of the younger Ss.

CHAPTER IV

DISCUSSION

The main purpose of this study was to examine the relationship between the development of the child's conception of time as defined by Piaget and the development of those aspects of language that express temporal relationships. Two general hypotheses were tested in order to provide further data relevant to this relationship:

(1) Cognitive development precedes or is concomitant with linguistic development

(2) Language is not sufficient to advance cognitive development.

Hypothesis I

The first hypothesis tested was that cognitive development precedes or is concomitant with linguistic development. Specifically, it was hypothesized that reversible operations are correlated with or precede the comprehension of the complex tenses, and the ability to comprehand the connectives before and after in both positions of a sentence.

It was found that a majority of the nursery school children, scored correctly on the items dealing with the present progressive, the past and the future (I). On the other hand, less than 60% of the subjects tested in the second grade had mastered such tenses as the past progressive, conditional II, present perfect II. In contrast, none of the nursery Ss had attained reversibility whereas all of the second graders had. Reversibility, then, seems to evolve sooner and faster than the comprehesnion of the complex tenses. Analyses of the relationship between the complex tenses and reversibility showed none of these relationships to be significant. It was expected that Ss

who demonstrated reversibility would score correctly on items dealing with the complex tenses. Such a trend appeared in the nursery grade for the past progressive and present perfect II. On the other hand, the reverse held true for conditional I and present perfect I, that is, the comprehension of these tenses preceded that of reversibility. One possible reason for this may be that in the case of present perfect I and conditional I the subjects were responding only to the word "won." This becomes evident from a comparison of the performance between present perfect I and the past tense. Performance on these two items was very similar. Although present perfect I appeared somewhat more difficult for the nursery group and the kindergartners than the past tense, the first and second graders both achieved 100% performance on these two items. In the case of the conditional, it is quite possible that the Ss were not responding to the entire construction "if..., which...would...." but only to the latter part of the construction "would win," and were interpreting this as "will win." Only with the nursery Ss does there seem to be a difference between future I and conditional I. Kindergartners, first graders and second graders performed similarly on these items.

Although there are grammatical and cognitive differences between the past tense and the present-perfect tense, and between the future and the conditional (see Chapter I, p. 9 for Jesperson's distinctions), it was difficult to find items that could make such distinctions. One way to see if a child makes the appropriate cognitive distinctions among the grammatical forms is to examine his language output over a period of time, so that an observer could determine which constructions were truly present perfect constructions and which were cognitively the simple past;

and determine which conditional constructions were confused with future constructions. Cromer (1968), in his analysis of Adam's and Sarah's protocols points out that the present perfect construction does not appear until 4;6 and then very rarely. He does not point out whether the use of this construction was correct or was used interchangeably with the past. In an attempt to delineate the cognitive concepts necessary for the formation of tenses which developed at a later stage, he also failed to find situations which would differentiate the past from the present perfect, and the future from the future perfect. Thus one possibility for not finding a significant relationship between reversibility and these two complex tenses may be due to the failure in developing items which make the necessary cognitive distinctions.

Another problem in interpreting these results is related to the difference between those constructions which can be comprehended by relying on both speed and/or position cues (labelled I) and those constructions which can only be answered by making inferences from speed cues alone (labelled II). When comprehension of the complex tenses had to be inferred from both speed and position cues, there was less of a tendency for reversibility to precede the understanding of the complex tenses. In fact, in the case of conditional I, 24% of the Ss scored correctly on the complex tenses and failed the reversibility item. Such a relationship also held true for present perfect I. As was mentioned above this could be because the Ss were interpreting those constructions as though they were simple tenses and not complex tenses. On the other hand, when speed cues alone were available, there were only six Ss (6%) who scored correctly on the present perfect who did not

attain reversibility and twelve Ss (12%) who scorec correctly on the conditional who had not attained reversibility. Thus, when the comprehension of a tense can be inferred from both position and speed cues, such comprehension is much simpler than when only speed cues are available. This finding also held true for the future tense, that is, the ability to comprehend a syntactic structure depended on the number on contextual clues available. Herriot (1969) also found that his 4-, 5-, and 6-year-old subjects' understanding of the future was influenced by the number of situational cues available to them.

Two major problems have arisen in trying to interpret the results of the relationship between reversibility and the complex tenses: (1) the failure to find measures that make the necessary cognitive distinctions between the simple and the complex tenses; (2) the fact that language comprehension is inextricably bound by the situation in which it is presented. Nevertheless, the fact that reversibility operations were mastered between the ages of 4 and 8 while a complex tense such as the past progressive was not mastered by 60% of the eight-year-olds is very much in contrast with the generative linguist's argument (such as McNeill's, 1966) that the rules of grammar have been attained by age 5, while Piaget-type problems are not similarly solved at that age. These findings lead one to believe that psycholinguists have been studying grammatical structures that are cognitively simple. Carol Chomsky (1969) and Menyuk (1969) have more recently shown that syntactic functions are not fully achieved even by age 8 or 9.

A second prediction of this study was that concept reversibility would be related to before/after reversibility. Again, we find that concept reversibility was acquired prior to before/after reversibility.

Only 13% of the Ss who demonstrated knowledge of before-reversibility had not acquired concept-reversibility; and 10% of those Ss who had acquired after-reversibility had not acquired concept-reversibility. There was no significant correlation, however, between before/after-reversibility and concept-reversibility. Cromer (1969) proposed that the ability to "decenter" might be related to before/after-reversibility; this hypothesis, however, was not confirmed by him. Nevertheless he maintains that there is some cognitive component to before/after-reversibility since it is late in emerging in the child's syntactic development. Neither the cognitive measures of this study nor those of Cromer's have resulted in a cognitive explanation of the late emergence of before/after-reversibility.

Hypothesis II

The second hypothesis observed that while language and thought might develop concurrently, the child's language would not be sufficient to advance him to the next stage of operational thinking. Although no theory would be seriously disconfirmed by a positive relationship between the language and thought measures, cognitivists would predict that there would be significantly fewer Ss who would score high on the language measures and low on the concept measures than Ss who would score low on the language measures and high on the concept measures. Further, they would expect a higher correlation between syntactic development and concept development than between vocabulary development and concept development since they feel that similar operations underlie both cognitive and linguistic transformations.

The overall relationship between the language measures (combined vocabulary and syntax scores) and the Piaget Time-Concept Task was

significant. However, except for the kindergartners, none of the individual relationships within each grade was significant. This suggests that the relationship is in part developmental in that a full range of scores in not achieved within any one grade but only over the developmental span. Further, there were no significant relationships between each of the Piaget time-concept situations and syntax comprehension, nor between the vocabulary measures and each time-concept situation within the age range studied. Thus, McCarthy's (1955) comments that Piaget's time concepts were inextricably tied to the child's verbal understanding of these terms does not seem valid.

Other researchers (Inhelder and Sinclair-de-Zwart, 1969; Sinclair-de-Zwart, 1969) have found a higher relationship between Piaget operativity and syntax than between operativity and vocabularly. However, Inhelder and Sinclair were correlating the Ss' production scores and not their comprehension scores. Sinclair (1969) points out that all her subjects comprehended correctly the lexical and structural commands on her comprehension tests. The main difference in language production between those Ss who demonstrated operativity and those who didn't was that the operational child was able to express differences between two objects in one all-embracing sentence using a comparative and coordinated structure. The operational child would say: "This one is longer and thinner (than the other one)," whereas the preoperational child would say: "This pencil is long, this one is short; this one (the first) is thin, this one (the second) is fat (Inhelder and Sinclair, 1969, p. 16)." In the present study the language productions of the children were analyzed for the type of cognitive explanations given. The language structure reflected in the Ss' explanations do not seem to differentiate

an operational child's performance from a preoperational child's performance. A typical sentence uttered by an operational child would be; "These two cars took the same amount of time because they started and stopped at the same time." However, even Ss who show no operativity would use that type of sentence structure. For example, a second grade child (#63, see page 135 of Appendix D) would say: "They started off the same time and stopped the same time but they didn't stop the same distance." The sentence structure "they started at the same time and stopped at the same time' was even used by kindergarten Ss in Situation I of the Piaget-Time-Concept Task. In this situation the cars had started and stopped at the same time and traveled at the same speed. The language constructions, in the case of the Inhelder and Sinclair experiments allowed the child to organize and structure what he saw in front of him efficiently. In the time experiments here it was not enough to organize what was perceptually in front of the child. The child not only had to incorporate certain notions such as speed, but also ignore others such as distance. A cursory glance at the protocols reveals that children at all levels produce comparative statements and coordinated descriptions even though they were used more frequently by the older Ss. However, even operational Ss would occasionally use sentence structures that were not well coordinated. For example, subjects #108 (age 10) in Situation II demonstrated operativity and a well-coordinated sentence: "They both stopped at the same time and they both started at the same time." In contrast, in situation V, he used a descriptive sentence reminiscent of Inhelder's preoperational example: "After the black one started and it stopped and the white one stopped in the same place." One important measure which Inhelder and Sinclair have not reported to the writer's

knowledge is the consistency of sentence structures across various situations.

The nonverbal concept-attainment task and the subsequent verbal training provides the strongest evidence for the notion that language is not sufficient in advancing the child's operative level. Bruner argues that verbal representation of objects and events is what enables the child to acquire concepts and operations. Berko and Brown (1960) have argued and taken the position that cognitive advancement is nothing but vocabulary growth. One of the most interesting findings in this study is that there were a few Ss as early as the kindergarten grade that had available the appropriate verbal algorithm that was necessary to demonstrate operativity: "The cars started and stopped at the same time." In the Piaget situation when the two cars were traveling at the same speed the Ss had no difficulty in expressing simultaneity of start and stop and equality of duration. However, as soon as the speeds differed these subjects no longer used the appropriate linguistic expression.

The verbal-concept-training method which was initiated to teach the concept of time showed that none of the kindergartners, and only 20% of the first and second graders profited from this training, whereas almost all the 9-, 10-, and 11-year-olds were able to acquire the concept. This finding substantiates other research on the limited effects of training in improving cognitive performance (e.g., Beilin and Franklin, 1962) and supports the Piaget position that the child's ability to benefit from training depends on his level of conceptual development. Although Bruner may argue that it was the "activation of language habits" which led to improved performance, this "activation" only helps in the case where a specific level of operativity has been

attained or only serves to provide algorithms of limited utility as is argued by Beilin (1969a).

Piaget (1963) has stated that "language is the vehicle par excellence" through which thought is expressed. This statement seems to be confirmed by the positive relationship between the type of cognitive explanation used after each Piaget situation and correct scores on these situations. There was also a relationship between type of explanation used after 40 concept-acquisition trials and trainability. The data reveal that there was a tendency for the younger Ss who were trainable to use the response patterns of the older Ss, while there was a tendency for the older Ss who were not trainable to show a response pattern more typical of the younger Ss. Sinclair-de-Zwart (1969) also found this to be true in her study. It should be emphasized that the responses in this case were classified according to cognitive explanation and not according to linguistic structure of the sentence. Language is one method by which a person can express his cognitive organization but that does not imply that improvement of language skills will reflect or bring about increased cognitive organization.

A serious methodological problem seems to exist in studying the relationship between time language and time concepts. Methodologically it is easier to dissociate language cues from cognitive tasks than it is to eliminate cognitive cues from language. The former can be done by developing nonverbal-problem-solving procedures. In the present study it was difficult to delineate the differences between items designated as language and those designated as cognitive. The cognitive items were designed so that the notions of order and duration would be required in order to answer them appropriately. Analysis of the

explanations given in the cognitive tasks shows that the children confused time, space, speed and distance. This leads one to conclude that the errors the Ss made were logical and not linguistic. In the language tasks, the S was shown a situation which illustrated a specific lexical or syntactic item. In dealing with tense and time words, however, each structure reflected a very specific cognitive meaning. The language items, in retrospect illustrated the child's understanding of a specific concept, whereas the Piaget-type problems reflected a general operation. There is a cognitive component in each, and at best, when comparing language comprehension items to the Piaget items we may be making a distinction between concepts and operations and not between language competence and operativity.

Intratest Comparisons

The purpose of the intratest comparisons was to determine if there were any developmental trends among the measures and where appropriate, to replicate the findings of other research.

Language Tasks

Three language measures were administered: comprehension of time vocabulary, time syntax, and the connectives before and after. Analyses of the vocabulary measures indicated developmental trends but the only significant difference was between the nursery Ss and the first grade. Words dealing with speed were the easiest although it is important to note that the concept of speed is the most difficult for the Ss to incorporate into their judgements, and that it is not done until about age 9. This is another example of the child's possession of a lexical item representing a specific concept but where he lacks possession of the operation. Another interesting discrepancy is in regard to the

difference between first and last. Across grades last was easier than first. This difference may be due to the context in which the items were presented. Although the technical aspects of the two items were identical (that is, for both questions the cars were an equal distance apart, each of the cars traveled for the same amount of time, etc.), both items asked the question: "Which car stopped first?" or "Which car stopped last?". It might be easier to remember which car stopped last because it is the last thing the Ss saw moving. On the other hand, when the question "Which car stopped first" was asked, the Ss in order to respond correctly, had to go through a two-step reasoning process. "The black one stopped last, so that it's the white one which must have stopped first." Thus, stop first would require two steps in remembering whereas last would require only one step. These items might not have been making a distinction between first and last but between stop first and stop last. The comprehension of these vocabulary items was a function of the context in which they were presented.

