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THE EFFECTS OF EXTRALINGUISTIC CONTROL OF COMPREHENSION AND PRODUCTION IN THE NON-FLUENT CHILD

by

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The present study investigated (1) the developmental sequence postulated to exist between the processes of comprehension and production, and (2) the effects of syntactic (word order), semantic (animacy of subject and object), and extra-semantic (directional correspondence between verbal and visual sentence presentations, and task complexity) variables upon comprehension and production in the non-fluent child. Fifteen nursery school children grouped in terms of age and performance on the McCarthy (1972) Scales of Children's Abilities constructed puzzles corresponding to sentences during comprehension trials, and labeled preconstructed puzzles corresponding to the same sentences during production trials. Phase I of comprehension trials required the child to choose among two subject and two object puzzle piece alternatives, to construct correct sentences containing (a) an animate subject/inanimate object, (b) an inanimate subject/animate object, and (c) an animate subject/object, and an inanimate subject/object. Correct constructions corresponded to the sentence form: "The agent is running/going to the object." Selection of the incorrect subject and object alternatives resulted in the construction corresponding to the sentence form: The agent is running/going away from the object" (a reverse direction error). Illogical response strategies resulted in the construction of a puzzle where

both pieces contained the agent (subject-subject error) or both pieces contained the object (object-object error). Phase II comprehension trials required the child to choose among three subjects and one object alternative. Correct Phase II constructions corresponded to both "agent to, and agent away from" sentences; incorrect constructions involved either reversing the preposition (reverse direction error) or choosing the subject-alternative where the subject was not the agent (no action was depicted, termed a no-direction error). In both Phases I and II, the correspondence between the experimenter-presented sentences and the pictorial-puzzle stimulus was manipulated. In the matched condition, the subject of the sentence was named first and the object second. The child then was instructed to construct a puzzle whose subject was placed in the first position and whose object was placed in the second position (going from left to right). In the mismatch condition, the instructions were identical but the correct puzzle construction required that the child place the object in the first position and the subject in the second position (going from left to right).

Multiple repeated measures analyses of variance performed between Phases and within each Phase for both percent correct responses and response errors disclosed that production exceeds comprehension during Phase I ($p < .001$) and Phase II "away from" sentences ($p < .05$) for all children. However, comprehension was found to equal production during Phase II "to" sentences, for children in groups having mean ages of

4 years 1 month, and 4 years 8 months. For younger children (mean age 3 years, 6 months) the same task found production to exceed comprehension. Differential effects of semantic and extra-semantic variables were found primarily for the youngest children who performed significantly and consistently at a level below the older groups on all tasks. Moreover, the youngest children made significantly more illogical comprehension errors than the other groups, suggesting that the child of this age is not under the sole control of the logical relations between agent-actor-object, as had been traditionally postulated. Production responses were not found to be under non-syntactic control for any of the groups, although the youngest children made significantly more production errors than the older children.

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CHAPTER I

INTRODUCTION

Language development in the young child shows a qualitative progression in terms of both comprehension and production of verbal structures. Such a qualitative progression indicates that the variables controlling comprehension and production of the non-fluent child change systematically to produce related qualitative changes in behavior. The nature of the developmental progression and, to an extent, the variables controlling appropriate comprehension and production remain a matter of speculation and controversy. This controversy is complicated by recent research suggesting that the comprehension and production strategies used with any particular grammatical structure may be controlled by different variables (Chapman & Miller, 1975). Such findings have led to further questions related to the independence, interdependence, or equivalence of the two processes of comprehension and production.

A number of explanations have been offered to account for the variables controlling verbal behavior. Nativists such as Chomsky (1965, 1968), Lenneberg (1967), and McNeil (1966, 1970a) have suggested a genetically pre-programmed maturational unfolding of verbal behavior over time. Piagetians have suggested a process akin to that underlying cognitive development, which states that linguistic structures are constructed over time, as the individual experiences his environment (Beilin, 1975). This explanation relies heavily on prior constructions of mental imagery and object-image relationships. Behaviorists have suggested that language learning is due to modeling, imitation, and environmental contingencies, and the so-called "neopsycholinguists" (e.g., Staats, 1974) have suggested that learning principles interact with cognitive structures, affecting a systematic development of language.

The paucity of existing experimental evidence relating to the variables which control comprehension and production precludes conclusions regarding the exact nature of this control. However, new research developments provide some insight into this issue, and these, in conjunction with a brief summary of existing views of verbal behavior will be briefly reviewed.

Qualitative changes in language development have been taken as evidence that the language acquisition process is constructive rather than genetically pre-programmed. Piagetians have taken a somewhat epigenetic view of language development, believing language to be acquired "...in the same manner and based upon the same principles with which Piaget has analyzed intellectual-cognitive development generally" (Moerk, 1975, p. 151). The view that language is constructed and not innately programmed has a number of proponents (e.g., Beilin, 1975; Bloom, 1970, 1973, 1974;

Bowerman, 1973, 1974; Brown, 197 ; Hutson, 1974; Huttenlocher, 1974; Morehead & Morehead, 1974; Premack, 1972, 1973; Premack & Premack, 1974; Sinclair-de-Zwart, 1969, 1971, 1973a,b). However, despite the popularity of the Piagetian viewpoint, the theory is not an adequate explanation of cognitive or language development. The basic concepts in Piaget's (1952, 1962, 1970, 1971) theory describe only the believed continuity of cognitive intellectual development; the variables that control structural changes in development are still unknown (cf. Etienne, 1973; Hutt, 1973). Indeed, realization of this problem has led some investigators (e.g., Staats, 1968, 1971, 1974; Bricker & Bricker, 1974) to emphasize the interaction of learning principles with the proposed cognitive structures.

Recently, Beilin (1975) has proposed that acceptance of the constructive nature of language acquisition and development requires certain data. Specifically, evidence of stepwise qualitative differences in performance, which would suggest developmental transitions in linguistic processing, would support a constructive explanation. Restated in terms of a functional analysis, the experimental data required would be an analysis of the variables which control a particular verbal response form, and a demonstration of a developmental shift in control by these variables. Beilin (1975) has cited the results of his own research to demonstrate that indeed, a developmental progression is evident in, for example, the young child's use of passive constructions. Moreover, support for a developmental progression in children's comprehension and production of the passive form has come from numerous other investigators (Huttenlocher, Eisenberg, & Strauss, 1968; Huttenlocher & Strauss, 1968; Huttenlocher & Weiner, 1971; Strohner & Nelson, 1974). Although a constructive view of language development is supported by data indicating that the correct use of the passive is prefaced by a stepwise developmental progression, the data do not eliminate alternative explanations. Indeed, any statements made at this time concerning the underlying nature of developmental change are necessarily inferential.

A finding that language acquisition is a gradual developmental process does not logically exclude the possibility that the process is under changing external stimulus control. Several theorists have proposed that language is learned, at least in part, through contingency management (Guess, 1969; Guess & Baer, 1973; Guess, Sailor, & Baer, 1974; Guess, Sailor, Rutherford, & Baer, 1968; MacCorquodale, 1969, 1970; Miller & Yoder, 1974; Sailor, 1971; Segal, 1975; Skinner, 1957; Staats, 1968, 1971). Other investigators have also demonstrated that imitation and modeling play a greater role in language acquisition than was originally believed (Bandura, 1965; Sherman, 1972; Whitehurst & Vasta, 1974). Indeed, even some constructive theorists have acknowledged the role of external stimulus control in the acquisition of different linguistic structures. For example, Beilin (1975) has suggested that language development may not be accounted for by any single process. Moreover, he suggests that "...the processes associated with language development generally are affected by a complex of factors that include conditions external to the individual as well as internal" (p. 370).

The relationship of extralinguistic stimulus control in the production and comprehension of sentences has, however, generally been omitted from developmental accounts of language development. This omission can be traced to the traditional framework of language development formulated by Chomsky and his followers (cf. Bever, 1970). This framework explained language acquisition on the basis of the child's innate knowledge of basic grammatical (syntactic) relations. The nativists posited that language could not be accounted for by variables external to the organism, because basic grammatical relations can be consistently defined only in the deep structures of sentences that are beyond the reach of any linguistic experiences a child may have (McNeill, 1971, p. 23). Chomsky (1968), for example, postulated the existence of some genetically based language acquisition device which abstracted rules of syntax according to some unexplained grammar. In his view, these syntactic rules were abstracted from the language corpus a child normally hears. Studies which have attempted to demonstrate that children in the early stages of language production have knowledge of basic grammatical relationships, apart from non-syntactic (extralinguistic) stimulus control, have failed to support this claim (Bloom, 1974; Bowerman, 1973; Chapman & Miller, 1975; Hutson, 1975; MacNamara, 1972).

Current research findings are, however, supporting a view that the child's early sentence comprehension is, at least partially, under semantic control. Specifically, Huttenlocher (1974) has shown that a child understands the meaning of a sentence in terms of logical relations between agent, action, and object (i.e., semantic relationships, cf., Bowerman, 1973; Schlesinger, 1971, 1974) and not by grammatical or syntactic relationships such as subject of the sentence, predicate of the sentence, verb of the verb phrase, etc.

When semantic interpretations are included in a child's early comprehension and production strategies, however, the question of Chomsky's abstract deep structure acquisition is brought into sharp focus. Specifically, if grammatical relations can only be defined in the abstract deep structures of sentences, and these deep structures are not directly exhibited in the speech to which the child is exposed, then grammatical relations certainly cannot be learned through semantic components. Some researchers have suggested that the problem of learning about abstract deep structure when abstract deep structure has never been directly represented to the child can be solved by arguing that such deep structures do not exist. For example, Schlesinger (1971) has argued that language acquisition involves the direct mapping of semantic intentions onto surface structures. Taking a less extreme view, Bowerman (1973), however, has suggested that deep structures need not be discarded altogether. In fact, she has suggested that basic grammatical relations may be acquired through experiencing the ways in which various semantic relationships are formally dealt with in language (p. 193). Thus, for example, in early speech productions, the syntactic relation of "subject" is understood in terms of the semantic function of agent. With increasing linguistic and experiential development, the syntactic relation of "subject" expands because the semantic functions of subject have become increasingly diverse and have extended the sole subject-as-agent function. Bowerman (1973) has suggested that early speech may in fact only express simple rules for ordering words which are understood functionally. These words may be seen as performing semantic functions such as "agent, action, and object upon agent" (Bowerman, 1973, p. 190).

Behaviorists, although perhaps not disagreeing in total with the semantic view of acquisition, have objected to the use of the term "semantic intentions." Segal has argued that "Semantic intentions translates as control of verbal behavior by discriminative stimuli and reinforcing consequences" (1975, p. 51). In this view, meaning or understanding is not a necessary component of learning. She contends that this control is determined "...not by isolated features of the environment but by consequences uniquely correlated with relations among environmental events." This assertion of control has been demonstrated in a series of studies concerned with the acquisition and subsequent generalization of certain grammatical structures, such as the plural morpheme, in retarded children having mental ages up to four years, five months, as well as severely retarded children having virtually no prior verbal histories (Guess, 1969; Guess et al., 1973, 1968; Sailor, 1971).

Indeed, Chapman and Miller (1975) have suggested that external control is the basis of production in verbal sequences. They suggest, however, that the principles of reinforcement which operate in the control of appropriate production responses, may not be operating, or may be operating in different ways, in the comprehension of verbal sequences. Stated differently, comprehension by the non-fluent child may be inappropriately based on relations among environmental events which do not control comprehension at a later time in language development (viz., extralinguistic relations). Moreover, when comprehension is inappropriately controlled by extralinguistic factors, a different set of variables may simultaneously produce correct production responses. These suggestions are based on the *a priori* assumption that comprehension in the *fluent* child is primarily under syntactic control. If this assumption is accepted, therefore, any non-syntactic control, with reference to this discussion, is seen as an inappropriate source of control. Moreover, correct syntactic productions in the *non-fluent* child are assumed to be under the control of a verbal community which reinforces only those correct productions. Thus, if at some early point in his linguistic development a child can correctly produce some syntactic structure (e.g., the plural morpheme), a question remains as to whether the child's comprehension of this structure is based on syntactic stimulus control (that is, the "s" is produced in response to certain grammatical constraints), or based on some non-linguistic, external stimulus control (e.g., a verbal community which reinforces pluralization in the presence of more than one stimulus).

The variables controlling early comprehension have only recently come under experimental scrutiny (cf., Friedlander, 1970). Intertwined in this issue is a second related issue: How do the variables controlling comprehension at any point in time differ from those controlling the production strategies at the same point in time, for any particular grammatical structure. The present study was interested in these two related research areas in receptive language learning. Specifically, this research was concerned with (a) the variables controlling verbal and particularly non-verbal responding to verbal stimulation, and (b) the nature of the developmental sequence between comprehension and production of particular grammatical structures at the same point in time, in the non-fluent child.

CHAPTER II

REVIEW OF RELATED LITERATURE

In a recent series of studies, Huttenlocher and her associates (Huttenlocher, Eisenberg, & Strauss, 1968; Huttenlocher & Strauss, 1968; Huttenlocher & Weiner, 1971) have investigated a child's ability to determine a relationship between two heard nouns in a sentence as a function of external non-linguistic control. For example, using a ladder in which certain items are fixed and other items are mobile, the child may be asked to respond to such questions as "Put the green block on top of/under the red block." Even when the mobile item is the grammatical subject and the fixed item is the grammatical object, a number of possible variations in context are possible. If there is more than one mobile object, the child must attend to the subject term; if there are possible variations in placement, the child must respond to the relational term; if there are multiple fixed items, the child must respond to the object term. Moreover, when all items are mobile, the child should presumably incorporate syntactic cues into his response strategy. Huttenlocher and Strauss (1968) instructed nursery school children to place one block relative to a second block. The second block was fixed in the middle of a ladder. Responses had shorter latencies when the mobile object was the grammatical subject of the relational term and the fixed object was the grammatical object (e.g., The red block [grammatical subject] is on top of the green block [grammatical object]). The authors argued that comprehension, as reflected in response latency, may require a correspondence between the form of a linguistic description and the external (extralinguistic) stimulus situation. They postulated that a child ascribed the role of actor to the grammatical subject. For active sentences, the grammatical and logical subjects coincide, but for passive forms, the grammatical object is the logical subject (e.g., Tom hit John vs. John was hit by Tom). Huttenlocher, Eisenberg, and Strauss (1968) demonstrated that for active sentences, fourth graders had shorter latencies in placing a mobile object with respect to a fixed object when the mobile object was the grammatical subject rather than grammatical object. For passive constructions, children had shorter latencies in placing the mobile object when it was the grammatical object rather than the grammatical subject. The authors concluded that the differences in reaction time were caused by the child's transforming the experimenter's statement to correspond to the extralinguistic situation in order to comprehend the sentence (i.e., exchanging object and subject, and reversing the relational term). The authors suggested that "...when the mobile truck is described as logical object, they [the children] accomplish this by imagining that the fixed truck is actually mobile" (Huttenlocher, et al., 1968, p. 304).

In a subsequent study, Huttenlocher and Weiner (1971) found that fourth graders had more difficulty in responding to a relational description when both items were mobile than when one item was fixed. In the experimental situation where one item was fixed, children's tendency to move the described actor was found to be partially a function of the word order of the sentence. Subjects were more likely to move the described actor in active sentences when it was mentioned first (78 percent) than in passive sentences where it was mentioned last (64 percent). This difference in the likelihood of moving the described actor in active compared to passive sentences was statistically significant.

When both objects were mobile, word order exerted even greater control over the order of the moves. In both active and passive sentences, the first object mentioned was also the first object moved. It appears that the children in this condition matched the external context to the instructional verbal stimulus.

Huttenlocher's findings that sentence comprehension is facilitated when the events that the sentences describe are consonant rather than dissonant with the accompanying nonverbal context have been supported by other investigators. Non-syntactic control of sentence comprehension has been demonstrated by Bever (1970), who found four year olds understand sentences better if the events they described were probable rather than rare. Moreover, Strohner and Nelson (1974) have extended Bever's (1970) findings to younger children. In their study, children aged two through five were instructed to act out the meanings of sentences using handpuppets. The three, four, and five year olds were presented probable and improbable active sentences (e.g., The girl feeds the baby; The baby feeds the girl, respectively); probable and improbable passive sentences (e.g., The baby is fed by the girl; The girl is fed by the baby); reversible active sentences (e.g., The girl follows the boy); and reversible passive sentences (e.g., The boy is followed by the girl). Thus, reversible sentences, for both the active and passive voice, were sentences whose semantic probability was not altered when the subject and the object of the sentence were interchanged. The two year olds were presented the same types of sentences, except that probable and improbable passive sentences were not presented.