The syntax items showed a clear dichotomy. Those items which could be answered on the basis of speed and/or position cues were answered correctly by at least 90% of the kindergartners, first and second graders; those items which could only be answered by incorporating a concept of speed were answered correctly by less than 50% of the Ss. The past progressive tense was an exception. The question: "Which car was winning when the bell rang?" was asked twice. Only the child's second response was scored. When the bell rang, the winning car was clearly in front of the other car. Nevertheless, only 50% of the second graders answered this item correctly. Many nursery Ss refused to choose one car and kept insisting that both cars "win." The past

progressive tense is a good example of a syntactic structure which appears later in the child's linguistic development. Whether the other complex tenses are similarly belated in appearance is difficult to determine from this study because of the lack of clarity between the complex tense and the simple tense items.

An interesting result that emerged from the before/after test was that before-reversibility is easier than after-reversibility. A transformational explanation alone cannot explain this finding since the number of transformations required to perform either of the reversibilities is the same. Using college sophomores, Smith and McMahon (1969) have also been studying the comprehension of sentences using these two connectives. They found that: (1) their Ss spend more time looking at sentences containing the connective after than a sentence containing the connective before regardless of the position in the sentence; (2) what comes first in space or time is more accessible then what comes second: (3) sentences which mention the first event first were inspected longer than sentences which mentioned the second event first. It should be mentioned that in the tasks used in Smith's and McMahon's study the S had to view the sentence, and then was asked such questions as 'What happened first?" 'What happened second?". Error scores were very low and only latency scores were significant. In the present study, the Ss had to remember the sentence and act it out in the correct order. Thus, the task resembled a verbatim recall task. One explanation for the before/after differences may be one of information coding. When the word before appears at the beginning of a sentence it serves as an immediate cue. The cue amounts to forewarning that the first event mentioned is the second event in time. In contrast, when the

reversal of time order is accomplished by the connective after, there is no cue until the middle of the sentence. The first thing S hears is an event in time; not until the middle of the sentence does he know whether the key word will be before or after. If it is after, the S must mentally recode the first part of the sentence in order to establish its position in time. There is a likely bias in favor of before reversibility because of this build-in early warning required by the sentence structure. For after reversibility there can be no such early warning, and the coding must take place in the middle of the sentence. A transformational grammar could only account for part of the before/after difference. A memory and/or information processing theory would have to account for the rest.

Time-Concept Tasks

Although there was a developmental trend in the Piaget-time concept measures, none of the Ss through the second grade attained time operativity. This is contrary to the results of Lovell and Slater (1960). They found that the responses of 13% of their 5-year-olds, 17% of their 6-year-olds, and 30% of their 8-year-olds indicated operativity, that is, that the Ss answered correctly question 4 of the situation dealing with equality of synchronoous intervals (situation II: Did both cars travel for the same amount of time?). There may be several reasons for the discrepancy between the two studies: (1) Lovell and Slater, in analyzing the S's response to question 4, did not take into account the Ss performance on the first three items. They only report the percentage of correct replies. In the present study, several Ss in each of the grades answered question 4 correctly. However, since they did not answer one of the first two questions correctly, they were not scored

as operational. If the child states that one car stopped or started before the other car, it does not logically (i.e., necessarily) follow that the two cars traveled for the same amount of time. Perhaps the percentage of Ss attaining operativity in the Lovell and Slater study would be reduced if they had taken the first two questions into account. Moreover, they did not analyze whether those who answered appropriately on question 4 gave the appropriate reason (that is, "the two dolls started and stopped at the same time, therefore they traveled for the same amount of time"). In addition, in the Lovell and Slater study the Ss saw the same situation 3 times in a row. Each of the situations lasted 50 seconds, 25 seconds, and 12 seconds respectively. In the present study, the S saw the situation only once and it lasted 6 seconds. The percentages that Lovell and Slater report are not the number of Ss who responded appropriately to each of the situations but rather the percentage of correct replies for the total of the three situations. With only N=10 per group, one operational child could inflate the scores for the entire group. Nevertheless, Lovell and Slater do show that most of the children thought that the doll which travelled faster and/or further took the greater amount of time, a finding which generally supports Piaget's notions, and which is also substantiated in this study.

Although operativity had not been attained by age 8 in this study, an important finding is that the items were fairly scalable and in the direction predicted by Piaget despite the fact that two of the items were almost equal in difficulty. It is quite possible that a higher scalability index would have been attained had there been more levels. There were only three levels of predicted difficulty, which according to Green (1954) is too few to be scalable.

Conclusion

The main purpose of this study was to examine the relationship between time-operativity and time-language. The first hypothesis tested was that reversibility operations precede of develop concomitantly with the complex tenses, and before/after reversibility. This hypothesis was only partially confirmed. The reversibility operation seems to precede developmentally only the past progressive, and the before/after connectives when the order of events are the reverse of the order in which the sentence is spoken. Possible sources for a lack of consistent priority could be methodological: (1) It was very difficult to dissociate cognitive cues from linguistic structures. Syntactic comprehension is very dependent upon the contextual situation in which it is presented. The number and type of contextual cues available greatly influence the facility with which a sentence is comprehended. (2) Items must be so constructed that they clearly present the cognitive distinctions implied by certain syntactic structures. There was insufficient cognitive distinction between the simple and complex tenses.

The second hypothesis tested was that language was not a sufficient condition to advance operational thinking. This hypothesis was confirmed. When the language was used appropriately, it only acted as a dependent variable, that is, as an expression of a cognitive structure already present.

The language measures used in this study again emphasized the importance of the context within which a lexical item is presented. Children may comprehend a term in one context (e.g., Future I) and not in another (e.g., Future II).

Analysis of the Piaget Time-Concept Task indicated that the order

of difficulty of the items was similar to that of Piaget's and closely approximated scalability criterion. The children's explanations in the age range studied revealed that time, space, distance and speed were confused, lending support to Piaget's conception of the development of the child's conception of time.

FOOTNOTES

1. Beilin (1969c) makes a distinction between the time lexicon and time syntax and calls attention to its heuristic value. Cromer makes no such distinction nor uses these terms.

2. Because of one E's illness, two Ss in the kindergarten, three Ss in the first grade, and two Ss in the second grade were seen by the same E (the author) on both sessions.

3. On items labelled II there is a confounding of language cues with cognitive cues.

4. The scoring reliability for the younger Ss was very poor. It was very difficult to judge if in fact these Ss were making the appropriate motor response required by the questions. Consequently, is was decided not to report the results of the demonstration vocabulary task, but consider it merely as an activity task.

5. This playground school is associated with the same school that was used for testing during the academic year. Of the 30 Ss tested, 21 attend this school during the academic year. The other 9 children were from the neighborhood who attend parochial schools during the academic year.

6. Means and standard deviations were calculated separately for each of the three age groups (9-10- and 11-year olds). An analysis of variance revealed no significant age differences ($F=.54$; $df=2,27$; $p < .05$). The three age groups were combined to form the older group.

7. Means and standard deviations were calculated separately for each of the three age groups for acquisition, training and criterion. An analysis of variance revealed no significant age effects for acquisition ($F=1.71$; $df=2,27$; $p < .05$); training ($F=2.29$; $df=2,27$;

FOOTNOTES Cont.

$p < .05$), and criterion ($F=1.18$; $df=2.27$; $p < .05$).

8. It was felt that a score of 1 showed some reversibility as opposed to none of all, and therefore scores of 1 and 2 were combined into one category. Analyses were also carried out combining those Ss who had a score of 0 with those who has a score of 1. All the χ^{2}'s remained non-significant.

TABLE 1

Order of Tasks by Session and Sequence

Session	Sequence I	Sequence II
I	(C) Pretest to Piaget	(L) Language Film[b]
	(C) Piaget Time Concepts	(L) Before/After[a]
	(C) Reversibility[a]	(C) Reversibility[a]
	(L) Before/After[a]	(C) Pretest to Piaget
	(L) Language Film[b]	(C) Piaget Time Concepts
II	(C) Concept Attainment Task	(L) Language Film[b]
	(L) Demonstration Vocabulary[a]	(L) Demonstration Vocabulary[a]
	(L) Language Film[b]	(C) Concept Attainment Task

Note.—Letter preceding task denotes type of task: L=Language task; C=Cognitive task.

[a] These tasks are activity tasks.

[b] The language films are identical. Each language film was administered twice, once at each session.

TABLE 1 Cont.

Session	Sequence	
	III	IV
I	(C) Concept Attainment Task	(L) Language Film[b]
	(C) Demonstration Vocabulary[a]	(L) Demonstration Vocabulary[a]
	(L) Language Film[b]	(C) Concept Attainment Task
II	(C) Pretest to Piaget	(L) Language Film[b]
	(C) Piaget Time Concepts	(L) Before/After[a]
	(C) Reversibility[a]	(C) Reversibility
	(L) Before/After[a]	(C) Pretest to Piaget
	(L) Language Film[b]	(C) Piaget Time Concepts

Note.—Letter preceding task denotes type of task: L=Language task; C=Cognitive task.

[a] These tasks are activity tasks.

[b] The language films are identical. Each language film was administered twice, once at each session.

TABLE 2

Vocabulary Scores by Grade and Sex ($\bar{X}$s and S.Ds)

Sex[b]	Grade[a]							
	N (N=12)		K (N=29)		1st (N=29)		2nd (N=30)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
M	3.67	1.07	4.40	.99	5.47	1.12	4.87	.99
F	4.17	.75	4.57	1.28	5.00	1.24	4.47	1.13
Total	3.92	.90	4.48	1.12	5.24	1.15	4.67	1.06

[a] Grade differences are significant ($F=5.00$; $p < .01$).

[b] Sex differences are not significant ($F=.02$).

TABLE 3

Subjects Passing Each Vocabulary Item by Grade (in Per Cents)

Item	Grade			
	N (N=12)	K (N=29)	1st (N=29)	2nd (N=30)
Slower	83.33	96.55	100.00	93.33
Faster	83.33	96.55	100.00	93.33
First[a]	33.33	51.72	55.17	66.67
Last[b]	58.33	65.52	93.10	73.33
Shorter (less) time[c]	41.67	75.86	89.66	66.67
Longer (more) time (I)[d]	33.33	27.59	58.62	26.67
Longer (more) time (II)	25.00	34.48	27.59	50.00

[a] The difference between N and 2nd grade is significant ($z=1.97$; $p < .05$).

[b] The following differences are significant: N and 1st grade ($z=2.24$; $p < .05$); K and 1st grade ($z=2.59$; $p < .01$); 1st and 2nd grade ($z=2.02$; $p < .05$).

[c] The following differences are significant: N and 1st grade ($z=2.85$; $p < .01$); 1st grade and 2nd grade ($z=2.15$; $p < .05$).

[d] The following differences are significant: K and 1st grade ($z=2.39$; $p < .05$); 1st grade and 2nd grade ($z=2.48$; $p. < .01$).

TABLE 4

Syntax Scores by Grade and Sex ($\bar{X}$s and S.Ds)

Sex[b]	Grade[a]							
	N (N=12)		K (N=29)		1st (N=29)		2nd (N=30)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
M	4.00	1.26	4.93	2.07	5.47	1.27	5.87	1.27
F	4.67	1.51	5.28	.99	5.35	.71	5.60	1.97
Total	4.33	1.37	5.10	1.52	5.41	.97	5.73	1.58

[a] Grade differences are significant ($F=5.33$; $p < .01$).

[b] Sex differences are not significant ($F=.37$).

TABLE 5

Subjects Passing Each Syntax Item (in Per Cents)

Item	Grade			
	N (N=12)	K (N=29)	1st (N=29)	2nd (N=30)
Present Progressive	100.00	93.10	96.55	100.00
Past Tense	83.33	100.00	100.00	96.67
Future I[a]	58.33	96.55	100.00	96.67
Conditional I	83.33	89.66	100.00	100.00
Present Perfect I	66.67	76.47	100.00	100.00
Future II	16.67	17.24	27.54	40.00
Conditional II	66.67	41.38	34.48	33.33
Present Perfect II[b]	8.33	41.38	34.48	50.00
Past Progressive[c]	16.67	27.59	48.28	56.67

Note.—Only 17 kindergartners, 22 first graders and 15 second graders were given the present perfect I.

[a] The following differences are significant: N and K ($z=2.67$; $p<.01$); N and 1 ($z=3.88$; $p<.001$); N and 2nd ($z=2.73$; $p<.01$).

TABLE 5 Cont.

[b] The difference between N and 2nd grade is significant ($Z=2.17$; $p < .05$).

[c] The following differences are significant: N and 2nd grade ($Z=2.17$; $p < .05$); K and 2nd grade ($Z=2.26$; $p < .05$).

TABLE 6

Subjects Passing Each Item on the Before/After Test (in Per Cents)

Category	Concept	Grade			
		N (N=12)	K (N=29)	1st (N=29)	2nd (N=30)
OS = OT	Before	75.00	89.66	89.66	76.67
	After	66.67	68.97	82.76	90.00
OS ≠ OT	Before[a]	33.33	72.41	72.41	86.67
	After[b]	33.33	37.93	58.62	70.00

[a] The difference between N and K, and N and 1st grade is significant ($Z=1.98$; $p < .05$) as well as between N and 2nd grade ($Z=3.08$; $p < .01$).

[b] The difference between K and 2nd grade is significant ($Z=2.47$; $p < .01$).