For the three to five year olds, the most dramatic changes across ages were reported for reversible passive sentences and for improbable active sentences. Together, these two sentence types were correctly portrayed only 30 percent of the time by the three year olds, but 85 percent of the time by the five year olds. Probable active sentences were consistently correct for all age groups. Although the three year olds responded correctly to probable active and passive sentences 100 percent of the time, correct responses were never made to improbable passives. These results suggest that three year olds use a probable-event strategy when presented with improbable action sequences. (See also Hutson and Powers [1974] for similar findings with older children.) However, in the reversible sentences, the three year olds could not use this probable-event strategy since both actor-action-object sequences and object-action-actor sequences would be equally probable in the natural environment. A second strategy appeared in these cases. Three year olds seemed to use an actor-action-object strategy, where any noun-verb-noun sequence was interpreted as actor-action object, irrespective of sentence voice. This strategy is evident when correct performance on reversible actives (80 percent) is compared to that on reversible passives (27 percent). These findings are in accord with Bloom's (1974) observations of early two and three word utterances. Bloom has hypothesized an underlying subject-verb-object structure for the majority of sentences produced by non-verbal children (see also Schlesinger, 1974).

Strohner and Nelson's findings for two year olds were very similar to those of the three year olds. However, the two year olds appeared to use the actor-action-object strategy less than the three year olds (in reversible active and reversible passive sentences). A probable-event strategy was also shown to operate for the two year olds when improbable active sentences were presented (17 percent correct). Strohner and Nelson's findings are important when compared to those of Bever (1970) who reported negative results for the use of semantic-probability information by children under the age of four. Strohner and Nelson (1974) have concluded that by the time a child is five, he is relying less on semantic probability information than on syntactic structure.

The differences in results reported by Strohner and Nelson and Bever are possibley due to an age selection criterion. That is, where Strohner and Nelson grouped their subjects according to both age and mean length of utterance (MLU), Bever's subjects were grouped only according to age. A recent study by de Villiers and de Villiers (1973b)on the use of word order in sentence comprehension has provided some support for this suggestion. De Villiers and de Villiers (1973 b) compared their results to those reported by Bever (1970; see also Fodor, Bever, & Garrett, 1974; Bever, Mehler, Valian, Epstein, & Morrissey, In press). In Bever's study, two and three year olds correctly interpreted the reversible active sentences on 95 percent of the trials. Moreover, in an investigation of semantically reversible and irreversible passive sentences, two and three year olds were reported to perform at chance, even in the presence of semantic constraints to facilitate comprehension. However, girls aged three years-four months to three years-eight months, and boys aged three years-eight months to four years, performed at better than chance levels on reversible passives. Interestingly, a group four months older performed below chance level, systematically reversing the passive sentences. Bever has suggested that at this stage, a new perceptual strategy was employed, where any noun-verb-noun construction was treated as the more common active order, agent-action-object. From four years on, there was a steady improvement in the comprehension of all passive constructions. De Villiers and de Villiers (1973 b) also investigated a child's comprehension of reversible sentences, but unlike Bever's (1970) study, the child's level of language production was indicated by MLU (cf. de Villiers & de Villiers, 1973 a) and not by age. De Villiers and de Villiers reported that with reversible passives, children in Stages I, II, III, and IV MLU (1-1.5; 1.5-2.5; 2.5-3; 3-3.5 morphemes, respectively) showed no preference for using either noun as agent. However, the early Stage IV group showed a trend in using the first noun of the passive sentence as the agent, thus reversing the meaning. On the basis of this finding, there is no evidence to support Bever's conclusions, namely that children act out reversible passives correctly until after early MLU Stage IV. Thus, the use of a word order strategy employed by young children, as evidenced by correct responses on reversible active sentences and incorrect responses on reversible passive sentences, is not supported until a more advanced stage of development (de Villiers & de Villiers, 1974; Strohner & Nelson, 1974; Chapman & Miller, 1975).

In agreement with the findings of Strohner and Nelson (1974) and de Villers and de Villiers (1973 b), Clark (1973, 1974) and Bloom (1973, 1974) have also reported various observational and experimental accounts that provide support for extrasyntactic control of comprehension behavior in one and two year olds. Their data indicate that comprehension may be multiply determined by such variables as the observed relations among environmental events, the observed relations among environmental events previously mentioned in conversation, and the typical relations among the environmental events and objects found in the child's previous stimulus history. (See also Gowie, 1974; Gowie & Powers, 1972, for a discussion of the effects of expectation on comprehension, in children from kindergarten through first grade.)

Similarly, Vincent-Smith, Bricker, and Bricker (1974) have found that contextual cues provided by the experimental stimulus situation, gestures, and the child's expectations, together with the verbal stimulus, provided a source of control of comprehension behavior. Thus, language comprehension has been shown to be at least partially under the control of non-linguistic events. (See also Powers & Gowie, 1975, for a discussion of comprehension in the absence of contextual cues.) Moreover, in a recent study, Bricker, Vincent-Smith, and Bricker (1973) demonstrated differential control of comprehension behavior when developmentally delayed (developmental quotients below 75 on the Bayley Scales of Infant Development) and non-delayed (100 or above IQ on the Stanford Binet Form LM or the Bayley Scales of Infant Development) children were compared. In a two-choice discrimination test of word comprehension, 28 month old non-delayed infants were found to respond to the instructions ("Take X") on the basis of the name of the object. Conversely, younger non-delayed (18 months) and both older and younger delayed infants matched for age with their non-delayed counterparts responded on the basis of object-name irrelevant stimulus control (i.e., object preference, object avoidance, position preference). Thus, these data show that children who are developmentally delayed, as well as those who are young and non-delayed, are under inappropriate control of non-linguistic stimuli. These data strongly suggest that comprehension develops when the semantic properties of objects replace linguistically inappropriate stimulus control by other dimensions. Unfortunately, the design of this experiment did not allow any conclusions of control by syntactic dimensions to be made.

Whetstone and Friedlander (1973), however, have studied the degree to which one element of syntax, word order, controls correct comprehension behavior in two and three year olds, when compared to the control exerted by the semantic function of familiar words out of syntactic context. Questions and commands were spoken in various degrees of word order distortion (viz., normal, misplaced, and scrambled word order). The misplaced sentences were formed by reducing normal sentences to telegraphic form (e.g.,"Where is the truck?" reduces to "Where truck?") and arbitrarily reinserting the non-referent words (i.e., "is" and "the") out of their normal order. The sentence in final misplaced order, then, was "Where the is truck?" Scrambled sentences were formed by first disordering the telegraphic form and then reinserting the non-referent words at random (e.g.,"Truck the where is"). The majority of children who were classed as non-fluent and holophrastic (mean length of utterance [MLU] = 1.75 morphemes) and those classed as non-fluent and telegraphic (MLU = 2.79 morphemes) responded appropriately to both normal, misplaced, and scrambled sentences. However, the fluent children (MLU = 3.73 morphemes) responded significantly less to the scrambled sentences than to the normal sentences. These data suggest that young non-fluent children's receptive language is controlled by semantic rather than syntactic elements. In the same study, Whetstone and Friedlander (1973) have addressed themselves to the second issue in this proposal. Even though the fluent children had difficulty in responding to the scrambled sentences (correct responses were significantly lower than those of the non-fluent telegraphic and holophrastic groups) their responses were not affected by the misplaced word order (e.g., scrambled: "Truck the where is"; misplaced: "Where the is truck"). This finding suggests that both syntactic and semantic control was exerted, and also suggests that for the misplaced word order, syntactic non-referent words were not controlling comprehension. This is curious in the sense that the fluent children correctly produced these forms in their own spontaneous speech. The authors suggested that:

> This paradoxical situation leads to the supposition that although comprehension may proceed more rapidly than production in the initial stages of language development, there may come a point when the child may produce more fluently than he can comprehend. That is, a child may be able to pattern his own utterances in accordance with the niceties of grammar. (Whetstone & Friedlander, 1973, p. 738)

The comprehension-production issue has also been studied by other investigators. Shipley, Smith, and Gleitman (1969) studied the comprehension of four holophrastic children (i.e., children in the one word stage of production) by observing the children's responses to commands. These commands were divided into so called adult forms (e.g.,"Throw me the ball!") and so called child forms (verb + noun: "Throw ball!" and noun: "Ball!"). Holophrastic children responded correctly more often to the child forms than to the adult forms suggesting that these children responded to speech at or just above their own productive limit. However, children who began to combine words (telegraphic stage) were reported to respond significantly better to the adult commands, suggesting that for these children, comprehension exceeds production.

These results have been criticized by both Ingram (1974) and Bloom (1974). Bloom has indicated the Shipley et al. (1969) results for the holophrastic children are not clear, since the experimental task did not evaluate whether or not the children analyzed the sentence structure of the command. This observation was based on the liberal scoring criteria employed: only touching or picking up the ball was accepted as a correct response. Moreover, both Bloom and Ingram claim that the results of the telegraphic children cannot be accepted to mean that comprehension exceeds production if the adult commands represented the same syntactic structure as that contained in the telegraphic children's own productions. This objection stems from Bloom's (1970) finding that early two and three word utterances are often reductions of a more complete structure. That is, early utterances appear to be marked by noun-verb, verb-noun, and noun-noun constructions, leading Bloom (1970) to postulate an underlying noun-verb-noun structure. Bloom elaborates her position by stating:

> the actual utterance "read book" and "Mommy book" would have the fuller underlying structure "Mommy read book" given (1) the relevant nonlinguistic state of affairs (Mommy reading, or about to read, or supposed to read a book), and (2) evidence elsewhere in a large enough corpus of utterances that the child understands the linguistic relations between agent (of an action) and object (affected by the action). (Bloom, 1974, p. 292)

Supposedly then, the reduction rules used by the children in the Shipley et al. 1969 study may have distorted the fact that the child has an underlying noun-verb-noun structure in his production. If so, comprehension cannot be concluded as exceeding production.

Bloom (1974) has also criticized the classic study by Fraser, Bellugi, and Brown (1963) which concluded that the comprehension of syntactic structures precedes the production of those structures. The experimental question in the Fraser et al., (1963) study was the developmental sequence of grammatical control in imitation, comprehension, and production language tasks. In the comprehension task, 34 to 44 month old children were shown pairs of pictures portraying ten different grammatical relationships. For example, one picture illustrated one sheep jumping and one sheep not jumping while a second picture illustrated both sheep jumping. The stimuli were designed to insure that the grammatical contrasts presented did not include the number of sheep in the picture, but rather the number of sheep jumping. The experimenter showed the child both pictures and named them but did not indicate which name corresponded to which picture. The experimenter then spoke one of the picture labels and asked the child to point to the correct picture (e.g., Which picture shows X?). After all three operations were tested (imitation, comprehension, and production) the authors concluded that the developmental sequence in language acquisition (on the basis of correct responses) was imitation, then comprehension, then production of the appropriate grammatical structures; hence, the ICP hypothesis. Lovell and Dixon (1967) provided further support for this position by replicating these results with two year olds.

Bloom (1974) has suggested that the production tasks employed by Fraser et al. (1963) added information to the experimental task, and this added information may have influenced the child's response. Specifically, children heard the criterion production sentence, during the instructions: "There are two pictures, one of X and the other of Y."

Bloom also noted that while imitation was shown to be the easiest task, the length of the sentence was always within the limits of the child's auditory memory span. Since children may have trouble repeating sentences which are beyond their span, and yet have no trouble producing these sequences in their own spontaneous speech, the task may have been inappropriate for making comparisons between imitation and production.

The ICP test along with the results found by Lovell and Dixon (1967) have both been criticized on methodological grounds (Baird, 1972; Fernald, 1972). Since response probabilities were not equated in the comprehension and production tasks, higher comprehension scores became a procedural artifact. In the comprehension task, there are only two possible responses a child can make; he can point to the picture on the left or on the right. However, in the production task, there are more than two responses a child can make. He can make the appropriate response, the inappropriate response (verbal production sequence which corresponds to the picture other than the one pointed to by the experimenter), and he can make a novel response which would also be counted as incorrect. Thus, two incorrect response categories bias the score against production whenever a child guesses. When Fernald (1972) replicated the study of Fraser et al. (1963), equating for response probabilities by not counting the third unscoreable or missing response category, comprehension and production scores were not significantly different.

The ICP hypothesis has also been challenged by Whitehurst and Vasta (1975). These researchers, after carefully reviewing the child language area, have concluded that the actual ordering of the three stage language process is not imitation, comprehension, production, but rather comprehension, imitation, production (CIP). According to these authors, a child first comes under the discriminative control of the relationship between a syntactic structure as produced in adult speech and correlated environmental events. Such a comprehension process was hypothesized to be a function of the variables important to observational learning, including explicit reinforcement. In the second stage of selective imitation, early utterances are matched in structure to previously heard grammatical utterances. Thus, the syntactic structure employed by adults is thought to acquire stimulus control prior to its selective imitation. The final stage included the spontaneous production of the syntactic structure in the absence of an imitative component. Although comprehension is thought to precede production in this formulation, the authors did not suggest that comprehension reaches asymptote prior to the imitation or production (Whitehurst & Vasta, 1974, p. 53).

In a recent study, Chapman and Miller (1975) have argued two important points. The first is that production actually precedes comprehension based on syntactic structure alone. They propose that while production may be controlled by environmental contingencies, comprehension of different syntactic structures may be a function of the patterning of intellectual functioning found in Piaget's pre-operational stage of intellectual development. Their second point is that extralinguistic, non-syntactic stimulus control may constitute the only means by which children learn to comprehend sentences in the early linguistic stages of development (cf., de Villiers & de Villiers, 1974; Strohner & Nelson, 1974). The importance of this second point is due to the prevailing attitude toward extrasyntactic control of comprehension. Chapman and Miller note that, although extrasyntactic control of comprehension has been demonstrated, "...we have tended to assume that these strategies were overlaid on a basic capacity to understand sentences on the basis of linguistic form alone" (1975, p. 356).

Chapman and Miller found that even though children could produce correct syntactic sequences, they did not show comprehension in a task employing the same experimental word sequences. The subjects in this study were chosen to closely correspond to Brown, Cazden, and Bellugi's (1969) Stage I, II, and III children. The Stage I children, ages 20-26 months, had an average mean length of utterance (MLU) of 1.75 morphemes; Stage II children, ages 20-23 months had an MLU of 2.25 morphemes; and the Stage III children, ages 28-32 months, had an MLU of 2.75 morphemes.

The stimuli employed in the study were twenty-four sentences, half of which were exact reversals of the other twelve with respect to subject and object. They were constructed from three familiar animate nouns (boy, girl, dog), three inanimate nouns (car, truck, boat), and six transitive verbs (hit, bump, chase, push, pull, and carry). The six nouns were all represented by corresponding toy objects. In the comprehension task, the child was presented with the six toys and a sentence was presented. The child was then to choose the correct toys and act out the sentence. In the production task, the child watched the experimenter performing the action corresponding to the sentence sequences and was asked to describe the action. All lexical items were pretested for both comprehension and production.

In accordance with Fernald's (1972) suggestions for equating response probabilities for comprehension and production, Chapman and Miller's scoring criteria were rigid. Responses in the comprehension task were scored as correct if the action was correctly demonstrated with the appropriate subject-object assignments; incorrect, if the action was correctly represented but subject and object were reversed; and as "no response" if the response was ambiguous, if the wrong toys were selected, or if the wrong action was depicted. If an unscoreable response was retested, the second test result was used as the datum. Guessing rate for a scoreable response, if the child did not attend to the order of the words in the sentence, was 50 percent. Correct production responses included subject-verb-object; subject-verb; verb-object; or subject-object sentences. Incorrect production responses included the reverse order form of the correct responses.

Chapman and Miller (1975) reported almost 100 percent mastery on the comprehension task for that group of sentences having an animate or human subject and an inanimate object. For the Stage I and II MLU groups, performance on the reversals of those sentences (inanimate subject, animate object) was below chance, indicating that the children were reversing the word ordering for the majority of these sentences. Stage III children, however, showed no such reversal. Performance on those sentences where both subject and object were animate or both subject and object were inanimate, was intermediate. Size and color as well as animacy were offered as explanations for the differences in performance, since these dimensions were confounded. The production data revealed higher percentages of correct responses across all sentence types for all stage groups, with no pattern similar to that in the comprehension task. The authors suggested that the strategies for the encoding of an event may be different from those operative in the comprehension of a sentence. This suggestion parallels closely Bloom's (1974) proposal that the processes underlying comprehension and production may be mutually dependent but different.

The issue involved in the relationship between comprehension and production has led to different lines of theorizing which have promoted a great deal of controversy. For example, Bloom (1974) has proposed a developmentally shifting influence between two dependent but different underlying processes, while Ingram (1974) has concluded that the relationship is unidirectional and comprehension of a particular syntactical form must occur before or at the same time it is produced.

Chapman (1974) has suggested that these different conclusions regarding the relationship between comprehension and production are a function of differing meanings applied to the term "comprehension." For greater clarification, Chapman (1974, pp. 335-344) has identified four versions of the postulated relationship between comprehension and production. The first version is the one ordinarily understood when the assertion that comprehension precedes production is made. In this version, the comprehension of a particular grammatical structure may be controlled by one linguistic or extralinguistic variable; the production of that same structure may be controlled by a second variable. Even though the locus of control for the two processes differs, comprehension of the structure precedes the production of the structure. As Chapman has noted, the basis for comprehension is not necessarily the syntactic structure; in fact the utterance itself may play a minimal role in the understanding of its meaning. Moreover, in this version, the cues used for comprehension and production are not necessarily identical. Thus, Brown's (1973) finding that his famous three subjects, "Adam, Eve, and Sarah" produced plural morphemes 90 percent of the time, while showing no comprehension of the plural morpheme in a controlled test, could be countered by the objection that the comprehension test situation, but not the production situation, omitted the appropriate contextual stimuli which would control normal discourse. Moreover, researchers who operate from this theoretical version agree that the important experimental questions include (a) the extent of the comprehension-production gap for any particular syntactic structure, (b) the way in which the gap may change with time, (c) the variations in the gaps for different structures, and (d) an explanation for why the gap exists at all. Chapman cites Ingram (1974) as concluding that given version I, the data suggest comprehension before production.