TABLE 7

Comparison of Before vs. After Performance in Reversed and Non-Reversed Orders: Within Grade Comparisons[a]

Category	Concept	Grade			
		N (N=12)	K (N=29)	1st (N=29)	2nd (N=30)
OS = OT	After vs. Before	0	4.16*[b]	.50	1.12
OS ≠ OT	After vs. Before	.25	5.06*[c]	.90	1.17
OS = OT vs. OS ≠ OT	After vs. After	1.50	4.92*[d]	2.40	2.50
	Before vs. Before	3.20	1.78	1.78	.44

[a] Chi square values based upon McNemar's test (Siegel, p. 64).

[b] Before is easier than after.

[c] Before is easier than after.

[d] OS = OT is easier than OS ≠ OT.

* $p < .05$.

TABLE 8

The Relationship Between Before/After and Vocabulary and Syntax Scores by Grade (Point-Biserial Correlations)

Category	Concept	Grade							
		N (N=12)		K (N=29)		1st (N=29)		2nd (N=30)	
		Voc.	Syn.	Voc.	Syn.	Voc.	Syn.	Voc.	Syn.
OS = OT	Before	-.28	-.29	.15	.12	.26	.15	-.12	.20
	After	.14	-.09	-.04	.12	.26	.10	-.32	-.05
OS ≠ OT	Before	-.34	-.45	.36*	.24	.20	-.14	-.31	-.00
	After	-.34	-.45	.21	-.18	-.19	-.22	.07	-.32

* $p < .05$.

TABLE 9

Correct TCT Responses by Grade, Sex, and Situation

Grade[a] and Sex[b]		Situation											
		I		II		III		IV		V		Total	
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
	M	3.60	.63	1.47	.52	2.93	.67	3.37	.69	2.33	.67	13.20	2.22
K	F	3.57	.76	1.29	.73	2.75	.53	3.37	.83	2.43	.55	12.71	1.93
	T	3.59	.68	1.38	.62	2.84	.59	3.37	.75	2.38	.61	12.97	2.06
	M	3.60	.91	1.93	.88	3.23	.62	3.40	.51	3.23	.59	15.40	1.86
1st	F	3.93	.27	2.00	.96	3.25	.61	3.50	.52	2.68	.58	15.36	1.62
	T	3.76	.69	1.97	.91	3.24	.61	3.45	.51	2.97	.64	15.38	1.72
	M	3.47	.92	2.13	.92	3.50	.60	3.37	.48	3.07	.62	15.53	2.22
2nd	F	3.60	.83	1.93	.80	3.03	.93	3.37	.70	3.00	.87	14.93	2.53
	T	3.53	.86	2.03	.85	3.27	.81	3.37	.58	3.03	.74	15.23	2.36
	M	4.00	0	3.27	.59	3.90	.20	3.63	.55	3.37	.44	18.03	1.25
Older	F	4.00	0	3.60	.83	3.73	.56	3.80	.37	3.30	.41	18.40	1.40
	T	4.00	0	3.43	.73	3.82	.42	3.72	.47	3.33	.42	18.21	1.32

TABLE 9 Cont.

[a] Grade differences are significant ($F=35.33$; $p < .01$).

[b] Sex differences are not significant ($F < 1.00$).

TABLE 10

Subjects Giving Correct Situation Responses: Criterion A (in Per Cents)

Situation	Grade				Overall χ^2
	K (N=29)	1st (N=29)	2nd (N=30)	Older (N=30)	
I	89.66	93.10	90.00	100.00	3.54
II	3.45	31.03	33.33	93.33	53.94***[a]
III	48.28	79.31	70.00	96.67	18.53***[b]
IV	55.17	93.10	80.00	100.00	23.43***[c]
V	20.69	55.17	70.00	96.67	37.29***[d]

[a] The following differences are significant: K vs. 1st grade ($\bar{z}$=2.43; $p < .05$); K vs. 2nd grade ($\bar{z}$=2.61; $p < .01$); K vs. older ($\bar{z}$=6.65; $p < .001$); 1st grade vs. older ($\bar{z}$=4.68; $p < .001$); 2nd grade vs. older ($\bar{z}$=4.56; $p < .001$).

[b] The following differences are significant: K vs. 1st grade ($\bar{z}$=2.18; $p < .05$); K vs. older ($\bar{z}$=3.89; $p < .01$); 1st grade vs. older ($\bar{z}$=2.06; $p < .05$); 2nd grade vs. older ($\bar{z}$=2.43; $p < .05$).

[c] The following differences are significant: K vs. 1st grade ($\bar{z}$=2.99; $p < .01$); K vs. older ($\bar{z}$=3.84; $p < .01$); 2nd grade vs. older ($\bar{z}$=2.15; $p < .05$).

[d] The following differences are significant: K vs. 1st grade ($\bar{z}$=2.43; $p < .05$); K vs. 2nd grade ($\bar{z}$=3.54; $p < .01$); K vs. older ($\bar{z}$=5.68; $p < .01$); 1st grade vs. older ($\bar{z}$=3.44; $p < .01$); 2nd grade vs. older ($\bar{z}$=2.43; $p < .05$).

*** $p < .001$.

TABLE 11

Subjects Giving Correct Situation Responses: Criterion B (in Per Cents)

Situation	Grade				Overall χ^2
	K (N=29)	1st (N=29)	2nd (N=30)	Older (N=30)	
I	68.97	86.21	73.33	100.00	11.60**[a]
II	--	--	--	53.33	5.90*
III	17.24	24.14	40.00	76.67	26.14***[b]
IV	10.34	37.93	43.33	63.33	8.61*[c]
V	3.45	6.90	13.33	20.00	n.s.

[a] The following differences are significant: K vs. older (Fisher's exact $p < .002$); 2nd grade vs. older (Fisher's exact $p < .005$).

[b] The following differences are significant: K vs. older ($z=4.31$; $p < .001$); 1st grade vs. older ($z=3.77$; $p < .001$); 2nd grade vs. older ($z=2.62$; $p < .01$).

[c] The following differences are significant: K vs. 1st grade ($z=2.14$; $p < .05$); K vs. 2nd grade ($z=2.56$; $p < .01$); K vs. older ($z=3.94$; $p < .001$) 1st grade vs. older ($z=1.95$; $p < .10$).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

TABLE 12

Number of Correct Responses on Time-Concept Attainment Trials, Training and Criterion by Concept and Grade ($\bar{X}$s and S.Ds)

Grade	Concept-Attainment[a]				Training[b]				Criterion[c]			
	More		Less		More		Less		More		Less	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
K	28.13	3.52	21.29	5.47	5.80	1.57	5.43	1.40	4.00	4.05	2.29	2.58
1st	28.23	3.63	24.31	4.53	6.69	1.49	6.56	1.36	9.23	6.38	6.94	6.62
2nd	26.40	4.40	23.87	3.14	6.60	1.99	6.20	1.65	9.67	5.75	7.73	6.84
Older	25.44	3.90	22.57	4.47	9.00	1.21	8.57	1.22	18.63	2.22	14.64	6.37

[a] There is a significant concept effect for concept-attainment trials ($F=22.11$; $df=1, 110$; $p < .001$).

[b] There is a significant grade effect for training ($F=21.23$; $df=3, 110$; $p < .001$).

[c] There is a significant concept effect ($F=5.43$; $df=1, 110$; $p < .05$) and a significant grade effect ($F=28.17$; $df=3, 110$; $p < .001$) for criterion.

TABLE 13

Subjects Attaining Reversibility by Grade (in Per Cents)

Level	Grade				
	N (N=12)	K (N=29)	1st (N=29)	2nd (N=30)	Older
No reversibility[a]	100	44.84	10.34	0	--
Intermediate level	--	34.48	17.24	16.67	--
Reversibility[b]	--	20.69	72.41	83.33	100

[a] The following differences are significant: N vs. K, N vs. 1st, and N vs. 2nd (Fisher's exact $p < .001$); K vs. 1st ($z=2.94$; $p < .01$); and K vs. 2nd ($z=4.16$; $p < .001$).

[b] The following differences are significant: N vs. 1st, N vs. 2nd (Fisher's exact $p < .01$); K vs. 1st ($z=3.95$; $p < .01$); and K vs. 2nd ($z=4.82$; $p < .01$).

TABLE 14

Subjects' Performance on Piagetian Tasks (Criterion A) and Language Scores (Vocabulary and Syntax Scores Combined) (Ns)[a]

	Grade					
	K (N=29)		1st (N=29)		2nd (N=30)	
	Hi Lang.	Lo Lang.	Hi Lang.	Lo Lang.	Hi Lang.	Lo Lang.
Hi Concept	6	5	7	9	10	7
Lo Concept	10	7	9	4	7	6

[a] Median scores for each grade serve as cut-off points.

TABLE 15

Subjects' Performance on Piagetian Tasks (Criterion B) and Language Scores (Vocabulary and Syntax Scores Combined) (Ns)[a]

	Grade					
	K (N=29)		1st (N=29)		2nd (N=30)	
	Hi Lang.	Lo Lang.	Hi Lang.	Lo Lang.	Hi Lang.	Lo Lang.
Hi Concept	2	3	9	4	11	6
Lo Concept	6	18	7	9	6	7

[a] Median scores for each grade serve as cut-off points.

TABLE 16

Relationship Between Piaget Situations and Total Syntax Score (Point-Biserial Correlations)

Situation	Grade					
	K		1st		2nd	
	Criterion		Criterion		Criterion	
	A	B	A	B	A	B
I	-.16	.30	.12	.17	.11	-.01
II	- [a]	- [b]	.02	- [b]	.00	- [b]
III	.09	.04	-.05	.26	-.02	.07
IV	-.10	-.31	.12	.25	-.18	.35
V	-.11	- [b]	.03	.31	.33	-.07

[a] There was only 1 S who met 3 correct as criterion.

[b] Due to task difficulty, there were no Ss in this category.

TABLE 17

Relationship Between Each Piaget Situation and Total Vocabulary Score (Point-Biserial Correlations)

Situation	Grade					
	K		1st		2nd	
	Criterion A	Criterion B	Criterion A	Criterion B	Criterion A	Criterion B
I	.25	.02	.30	.26	.11	.13
II	- [a]	- [b]	-.14	- [b]	.07	- [b]
III	-.11	-.20	.03	.09	.28	.13
IV	.02	-.25	.06	.02	.08	.30
V	.39*	- [a]	-.30	-.18	-.07	-.16

[a] There was only 1 S who met 3 correct as criterion.

[b] Due to task difficulty, there were no Ss in this category.

* $p < .05$.

TABLE 18

Relationship Between Concept Reversibility and the Comprehension of the Complex Tenses (Expressed in Number of Ss)

Tense	Score	Grade							
		N (N=12)		K (N=29)		1st (N=29)		2nd (N=30)	
		Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev
Past Progressive	+	2	0	3	5	1	12	0	17
	-	10	0	9	12	2	14	0	13
Present Perfect I	+	8	0	4	9	2	20	0	15
	-	4	0	2	1	0	0	0	0
Present Perfect II	+	1	0	5	5	0	10	0	16
	-	11	0	7	12	3	12	0	14
Conditional I	+	10	0	11	15	3	26	0	30
	-	2	0	1	2	0	0	0	0

TABLE 18 Cont.

Tense	Score	Grade							
		N (N=12)		K (N=29)		1st (N=29)		2nd (N=30)	
		Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev
Conditional II	+	8	0	3	9	1	9	0	10
	-	4	0	9	8	2	17	0	20

TABLE 19

Concept Reversibility Performance as a Function of Language Reversibility (Ns)

Concept (OS ≠ OT)	Score	Grade							
		N (N=12)		K (N=29)		1st N=29)		2nd (N=30)	
		Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev
Before	+	4	0	7	14	2	19	0	26
	-	8	0	5	13	1	7	0	4
After	+	4	0	4	6	2	15	0	21
	-	8	0	8	11	1	11	0	9

TABLE 20

Kindergarten Subjects Giving Correct Responses to Each Piaget Situation as a Function of Language Reversibility (in Per Cents)

Situation	Criterion A				Criterion B			
	Before		After		Before		After	
	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev
I	87.5	90.5	88.9	47.6	62.5	71.4	72.2	63.6
II	0.0	4.8	5.6	0.0	0.0	0.0	0.0	0.0
III	37.5	52.4	44.4	54.5	25.0	14.3	11.1	27.3
IV	50.0	57.1	61.1	45.5	12.5	9.5	11.1	9.1
V	25.0	19.0	16.7	27.3	0.0	4.8	5.6	0.0

TABLE 21

First Grade Subjects Giving Correct Responses to Each Piaget Situation as a Function of Language Reversibility (in Per Cents)

Situation	Criterion A				Criterion B			
	Before		After		Before		After	
	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev	Non-Rev	Rev
I	100.0	90.5	100.0	88.2	100.0	81.0	91.7	76.5
II	37.5	28.6	33.3	29.4	0.0	0.0	0.0	0.0
III	75.0	81.0	83.3	76.5	25.0	23.8	41.7	11.8
IV	100.0	90.5	100.0	88.2	25.0	42.9	33.3	41.2
V	62.2	52.4	58.3	52.9	12.5	4.8	8.3	5.9

TABLE 22

Second Grade Subjects Giving Correct Responses to Each Piaget Situation as a Function of Language Reversibility (in Per Cents)

Situation	Criterion A				Criterion B			
	Before		After		Before		After	
	Non-Rev	Rev	Non-Rev	Rev	Non Rev	Rev	Non Rev	Rev
I	100.0	88.5	100.0	85.7	75.0	73.1	66.7	76.2
II	50.0	30.8	33.3	33.3	0.0	0.0	0.0	0.0
III	75.0	69.2	66.7	71.4	50.0	38.5	22.2	47.6
IV	100.0	76.9	77.8	81.0	50.0	42.3	44.4	42.9
V	75.0	69.2	77.8	66.7	0.0	15.4	11.1	14.3

TABLE 23

Relationship Between Reaching Criterion after Verbal Training and Language Scores (Point-Biserial Correlation)

Language Tasks	Grade		
	1st (N=29)	2nd (N=30)	Combined (N=57)
Vocabulary	.31	-.17	.02
Syntax	.28	.22	.29

[a] Ss are divided into those reaching and not reaching criterion in verbal training.