In the next two versions, Chapman sees the direction of the relationship as having key theoretical and experimental interest. Version II states that if comprehension of a particular grammatical structure is under the control of the structure itself, then comprehension will precede the production of the grammatical structure. Production may be controlled by some linguistic or contextual stimulus but not by the grammatical structure. Version III states the converse. Under the conditions of version II, production precedes comprehension in version III. As noted by Chapman, these versions permit questions regarding the types of comprehension strategies (based both on linguistic and non-linguistic information) that lead to early understanding of the grammatical structures. Additionally, these versions promote the question of how these comprehension strategies change prior to the use of the syntactic structure itself as the sole cue. While there is little evidence regarding these questions, the grammatical component for some structures is appropriately produced before it is used as the sole cue for comprehension (Chapman & Miller, 1975). This also appears to be true for plural morphemes (Brown, 1973; Keeney & Wolfe, 1972). For other grammatical structures, Chapman has suggested that version II may be correct, and cites Ingram (1974) and Fernald (1972) as support.

The fourth version is representative of Bloom's (1973, 1974) views on language and is designed to specifically define production as well as comprehension cues. Chapman has designated this version to be a series of statements of possible relationships between comprehension of "x" as a function of "y" cues, and production of "x" as a function of "z" cues, where all terms are specified. Specifically, the fourth version states that when a grammatical structure provides the only source of control for the comprehension of that structure, the context dependent production of that structure can either precede or follow the comprehension of that particular structure. As Chapman has noted, this version curtails the search for any single relationship between comprehension and production. For example, Chapman has cited Premack's (1974) comment that if one first trained a production strategy, the comprehension production gap may be larger if the subjects' production was a description rather than a mand or imperative, since the latter may require an internal representation to mediate between the two modalities. Version IV invites experimental questions relating to the variables important to the comprehension of a sentence in context, prior to the use of syntactic cues, as well as the methodologically more difficult question concerning the variables important to the comprehension of sentences that are not related to stimuli in the immediate environment. The most important question to be asked, however, is how do production and comprehension strategies differ and relate to each other for given grammatical structures (Chapman, 1974) and how given contextual cues relate to the meanings of these grammatical structures. The present research was involved with these two experimental questions. As an introduction to this research, a brief review of the most relevant studies is in order.

Chapman and Miller (1975) have demonstrated that a subject-verb-object ordering appeared in the child's productions before the time that subject-verb-object word order alone was used by the child as a cue to the deep structure subject and object status, in reversible sentences. Specifically, for children in Stages I, II, and III, consistent fully correct comprehension was reported for all groups when the sentences were of the order: animate subject-verb-inanimate object. When the sentences were of the order: animate subject-verb-animate object, or inanimate subject-verb-inanimate object, performances for the three groups were intermediate. Performance was below chance, however, for Stage I and II children when the sentences were of the order: inanimate subject-verb-animate object.

Similarly, de Villiers and de Villiers (1973) showed that children below Stage IV did not use word order as the only cue in comprehension. Stage IV children, however, did show a strong tendency to use the first noun of a passive sentence as agent, thus reversing the meaning of the sentence.

Moreover, Huttenlocher and Strauss (1968) asked nursery school children to place one block relative to a second block which was fixed in the middle of a ladder. Shorter delays were reported when the mobile object was the grammatical subject of the relational term, and the fixed object was the grammatical object. However, it was more difficult for fourth grade children to respond to a relational term when both items were mobile (Huttenlocher & Weiner, 1971). In this situation, word order was reported to account for the order of the moves: the first object mentioned was the first object moved, in both passive and active constructions.

Both Chapman and Miller (1975) and Huttenlocher and Strauss (1968) have provided support for the idea that sentence comprehension is facilitated when the sentence to be understood is of the order: subject-verb-object. In the Chapman and Miller study, animacy of the subject appeared to be critical; in the Huttenlocher and Strauss study, the mobility of the grammatical subject appeared to be critical. In either case, children appeared to be attributing the role of "actor" to the grammatical subject; therefore, the subject performed the action to the object in the Chapman and Miller study, and the subject was placed relative to an object in the Huttenlocher and Strauss study. From these results, one might conclude that the child was responding on the basis of the logical meaning of the sentence; the logical semantic relationship between agent, action, and object. This semantic relationship also appeared to underlie the probable event strategies reported by Strohner and Nelson (1974) for the performance of three and four year olds to improbable active and passive sentences, as well as to the actor-action-object strategy employed by two and three year olds for reversible active performances. A logical event strategy also appeared to underlie Chapman and Miller's (1975) findings for Stage I and II children, when sentences were of the order: inanimate subject-verb-animate object. Such strategies were suggested to account for the low performance on these tasks.

However, in those studies where correct comprehension performance was found to correspond to probable, subject-verb-object forms, the ordering of the words in the sentences corresponded to the correct ordering of the non-verbal stimuli (where either hand-puppets were used to demonstrate the sequence, or a mobile object was placed relative to a fixed object). For those cases, the sequence of orderings was Left-Right (L-R). However, one might ask whether correct performance (comprehension) of those forms might also be expected if a L-R ordered verbal statement corresponded to a Right-Left (R-L) ordered visual statement, in the active voice. Consider the following situation:

A two-piece puzzle representing a sentence of the form Subject-Verb-Prepositional Phrase (Preposition + Object of the Preposition) may represent the sentence in two different ways. For example, the sentence "The dog is running to the tree" may be pictorially represented by the two-piece puzzles in either Figures 1 or 2. In Figure 1, the dog running towards the tree is represented by puzzle piece (1), and the non-action tree, by puzzle piece (2). Both the verbal and the pictorial statement are L-R in direction.

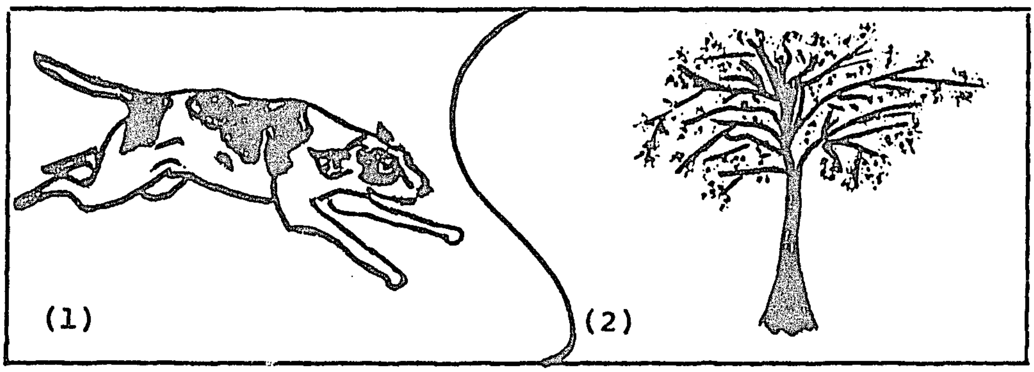

Figure 1. The L-R construction for the sentence, "The dog is running to the tree."

In Figure 2, the dog running towards the tree is represented by puzzle piece (2), and the non-action tree, by piece (1). Although the verbal statement is L-R, the correct pictorial statement must read R-L, when only the Figure 2 puzzle pieces are considered.

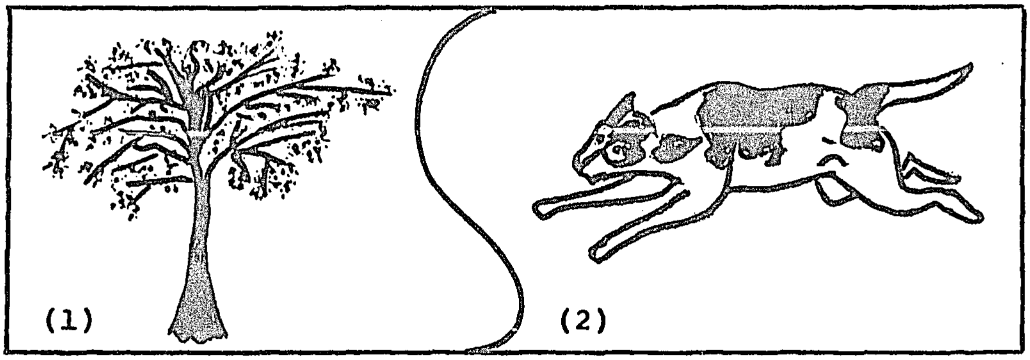

Figure 2. The R-L construction for the sentence, "The dog is running to the tree."

Further, if the dog were placed in position (1), and the tree in position (2), to correspond to the order of the verbal statement, "The dog is running to the tree," then the puzzle would represent the incorrect L-R representational sequence, "The dog is running away from the tree," seen in Figure 3.

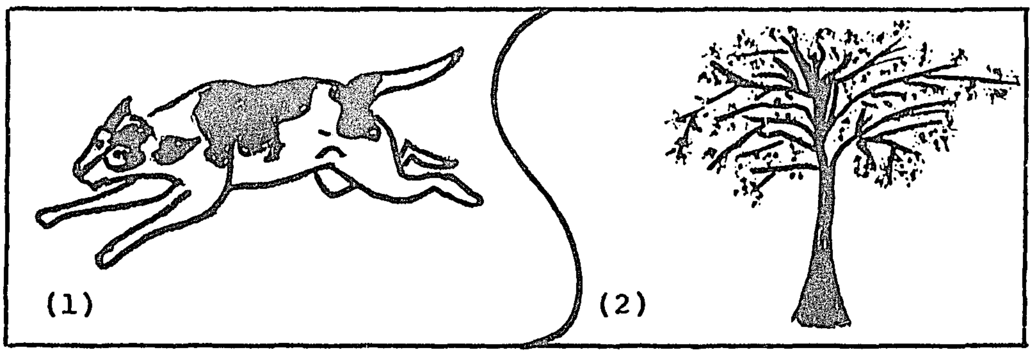

Figure 3. The L-R construction for the sentence, "The dog is running away from the tree."

This type of task is different from the hand-puppet task ordinarily used to demonstrate the reversible sequences: "The dog is running to the tree" versus "The tree is running to the dog," as well as the active-passive tests: "The dog is running to the tree" versus "The tree is being approached by the dog," since no passive form acceptable to our verbal community exists for this type of task (cf., "Tom hit John," versus "John was hit by Tom"). This type of puzzle construction task, moreover, eliminated the complications produced when active and passive tests are employed (that is, passive constructions are not correctly comprehended until past Stage IV).

If the child were presented the verbal statement, "The dog is running to the tree" and he or she constructed the puzzle represented by Figure 3 rather than Figure 2, one could conclude that the child used a subject-verb-object (of the preposition) strategy irrelevant to the logical meaning of the sentence. In fact, such a response would indicate that the child was simply matching the pictorial stimulus to the verbal stimulus. This might be expected in light of Huttenlocher and Weiner's (1971) finding that word order accounted for the order of moves in both active and passive sentences, when the child was required to move two mobile objects (for example, "Put the red car on top of the blue car").

The response strategy used in Figure 3 would strongly suggest that the child is not performing the critical operations required to equate the L-R action sequence with the corresponding R-L visual stimulus. In the case where a L-R verbal and R-L visual stimulus are correctly matched, yet a

L-R verbal and a R-L visual stimulus are incorrectly matched, control is exerted by factors other than semantic relations among the named objects.

Bever (1970, pp. 279-353) has been a major proponent of the view that children use several perceptual-response strategies to aid in their comprehension of sentences. Presumably, such strategies are employed in order to map the external sentence form (surface structure) onto the actual internal sentence structure (deep structure). According to this view, sentences are understood in a form closely corresponding to the internal syntactic structure of the sentences themselves.

Among these perceptual strategies, Bever has included five factors. The first factor is segmentation: "Segment together any sequence X...Y, in which the members could be related by primary internal structural relations such as actor, action, object...modifier." The segmentation strategy utilizes many situational, semantic, and pronunciation cues. Bever has presented much convincing data demonstrating that the most likely semantic organization among a group of phrases can guide the interpretation of sentences, independent of, and in parallel with the perceptual processing of the syntactic structure. Moreover, in sentence comprehension, basic relational functions (actor, action, etc.) may be assigned purely on the basis of semantic probabilities (e.g., men eat cookies, cookies don't eat men).

Bever's second perceptual strategy is: (2) "The first noun-verb-noun clause (isolated during the segmentation strategy) is the main clause. Bever further suggests that some semantic constraints allow syntactic factors to be completely bypassed (for example: "The cookie was eaten by the dog.") Thus, Bever's third factor is: (3) "Sentence constituents are functionally related internally (deep structure), according to semantic constraints. Bever's sequential labeling strategy (4) and lexical ordering strategy (5) are very similar. They suggest that "Any Noun-Verb-Noun sequence within a potential internal unit in the surface structure corresponds to actor-action-object." Since the actor-action-object organization is imposed on sentences as part of the basis for segmentation of clauses, comprehension errors during passive constructions, for example, are easily understood.

Bever has emphasized that children between two and six years depend almost totally on these perceptual strategy generalizations in sentence comprehension. At about the third year, according to Bever, children have acquired enough experiential data to actively use contextual probability information (Strategy 3, above). Other researchers, however, have reported these contextual probability cues operate much earlier than three years (cf., Strohner & Nelson, 1974).

A major consideration in the design of this puzzle construction experiment, therefore, was to provide a way to analyze the step by step strategy employed by the child in arriving at the final puzzle solution, as well as a careful consideration of the types of solutions constructed. Such a step by step response strategy analysis would eliminate the need for inferences regarding comprehension by providing direct observations of the logical strategies employed by the child when constructing a picture which corresponded to the verbal stimulus. For example, when considering both puzzle pieces in Figures 2 and 3 four puzzle constructions are possible. These are shown below:

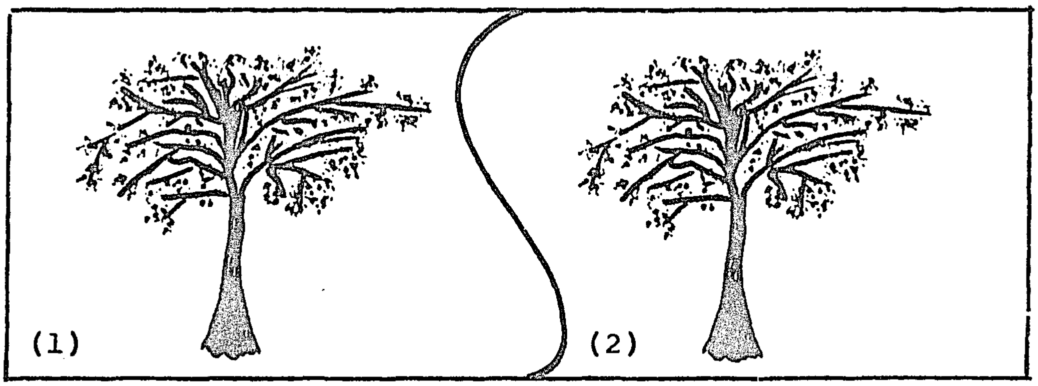

Figure 4. The puzzle construction representing two trees in no specified relationship.

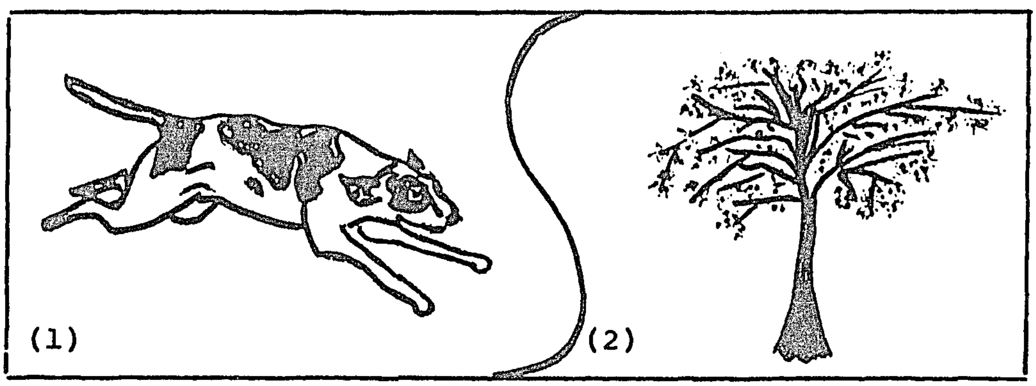

Figure 5. The correct L-R construction for the sentence, "The dog is running to the tree."

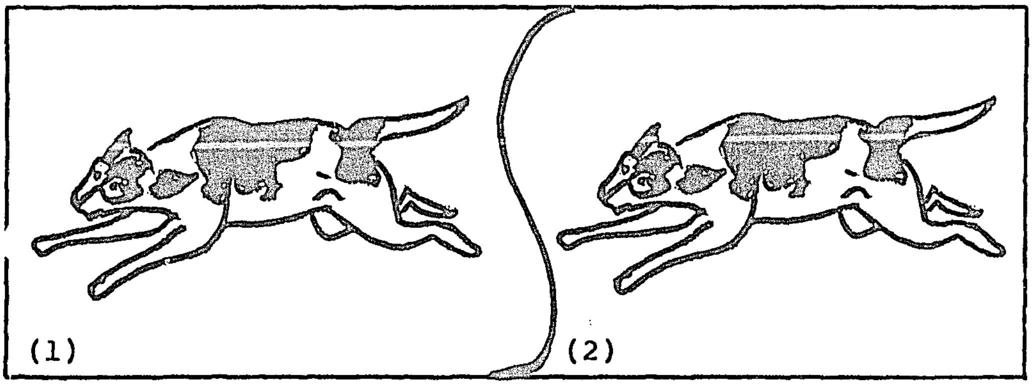

Figure 6. The puzzle construction representing the L-R sentence, "The dog is being chased by the dog," or the R-L sentence, "A dog is chasing a dog running."

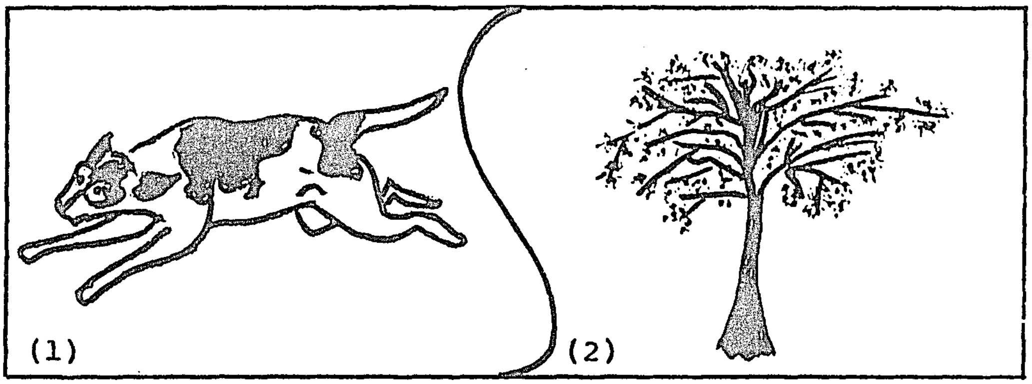

Figure 7. The incorrect L-R construction for the sentence, "The dog is running to the tree." This construction reads, "The dog is running away from the tree."

In the construction of the puzzle in Figure 4, "Tree and Tree," no relationship between objects (other than spatial) is depicted. This construction is improbable, if the child is attending to both subject (dog) and object (tree), and understands that both subject and object stand in some specified relationship to one another. The puzzle construction in Figure 5 is the correct visual representation of the verbal stimulus "The dog is running to the tree." The puzzle construction in Figure 5 indicates that the child is comprehending the correct semantic relationships depicted between subject and object, even when the visual and verbal stimuli are in the opposite direction. Construction of the puzzle in Figure 6, "The dog is chasing a dog running" (L-R), or the passive version, "The dog is being chased by a dog" (R-L), is also improbable if the child is attending to both subject and object and understands that they stand in a specified relationship to each other. The puzzle in Figure 7 is a probable yet incorrect construction, "The dog is running away from the tree." Construction of this puzzle indicates that the child is matching the visual stimulus to the verbal stimulus; i.e., the first object named is also the first object placed in the puzzle (i.e., position 1). Construction of the puzzle in Figure 7, further indicates that the child is not responding to the semantic relationship between subject and object.

If the child constructs the puzzle in Figure 5, rather than the puzzle in Figure 7, one might conclude that the child is under the control of the correct logical relationships portrayed by the verbal statement: "The dog is running to the tree." That is, the child understands that the subject is also the agent acting in terms of a particular locational object.

Solution on the basis of a subject-verb-object strategy is still a possibility, however, if one were to assume the logical equivalence of a L-R verbal sequence and a R-L visual sequence. In this sense, the direction of the two stimuli in the two modalities are reversible. That is, the amount of semantic information conveyed is the same, regardless of the direction of the stimulus. A test of this reversibility can be made by presenting the child four possible puzzle pieces, where both R-L and L-R alternatives in combination are (a) correct (Figures 8 and 9), and (b) incorrect (Figures 10 and 11). When either the L-R (Figure 8) or the R-L (Figure 9) puzzle construction is correct, the probability that either alternative would be selected = .5, if the alternatives were logically equivalent. Similarly, when either the L-R (Figure 10) or the R-L (Figure 11) puzzle is incorrect, constructions would be expected to be equally distributed, if the child does not understand that the appropriate semantic relationships described by the verbal stimulus are not constructable from the given alternatives. However, if the child recognizes that the alternatives are incorrect for the given verbal stimulus, the R-L and L-R alternatives would be viewed as being equally incorrect.

Indeed, if these expectations were met, in either the (a) or (b) conditions, one still could not conclude that the R-L and L-R stimulus directions were logically equivalent. However, if consistent directional preferences were shown for either the L-R or the R-L constructions, even after the child

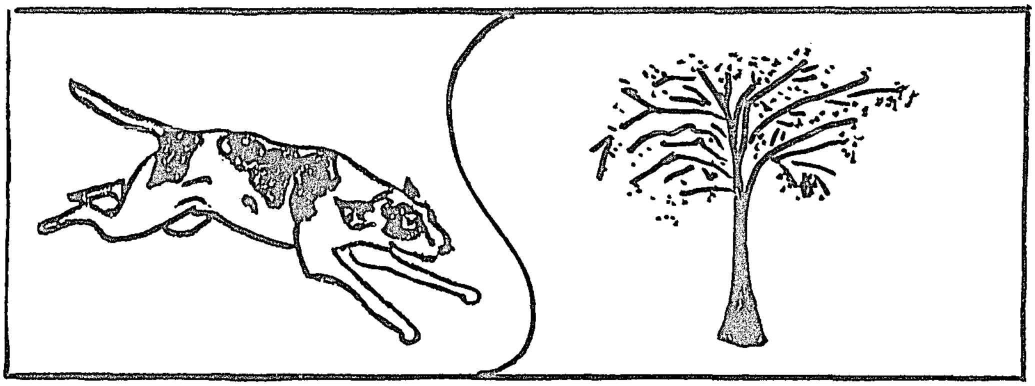

Figure 8. Correct L-R alternative.

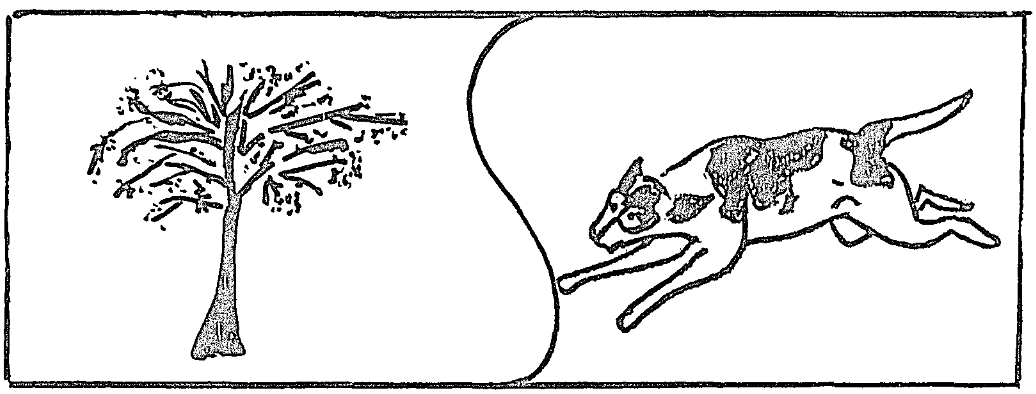

Figure 9. Correct R-L alternative.

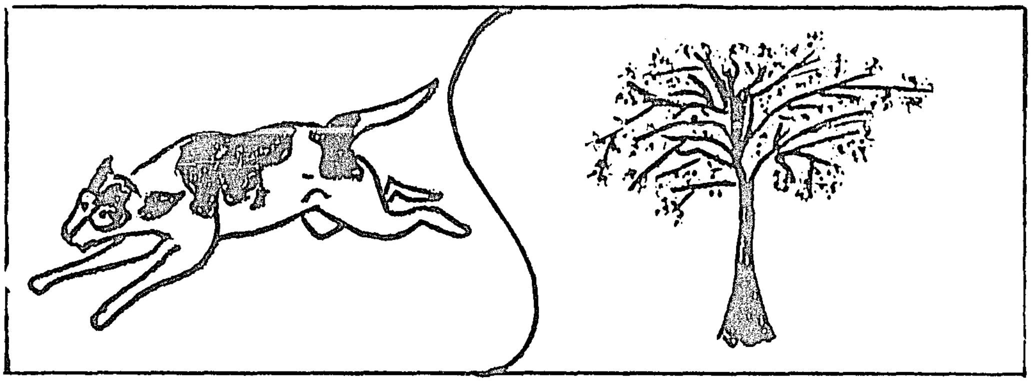

Figure 10. Incorrect L-R alternative.

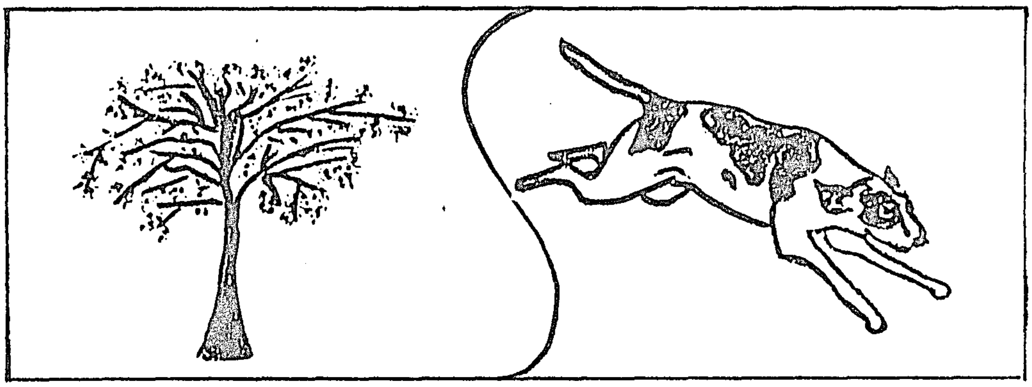

Figure 11. Incorrect R-L alternative.

was asked to construct the puzzle for the correct (a) condition both ways (L-R and R-L), appropriate correction factors could have been employed in the final data analysis, to balance the response bias, after correct comprehension scores had been computed.

Within this study, differences in comprehension and production of sentences having the form: Subject-Verb-Object of the Prepositional Phrase were assessed. If a child could correctly label the various puzzles for both the L-R and R-L sentences, yet incorrectly construct these same sentences from the four puzzle alternatives, one could conclude that production and comprehension responses, respectively, were controlled by different variables. The nature of this control was the object of the experimental manipulations.

A second task was designed to test the extent of the child's comprehension abilities for L-R verbal/L-R visual stimulus sentences and L-R verbal/R-L visual stimulus sentences. For both conditions, the object was fixed, by presenting only one right puzzle piece (L-R sentences) or only one left puzzle piece (R-L sentences) as object. This left the subject-verb relationship to vary with the remaining three puzzle piece alternatives. For example, when the verbal stimulus, "The dog is running to the tree," was presented, three different puzzles could have been constructed from the four piece alternatives. A simple subject-verb-object strategy could not have been employed since the subject was also fixed (all three alternatives were pictures of dogs). What varied, however, was the subtle subject-verb-relationship. It was expected that when the discrimination was complicated by the simultaneous introduction of several same-subject different-verb alternatives, comprehension, even for the L-R sentences, would become more difficult. Figure 12 illustrates a correct puzzle construction for the sentence, "The dog is running to the tree." Figure 13 shows an incorrect construction for the same sentence. The dog in this picture is portrayed as having no action, thus this particular dog subject should not have been viewed as a functional agent. Furthermore, Figure 13 does not depict any subject-object relationship, other than a spatial relationship. Figure 14 illustrates the incorrect construction for the sentence "The dog is running to the tree." Construction of this puzzle showed that the child was not under the control of the directional relationship implied by the prepositional phrase.

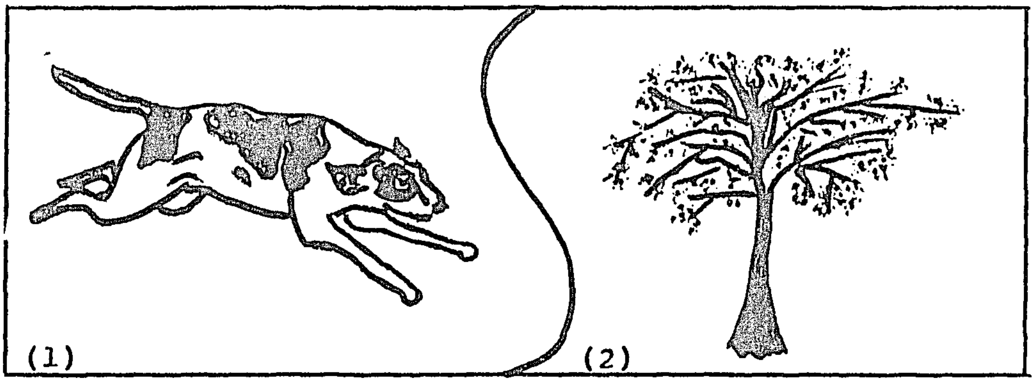

Figure 12. Correct L-R puzzle construction for the sentence, "The dog is running to the tree."

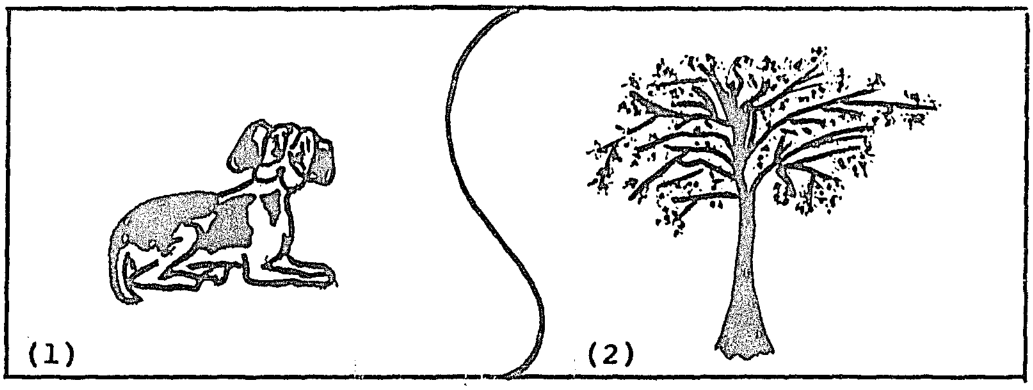

Figure 13. The incorrect puzzle construction showing no relationship between subject (dog) and object (tree) for L-R alternatives.

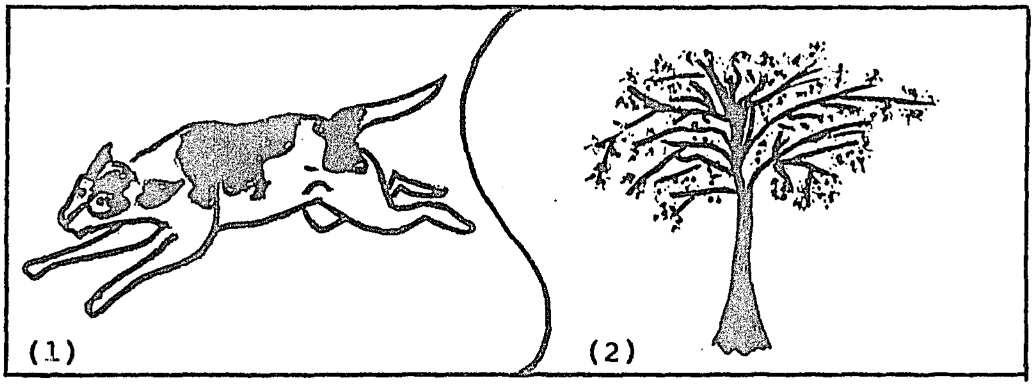

Figure 14. The incorrect L-R puzzle construction for the sentence, "The dog is running to the tree." This construction reads, "The dog is running away from the tree."

Figures 15, 16, and 17 represent the same puzzle construction for the R-L sentences as Figures 12, 13, and 14, represented for the L-R sentences, respectively. This task also included tests to assess differences in comprehension and production. Where comprehension was shown to be controlled by relations other than semantic relations among objects and events, a systematic analysis of subject-choices (e.g., the child consistently chose the dog facing right or the dog facing left) was performed to assess the extent of the child's comprehension of the subject-verb relationship.