TABLE 24

Classification of Explanation for Each Piaget Situation by Category and Age (in Per Cents)

Category	Situation							
	II		III		IV		V	
	Young	Old	Young	Old	Young	Old	Young	Old
1	37.20	20.00	53.40	40.00	55.68	63.00	29.54	43.33
2	1.16	0.00	1.13	0.00	4.54	0.00	1.13	0.00
3[a]	8.13	13.33	5.68	36.68	7.95	20.00	30.68	3.33
4[b]	27.90	10.00	12.50	3.33	13.63	0.00	9.09	13.33
5	3.48	0.00	5.68	3.33	0.00	0.00	1.13	0.00
6[c]	0.00	30.00	1.13	3.33	0.00	10.00	3.40	0.00
7, 8	15.11	3.33	14.77	6.66	13.63	3.33	10.22	3.33
9[d]	8.13	16.66	4.54	6.66	4.54	0.00	10.22	30.30
10	0.00	6.66	1.13	0.00	0.00	3.33	4.54	3.33

TABLE 24 Cont.

Note.—Total younger N for situation II is 86; all other situations, N=88. Older group, N=30.

[a] The difference between the younger and older group for situation III is significant ($z=3.99$; $p < .01$) and for situation V ($z=2.33$; $p < .05$).

[b] The difference between the younger and older group for situation IV is significant (Fisher's exact $p=.02$).

[c] The difference between the younger and older group is significant for situation II ($z=4.91$; $p < .01$) and IV (Fisher's exact $p=.02$).

[d] The difference between the younger and older group is significant for situation V ($z=2.33$; $p < .01$).

TABLE 25

Classification of Explanations for Each Piaget Situation by Category and Situation Score: Younger Ss (in Per Cents)

Category	Situation I		Situation III		Situation IV		Situation V	
	Correct (N=32)	Incorrect (N=21)	Correct (N=24)	Incorrect (N=64)	Correct (N=27)	Incorrect (N=61)	Correct (N=7)	Incorrect (N=81)
1	28.12	15.78	58.33	51.56	59.25	67.34	28.57	29.62
2	.00	.00	.00	1.56	3.70	4.91	.00	1.23
3[a]	21.87	5.26	16.66	1.56	18.51	3.27	28.53	30.86
4[b]	3.12	26.31	4.16	15.62	7.40	16.39	.00	9.87
5	12.50	10.52	.00	7.81	.00	.00	.00	1.23
6[c]	55.55	.00	.00	1.56	.00	.00	14.28	2.46
7, 8	12.50	21.05	12.50	15.62	11.11	14.75	.00	11.11
9	3.12	15.78	4.16	4.68	.00	6.55	28.57	8.64
10	.00	.00	4.16	.00	.00	.00	.00	4.93

TABLE 25 Cont.

Note.-Since no younger Ss scorec correctly on situation II, this situation has been omitted.

[a] The difference between per cent correct and incorrect is significant for situation III ($\bar{z}$=2.24; $p < .05$) and IV ($\bar{z}$=2.40; $p < .05$).

[b] The difference between per cent correct and incorrect is significant for situation I ($\bar{z}$=2.05; $p < .05$).

[c] The difference between per cent correct and incorrect is significant for situation I ($\bar{z}$=3.06; $p < .01$).

TABLE 26

Classification of Explanations for Each Piaget Situation by Category and Situation Scores: Older Ss (in Per Cents)

Category	Situation							
	II		III		IV		V	
	Correct (N=16)	Incorrect (N=14)	Correct (N=22)	Incorrect (N=8)	Correct (N=19)	Incorrect (N=11)	Correct (N=6)	Incorrect (N=24)
1	6.25	35.71	39.13	42.85	57.89	72.72	33.33	45.83
2	.00	.00	.00	.00	.00	.00	.00	.00
3	25.00	.00	39.13	28.57	26.31	9.09	.00	4.16
4	.00	21.42	.00	14.28	.00	.00	33.33	8.33
5	.00	.00	4.34	.00	.00	.00	.00	.00
6[a]	50.00	7.14	4.34	.00	10.52	9.09	.00	.00
7, 8	.00	7.14	4.34	14.28	5.26	.00	.00	4.16
9	6.25	28.57	8.69	.00	.00	.00	16.66	33.33
10	12.50	.00	.00	.00	.00	9.09	16.66	4.16

TABLE 26 Cont.

[a] The difference between per cent correct and incorrect for situation II is significant ($z=2.15$; $p < .05$).

TABLE 27

Type of Explanation Given After 40 Acquisition Trials as a Function of Age (in Per Cents)

Category	Younger (N=88)	Older (N=30)
1[a]	35.22	6.66
2	3.40	3.33
3	4.54	13.33
4	7.95	13.33
5	.00	.00
6	1.13	.00
7, 8	20.45	13.33
9[b]	22.72	46.67
10	1.13	.00
11	3.40	3.33

[a] The difference between the younger group and the older group is significant ($\bar{z}$=2.79; $p < .01$).

[b] The difference between the younger group and the older group is significant ($\bar{z}$=2.27; $p < .05$).

TABLE 28

Type of Explanation Given After 40 Acquisition Trials as a Function of Trainability and Age (in Per Cents)

Category	Younger		Older	
	Trainable (N=12)	Untrainable (N=76)	Trainable (N=24)	Untrainable (N=6)
1[a]	25.00	36.84	.00	33.33
2	.00	3.94	.00	16.66
3	8.33	3.94	16.66	.00
4	8.33	7.89	12.50	16.66
5	.00	.00	.00	.00
6	.00	1.31	.00	.00
7, 8	.00	23.68	16.66	.00
9[b]	50.00	18.42	50.00	33.33
10	.00	1.31	.00	.00
11	8.33	2.63	4.17	.00

TABLE 28 Cont.

[a] The difference between trainability and untrainability for the older group was significant ($Z=2.02$; $p < .05$).

[b] The difference between trainability and untrainability for the younger group was significant ($Z=2.05$; $p < .05$).

APPENDIX A

Assignment of Ss by Session, Sequence, Sex and E:
All Grades

Sequence	E	Session I			Session II			Session I & II		
		M	F	T	M	F	T	M	F	T
	SD	4	3	7	1	2	3	5	5	10
I	JW		1	1	10	6	16	10	7	17
	HR	7	6	13		2	2	7	8	15
Total		11	10	21	11	10	21	22	20	42
	SD	5	6	11	3	1	4	8	7	15
II	JW	2		2	10	9	19	12	9	21
	HR	6	4	10				6	4	10
Total		13	10	23	13	10	23	26	20	46
	SD	9	4	13	2	4	6	11	8	19
III	JW	2	8	10	9	8	17	11	16	27
	HR									
Total		11	12	23	11	12	23	22	24	46
	SD	3	9	12	6	1	7	9	10	19
IV	JW	7	2	9	4	10	14	11	12	23
	HR									
Total		10	11	21	10	11	21	20	22	42
	SD	21	22	43	12	8	20	33	30	63
Total All Sequences	JW	11	11	22	33	33	66	44	44	88
	HR	13	10	23		2	2	13	12	25
Total		45	43	88	45	43	88	90	86	176

APPENDIX A Cont.

Assignment of Ss by Session, Sequence, Sex, and E: Kindergarten

Sequence	E	Session I			Session II			Session I & II		
		M	F	T	M	F	T	M	F	T
	SD	1	2	3	1		1	2	2	4
I	JW				3	3	6	3	3	6
	HR	3	1	4				3	1	4
Total		4	3	7	4	3	7	8	6	14
	SD	2	3	5	2	1	3	4	4	8
II	JW				2	3	5	2	3	5
	HR	2	1	3				2	1	3
Total		4	4	8	4	4	8	8	8	16
	SD	4	2	6		1	1	4	3	7
III	JW		2	2	4	3	7	4	5	9
	HR									
Total		4	4	8	4	4	8	8	8	16
	SD	1	2	3	2		2	3	2	5
IV	JW	2	1	3	1	3	4	3	4	7
	HR									
Total		3	3	6	3	3	6	6	6	11
	SD	8	9	17	5	2	7	13	11	24
Total All Sequences	JW	2	3	5	10	12	22	12	15	27
	HR	5	2	7				5	2	7
Total		15	14	20	15	14	29	30	28	58

APPENDIX A Cont.

Assignment of Ss by Session, Sequence, Sex, and E:
First Grade

Sequence	E	Session I			Session II			Session I & II		
		M	F	T	M	F	T	M	F	T
I	SD	1		1		1	1	1	1	2
	JW				3	2	5	3	2	5
	HR	2	3	5				2	3	5
Total		3	3	6	3	3	6	6	6	12
II	SD	1	1	2	1		1	2	1	3
	JW	2		2	4	3	7	6	3	9
	HR	2	2	4				2	2	4
Total		5	3	8	5	3	8	10	6	16
III	SD	2	1	3	1	1	2	3	2	5
	JW	1	3	4	2	3	5	3	6	9
	HR									
Total		3	4	7	3	4	7	6	8	14
IV	SD	2	4	6	1		1	3	4	7
	JW	2		2	3	4	7	5	4	9
	HR									
Total		4	4	8	4	4	8	8	8	16
Total All Sequences	SD	6	6	12	3	2	5	9	8	17
	JW	5	3	8	12	12	24	17	15	32
	HR	4	5	9				4	5	9
Total		15	14	29	15	14	29	30	28	58

APPENDIX A Cont.

Assignment of Ss by Session, Sequence, Sex and E:
Second Grade

Sequence	E	Session I			Session II			Session I & II		
		M	F	T	M	F	T	M	F	T
	SD	2	1	3		1	1	2	2	4
I	JW		1	1	4	1	5	4	2	6
	HR	2	2	4		2	2	2	4	6
Total		4	4	8	4	4	8	8	8	16
	SD	2	2	4				2	2	4
II	JW				4	3	7	4	3	7
	HR	2	1	3				2	1	3
Total		4	3	7	4	3	7	8	6	14
	SD	3	1	4	1	2	3	4	3	7
III	JW	1	3	4	3	2	5	4	5	9
	HR									
Total		4	4	8	4	4	8	8	8	16
	SD		3	3	3	1	4	3	4	7
IV	JW	3	1	4		3	3	3	4	7
	HR									
Total		3	4	7	3	4	7	6	8	14
Total All	SD	7	7	14	4	4	8	11	11	22
Sequences	JW	4	5	9	11	9	20	15	14	22
	HR	4	3	7		2	2	4	5	9
Total		15	15	30	15	15	30	30	30	60

APPENDIX B

Language Film I

Session I

Name_____ Date_____ E_____

Situation 1 White car on top.
Black car on bottom.

Circle appropriate response.

E. says: Watch these two cars race.

Q1. IF I STOPPED THE RACE NOW (LIKE THIS) WHICH CAR WOULD WIN? A1. BLACK WHITE

Q2. HOW DO YOU KNOW? A2._____

Q3. After the cars have stopped running, E asks: WHICH CAR GOES SLOWER? A3. BLACK WHITE

E says: I am going to show you this race again.
(E reshows trial.)

Q4. E asks while car is running. WHICH CAR IS WINNING? A4. BLACK WHITE

Q5. WHICH CAR RAN FOR MORE TIME (A LONGER TIME)? A5. BLACK WHITE

Q6. WHICH CAR STOPPED FIRST? A6. BLACK WHITE

Q7. WHICH CAR HAS WON THE RACE? A7. BLACK WHITE

Situation 2 Black car on top.
White car on bottom.

E says: Now let's watch another race.

Q8. Stop race midpoint. WHICH CAR WILL WIN? A8. BLACK WHITE

Q9. WHICH CAR WON THE RACE? A9. BLACK WHITE

Q10. HOW DO YOU KNOW? A10._____

Q11. WHICH CAR RAN FOR LESS TIME (A SHORTER TIME)? A11. BLACK WHITE

APPENDIX B Cont.

E days: I am going to show you this race again.
(E reshows trials.)

Q12. WHICH CAR RAN FASTER? A12. BLACK WHITE

Situation 3 White car on top.
Black car on bottom.

Q13. After about 3½ seconds, E stops the race. There is a one second pause. E says: I JUST STOPPED THE RACE. GUESS WHICH CAR WILL WIN. A13. BLACK WHITE

Q14. HOW DO YOU KNOW? A14. _____ _____

Q15. E continues the race. When the race is over, he asks: WHICH CAR STOPPED LAST? A15. BLACK WHITE

Q16. E says: Watch this race again very carefully. WHICH CAR TOOK MORE TIME (A LONGER TIME)? A16. BLACK WHITE

Q17. E says: Now watch this race again. WHICH CAR HAS WON THE RACE? A17. BLACK WHITE

Q18. HOW DO YOU KNOW? A18. _____

Q19. E rings a bell about 4 seconds after trial begins. There is a sort of natural stop for bell. WHICH CAR WAS WINNING WHEN THE BELL RANG? A19. BLACK WHITE

19a. If child looks confused, doesn't remember, etc. reshow the trial. Say: Watch again! WHICH CAR WAS WINNING WHEN THE BELL RANG? 19a. BLACK WHITE

Situation 5 Black car on top.
White car on bottom.