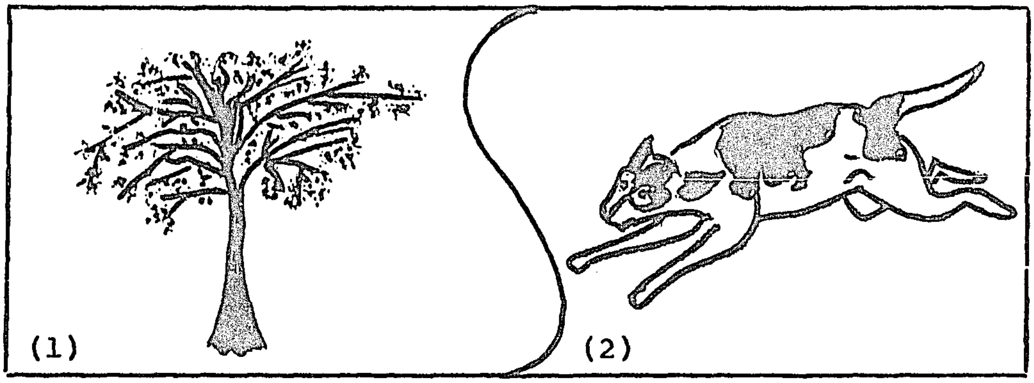

Figure 15. Correct R-L puzzle construction for the sentence, "The dog is running to the tree.

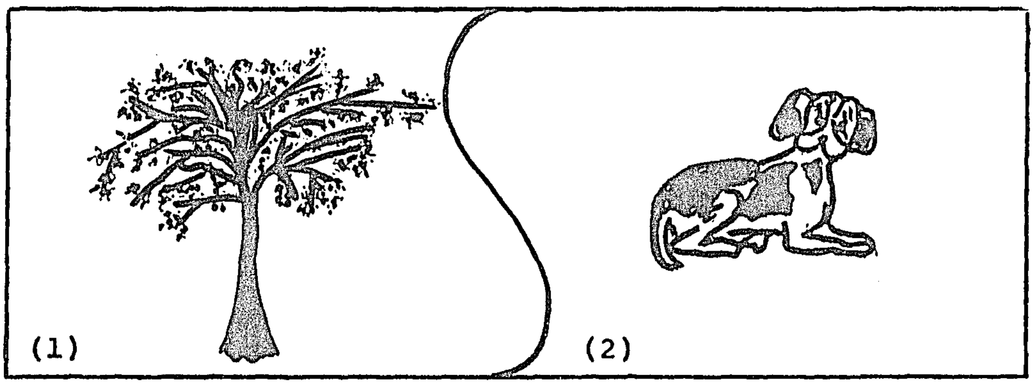

Figure 16. The incorrect puzzle construction showing no relationship between subject (dog) and object (tree) for the R-L alternatives.

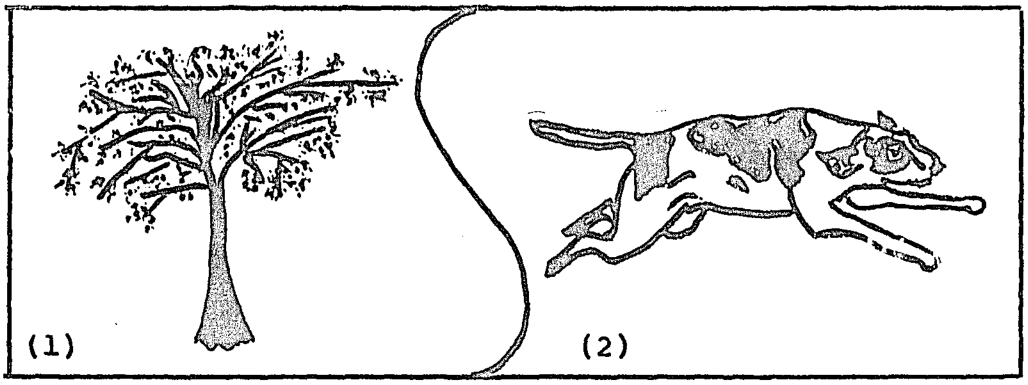

Figure 17. The incorrect R-L puzzle construction for the sentence "The dog is running to the tree." This construction reads, "The dog is running away from the tree."

CHAPTER III

METHOD

Subjects

Nine male (six White and three Black) and six female (four White and two Black) children enrolled in the Demonstration Day Care Center of the University of North Carolina at Greensboro participated in this study. All subjects came from middle class homes. The fifteen subjects were divided into three groups of five children on the basis of age and performance on the McCarthy (1972) Scales of Children's Abilities. The age ranges for the three groups were:

Group I: 4 years, 5 months, 23 days - 4 years, 10 months, 22 days
(mean age = 4 years, 8 months, 22 days)

Group II: 3 years, 11 months, 21 days - 4 years, 3 months, 0 days
(mean age = 4 years, 1 month, 9 days)

Group III: 3 years, 0 months, 13 days - 3 years, 9 months, 15 days
(mean age = 3 years, 6 months, 14 days)

Although this study had originally proposed to use both MLU and age as the criteria for group assignments, pilot data did not confirm the findings of earlier studies (viz., Brown, 1973; de Villiers & de Villiers, 1973a) which indicated that

MLU was a sensitive index of linguistic ability. A pilot population ranging in age from early two to late four years provided MLU data. All ages showed similar advanced stages of MLU development but strongly dissimilar performances on this particular experimental task. Children as young as early age three and as old as early age four all classified into Brown's (1973) most advanced stage of linguistic development prior to fluency, namely Stage V (MLU = 4 morphemes). Behaviorally however, as reflected on the experimental task scores, the children's performances were not similar. On the other hand, some children who scored in Brown's (1973) Stage III (MLU = 2.75 morphemes) performed as well as some of those children who had been classified as Stage V. (For these analyses, interrater reliability for MLU calculations from recorded tapes of linguistic interactions between child, parent, and experimenter was 0.98). Thus, for this particular pilot population, linguistic ability as measured by the present experimental task was not correlated with MLU data alone, or with MLU in conjunction with age.

Due to their limited attention spans, children under three were excluded from this study. Extensive pilot data indicated that children this young could not complete any one session (external reinforcers were not permitted by the day care agency). Moreover, children below three demonstrated more fear of strangers (two out of any possible eight undergraduate observers assisted the experimenter during any one session) and greater unwillingness to leave the nursery room, than did the older children. Finally, many of the two-year-olds did not master the pretest for experimental subject eligibility.

As a result of this failure to classify children on the basis of MLU, age was used as the criterion for group assignment. In order to avoid a completely arbitrary age classification, however, all children were administered the McCarthy (1972) Scales.

Of the five McCarthy (1972) Scales subtests (verbal, perceptual-performance, quantitative, memory, and motor), two (perceptual-performance and motor) were found to reliably predict group assignments.

Two Kruskal Wallis one-way-analyses of variance (Siegel, 1956) performed on the group mean raw scores (not scaled-scores) indicated that both the perceptual-performance subtest ($p < .001$) and the motor subtest ($p < .05$) reflected that the three groups of children were significantly different and therefore, that the age cut-offs were not arbitrary. The mean raw scores for the two subtests and the three groups are listed in Table 1.

<u>Procedure</u>

<u>Stimulus Objects</u>. One hundred and fifty-six 3" x 4" masonite "puzzle pieces" were constructed using a jig saw. Figure 1 shows the shape of the puzzle pieces. Each piece was cut to be either a left or a right puzzle piece (see

Table 1

Mean Raw Scores for the Perceptual-Performance and Motor Subtests

	Perceptual-Performance	Motor
Group I	48.2	36.0
Group II	36.4	26.4
Group III	22.4	21.0

Figure 18). Pictures consisted of a xeroxed black drawing on a white background. The pictures corresponded to the verbal stimuli and were hand drawn. All pictures corresponding to any one verbal stimulus were, therefore, identical. The stimulus pictures were then cut to fit each puzzle piece and affixed with glue. The number of puzzle pieces used in each part of the experiment is shown in Table 2.

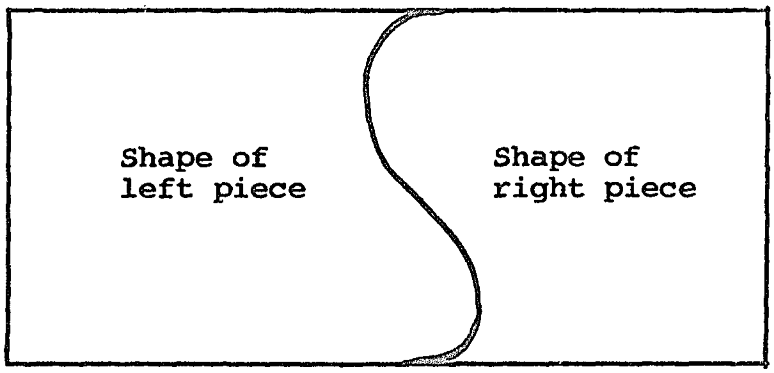

Figure 18. Representation of a left and right puzzle piece.

Sentences Phase I: The twelve sentences used in Experimental Phase I are presented in Table 3. They were constructed from the use of four familiar animate nouns: boy, girl, cat, dog (Chapman & Miller, 1975), four familiar inanimate nouns: tree, house, truck, car (Chapman & Miller, 1975), and two progressive verbs: running and going.

Although previous research in comprehension has used a variety of verbs such as bump, push, pull, hit, chase, kiss, bite, touch, and so on, the nature of the action (e.g., bumping

Table 2

Allocation of Puzzle Pieces to Particular Parts of the Experiment

Object Manipulation Pretest	08
Production Pretest Nouns	08
Production Pretest Verbs	12
Comprehension Pretest Nouns	16
Comprehension Pretest Verbs	24
Experimental Phase I	48
Experimental Phase II	32
Post Test	08

Table 3

The Twelve Sentences Used in
Experimental Phase I

Group A/I Sentences:	
1.	The cat is running to the tree.
2.	The dog is running to the house.
3.	The boy is running to the car.
4.	The girl is running to the truck
Group I/A Sentences:	
5.	The car is going to the boy.
6.	The truck is going to the girl.
7.	The truck is going to the dog.
8.	The car is going to the cat.
Group A/A, I/I Sentences:	
9.	The girl is running to the boy.
10.	The dog is running to the cat.
11.	The truck is going to the tree.
12.	The car is going to the house.

vs. hitting) is not that discriminable when the child uses hand-puppets to model the verb. Consequently, the present study employed only the two progressive verbs: running and going. This procedure was designed to maintain certain probabilistic information found in the natural environment (e.g., trucks do not run in the same way that boys do, and similarly, trucks do not go in the same way that boys do). Because it was difficult to prescribe action to inanimate objects, the experimenter used both "going" and "moving" when talking about inanimate stimulus objects during the pretest. This was done to ascertain which verb most clearly conveyed the desired meaning to the child. Observations of the childrens' responses during production pretesting indicated almost total preference for the verb "going" as opposed to "moving". Hence, "going" was used exclusively by the experimenter during the actual experimental testing trials.

The present progressive tense was chosen as the most appropriate for describing an ongoing event (cf., Chapman & Miller, 1975). Moreover, Brown (1973) has shown that the present progressive tense appears earlier in the child's earliest utterances than does the third person singular present.

Animacy and inanimacy were manipulated in this study to provide support for the earlier findings of Chapman and Miller (1975) suggesting that animacy of the subject is an important variable in the comprehension of sentences by young children. As can be seen from Table 3, four of the twelve sentences contained an animate subject and an inanimate object (Group A/I

Sentences); four contained an inanimate subject and an animate object (Group I/A Sentences); and four contained subject-object redundancy. That is, two sentences contained an animate subject and an animate object, and two contained an inanimate subject and an inanimate object (Group A/A, I/I Sentences).

Sentences Phase II: The eight sentences used in Phase II are shown in Table 4. Four of the sentences contained an animate subject and an inanimate object (Group A/I Sentences). Of the remaining four sentences, two contained both an animate subject and animate object, and two contained both an inanimate subject and an inanimate object (Group A/A, I/I Sentences). Half of the eight sentences contained a "verb + to" phrase, while the remaining half contained a "verb + away from" phrase.

Phase I-Phase II Comparison. Phases I and II differed in several important respects. Phase I assessed the child's comprehension performance when presented with two subject alternatives (one correct and one incorrect) and two object alternatives (one correct and one incorrect). Thus, in terms of puzzle construction during comprehension trials, the child could respond by constructing (a) the correct subject-object puzzle, (b) the incorrect subject, incorrect object puzzle, (c) the correct subject, incorrect subject puzzle, and (d) the correct object, incorrect object puzzle.

Phase II, however, assessed the child's comprehension performance when three subject alternatives and only one object

Table 4

The Eight Sentences Used in Experimental Phase II

Group A/I Sentences
1. The cat is running to the tree.
2. The dog is running to the house.
3. The boy is running away from the car.
4. The girl is running away from the truck.
Group A/A, I/I Sentences
5. The girl is running to the boy.
6. The truck is going away from the tree.
7. The dog is running to the cat.
8. The car is going away from the house.

alternative were presented. Since the object was "fixed," the child could construct only (a) the correct subject-object puzzle, (b) the incorrect subject (the agent moving either "to" the object when the verbal stimulus was "away from," or the agent moving "away from" the object when the verbal stimulus was "to") and the correct object, and (e) the incorrect subject (the pictured agent is inactive) and the correct object. Therefore, Phase II offered a response alternative (e) above, not found in Phase I. Moreover, response alternatives (c) and (d) in Phase I were not possible in Phase II.

The final phase comparison was sentence type. Phase I assessed the effects of varying animacy at three levels: A/I; I/A; A/A, I/I. Phase II omitted the second level (I/A), but included another factor, Location, not found in Phase I. Specifically, in Phase II, two of the four A/I sentences contained the phrase "X is running/going to Y," and two contained the phrase "X is running/going away from Y." Similarly, two of the four A/A, I/I sentences contained a "to" phrase, and two contained an "away from" phrase.

In both Phases I and II, directionality was manipulated. For both phases, the LR condition consisted of a verbal stimulus which named the agent before the action ("The dog is running to the tree"), and which called for a matching puzzle construction (dog on the left puzzle facing right, and tree on the right puzzle). Conversely, in the R-L condition, although the verbal stimulus remained the same, the puzzle construction called for a reversal in placement (dog on the right puzzle facing left and tree on the left puzzle).

Testing Conditions. Each subject was individually tested in a separate room provided by the day care center. The subject was seated at a table directly across from the experimenter. Two undergraduate observers sat at either end of the table and assisted in the scoring procedures. One observer timed the subject's response latency and duration, while the second observer recorded the subject's comprehension and production responses. Eight undergraduates served as observers in this study, but only two observers were present at any one experimental session for any one particular child. Because such variables as subject attendance, day care priorities, and observer class schedules could not be controlled, observers were not randomly assigned to subjects or to groups.

Sessions. Each child participated in at least four different 30-45 minute experimental sessions, separated by a 24 hour minimum intersession interval. The first experimental session for each child consisted of Pretesting. The remaining three consisted of Phase I-Left Right (L-R), Phase I-Right-Left (R-L), and Phase II. For the younger children, Phase II was sometimes broken into Phase II L-R and Phase II R-L, resulting in five sessions. The order of Phase (I or II) and Direction (L-R or R-L) presentations was randomly determined for each child. However, at no time were the two phases mixed. That is, if Phase I was presented first, then both L-R and R-L conditions of Phase I were completed before Phase II testing began.

Pretesting. To insure that each child understood the lexical items used in constructing the experimental sentences, each item was presented for both production and comprehension pretesting.

Production Pretest Nouns. The puzzle pieces representing the eight nouns were presented on either a right or left puzzle piece at random. The child was asked, "Tell me what this is." If the child was incorrect in his label of the picture (e.g., "lady" instead of "girl" or "tiger" instead of "cat"), then the experimenter corrected the response by saying, "That's a girl/cat." "What is that?" After the child imitated the correct response, the next picture was presented. When all the pictures had been presented once, the missed items were re-presented. No items were missed on the second trial by any child.

Comprehension Pretest Nouns. In the noun comprehension pretest, the child was asked to "Give me (the experimenter) the picture of X," when "X" was simultaneously presented with another one of the seven remaining nouns. Therefore, the noun comprehension pretest consisted of a simple simultaneous stimulus discrimination task. The nouns were randomly presented on either a right or left puzzle piece. The choice of noun alternative for any trial was also randomly determined. Comprehension training for errors was not necessary for any child.

Production Pretest Verbs. In the verb production pretest, each child was shown a picture of a boy running to the right, on a right puzzle piece (see Figure 19) and told:

"See, this is a picture of a boy running." "And see, he's running this way (the experimenter motioned the correct direction with her finger)." "What's he doing?" The child then modeled the correct response by saying, "He's running this way (motioning the correct direction with his finger)."