Q20. E stops the race in the middle. There is a natural stop to do this. IF THE CARS STOPPED, WHICH ONE WOULD WIN? A20. BLACK WHITE

Q21. HOW DO YOU KNOW? A21. _____

APPENDIX B Cont.

Language Film II

Session II

Name_____ Date_____ E_____

Situation 1 White car on top.
Black car on bottom.

Circle appropriate response.

E says: Watch these two cars race.

Q1. IF I STOPPED THE RACE NOW (LIKE THIS) WHICH CAR WOULD WIN? A1. BLACK WHITE

Q2. HOW DO YOU KNOW? A2._____

Q3. After the cars have stopped running, E asks: WHICH CAR GOES SLOWER? A3. BLACK WHITE

E says: I am going to show you this race again.
(E reshows trial.)

Q4. E asks while car is running. WHICH CAR IS WINNING? A4. BLACK WHITE

Q5. WHICH CAR RAN FOR MORE TIME (A LONGER TIME)? A5. BLACK WHITE

Q6. WHICH CAR STOPPED FIRST? A6. BLACK WHITE

Q7. WHICH CAR HAS WON THE RACE? A7. BLACK WHITE

Situation 2 Black car on top.
White car on bottom.

E says: Now let's watch another race.

Q8. Stop race midpoint. WHICH CAR WILL WIN? A8. BLACK WHITE

Q9. WHICH CAR WON THE RACE? A9. BLACK WHITE

Q10. HOW DO YOU KNOW? A10._____

Q11. WHICH CAR RAN FOR LESS TIME (A SHORTER TIME)? A11. BLACK WHITE

APPENDIX B Cont.

Q12. E says: I am going to show you this race again.
(E reshows trials.)
WHICH CAR RAN FASTER? A12. BLACK WHITE

Situation 3 White car on top.
Black car on bottom.

Q13. After about 3½ seconds, E stops the race. There is a one second pause. E says: I JUST STOPPED THE RACE. GUESS WHICH CAR WILL WIN. A13. BLACK WHITE

Q14. HOW DO YOU KNOW? A14. _____

Q15. E continues the race. When the race is over, he asks: WHICH CAR STOPPED LAST? A15. BLACK WHITE

Q16. E says: Watch this race again very carefully. WHICH CAR TOOK MORE TIME (A LONGER TIME)? A16. BLACK WHITE

Q17. E says: Now watch this race again. WHICH CAR HAS WON THE RACE? A17. BLACK WHITE

Q18. HOW DO YOU KNOW? A18. _____

Q19. E rings a bell about 4 seconds after trial begins. There is a sort of natural stop for bell. WHICH CAR WAS WINNING WHEN THE BELL RANG? A19. BLACK WHITE

19a. If child looks confused, doesn't remember, etc. reshow the trial. Say: Watch again! WHICH CAR WAS WINNING WHEN THE BELL RANG? 19a. BLACK WHITE

Situation 5 Black car on top.
White car on bottom.

Q20. E stops the race in the middle. There is a natural stop to do this. IF THE CARS STOPPED, WHICH ONE WOULD WIN? A20. BLACK WHITE

Q21. HOW DO YOU KNOW? A21. _____

APPENDIX B Cont.

The Concepts of Before and After

Name_____ Date_____ E_____ Score_____

I. Introductory Task

E says: NOW WE ARE GOING TO PLAY SOME GAMES WITH THIS BUNNY AND SOME OF HIS TOYS. I AM GOING TO SHOW YOU SOME OF THE BUNNY'S TOYS. CAN YOU TELL ME THEIR NAMES.

E shows each toy, one at a time. After S identifies the toys, they are placed in a circle on the table.

E says: THE BUNNY IS PICKING UP THE CUP. SHOW ME THIS. NOW MAKE THE BUNNY PLAY HIS GUITAR. NOW, MAKE HIM LISTEN TO THE RADIO, AND, READ HIS BOOK.

II. Scoring

On the scoring sheet simply write the name of the toy the child picks up. In the first blank write the name of the first toy he picks up, in the second blank write the name of the second toy.

APPENDIX B Cont.

BEFORE AND AFTER

Name_____ Date_____ E_____ Score_____

		Sequence of Action	
		1	2
1.	AFTER THE BUNNY PICKS UP HIS SKATE, HE PICKS UP HIS GUITAR.	_____	_____
2.	THE BUNNY PICKS UP THE TELEPHONE AFTER HE PICKS UP HIS TRUMPET.	_____	_____
3.	BEFORE THE BUNNY PICKS UP HIS BOOK, HE PICKS UP THE ROLLING PIN.	_____	_____
4.	THE BUNNY PICKS UP HIS CUP BEFORE HE PICKS UP THE RADIO.	_____	_____
5.	BEFORE THE BUNNY PICKS UP HIS TRUMPET, HE PICKS UP HIS SKATE.	_____	_____
6.	AFTER THE BUNNY PICKS UP THE SPONGE, HE PICKS UP HIS GUITAR.	_____	_____
7.	THE BUNNY PICKS UP HIS BOOK, AFTER HE PICKS UP THE TELEPHONE.	_____	_____
8.	THE BUNNY PICKS UP THE SPONGE BEFORE HE PICKS UP THE RADIO.	_____	_____

APPENDIX B Cont.

REVERSIBILITY

Name_____ Date_____ E_____ Score_____

1A

Materials: 4 pictures of trees depicting various stages of leaf growth.

E says: I am going to show you some pictures of a tree. Some of the trees have many leaves; some trees don't have any. Put these pictures in such a way they show how this tree went from many leaves to no leaves.

E places the tree with the most leaves in front of and to the left of S. Then he places the other pictures (3, 4, 2) facing the child. If the child hesitates or does not respond: Ask him: Which tree comes next. Can you put them in order for me?

	Picture order
1a.	4 ___ ___ ___

1B

After the child has completed 1A, E takes the materials and shuffles them. He places the tree with no leaves in front of the child and to the child's left. He places the other pictures (2, 1, 3) facing the child.

E says: Now show me how this tree had no leaves. Put these pictures in such a way to show how this tree went from no leaves to many leaves, etc.

1b. 1 ___ ___ ___

APPENDIX B Cont.

2A

Materials: 5 pcitures of a boy showing various stages of growth.

E says: Here are some pictures of a boy and how he grew up. Put these pictures in such a way that they show how this boy went for a little baby to an old man, etc.

E places the pictures in the following order in front of the child: Start at child's left with 4, 5, 3, 2.

2a. 1 ___ ___ ___ ___

2B

After the child has completed the task E takes the pictures from the child and shuffles them. E says: Now show me how this old man became a little boy. Start with this picture. Use the following order: 4, 2, 3, 1.

2b. 5, ___ ___ ___ ___ ___

APPENDIX B Cont.

Pretest

Name_____ Date_____ E_____ No. Corr._____

The purpose of this section is to insure that the child knows certain vocabulary words which are to be used throughout the various sections. Put a check in the appropriate line is S carries out the appropriate command. Put an X if he does not.

			1	2
Materials:	Red car and white car			
E says:	1.	Here are two cars. Make this car start to run.	____	____
	2.	Show me how the car goes. Now make the car stop.	____	____
	3.	Take the two cars. Make them travel for the same distance.	____	____
	4.	Now take this car and make him travel further than this one.	____	____
	5.	Make the two cars start at the same time.	____	____
	6.	Let's have a race. Make this car win.	____	____

Criterion

The child must carry out all the actions appropriately before any of the other tests may be given. If the child should get any wrong, appropriate training should be given. The concepts being tested are: start, stop, distance, further, time, win.

After training has been completed, give the test again. Score the child's answer in column 2.

APPENDIX B Cont.

Piaget Time Concepts

Name_____ Date_____ E_____ No. Corr.____

E says: Now we are going to watch a race. I am going to show you some movies about different races. Watch the movies very carefully because I am going to ask you some questions at the end.

General Instructions:

Before starting a trial make sure that the child is looking at the left hand corner. Verbal warnings such as "Ready," "Watch," "Look," "Here they go" should be used to insure that the child is watching. On Time 1 the child may see any trial over again. This is not a memory test. Be sure the child heard the question. In recording the answer on the answer sheet, E should write down exactly what the child says. Most of the time the response is yes or no, or black and white. If the child refuses to answer he may point to the car.

APPENDIX B Cont.

Time 1

Situation 1 - Black
White

01. DID THE CARS START THE SAME TIME? A1. YES NO
Note: If the child answers no, ask:
s1. Which car started first? s1. BLACK WHITE
s2. How do you know? s2. _____

02. DID THE CARS STOP AT THE SAME TIME? A2. YES NO
s1. If the child answers no, E asks:
Which car stopped first? s2. BLACK WHITE
s2. How do you know? s2. _____

03. DID BOTH CARS GO THE SAME DISTANCE? A3. YES NO
s1. If the child answers no, ask:
Which car went further? s1. BLACK WHITE

04. DID ONE CAR TAKE MORE TIME THAN THE OTHER? A4. YES NO
s1. If the child answers yes, ask:
Which car took more time? s1. BLACK WHITE
s2. How do you know? s2. _____

Situation 2 - Black
White

05. DID THE CARS START AT THE SAME TIME? A5. YES NO
If the child answers no, ask:
s1. Which car started first? s1. BLACK WHITE
s2. How do you know? s2. _____

06. DID THE CARS STOP AT THE SAME TIME? A6. YES NO
If the child answers no, ask:
s1. Which car stopped first? s1. BLACK WHITE
s2. How do you know? s2. _____

07. DID BOTH CARS GO THE SAME DISTANCE? A7. YES NO
If the child answers no, ask:
s1. How do you know that they didn't go
the same distance? s1. _____

08. DID ONE CAR TAKE MORE TIME THAN THE OTHER? A8. YES NO
If the child answers yes, ask:
s1. Which car took more time? s1. BLACK WHITE
s2. How do you know? s2. _____

APPENDIX B Cont.

Situation 3 - White
Black

Q9.	DID THE CARS START AT THE SAME TIME?	A9.	YES	NO
	If the child answers no, ask:			
	s1. Which car started first?	s1.	BLACK	WHITE
Q10.	DID THE CARS STOP AT THE SAME TIME?	A10.	YES	NO
	Note: If the child answers yes, skip Q10a.			
Q10a.	WHICH CAR STOPPED FIRST?	A10a.	BLACK	WHITE
Q11.	DID BOTH CARS GO THE SAME DISTANCE?	A11.	YES	NO
	Note: If the child answers yes, skip Q11a.			
Q11a.	WHICH CAR RAN FURTHER (OR A LONGER DISTANCE)?	A11a.	BLACK	WHITE
Q12.	DID ONE CAR RUN FOR MORE TIME THAN THE OTHER?	A12.	YES	NO
Q12a.	WHICH CAR RAN FOR A LONGER TIME (OR MORE TIME)?	A12a.	BLACK	WHITE
Q12b.	HOW DO YOU KNOW? A12b._____			

Situation 4 - White
Black

Q13.	DID BOTH CARS START AT THE SAME TIME?	A13.	YES	NO
Q14.	DID BOTH CARS STOP AT THE SAME TIME?	A14.	YES	NO
	Note: If the child answers yes, skip Q14a.			
Q14a.	WHICH CAR STOPPED LAST?	A14a.	BLACK	WHITE
Q15.	DID BOTH CARS GO THE SAME DISTANCE?	A15.	YES	NO
	Note: If the child answers yes, skip Q15a.			
Q15a.	WHICH CAR WENT FOR A SHORTER DISTANCE?	A15a.	BLACK	WHITE
Q16.	DID ONE CAR RUN FOR LESS TIME THAN THE OTHER?	A16.	YES	NO
	Note: If the child answers no, skip Q16a.			
Q16a.	WHICH CAR RAN FOR LESS TIME?	A16a.	BLACK	WHITE
Q16b.	HOW DO YOU KNOW? A16b._____			

APPENDIX B Cont.

Situation 5 - White
Black

Q17.	DID THE CARS START AT THE SAME TIME?	A17.	YES	NO
	Note: If the child answers yes, skip 17a.			
	17a. Which car started first?	17a.	BLACK	WHITE
Q18.	DID THE CARS STOP AT THE SAME TIME?	A18.	YES	NO
	Note: If the child answers yes, skip 18a.			
	18a. Which car stopped first?	18a.	BLACK	WHITE
Q19.	DID BOTH CARS GO THE SAME DISTANCE?	A19.	YES	NO
	Note: If the child answers no, ask 19a.			
	19a. Which car went further?	19a.	BLACK	WHITE
	19b. Why do you think so? 19b. _____			
Q20.	DID ONE CAR TAKE MORE TIME THAN THE OTHER?	A20.	YES	NO
	Note: If the child answers yes, ask:			
	20a. Which car took more time?	20a.	BLACK	WHITE
	20b. Why do you think that? 20b. _____			

APPENDIX B Cont.