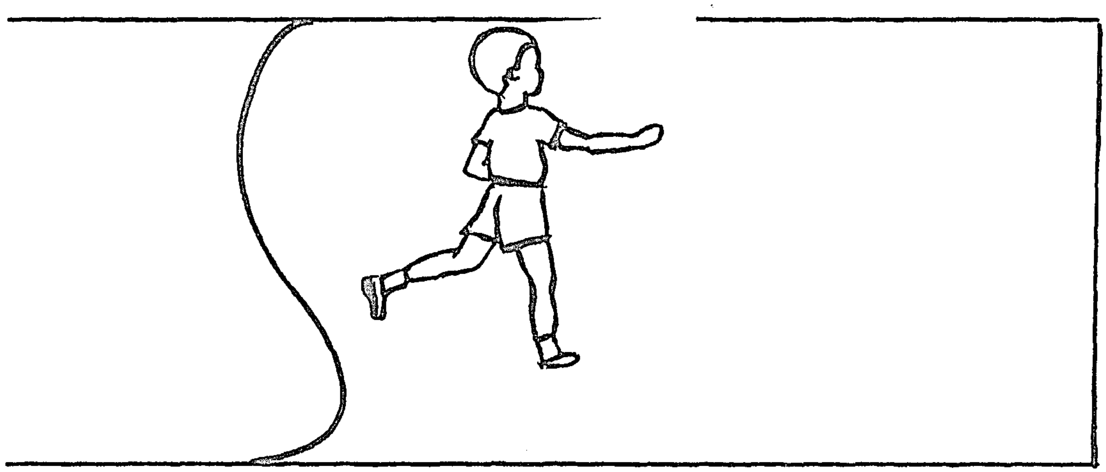

Figure 19. Boy running to the right on a right puzzle piece.

Similarly the child was shown a picture of a truck moving toward the left, on a right handed puzzle piece, and the modeling procedure was repeated. After these two modeling trials had been completed, the child was instructed "Now tell me what these pictures are and what they are doing." Six of the eight nouns (tree and house were omitted) were represented as pictures having action and were included in this pretest. The animate nouns were depicted as running either to the left or to the right, and the inanimate nouns were depicted as moving either to the left or to the right. Thus the pictures presented in the noun and verb pretests differed in terms of action. For example a truck in the noun pretest was represented as having no driver, parked, and facing the child. However, the verb pretest represented the truck from the side rather than the front, and a driver was clearly visible (see Figures 20 and 21).

All six nouns were presented twice, once facing the left and once facing the right. Whether the right or left facing pictures appeared on right or left puzzle pieces was randomly determined. In this pretest, the child was asked to attend to the direction of the stimulus as well as to the nature of the stimulus. Therefore, if the child correctly motioned "It's going this way" but failed to identify the picture, he was asked "What's going this way?" If the child correctly identified the stimulus as "That's a boy running" but did not motion the direction, he was asked "Which way is he running?" After two or three such corrections, the children needed no further prompts.

Comprehension Pretest Verbs. In the comprehension pretest, each child was asked to "Give me (the experimenter) the picture of X who is/that is running/going," when the action noun was simultaneously paired with its non-action noun. For example the child was shown a picture of a cat running and a cat not running and asked to discriminate which one was being asked for. An incorrect response elicited the

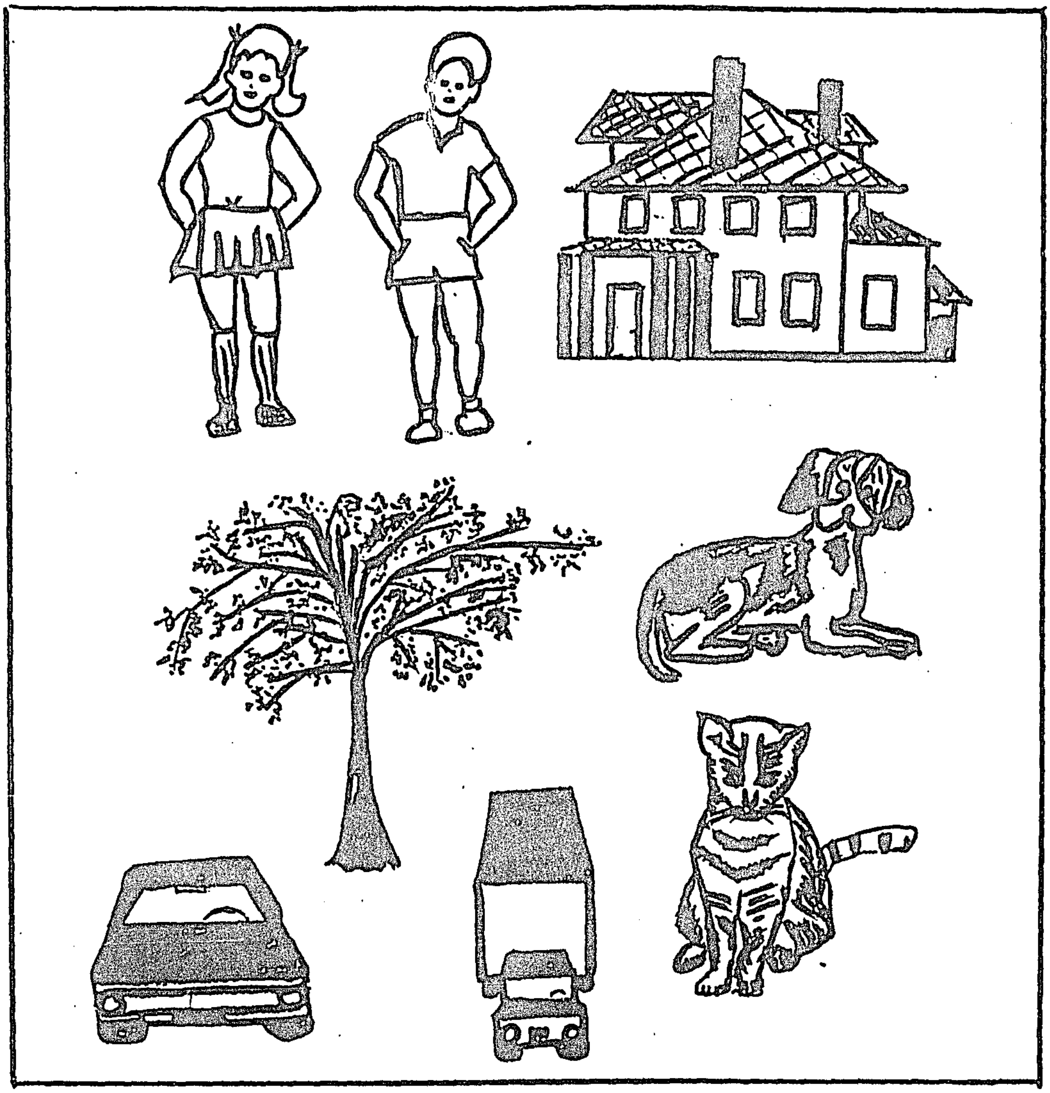

Figure 20. The noun pretest pictorial stimuli.

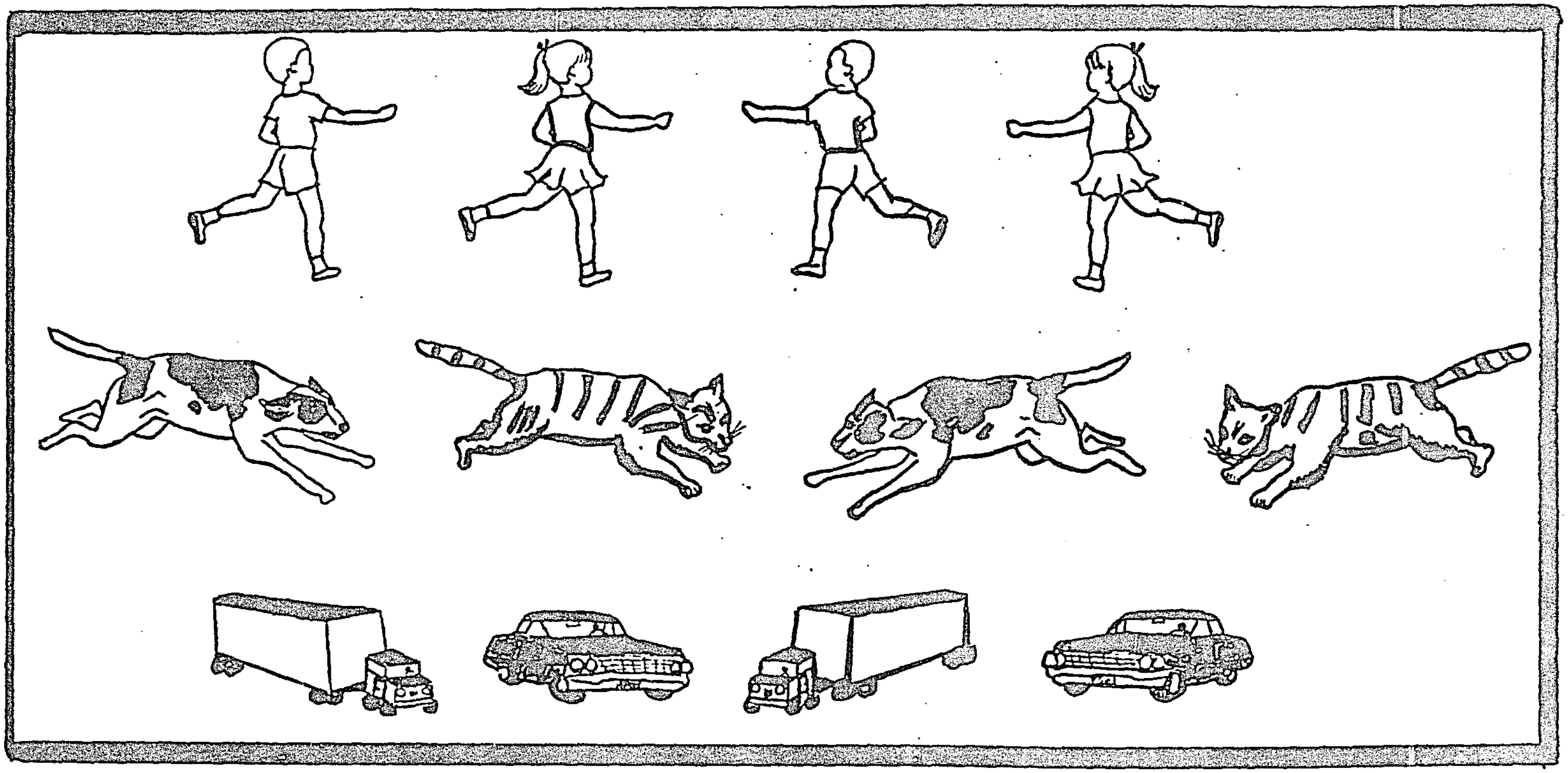

Figure 21. The verb pretest pictorial stimuli.

verbal correction "No, see, <u>this</u> cat is running, that cat is just sitting. Now, which cat is running?" All six action nouns were randomly presented twice, once facing left and once facing right. Whether the stimulus was presented on a right or left puzzle piece was randomly determined. At the end of the twelve trials, all missed items were re-presented. No items were missed by any of the children on the second trial.

Object Manipulation and "To-From" Pretest. The object manipulation pretest was designed to adapt the child to the use of the apparatus and to teach him how to "construct" a puzzle. This pretest also exposed the child to the location alternatives: "X running/going to Y" versus "X running/going away from Y."

Trial One: The child was shown a rabbit facing right on a left puzzle piece and a non-action baby on a right puzzle piece (R rabbit on L + baby on R). After the child identified each picture he was asked to "make a picture of the rabbit running to the baby" in the construction box. Since there were only two alternatives, most children were able to follow the instructions simply by sliding the two pieces together. Prompting followed the instructions in a few cases. After the puzzle had been constructed, the child was asked, "What picture did you make?" If the child did not respond "A rabbit running (hopping, jumping, etc.) to a baby," the correct response was supplied and the child was asked to model. If the child responded with incomplete answers such as "a rabbit" or "a baby" or "a rabbit and a baby," he was asked "What's the rabbit doing?" or "What's happening in this picture?" After the child emitted the correct response, he was asked to repeat the response, as the question "What picture did you make/What's happening in this picture?" was repeated by the experimenter.

Trial Two: The child was shown a picture of a (L rabbit on R + baby on L). The procedure for trial two followed that for trial one.

Trial Three: The child was shown a picture of a (R rabbit on R + baby on L). This time the instructions given to the child were to "make a picture of a rabbit running away from a baby." The procedure then followed that for trials one and two.

Trial Four: The child was shown a picture of (L rabbit on L + baby on R) and again asked to "Make a picture of a rabbit running away from a baby." The procedure then followed that for the other trials.

In this pretest, trials one and three corresponded to the L-R condition in the experimental task, and trials two and four corresponded to the R-L condition.

Testing Apparatus and Procedure. Subjects were presented with a 10½" x 5½" x 1" cardboard container in which a 3" x 8" puzzle construction area was clearly marked off from the rest of the box with masking tape. This container was placed before the child. During inter-trial intervals, a 5½" x 21" cardboard screen was placed between the child and the card-board container to prevent the child's viewing of the puzzle piece alternatives. The experimenter held the screen with one hand and sorted out the puzzle alternatives with the other, placing each of the four alternatives in a pre-assigned randomized position order. This randomized order for positioning was different for each trial for each child. The four alternatives were placed in front of the child in a straight line, and then covered by the cardboard screen.

Comprehension. During comprehension trials the child was asked to "Make a picture of X going/running to/away from Y." At the end of this statement the experimenter removed the screen. The child was then required to choose the two alternatives that fit the instructions, and interlock the pieces in the construction container. The child also indicated when he was finished with each task. The experimenter then picked up the pieces, returned the screen, and began a new trial. All constructions, correct and incorrect, were followed by "Ok, good, let's try another one."

Informative feedback was provided by the experimenter, however, when the child attempted to place one piece that was right side up relative to a second piece that was upside down. In this case, the experimenter said: "One of those pictures is upside down. Try it again. Maybe you should try to make the puzzle another way." If still perplexed, the experimenter added "Maybe you should try another piece." All such incorrect construction instances were categorized as "other" or non-scoreable responses.

Production. During the Production trials, the experimenter placed the cardboard screen over the construction container, at about a 120° angle from the top of the table, and constructed the correct puzzle sequence in the cardboard container. These correct sequences were the correct alternatives in the comprehension phase. After the puzzle had been constructed, the cardboard container was completely covered by the screen, and the child was instructed to "Tell me about this picture." The container was then uncovered and the child's response recorded. If the child noted only the subject (e.g., "a girl") or only the object (e.g., "a tree"), or both nonrelationally, (e.g., "a girl and a tree"), the experimenter asked "What's happening in this picture?" or "What's the girl doing?" Sentence presentations were randomly selected for each child. All productions responses were recorded verbatim.

Scoring. Comprehension (Phases I and II). Several responses were measured during the comprehension phases of this study. These responses are defined below.

A. Latency: The time in tenths of seconds, required for the child to make his first comprehension response. Latency was measured from the time that the experimenter completed the instructions, "Make a picture of X running/going to/away from Y" and lifted the screen (t_1), until the child made the first physical contact with the puzzle alternatives (t_2). Latency was measured by stopwatch.

B. Duration: The time in tenths of seconds required to complete the trial. A second stopwatch, started simultaneously with the first at (t_1), was stopped at the end of the trial (t_3). Trial termination (t_3) was cued by the experimenter saying "Okay, good." Both latency and duration were recorded by the same observer for any one trial.

C. Strategy: A second observer scored the step by step response strategy of the children. The strategy was later scored as correct or incorrect. Each of the puzzle alternatives was number coded in the upper-right hand corner such that the observer could record (1) which piece was contacted and (2) the type of contact. The type of contact was coded as either (T): Touch but not move, (M): Move to construction area, (R): Return from construction area, or (J): Join. A sample strategy score, then, might have taken the form: M3 T1 M4 J34 R4 M1 R3 M2 J12. The final response in this strategy (e.g., J12), was compared to the correct response listed on the coding sheet and marked as correct or incorrect.

Correct (Phase I and Phase II "to" condition). The response was scored as correct in the L-R comprehension condition when the agent facing right on the left handed puzzle piece and the object on the right handed puzzle piece were joined (R agent on L + object on R). If the correct pieces were joined and both were upside down, the response was also scored as correct.

In the R-L comprehension conditions, the response was scored as correct when (L agent on R + object on L) were joined.

Correct (Phase II "away from" condition). During the L-R condition the response was scored as correct when (L agent on L + object on R) were joined. During the R-L condition, the response was scored as correct when (R agent on R + object on L) were joined.

D. Codings of Response Errors.

Phase I

(1) Reverse direction. A reverse direction error was defined as joining (L agent on L + object on R) during the L-R condition, or joining (R agent on R + object on L) during the R-L condition.

(2) Subject-Subject. A subject-subject error was defined in both the L-R and R-L conditions, as the joining of a right and left handed puzzle piece which portrayed pictures of the same subject (e.g., agent + agent).

(3) Object-Object. An object-object error was defined in both the L-R and R-L conditions as the joining of a right and left handed puzzle piece which portrayed pictures of the same object.

(4) Other. An "Other" error was scored when the child attempted to join a right-side-up puzzle piece with one which was up-side-down; when the child put the two pieces back to back rather than joining the interlocking sides;

when the child joined the two pieces together with the picture sides down; or when the child stacked two, three, or all four pieces on top of each other.

Phase II

(1) Other. Same as for Phase I.

(2) Reverse Direction. In the Phase II "To" condition, the error was defined as in Phase I. However, for the "away from" condition, a reverse direction error was defined as joining (R agent on L + object on R) during L-R testing, and joining (L agent on R + object on L) during R-L testing.

(3) No Direction. A no-direction error was defined as joining an object with a no action subject, in both the L-R and R-L conditions.

Response errors object-object and subject-subject were not possible in Phase II. The object-object error was excluded because there was only one possible object picture; subject-subject response errors were impossible because the subject alternatives were either all on left puzzle pieces (L-R condition) or on all right puzzle pieces (R-L condition). To join two subjects (agents), therefore, meant that the child would have to turn one piece upside down. Such a response strategy was classified as "other" (see Figures 22, 23).

Production. The responses measured during the production phases of the study are defined below.

A. Latency: The time in tenths of seconds required for the child to make his first production response. Latency

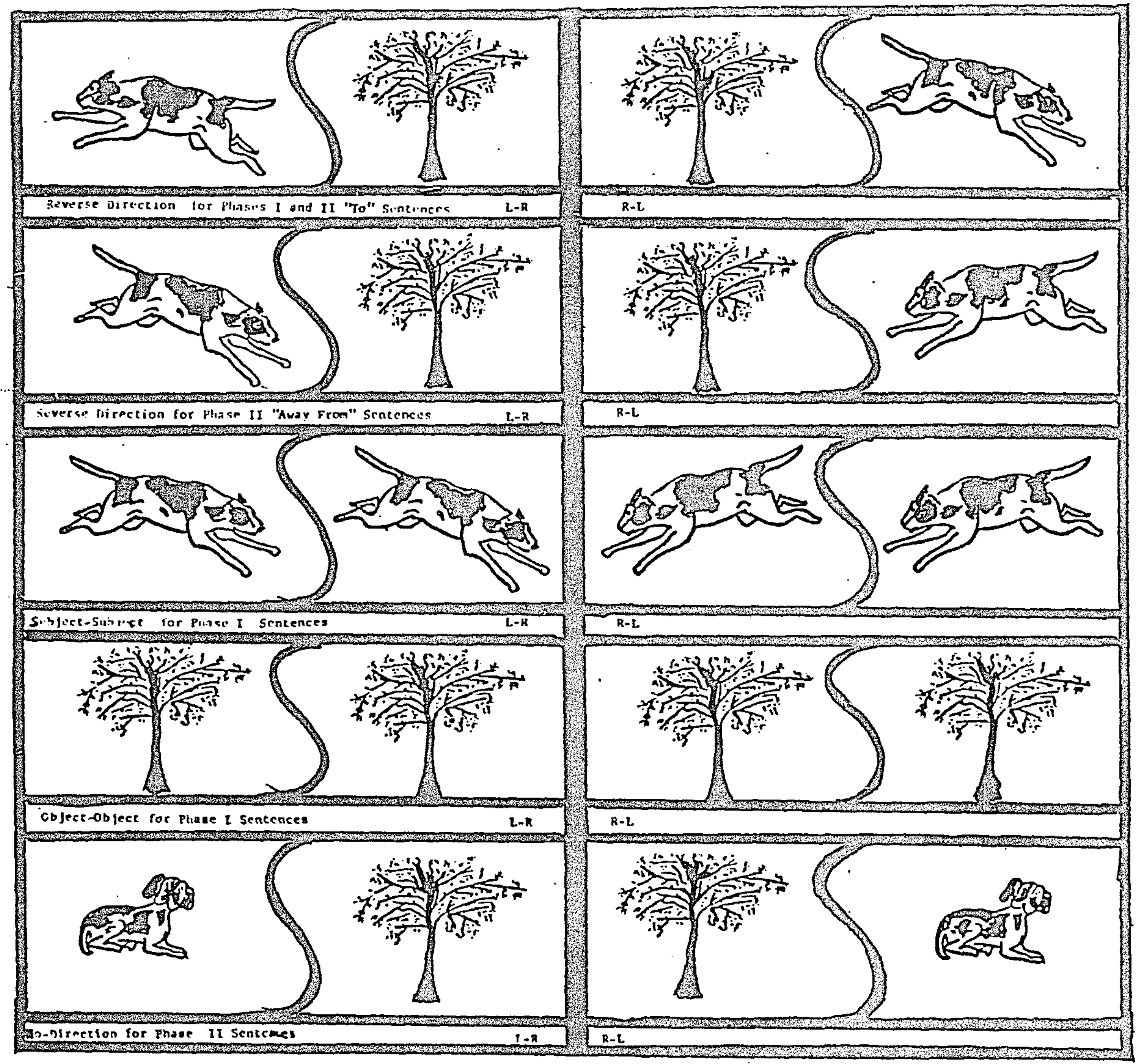

Figure 22. Representations of possible response errors.

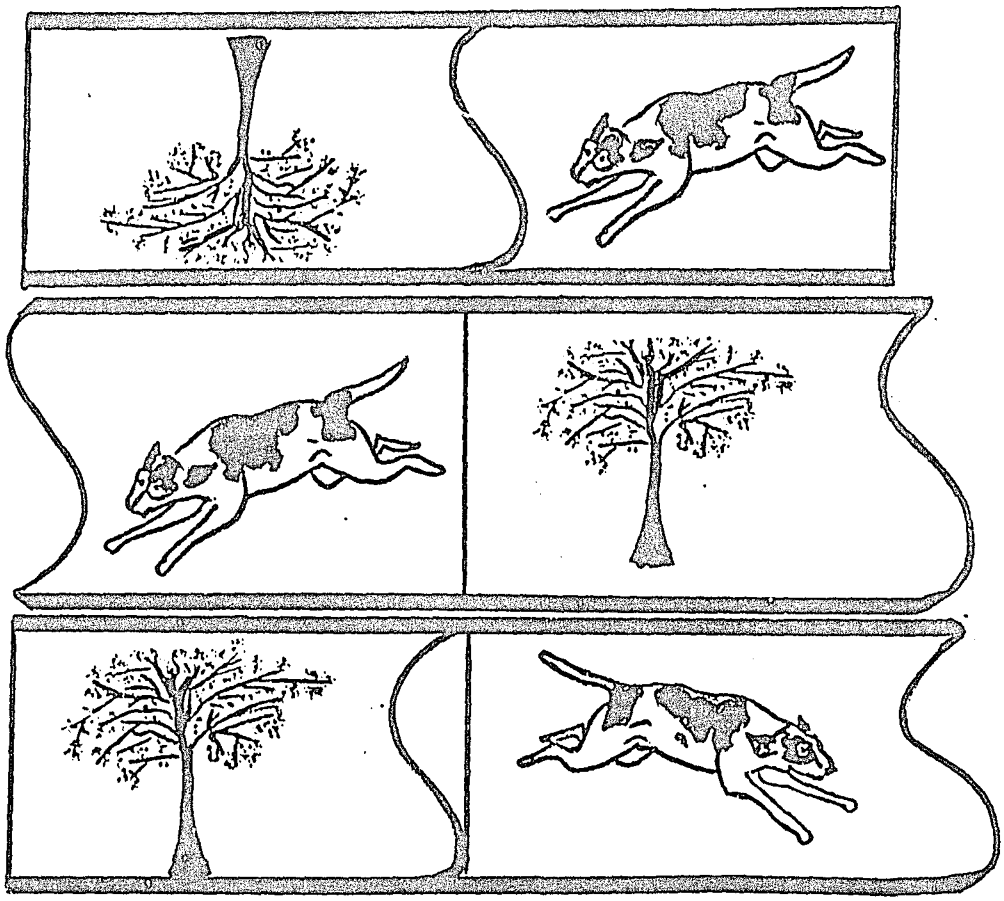

Figure 23. Representations of "other" errors.

was measured from the time the experimenter completed the instructions "Tell me about this picture" and lifted the screen (t_1) until the subject made the first verbalization (t_2). T_2 was not measured when the child made random verbalizations (e.g., "mmm," "let's see," "uh") or made irrelevant comments such as "I'm a cookie monster and I'm gonna eat you up," or made comments irrelevant to the task but task related (e.g., "I got pig tails just like her [the girl in the picture]"). When the child made irrelevant or task irrelevant comments, the trial was terminated and rerun at the end of the session.

B. Correct responses. Correct production responses included: subject-verb-object; subject verb, verb-object, or subject object sentences. However, when the sentence was not subject-verb object, appropriate prompts were supplied.

Subject-Verb: "Which way is he running?"

Verb-object: "What's going to the tree?"

Subject-object: "What's the girl doing?"

Prompts were only necessary in a few cases, after which the subject-verb-object form was always completely supplied.

Synonyms were accepted (e.g., "Cindy" for "girl," "Kitty-Kitty" for "cat," "Rover" for "dog," etc.).

C. Production Errors

(1) Reverse Direction. Reverse direction errors were defined as the use of "away from" when the verb phrase "to..." was appropriate, or the use of "to" when "away from" was appropriate. With the younger children, approximations of "to" were accepted when the child said such things as:

"The dog is gonna jump on the girl and eat her up."

"That truck is gonna run over the dog."

"That boy is gonna run and hit that girl in the nose."

These approximations occurred infrequently.

Approximations of "away from " were also infrequent. Examples of such approximations were:

"The boy is mad at the girl and is going away."

"The dog's not running to the house 'cause he's going the other way."

"The cat's not running to the boy. He's going this way (child motions the correct direction of the agent)."

(2) Reverse Subject Reverse Object: A reverse subject and object error was defined as the use of "to" and "away from" correctly, but reversing the subject and the object (e.g., "The girl is running to the boy," instead of "The boy is running to the girl").

(3) Reverse Subject, Object, and Direction: These errors were defined as the incorrect use of "to" and "away from" in conjunction with reversing the subject and the object (e.g., "The girl is running away from the boy," instead of "The boy is running to the girl").

In those cases where the child made a production error and corrected himself, the corrected response was used as the datum.

Experimental Post Test

A post test for L-R--R-L equivalence was administered to each child after all experimental sessions had been completed. A test for this equivalence was made by presenting each child four possible puzzle pieces where both R-L and L-R alternatives were (a) both correct in Trial 1, and (b) both incorrect in Trial 2. All comprehension responses were recorded.

In the trial where both alternatives were correct, the child, after constructing either a L-R or a R-L sequence, was then asked "Can you make a picture of X running to Y" another way.

In the trial where both alternatives were incorrect, the child's response was scored as correct if he verbalized "I can't do it" or "It won't work." Often such responses had to be cued. The prompt, "What's the matter?" was supplied when the child behaviorally indicated his frustration, such as shaking his head, or blowing air, or repeatedly commenting "Oh Brother," or indicated that he didn't want to play the game any longer. Children who incorrectly constructed the puzzle were asked "Is that it?" An affirmative response was not corrected.

Experimental Design

Phase by Phase Comparison. The overall experimental design is shown in Table 5. This design calls for a multivariate analysis of variance for a one Between Subjects (Groups) by four Within Subject (Phase by Task by Direction by Sentence

Table 5

Overall Experimental Design:
Phase I by Phase II Comparison

	Phase I				Phase II			
	Comprehension Task		Production Task		Comprehension Task		Production Task	
	L-R Direction	R-L Direction	L-R Direction	R-L Direction	L-R	R-L	L-R	R-L
	A/I A/A, I/I	A/I A/A, I/I	A/I A/I, A/I	A/I A/A, I/I	A/I A/A, I/I	A/I A/A, I/I	A/I A/A, I/I	A/I A/A, I/I
Gr I								
S1								
S2								
S3								
S4								
S5								
Gr II								
S6								
S7								
S8								
S9								
S10								
Gr III								
S11								
S12								
S13								
S14								
S15								

Type) repeated measures design for fixed effects. This design permitted assessment of three dependent measures: total percent responses correct; response latency; and total number of reverse direction errors. These dependent measures were common to both phases of the experiment, and to the comprehension and production conditions within each of the phases. However, since current computer programs were not available for this multi-factored design, simple analyses of variance for each dependent measure were performed on this and all subsequent designs. Correlations computed between all possible dependent measures confirmed the suitability of multi-analyses of variance in place of a multivariate analysis; no measures were significantly related.

Phase I Comparison. The experimental design for the Phase I comparison is shown in Table 6. This design involved three analyses of variance for a one Between Subjects (Groups) by three Within Subjects (Task by Direction by Sentence Type) repeated measures design for fixed effects. One analysis was performed for each of the three dependent measures: total percent responses correct, response latency, and total number of reverse direction errors. The Phase I comparison assessed the effects of the "inanimate subject/animate object (I/A)" comparison, not represented in Phase II.

Phase II Comparison. The experimental design for the Phase II comparison is shown in Table 7. Three analyses of variance for a one Between Subjects (Groups) by three Within

Table 6

Experimental Design for
Phase I Comparison

		Phase I											
		Comprehension						Production					
		L-R			R-L			L-R			R-L		
		A/I	I/A	A/A, I/I	A/I	I/A	A/A, I/I	A/I	I/A	A/A, I/I	A/I	I/A	A/A, I/I
Gr I	S1												
	S2												
	S3												
	S4												
	S5												
Gr II	S6												
	S7												
	S8												
	S9												
	S10												
Gr III	S11												
	S12												
	S13												
	S14												
	S15												

Table 7

Experimental Design for
Phase II Comparison

		Phase II															
		Comprehension								Production							
		L-R				R-L				L-R				R-L			
		A/I		A/A,I/I		A/I		A/A,I/I		A/I		A/A,I/I		A/I		A/A,I/I	
		To	Away	To	Away	To	Away	To	Away	To	Away	To	Away	To	Away	To	Away
Gr I	S1																
	S2																
	S3																
	S4																
	S5																
Gr II	S6																
	S7																
	S8																
	S9																
	S10																
Gr III	S11																
	S12																
	S13																
	S14																
	S15																

(Task by Direction by Sentence Type) repeated measures design for fixed effects, were performed on the data. One analysis was performed for each of the following dependent measures: Total percent responses correct ("to " and "away") response latency ("to " and "away") and total number of reverse direction errors ("to " and "away"). The Phase II comparison assessed the effects of the location factors, "To " and "Away from " not manipulated in Phase I.

Production Comparisons. The experimental design for the Production data is shown in Table 8. A repeated measures analysis for fixed effects was performed for each of five dependent measures. The analysis involved a one Between Subjects (groups) by three Within Subjects (Phase by Direction by Sentence Type) design. The dependent measures included: Total percent responses correct, response latency, total number of reverse direction errors, total number of reverse subject + object errors, and total number of reverse subject, object, and direction errors. Since only two of the three levels of sentence type manipulated in Phase I were represented in Phase II, the inanimate subject/animate object (I/A) sentence type was omitted from this analysis. The Production comparison assessed the effects of the independent variables on all possible production responses.

Comprehension Comparison: Phase I. This design, shown in Table 9, involved a repeated measures analysis of variance for a one Between Subjects (Groups) by two Within Subjects (Direction by Sentence Type) for fixed effects. This analysis was

Table 8

Experimental Design:
Production

		Production							
		Phase I				Phase II			
		L-R		R-L		L-R		R-L	
		A/I	A/A,I/I	A/I	A/A,I/I	A/I	A/A,I/I	A/I	A/A,I/I
Gr I	S1								
	S2								
	S3								
	S4								
	S5								
Gr II	S6								
	S7								
	S8								
	S9								
	S10								
Gr III	S11								
	S12								
	S13								
	S14								
	S15								

Table 9

Experimental Design:
Comprehension Phase I

Phase I Comprehension						
	L-R			R-L		
	A/I	I/A	A/A, I/I	A/I	I/A	A/A, I/A
Gr I S1						
S2						
S3						
S4						
S5						
Gr II S6						
S7						
S8						
S9						
S10						
Gr III S11						
S12						
S13						
S14						
S15						

performed for each of seven dependent measures: total percent responses correct, response latency, response duration, total number of reverse direction errors, total number of subject-subject errors, total number of object-object errors, and total number of response errors classed as "other." A phase comparison was not included in this design since the possible dependent measures for the two phases differed.

Comprehension Comparison: Phase II. Table 10 shows the Comprehension design for Phase II. A repeated measures analysis of variance for fixed effects was performed on the data (one Between Subjects [Groups] by two Within Subjects [Direction by Sentence Type]). This analysis was performed for each of the following six dependent measures: total percent responses correct, response latency, response duration, total number of reverse direction errors, total number of no direction errors, and total number of unscoreable responses called "other."

Table 10

Experimental Design:
Comprehension Phase II

Phase II - Comprehension					
	L-R		R-L		
		A/I	A/A, I/I	A/I	A/A, I/I
Gr I	S1				
	S2				
	S3				
	S4				
	S5				
Gr II	S6				
	S7				
	S8				
	S9				
	S10				
Gr III	S11				
	S12				
	S13				
	S14				
	S15				

CHAPTER IV

RESULTS

Experimental results for response latency and response duration were found to be generally insensitive to the experimental manipulations. That is, response latency was found to be sensitive to the independent variables for only two out of six statistical analyses, where a Group main effect was produced, in addition to a four-way interaction. Similarly, duration was only sensitive to the experimental manipulations in one analysis, again producing a group main effect. Since it was believed that discussion of these effects would add no more additional information to the present results, and because possible human timing errors may have been responsible for the lack of sensitivity to the experimental manipulations, these dependent measures were omitted from the present discussion.

Thus experimental comparisons were confined to two measures: correct responses and types of response errors. The subsequent result section will begin with the analysis of correct responses.