Time Concept Attainment: MORE

Answer Sheet

Trial											
1.	Bl+	Wh	11.	Bl	Wh+	21.	Bl+	Wh	31.	Bl	Wh+
2.	Bl	Wh+	12.	Bl+	Wh	22.	Bl	Wh+	32.	Bl+	Wh
3.	Bl+	Wh	13.	Bl	Wh+	23.	Bl+	Wh	33.	Bl	Wh+
4.	Bl	Wh+	14.	Bl+	Wh	24.	Bl	Wh+	34.	Bl+	Wh
5.	Bl	Wh+	15.	Bl	Wh+	25.	Bl	Wh+	35.	Bl	Wh+
6.	Bl	Wh+	16.	Bl+	Wh	26.	Bl	Wh+	36.	Bl+	Wh
7.	Bl+	Wh	17.	Bl+	Wh	27.	Bl+	Wh	37.	Bl+	Wh
8.	Bl+	Wh	18.	Bl	Wh+	28.	Bl+	Wh	38.	Bl	Wh+
9.	Bl+	Wh	19.	Bl+	Wh	29.	Bl+	Wh	39.	Bl+	Wh
10.	Bl	Wh+	20.	Bl	Wh+	30.	Bl	Wh+	40.	Bl	Wh+

At the end of trial 40, E asks:

1. Why did you pick that (black or white) that car? _____

_____

2. Is that reason the same one you always used? Is that why you picked the other cars? _____

_____

APPENDIX B Cont.

Concept Training

Name_____ Date_____ E_____

1. Take the child and walk with him from one side of the room to the other. Ask him who took more or less time depending on which concept he is being trained. Do not do both. Substitute the words longer time or shorter time and use them interchangeably. Mark down whether the child was correct or not. Do this 2 or 3 times.	Trial 1 _____	Trial 2 _____	Trial 3 _____
2. Then go back to chair and use the two cars. Make the two cars start at the same time but one car continue for a longer time. If the child appears confused let him put his hands on the car while you demonstrate. Again ask him which car took more or less time. If he is confused the first time but was correct while moving across the room take him across the room again.	Trial 1 _____	Across Room? _____	2 _____ 3 _____
3. Make the two cars start at different times but end at the same point. Thus one car, the one that started last, must go faster.	Trial 1 _____	Trial 2 _____	Trial 3 _____

After the child has finished going through these situations, ask him:

DO YOU THINK YOU CAN FIND THE CORRECT CAR, THE ONE THAT TOOK _____

TIME ON THE MOVIES. LET'S SEE IF YOU CAN GET ALL THE CORRECT CARS

THIS TIME.

APPENDIX B Cont.

Time Concept Training Procedure: Instructions to the E

NOTE: The following is only a sample of a training procedure. In each case, be sure to modify your responses according to the S's response. The important verbal rules are: (1) If the cars start at the same time, it's always the car that stops last that takes the most time. (2) If the cars start at different times and they stop at the same time, it is always the car that starts first which travels for the more time. It is important for the Ss to realize that this is the case regardless of speed or distance. In trying to teach the concepts, be sure to use the following verbal phrases: Who started first? Did we start at the same time? Who stopped last? Did we stop at the same time? Who stopped first? Who was walking faster (slower)? Who was walking for a longer time?

Sample Training Procedure

The E says: THE CORRECT CAR WAS THE CAR THAT TOOK MORE TIME. DO YOU KNOW WHAT MORE TIME MEANS? LET ME SHOW YOU.

The E takes the child to one corner of the room and says:
NOW STAND NEXT TO ME SO THAT WE BOTH START FROM THE SAME PLACE. LET'S HAVE A WALKING RACE ACROSS THE ROOM.

The E and the S begin at the same time. They walk at the same speed but the E stops before (in time and space) the S. The E asks:
DID WE START AT THE SAME TIME?

If S says "yes" continue:
DID WE STOP AT THE SAME TIME? WHO STOPPED LAST?
WHO WALKED FOR A LONGER (MORE) TIME? HOW DO YOU KNOW?

E reinforces the appropriate rule:
IF WE START AT THE SAME TIME, AND YOU STOP LAST, THEN YOU SPENT MORE TIME WALKING THAN I DID.

The E then says:
NOW LET'S RACE AGAIN.

The E let's the S begin first. Both stop at the same time. E repeats the questions:
DID WE BEGIN AT THE SAME TIME? YOU BEGAN FIRST. DID WE STOP AT THE SAME TIME? WHO SPENT MORE TIME WALKING? YOU DID, BECAUSE YOU STARTED FIRST AND WE STOPPED AT THE SAME TIME. THEREFORE YOU SPENT MORE TIME WALKING.

Repeat this kind of technique using all the variations outlined in the preceding page.

If the child answers incorrectly repeat the situations, and ask the questions again, not at the end of the situation but at the moment it is taking place. Correct him immediately if necessary.

APPENDIX C

TYPES OF EXPLANATIONS USED AFTER SITUATION I

I. PERCEPTUAL

Kindergarten[1]

1. Cause they're even.
10. Both went together.
11. It's not ahead.
14. Because they were going the same.
24. Cause they went the same.

First Grade

32. Because they were both even.
43. Because one's on bottom and one's on top and they're even.
48. The white one was still going.
56. Because the black car got there just a little uphead of the white car.

Second Grade

72. Cause the black car started and the other car catched up cause they started like an inch away from each other.
73. They kept together.
90. Because they were going together.

Ages 9, 10, & 11

None

---

[1]Number left of sentence is the S's identification number.

APPENDIX C Cont.

II. SPATIAL

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

17. Because it started last; they went the same time.
18. Because I saw it go first.
20. They both ran at the same time.

First Grade

37. Because they went same time.
40. Cause I saw them taking off the same time.
44. Because they stopped at the same time.

Second Grade

68. Because they started together.
69. Cause they started at the same time.
85. They both went at the same time.

APPENDIX C Cont.

II. SPATIAL

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

18. Because I saw it go first.

First Grade

37. Because they went same time.
40. Cause I saw them taking off the same time.
44. Because they stopped at the same time.

Second Grade

68. Because they started together.
69. Cause they started at the same time.
85. They both went at the same time.
86. The black car stopped first and the white car took more time to get to the black car.

Ages 9, 10, & 11

None

APPENDIX C Cont.

IV. SPEED

Kindergarten

3. Going slower.
5. It went slower.

First Grade

36. Red one went a little bit faster.

Second Grade

71. One went at more faster speed.
75. Because the brown one went faster.
80. Cause the white was going slower than the red.

Ages 9, 10, & 11

None

V. DURATION

Kindergarten

8. Both took same time.

First Grade

50. Because they were both going at the same time.

Second Grade

70. Because they were going in the same time.
82. Cause they were both together on the same time.

Ages 9, 10, & 11

None

APPENDIX C Cont.

VI. COORDINATION OF STOP AND START TIME

Kindergarten

15. Because they both left at the same time and they both stopped at the same time.

First Grade

41. They both went at same time and got there at same time.
45. Cause they both started and they both stopped at the same time.

Second Grade

62. Started at same time and stopped at same time.
66. Both started and ended at same time.

Ages 9, 10, & 11

None

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

4. No Response
6. I don't know.
9. Cause it was a tie.
13. The white car isn't good there.

First Grade

35. Don't know.

Second Grade

64. Don't know.
65. I don't know.
84. Because the black car won.

Ages 9, 10, & 11

None

APPENDIX C Cont.

IX. COMBINATION

Kindergarten

None

First Grade

31. Both started at same time and went just as fast as each other. (III, IV)
33. He didn't go as fast so the red car won so the white car last. (II, IV)

Second Grade

74. Because the black car went faster than the white car, white took more time.
86. The black car stopped first and the white car took more time to get to the black car. (III, V)

Ages 9, 10, & 11

None

X. AMBIGUOUS

Kindergarten

7. Because the other one didn't go before.

First Grade

None

Second Grade

79. Cause the both traveled the same.

Ages 9, 10, & 11

None

APPENDIX C Cont.

XI. ALTERNATION

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

XII. HYPOTHESIS TESTING

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

APPENDIX D

TYPES OF EXPLANATIONS USED AFTER SITUATION II

I. PERCEPTUAL

Kindergarten

1. Cause it's in back.
2. Becuase they didn't go same distance.
11. Because it's all the way down there.
14. Because they're in different places.
15. Because the black one is ahead of the white one.
16. Because it's behind the black one.
19. Because the white one is behind the black one.
21. Because it's back there.
22. Because it stopped when it was nearest to the
23. Cause the red is further than the white.
25. Because it was ahead.
26. Because the black car was more out, the white car is more in.
27. Because the black one was at the finish line.

First Grade

31. Because it's way in the back.
32. Because it's all the way in back.
33. Because the white one is at the pole.
37. Because it went farther.
38. White in back, brown in front, white one not too much gas.
42. Black one is in front of white one.
46. Cause he's finished and won the game.
52. Cause it's further up ahead.
53. Cause it's behind.
58. It's in the lead.
59. Because it's in back.
60. Because it's behind the white one.

Second Grade

66. It didn't go all the way to end.
73. It's way in the back.
77. Because at the end he way longer.
78. Because it's in back of the black one.
81. Because it went in a further distance.
86. Because it's in back.
89. Because it's more further back.

APPENDIX D Cont.

Ages 9, 10, & 11

93. Because it was ahead of the white car.
95. You can see that the black car is ahead of it.
101. Because when the picture stopped you could see that the white car was behind the black car.
112. Because it went further.
113. Because the black is near the end and the white is in the middle.
114. Because the black stopped before the white.

II. SPATIAL ORDER

Kindergarten

5. Because it come in second place.

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

29. Because he was going when the white one stopped.

First Grade

48. The brown was stopped when the white one was still going.

Second Grade

61. Like that car started before.

APPENDIX D Cont.

67. Because the red one finished first.
68. Because it started last.
69. Because black started before and white started last.

Ages 9, 10, & 11

97. Because the black stopped first.
99. Because they stopped at the same time.
107. They bot. stopped at the same time.
117. They both stopped at the same time.

IV. SPEED

Kindergarten

3. Going slower.
4. Because the white one was going slower.
7. The other one went faster.
10. Because it went slow.
12. He was slower.
18. Because it was slower than the other one.
28. Because he went a little bit fast.

First Grade

34. Because the white one was so slow.
35. Red one was going faster.
36. Because white one went slow.
43. White one is slower than black one.
44. Because the white car was going slower.
50. Because the white one was going slower and the black one was going faster.
51. Because he's going slower than the black car.
56. Because the black car was going faster than the white car.
57. The white slowed down when the black still went.

Second Grade

62. Went slower.
65. The white one went more slowly than the other car.
71. Because it went slower.
74. It was slower than the black car.
75. It went slower.
79. Cause it went real slow and the black one went real fast.
82. Because he went slower than the black one.
83. Because he's slower than the black one.

APPENDIX D Cont.

Ages 9, 10, & 11

100. Because the white car was slower.
106. Because the black car was going slow and the black car was going fast.
116. Because it went slower.

V. DURATION

Kindergarten

None

First Grade

47. Because the white car took less time right there.
49. The white was moving a shorter time than the black one.

Second Grade

84. Because it's losing, it took more time to get out.

Ages 9, 10, 11

None

VI. COORDINATION OF STOP AND START TIME

Kindergarten

None

First Grade

None

Second Grade

None

APPENDIX D Cont.

Ages 9, 10, & 11

102. They stopped and started at the same time.
103. Because they started at the same time and they stopped at the same time.
105. Because they started at the same time and they stopped at the same time.
108. Because they both stopped at the same time and they started at the same time.
111. Because they both started at the same time and they both stopped at the same time.
115. They started at the same time and they stopped at the same time so they have to go the same time.
118. They stopped at the same time and they began at the same time.
119. Because they both stopped and started at the same amount of time.
120. Because they both stopped at the same time and they both started at the same time.

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

6. I don't know.
9. Cause he won.
13. Because I see that car and that car one tells me won the other didn't.
20. Cause it stopped.
24. Because, I don't know.

First Grade

39. Cause of I look
40. I saw it.
41. Cause he won.
45. Cause it won first.
54. Because he won more times.

Second Grade

64. Cause it won.
70. Just did.
90. I don't know.

Ages 9, 10, & 11

92. Because I saw it.

APPENDIX D Cont.

IX. COMBINATION

Kindergarten

8. Black went further and took more time. (I, V)
30. Just because the black one is ahead of the white one and the white one took more time. (I, V)

First Grade

55. Because the black car started after the white car and didn't go as far. (I, III)

Second Grade

63. Cause they started off the same time, and stopped the same time, but they didn't stop the same distance. (I, VI)
72. Cause it's slower than the black one, the black one finished. (I, IV)
80. Cause the red won and the white was in the back so the white took the less, more time. (I, V)
87. Because if the white one started when the black one started and they were at the same distance, they'd be at the finish line at the same time. The white one. (I, VI)

Ages 9, 10, & 11

91. The car on the top went a little faster and the one on the bottom took more time. (IV, V)
94. Because it went faster and it got there before the other one. (III, IV)
96. Even though the black car traveled further, the white car went slower but it still went the same amount of time. (I, IV, V)
104. It's in back of the white one and went slower. (I, IV)
110. It was going slower and didn't even get there. (I, IV)

X. AMBIGUOUS

Kindergarten

None

APPENDIX D Cont.

First Grade

None

Second Grade

None

Ages 9, 10, & 11

98. Because they started the same and they stopped the same.
109. It started the same and it stopped the same.

APPENDIX E

TYPES OF EXPLANATIONS USED AFTER SITUATION III

I. PERCEPTUAL

Kindergarten

2. White one went farther.
3. They were going same amount.
5. Because it came in second.
6. Because it's over there and the black one's over there.
8. It went further and black one stopped.
12. He got at the end.
15. Because the white one is ahead of the black one.
16. Because the white one is ahead.
18. Because it's all the way down to the end.
19. Because the black one was behind the white.
21. Because it's back there.
22. Because it stopped when it was the closest.
23. Because the white is at the end and the red is further down than the white farer.
25. Because it was in the front.
27. Because the black one is not on the finish line and the white one is.
29. Because it's ahead of the black one.
30. Because the white is ahead of the black one.

First Grade

31. Because red one is way in the back.
32. He stopped short.
36. It's a little bit behind.
38. White one's ahead and brown in back.
40. It's ahead.
43. Because it's ahead.
46. Cause he's half-way and the white one's finished.
47. Because the black car was in the back of the white car.
49. It's in front.
51. Because it's ahead of the black car.
52. It's further up ahead than the black one.
53. White one is ahead and the black one is behind.
54. Because he's ahead.
55. Because the white car got to the place when the black car was still going.
56. Because the white car is ahead of the black car.

APPENDIX E Cont.

58. It's in the lead.
59. Because it's in front.
60. Because 't's behind the white one.

Second Grade

65. The white car is further more in front than the other car.
66. Red one stopped in front of white one.
70. Black one stopped and white didn't.
72. Because the black one's a little behind the white one, the white one went a little farther than the black one.
73. Because it's farther than the black one.
76. When one of the cars go further then we know because the white went to the end of the picture.
78. Because the white is at the end and the black is still going.
79. Cause it's at the finish line.
80. Cause the red car's in the back and the white in front.
81. Because he went for a further distance.
84. Cause it's behind the white car.
87. Because the white one's ahead of the black one.
89. Because it's more further back.

Ages 9, 10, & 11

92. Because the white car made it to the other side.
98. Because the white one is farther ahead then the black one.
100. Because its farther than the black one.
103. Because the white car is in the lead.
104. Because it went more distance and further.
107. Because the black one stopped and the white one kept on going.
109. Because they started the same and then the white car came ahead and they stopped the same.
110. When they were going the black stopped and the white went on a bit.
116. Cause it's behind the white car.
120. Because the white went further.

II. SPATIAL

Kindergarten

None

First Grade

None

APPENDIX E Cont.

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

None

First Grade

44. The black car stopped first and the white car kept going.

Second Grade

61. Black car stopped before white car did.
62. Because the black car stopped first.
67. They both stopped at the same time.
85. Because that stopped last.

Ages 9, 10, & 11

93. When the black car stopped the white car was still going on.
96. Because while the white car was still moving the black car stopped.
97. Because the black stopped first.
99. Because the black one stopped first when the white one was still going.
102. Because the black one stopped before the white one.
111. Because when the black car stopped the white car kept on going.
114. Because the black stopped before the white.
115. Because the black one stopped and the white kept on going.
117. Black one stopped sooner.
118. Because the white one stopped before the black one.
119. Because the black car stopped before the white one.

APPENDIX E Cont.

IV. SPEED

Kindergarten

7. The other one went faster.
9. Because he was slower.
10. Cause 't's going slower.
24. Cause ae went slow.

First Grade

50. Cause the white one was going faster.

Second Grade

69. Because it went slower.
71. It went at a more slower speed.
74. Cause it went slower than the white.
82. Cause he went faster.
83. Because it's slower than the white one.
88. Because it's faster.

Ages 9, 10, & 11

106. Because t ie black car was going a little faster than the white ca·.

V. DURATION

Kindergarten

11. Because it took longer.
14. Because all the other times it went longer.
20. The black car stopped for a longer time and the white car didn't.

First Grade

37. Because it took more time to get there.

Second Grade

77. Because the engine was running a little more longer than the white car.

APPENDIX E Cont.

Ages 9, 10, & 11

94. The white car took longer because the white car stopped.

VI. COORDINATION OF STOP AND START TIME

Kindergarten

None

First Grade

48. The white one was going and it stopped and the brown one was still going when the white one stopped.

Second Grade

None

Ages 9, 10, & 11

105. Because they started at the same time but didn't stop at the same time.

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

1. Can't answer.
4. White one was having more gas.
26. Because the white was the win.
13. NO RESPONSE.
17. NO RESPONSE.

First Grade

33. I don't really know how you say it because I'm only in the first grade and I never learned this type of thing.
35. Because red one was taking it's time.
39. Because you can look.
41. Cause white won.

42. NO RESPONSE.
45. Because it won first.

Second Grade

64. Because it's already won.
90. I just guessed.

Ages 9, 10, & 11

91. I don't know.
95. You can see it.

IX. COMBINATION

Kindergarten

None

First Grade

57. The black took more time than the white, the black stopped over there and the white stopped at the line. (I, V)

Second Grade

63. Well they start off the same time and they stop the same time, but the black one's in back of the white one. (I, VI)
68. Because it went last because other car went farther. (I, III)
86. Because he's ahead and the black car stopped first. (I, III)

Ages 9, 10, & 11

101. Because the white car was ahead of the black car when they both stopped. (I, III)
108. Because the white one went further and stopped after the white one. (I, III)

APPENDIX E Cont.

X. AMBIGUOUS

Kindergarten

None

First Grade

None

Second Grade

75. The brown one stopped before it.

Ages 9, 10, & 11

None

APPENDIX F

TYPES OF EXPLANATIONS USED AFTER SITUATION IV

I. PERCEPTUAL

Kindergarten

1. Cause it's in back.
2. Because red one didn't go as far as white one.
6. Because it's over there and the white one's over there.
7. The white one went further.
8. Cause it's in back.
12. Cause it got ahead of the other one.
14. Because black there and white there.
11. Because the black car is under the white car.
13. This car there and this car there and I can see the wheels.
15. Because the white one is ahead of the black one.
16. Cause it's behind the white one.
18. Because it's down to the end.
19. Cause the black is behind the white.
23. Because the red is farer down than the white.
25. Because it's going ahead.
27. Because he's over there and he's over there.
29. Because it's ahead of the white one.
39. Because the white one is ahead of the black one.

First Grade

31. Because red one is way in the back.
32. Yellow one up ahead.
36. A little bit behind white one.
40. Cause it's back of the other.
43. Because it's behind white one.
47. Because the black car is in back of the white car.
48. Because the white was further than the brown.
49. The white one is in front of the black and the white one went further.
51. Because the black car is behind the white car and the white car is all finished.
52. It's behind the white one.
53. Because it's behind and the white one is in front.
54. Because he's in the back.
55. Because the black car is closer to the starting line than the white car is.
59. Because it's in the back.
60. Because it's ahead of the black one.
44. Because the white car was still going when the white one stopped.

APPENDIX F Cont.

Second Grade

64. Because it's behind.
65. Because the red car is further back than the white car.
66. White one went all the way down and red one stopped.
67. Because when the white car stopped the red one stopped.
68. Because other one passed it.
73. It's in the back of the white one.
76. Because the white went further than the black.
78. Because it's in front.
79. Because it's more close to the start and it went shorter.
80. Because the black is in the front.
81. Because he went for a shorter distance.
83. Cause he's in back and the white one's in front.
88. Because it's not ahead, it's behind.
89. Because black is more further back.
90. Cause it's behind the white one.

Ages 9, 10, & 11

92. Because the black car is ahead before the white car.
94. Because it stopped and the other one kept on going.
98. Because the black one didn't go as far as the white one.
100. Because it's behind the white one.
101. Because the white car is behind the black car.
104. Because it didn't go as far as the white.
103. Because the white car went ahead of it.
107. Because the white one went all the way and the black one went all 3/4 of the way.
110. The black was ahead of the white and then the black stopped and the white went on.
109. Because the black one is shorter than the white, the black one is behind.
111. Because it's in back of the white car.
112. Because it didn't go as far as the white one.
113. Because the white car went farther than the black car.
114. Because the white went further.
115. Because the black one is behind the white car.
120. Because it stopped further back than the white one.
118. Because the black one is in back of the white one.
116. Cause it's behind the white one.
117. He stopped while the other car was still moving.

II. SPATIAL

Kindergarten

5. Because it came in second place.
22. Cause it got there first.

APPENDIX F Cont.

First Grade

37. Because it's last.
46. The white one ended up first.

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

None

First Grade

35. Because white one stopped last.

Second Grade

61. It stopped before white car did.
62. Because it stopped first.
70. Black stopped before white.
75. It stopped before the white.
85. Because it stopped first.
86. Because it stopped first.

Ages 9, 10, & 11

91. Because it stopped before the white one.
97. Because the white stopped first.
102. Because it stopped before the white one.
105. Because it stopped before the white one.
108. Because it stopped before the white one.
119. Because it stopped first.

APPENDIX F Cont.

IV. SPEED

Kindergarten

4. Because the black one was going slower than the white car.
9. Because the white went faster.
10. Cause it's going slow cause white one won.
20. Because it went slower.
21. Cause it went faster.

First Grade

39. Cause it runs slower.
50. Cause the white one was going faster.
56. Because the black car was going slow and the white car was going slow, but he (white) was giving more gas so the car was going faster.
57. The white went faster than the black.

Second Grade

71. Went almost at same speed.
72. Cause one car goes fast and the other car goes slow, they're using up the same amount of gas.
77. Because it was slower and white car was going a little faster and the engine was running longer.

Ages 9, 10, & 11

None

V. DURATION

Kindergarten

None

First Grade

None

APPENDIX F Cont.

Second Grade

None

Ages 9, 10, & 11

None

VI. COORDINATION OF STOP AND START TIME

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

93. When the black car stopped the white car was still going on.
96. Because when the white car was still moving the black car stopped.
99. Because the white one was going when the black one stopped.

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

3. Don't know.
17. NO RESPONSE.
24. I don't know.
26. Because the white was the win.

APPENDIX F Cont.

First Grade

38. I don't know how.
41. Cause white won.
42. NO RESPONSE.
45. Because the brown one didn't win.
58. It stopped winning.

Second Grade

69. Cause white won and black lost.
84. Because it won the race.
87. Because the white one won the race.

Ages 9, 10, & 11

95. You can see it.

IX. COMBINATION

Kindergarten

None

First Grade

33. Because he came ahead of the red car and he took less time to the finish. (V, I)

Second Grade

63. They start off the same time and they stop the same time but the black one's still in back of the white one. (I, VI)
74. Because it went faster than the black car, and that takes less time. (IV, V)
82. Because the white car was further than the black one and he stopped before. (I, III)

Ages 9, 10, & 11

None

APPENDIX F Cont.

X. AMBIGUOUS

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

106. Because it went more.

APPENDIX G

TYPES OF EXPLANATIONS USED AFTER SITUATION V

I. PERCEPTUAL

Kindergarten

1. Cause it was in back.
5. Because the white one was over there.
5. Because white kept on going a little more.
7. The red went further.
9. Cause he didn't get started.
10. Cause the white's a little more ahead.
11. Because it's under the white car.
16. Because it was lower than the white one.
19. Because they went the same distance.
23. Cause they both stopped at the same place.
25. Because it was ahead.
26. Because the white one was still left and the black was still going.
27. Because first the white one came over there and then the black one started to go.

First Grade

32. Yellow one at beginning and red one went ahead of it.
36. When red one started white was behind line.
39. Cause it was still at the start line.
43. White one was left behind.
52. Cause they both went to the same spot.
56. You could see as the black car was going and then it stopped the white car was going already and then it stopped.
58. Because they're both leading.
59. Because it left back.

Second Grade

65. The white one got to the front first then the red one.
77. Because the black car got a head start and then when it stopped the white car start to go.
79. Because they're above each other.
84. While he was moving he was still behind that black line.
89. Because the black is more further back.

APPENDIX G Cont.

Ages 9, 10, & 11

93. Because when the black car had stopped the white car was still going in.
97. Because they both went the same distance.
98. Because they both stopped even.
100. Because they both stopped at the same place.
102. Because they're both even.
103. Because the black started and went way ahead and the white car was still at the starting.
106. Because it, the black car, started and stopped. Then the white car came.
109. Because it went further
112. Because they both went the same distance.
113. Because they're both in the same distance.
114. Because the white was on the starting line when the black stopped.
119. One car started, then stopped, then the other car started and stopped but they still went the same distance.
120. Because they both went the same distance.

II. SPATIAL

Kindergarten

24. Cause the black one's first then the white.

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

2. Because it started last.

APPENDIX G Cont.

14. Because first black started then white one came.
15. Because the white one stopped last.
22. Because it started last.
29. Because the black one started first.
30. Because it started second.

First Grade

33. Because the red one left before the white one.
35. Because red car stopped first and white stopped last.
38. It started first.
41. Cause he was last to stop.
44. Because the black car started first.
45. Because the brown one went first and the white one went last.
49. The black went first.
54. Because he started first.
57. The white stopped first and the black didn't.
60. Because it started last.

Second Grade

61. Because the black car started before.
63. They didn't start off the same time. The black one wasn't first and the white one went second.
64. Cause it started first.
68. Because the brown one started before white one.
69. Because white started before and black started later.
70. White one started after black one.
81. Because it went last.
85. Because that stopped last.
88. Because the black car stopped first.
75. Because the brown one already went when the white one just started.

Ages 9, 10, & 11

116. Because it started later than the black one.

IV. SPEED

Kindergarten

3. Because it was going slower.
12. Cause he went slower.
18. Because it went slower than the red one.

APPENDIX G Cont.

First Grade

50. Because the black one was going faster.

Second Grade

62. Because he went slower than white car.
71. Both went at same speed.
78. Because it went slower.
82. Cause he went slower.

Ages 9, 10, & 11

92. Because the white car made it to a certain point faster than the black car.
94. Because it went very slow and the white car went fast.
104. It went slower.
117. Black one was going slower than the white one.

V. DURATION

Kindergarten

None

First Grade

31. Because it staved there for a longer amount of time.

Second Grade

None

Ages 9, 10, & 11

None

VI. COORDINATION OF STOP AND START TIME

Kindergarten

APPENDIX G Cont.

None

First Grade

51. Because the black car was starting first and then the white was coming up.

Second Grade

66. White didn't start yet but red one had all time to run until white started.
67. Because the red one started first, and then it stopped then the white one came and then it stopped.

Ages 9, 10, & 11

None

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

6. I don't know.
8. NO RESPONSE.
17. NO RESPONSE.
20. I don't know why.

First Grade

46. I don't know.

Second Grade

80. Because the white won.
90. NO RESPONSE.
83. NO RESPONSE.

Ages 9, 10, & 11

111. NO RESPONSE.

APPENDIX G Cont.

IX. COMBINATION

Kindergarten

21. Because the black one started first and the white one was back there. When the black one almost stopped the white one came up then. (I, III)

First Grade

37. Because the red started first and white second and both landed at same place. (I, III)
47. The black car started before the white car and the white car was still there and then the white car moved. (III, I)
53. Cause when the white one was behind the line and came speeding up. (I, IV)
55. Because the white car come to the place after the black car and it also came faster. (III, IV)

Second Grade

72. When the white car was still at the beginning the black car went but it was going slow and the black car started a little later but it carched up. (IV, I)
73. They stopped at the same time and they equal the same. (I, III)
76. Because the white one started last, if it started last it has to have more time to go. (III, V)
87. The black one started first but the white one went faster. (III, IV)

Ages 9, 10, & 11

91. Because the black one started ahead first and the white one was still at the starting line. (I, III)
96. I think the black car took a little more time, because the black car went a little bit slower than the white car. (IV, V)
99. They started at the different times but they took the same amount of time. (III, V)
101. Because first the black car started, then the white car had to wait a longer time before it started. (III, V)
107. They both took the same time. Both of them went slow. (V, IV)
108. After the black one started and it stopped and the white one stopped in the same place. (III, I)
110. Because the black one went first and then the white one got there. I think they went at the same speed. (III, IV)
115. They traveled the same amount of time because they went the same amount of distance. (I, V)

APPENDIX G Cont.

118. Because the black one started before the white one and the white one was going a little slower. (!!t, IV)

X. AMBIGUOUS

Kindergarten

13. I see this one more so, and not the other one.

First Grade

40. Because I saw this one over here and first this started and then that one.
48. Because the brown went before the white.

Second Grade

74. Because the black one got ahead start.

Ages 9, 10, & 11

95. Black one got there first then the white one.
105. Because it got there before the other one.

APPENDIX H

TYPE OF EXPLANATIONS GIVEN AFTER 40 CONCEPT-ATTAINMENT TRIALS: MORE

I. PERCEPTUAL

Kindergarten

5. Because it was ahead.
13. Cause I saw the white car there (point to line) but I didn't see the other car there.
14. The one that was more close I thought was it.
17. Cause it was ahead of the black one.
    Because the running car went, and one running car was left.
20. Cause it's ahead of the white car.

First Grade

39. It looks like it's closer.
42. The black car it went in front of the white and the white car it goes in front of the black.
43. Because the white car is always ahead of the white one.
51. Because it was going ahead most of the times. Yes.
60. Because it was always ahead.

Second Grade

62. Because it was ahead of the white car.
69. Cause it's going to win. Cause it's ahead.
74. Because it was ahead of the black.
78. The winner was in front and the one in the back could stop the traffic. When the car goes in front and the other one goes in front of the other one, I picked the one in back.

Ages 9, 10, & 11

None

II. SPATIAL ORDER

Kindergarten

2. Because the white car is first.

APPENDIX H Cont.

First Grade

None

Second Grade

70. Because it was first.

Ages 9, 10, & 11

None

III. TEMPORAL ORDER

Kindergarten

18. Because I always saw one car go first (which car went first good or bad?) Good one.

First Grade

49. Cause like this is going forward first (pointed to white car).

Second Grade

None

Ages 9, 10, & 11

119. The one that stopped last was correct.
106. The car that started first without stopping won. The other car that stopped and didn't go on. The car started first and stopped and the other car started last came all the way through and won.
108. The one that went first was it unless one went to the end.
111. Cause I was thinking of the questions that you gave me and I thought you were giving it to me.
Again. To see how I reacted. I was a thinking of what you were thinking. Which car started first.

APPENDIX H Cont.

IV. SPEED

Kindergarten

4. Because I saw which one was going faster.
25. Because it was going faster most times.

First Grade

None

Second Grade

83. Sometimes they go fast and sometimes they go slow.

Ages 9, 10, & 11

109. Because it was going slow.
Sometimes I picked the fast too.
117. It was going the slowest.

V. DURATION

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

APPENDIX H Cont.

VI. COORDINATION OF START AND STOP TIME

Kindergarten

None

First Grade

None

Second Grade

71. When the black car didn't start at the same time as the white, the white car won because the black car didn't have a head start. When the white car stopped, black car was still going, white car won.

Ages 9, 10, & 11

None

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

8. I just picked it.
10. Cause the brain food helped me.
23. I. D. K. Cause I thought white were better than black.
30. I just knew it. I learned so many homework.

First Grade

59. Because it won.
I don't know.

Second Grade

85. I don't know. When there wasn't any black dots it was the white car.

APPENDIX H Cont.

Ages 9, 10, & 11

99. I just guessed.
107. Cause I thought you were asking that question. (which? Guess?) Which car went further?

IX. COMBINATION

Kindergarten

24. Because the white went faster.
Because the white one first. (IV, II)

First Grade

32. Because the white one stopped first.
The one that stopped first. (III, V)
35. I. D. K. If one of them went first and the other went second. If one of them starts slow and the other starts fast the other one can win when it goes fast. (III, IV, VIII)
40. It went faster and went ahead.
I saw them go ahead. I saw them stop before the other person stop. (I, III, IV)
48. Because the black one was slower and the white one got a head start. (IV, X)
56. When the other car saw that the car won then it stopped. The the other car didn't think it was going to win. It took a chance in trying to get ahead.
The car that got there first lost and then the other guy won because he got there last. (I, III)

Second Grade

87. Because the one that got farther but sometimes I thought it was slower and that's why I picked the other car.
The one was starting first. (I, III, IV)
88. Because it was going faster.
Another reason it was ahead. (I, IV)
61. It started before the black car and it was ahead before it stopped. (I, III)
67. Because when I first tried the one that got to the end of the paper won most of the time.
Because some of the cars had a head start. Most of the time they won. (I, X)

APPENDIX H Cont.

77. The one that got a start first.
Because one got to this end and the other hasn't at the end yet. (I, III)
90. Because it was first.
Because I used the one that was further. (I, II)

Ages 9, 10, & 11

92. (What were you thinking?) How long it would go and the speed. (IV, V)
93. The one that started first or the one that made it to the end of the screen. (I, III)
100. The one car was further than the other one. It started first and sort of slowed down and the other stayed behind it. (I, III, IV)
104. Sometimes one was less behind and went slower. Sometimes the black would start and the white would pass. The one started first. (I, III, IV)
112. The one that was ahead of the other one. The other times just guessing. (I, VII)
95. Most of the cars are in the lead. (I, VIII)
101. Because it was in the lead before the other was. It came in first. Sometimes that came in last. The one that comes in first and then goes back to last again. (I, II)
103. Cause I saw the white car in the lead. If the white car went to the end and the black car caught up it would have been the black car. (I, XII)

X. AMBIGUOUS

Kindergarten

None

First Grade

68. Because it started first like if it had a head start it would probably win.

Second Grade

None

Ages 9, 10, & 11

None

APPENDIX H Cont.

XI. ALTERATION

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

XII. HYPOTHESIS TESTING

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

APPENDIX I

TYPES OF EXPLANATIONS GIVEN AFTER 40 CONCEPT-ATTAINMENT TRIALS: LESS

I. PERCEPTUAL

Kindergarten

1. Because it was in the back.
15. Cause the white one was ahead of the black one.
    Car I picked was ahead.
22. The white one was ahead and the black one was...So I picked the white one.
26. One was this way (S points to left one) One was that way.
    (Which one was right?) S ans: That way. (Points to left.)

First Grade

31. Because it's way in back.
36. Because the black one is a little behind the white one.
38. Because it was back.
    Yes.
46. By watching them race; because the one that went the farthest.
58. Because it was behind.
    Some were behind and some were in the lead.

Second Grade

65. The car had to be further back.
73. I think it was in the back more.
76. I kept guessing the back one and soon it was all right, and so I kept guessing the back one.
79. Because it's closer to that (S points to start line.)
    Tried the top one, the bottom one.
80. Because the black one was in the back.
81. I picked the one behind.
    (What did you pick when they were together.) If the one before was black I'd guess white.
82. Because it was back some. Back more than the white one.
    Sometimes it was a different car. It changed color.
89. The one that was closer to the line.
    When they looked the same I thought the one that was further up.

Ages 9, 10, & 11

98. The one that was behind.

APPENDIX I Cont.

113. The one behind.

II. SPATIAL ORDER

Kindergarten

None

First Grade

47. Cause I like black.
Cause it was first.

Second Grade

None

Ages 9, 10, & 11

116. The car that came in last.

III. TEMPORAL ORDER

Kindergarten

None

First Grade

41. Because they stopped last.

Second Grade

86. Because it stopped first.

Ages 9, 10, & 11

None

APPENDIX I Cont.

IV. SPEED

Kindergarten

7. The red went faster.
11. I was looking at how fast they were going.
Under the ties I checked how they look. Fast was right.

First Grade

54. It was going faster.
Sometimes I picked the losing car and sometimes I picked the winning car. Sometimes one was going faster and sometimes one was going slower.
57. Cause it went faster.
Like the slow one.

Second Grade

None

Ages 9, 10, & 11

110. The one that was the slowest. Twice it didn't work.
115. I was just thinking about the questions. Which one was going slower.
I changed the question each time.

V. DURATION

Kindergarten

None

First Grade

None

Second Grade

None

APPENDIX I Cont.

Ages 9, 10, & 11

None

VI. COORDINATION OF START AND STOP TIME

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

VII. & VIII. GUESSING AND I. D. K.

Kindergarten

3. I don't know.
6. I don't know.
9. I don't know. I guesses.
12. Figure something out.
19. I knew.
Guessed.
21. I guessed.
27. Because I guessed em. The car was my favorite color.
Cause if someone used a blue one, I would say...because blue is my favorite color.

First Grade

33. I don't know how to really do this cause I don't know whether you win or loose.
37. I think it's the one that looses.

APPENDIX I Cont.

45. Because it was- I don't know I just wanted to pick it. Everytime I picked one I was wrong when that one was it I took the other one.
52. The one that didn't win was the one that you were looking for.

Second Grade

64. No reason.

Ages 9, 10, & 11

91. I don't know.
105. Just guessed.

IX. COMBINATIONS

Kindergarten

16. Cause I can tell which one went the fastest. It's hard to tell when ones behind and th other gets the same spot as the other car...it's hard. (I, IV)
29. The black was in back of the white car. Because the black one wins sometimes going faster than the white one. (Did you always pick the faster one?) Yes. (I, IV)

First Grade

44. Because the black car was going faster. Sometimes the white car stops first and its going slower and the black car starts and its going faster. (Which one would win) The one started last. (IV, VI)
55. First I thought it was the black car because the black car started first because it went faster. (III, IV)

Second Grade

63. Because it was in back. I just guessed. (I, VII)
66. Because it seemed to stop last. Sometimes one that went nearest to the end. (I, III)
84. Because he stopped short. He was ahead of the white car until the black car went by. When the black car was going to the finish line maybe the white car was just coming out, then I picked the white car. (I, VI)

APPENDIX I Cont.

75. Because he started last.
Sometimes I thought one was behind and that was him, and then one went slower and one went faster. (I, III, IV)

Ages 9, 10, & 11

94. I thought that it was that the car that started first and then passed it was it. The car that went the furthest. (I, III)
96. Sometimes which car started first or started last. (Which car got to the end of the picture?) The car that started last; the car that stopped first. (I, III)
97. The one that ended last. (What did you do when they ended at the same time?) I just took a guess. (III, VII)
102. First I thought that it was the faster one, then furthest, on top, on bottom, the slowest. (I, IV)
114. It went the shortest.
Sometimes which stopped first, which stopped second. There might be a pattern to it. (III, XII)
118. First I thought it was the one that stopped first, sometimes I thought it was the one that stopped last. A lot of the times I just guessed. (III, VII)

X. AMBIGUOUS

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

APPENDIX I Cont.

XI. ALTERNATION

Kindergarten

None

First Grade

50. Black then white.

Second Grade

72. Cause, it was back forth-black/white. Then sometimes it was black-black-white-white.

Ages 9, 10, & 11

120. Black white-white black (She was trying to figure out the color sequence.)

XII. HYPOTHESIS TESTING

Kindergarten

None

First Grade

None

Second Grade

None

Ages 9, 10, & 11

None

References

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Education

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Employment and Research Experience

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1965-1966	Research Assistant, Division of Child Learning, Center for Urban Education. Conducted research on the development of the concept of size in young children.
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