Total Percent Responses Correct

Phase by Phase Comparison. A repeated measures analysis of variance was performed on the arcsine transformations of the percent correct data. The factors included one between-subjects-factor (Groups) and four within-subjects-factors (Phase by Task by Direction by Sentence Type). This analysis yielded the following significant effects:

Group (G), $F(2,12) = 56.03$, $p < .001$

Task (T), $F(1,12) = 18.81$, $p < .001$

Phase by Task (PxT), $F(1,12) = 6.44$, $p < .05$

Group by Phase by Task (GxPxT), $F(2,12) = 4.123$, $p < .05$

Group by Task by Direction (GxTxD), $F(2,12) = 5.94$, $p < .05$

Phase by Task by Direction (PxTxD), $F(1,12) = 9.673$, $p < .01$

Since the significant main effects for Group and Task can not be discussed without reference to their higher order interactions, the three-way interactions will be discussed separately. All statistical analyses, including post hoc tests and utility indices, refer to procedures cited in Soderquist and Gaebelein (1976).

Figure 24 illustrates the significant Group by Phase by Task (GxPxT) interaction. Panel 1 shows the Group by Phase interaction at both task levels (T_c = comprehension, T_p = production). Panel 2 shows the Group by Task interaction at both Phases I (P_1) and II(P_2), and Panel 3 shows the Phase by Task interaction for all three groups.

Inspection of Panel Group x Phase x Task Levels (GxP at T) shows that the oldest children, Groups I and II, gave more correct comprehension responses (T_c in Panel 1) than did the youngest children, Group III, during both phases of the experiment. For example, during Phase I, Group I made

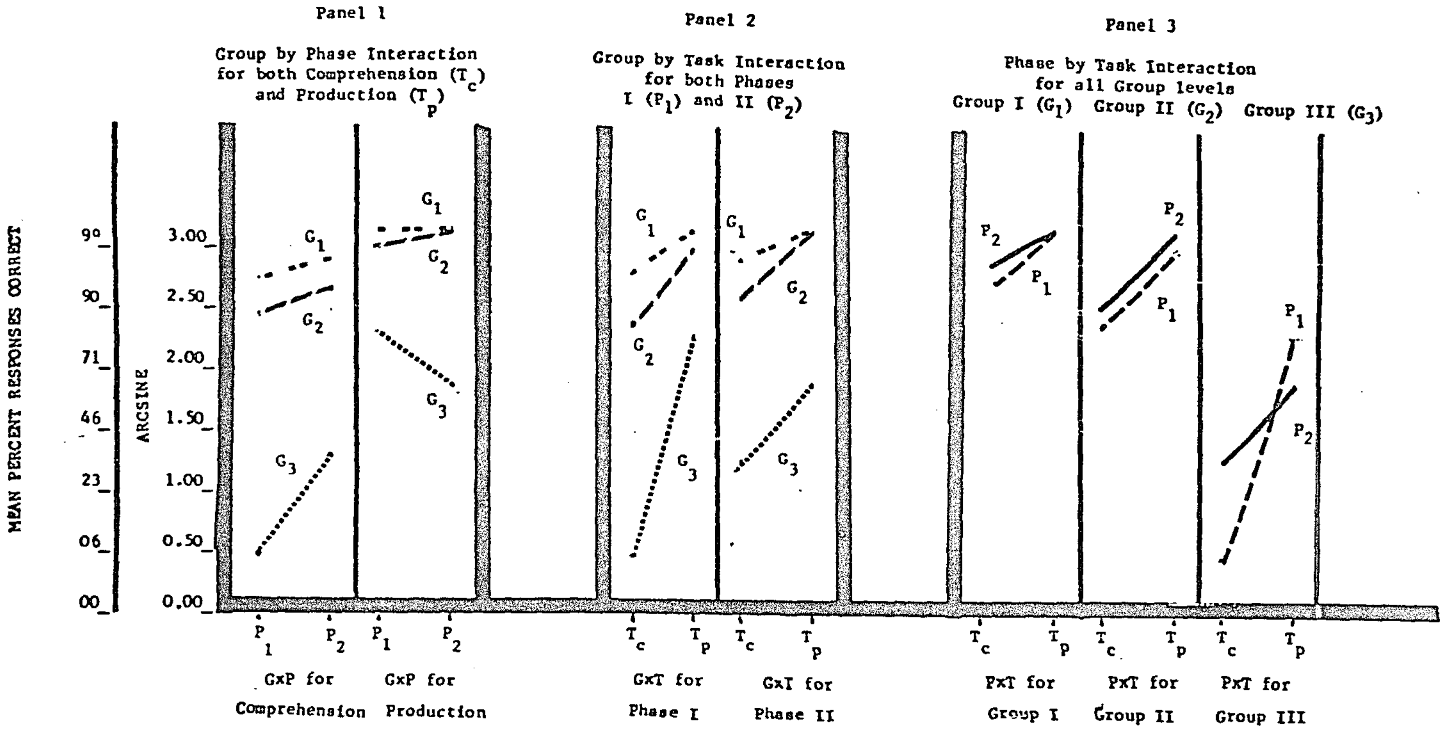

Figure 24. Phase by Phase Analysis showing the Group by Phase by Task interaction for total percent responses correct.

97 percent correct puzzle constructions, Group II made 88 percent correct constructions, while Group III made only 6 percent correct constructions. For Phase II, the percentages were increased to 98 percent, 93 percent and 36 percent, for Groups I, II, and III, respectively. These differences between the youngest (Group I) and both older groups (Groups I and II) were significant at the .05 level of confidence (Scheffe post hoc analyses between means; critical value [c.v.] for $p < .05 = 1.07$). However, in terms of production responses (T_p in this figure), the youngest children made significantly more production errors only during Phase II.

Thus, the youngest children showed significantly poorer performance during comprehension of sentences when "to" was the only preposition used, as in Phase I, than when both prepositions "to" and "away from," were used, as in Phase II. The youngest children performed almost as well as both older groups when producing "to" sentences during Phase I, but, again, had difficulty in producing "to" and "away from" sentences, in Phase II.

Inspection of Panel 2, Group by Task at Phases (GxT at P), shows that in the comprehension task (T_c) of Phase I, the youngest children, Group III, made significantly more errors (Scheffé, $p < .05$, c.v.=1.61) than either Groups I or II. During Phase II, however, only the oldest and youngest groups differed significantly in their performance and this difference was confined to the comprehension task.

Thus, the comprehension task during both experimental phases was more difficult for the youngest group. Both older groups performed better than the youngest group when "to" sentences had to be constructed from two subject and object alternatives. However, when both "to" and "away from" sentences had to be constructed from three subject and one object alternative, only the oldest and youngest groups differed significantly.

Inspection of Panel 3 Phase by Task at Groups (PxT at G) reflects the statistical finding that comprehension and production responses did not differ significantly at any one group level (Scheffe, $\underline{p} < .05$, c.v. = 1.19).

The Group by Task by Direction (GxTxD) interaction is shown by Figure 25. Panel 1 shows the Group by Direction interaction at levels of comprehension (T_c) and production (T_p). Panel 2 shows the Group by Task interaction at both directional levels (D_1 = left-right, D_2 = right-left), and Panel 3 shows the Direction by Task interaction at the three group levels.

The right half of Panel 1 reflects the statistical finding that none of the groups differed significantly at the L-R or R-L conditions during production trials (T_p), Scheffe, $\underline{p} < .05$, c.v. = 1.52). However, as shown by the left half of Panel 1, during comprehension trials (T_c), the youngest children made significantly more errors than either Groups I or II, in both the L-R and R-L conditions. Thus control of

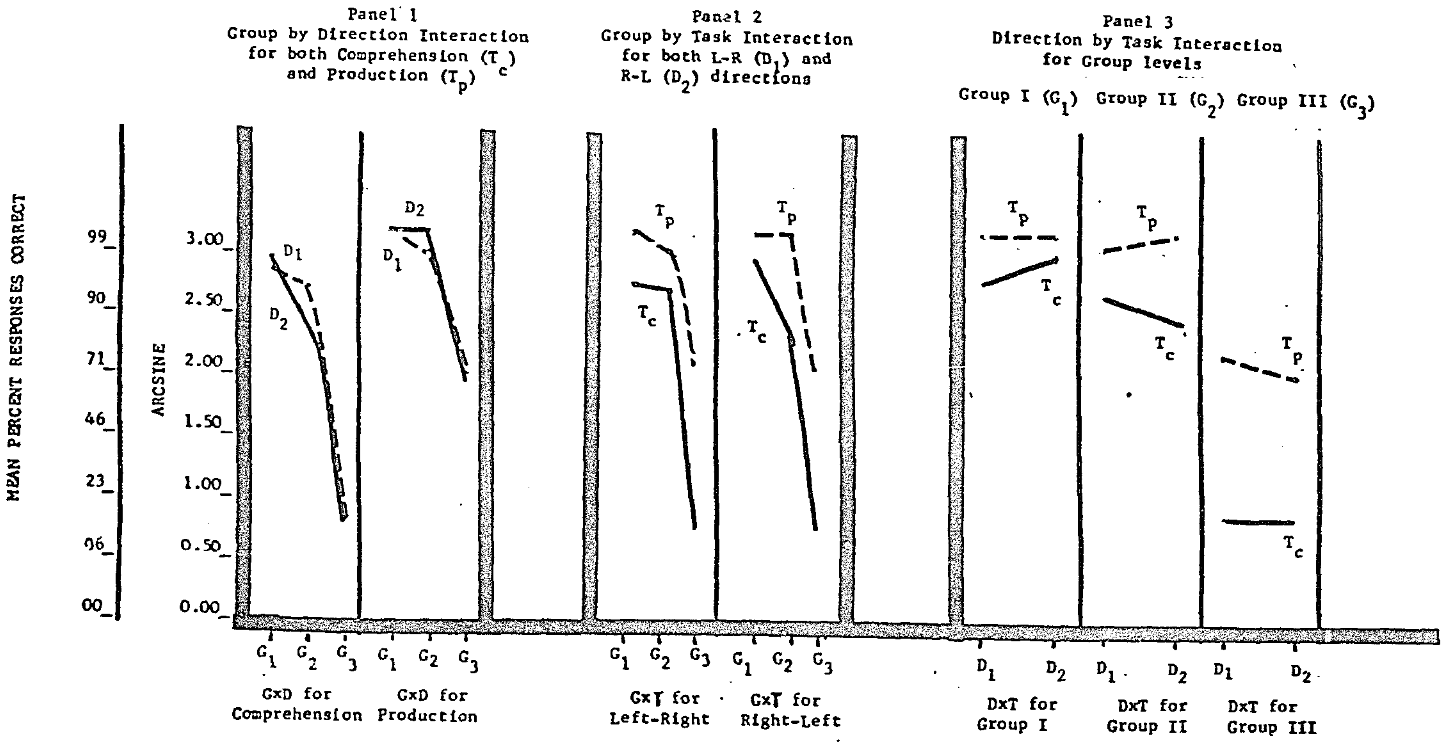

Figure 25. Phase by Phase Analysis showing the Group by Task by Direction interaction for total percent responses correct.

comprehension or production by direction was not found for any group.

Panel 2 of this figure shows the Group by Task interactions for both the L-R and R-L directions (GxT at D). For these interactions, the Scheffe critical value at the .05 level of confidence was .552. Inspection of these interactions disclosed that the youngest children, Group III, made significantly more comprehension and production errors than either Groups I or II with the L-R sentences. With the R-L sentences, the youngest group also made significantly more production errors than the other two groups. On the R-L sentence comprehension task, however, the oldest children, Group I, made fewer errors than the youngest children. Thus, for the R-L comprehension condition, there are larger differences among groups than in the L-R condition. In the R-L condition, the oldest group had little difficulty arranging a puzzle whose subject was facing in a direction opposite to that suggested by the verbal stimulus, Group II had some difficulty; and Group III had the greatest difficulty. Such clear group differences are lost, however, when the phase variable is introduced (c.f., Figures 24 and 26).

During production trials for the R-L condition, this three-group difference was not found. The data indicated that the youngest group made significantly more errors than either of the older groups, whose performances were almost 100 percent correct. Thus, for the intermediate group, production was a less difficult task than comprehension in the R-L condition, but not in the L-R condition.

The Direction by Task interaction at each age level (DxT at G) shown in Panel 3 did not yield significance (Scheffe, $p < .05$, c.v. = 1.6). Thus, R-L and L-R scores for comprehension, and R-L and L-R scores for production, did not differ significantly for any one group.

The Phase by Task by Direction (PxTxD) interaction is shown in Figure 26. Panel 1 shows the Phase by Task interaction at the L-R (D_1) and R-L (D_2) directional levels (PxT at D). Panel 2 shows the Phase by Direction interaction at comprehension (T_c) and production (T_p) levels (PxD at T); and Panel 3 shows the Task by Direction interaction for Phases I and II (TxD at P).

Post hoc analyses (Scheffe, $p < .05$, c.v. = .592) for Phase by Task at Direction (see Panel 1) indicated that Phase II differed from Phase I only during R-L comprehension conditions.

Thus, constructing a puzzle which required the child (a) to make a simultaneous discrimination among three subject alternatives with a fixed object and also (b) to discriminate between "to" and "away from" sentences (i.e., the Phase II task), was comparatively easy. On the other hand, having to choose among two subject and two object alternatives where no "to" and "away from" discriminations were necessary (in the condition where the verbal and visual stimulus did not

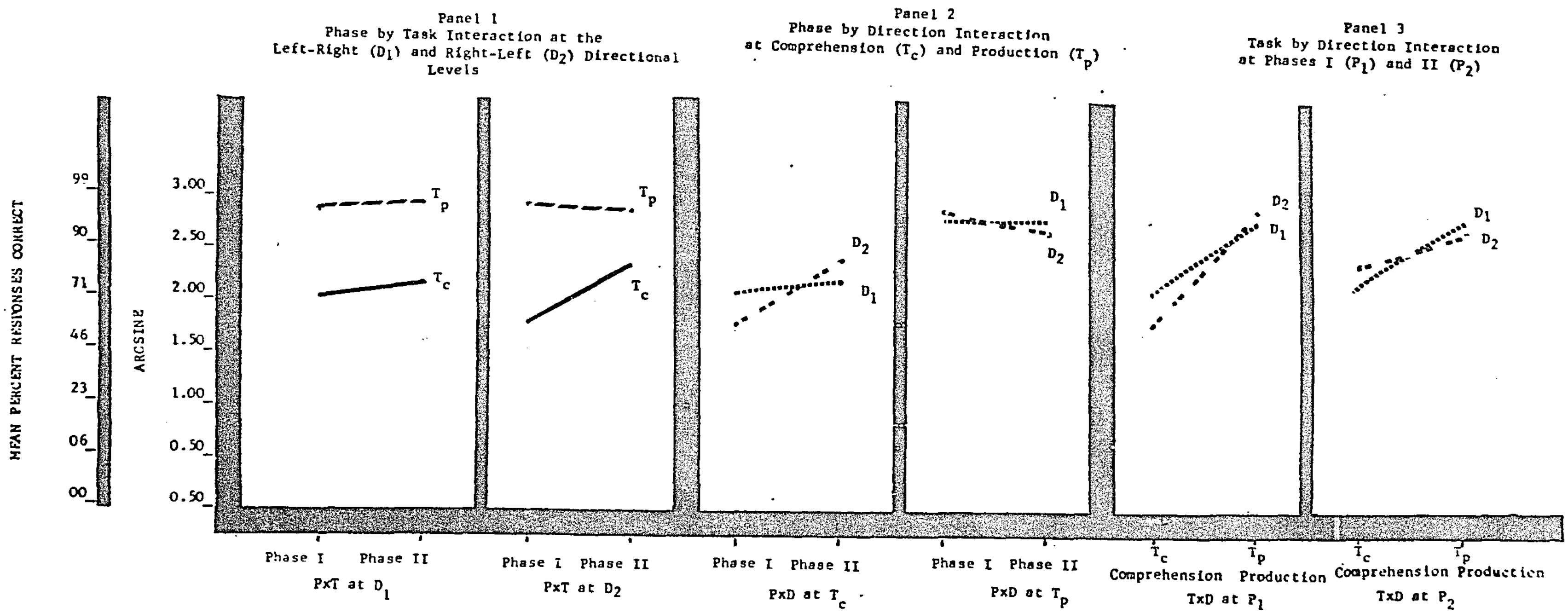

Figure 26. Phase by Phase Analysis for total percent responses correct showing the significant Phase by Task by Direction Interaction.

match) was comparatively difficult. In Phase I the child was never asked to construct an "away from" sentence. However, choosing the incorrect subject and object resulted in the incorrect construction of an "away from" sentence. Although Phase differences were controlled by direction in the R-L condition, the L-R condition where verbal and visual stimuli were matched had no differential effect on comprehension performance in the two experimental phases. Moreover, the production data yielded no phase differences at either the R-L or the L-R conditions.

Panel 2 shows the Phase by Direction interaction for Comprehension and Production (PxD at T). Only the R-L comprehension condition produced a significant difference between Phases I and II (Scheffe, $p < .05$, c.v. = .405). Comprehension scores were higher during the R-L condition of Phase II than during the R-L condition of Phase I, a duplication of the finding shown in Panel 1.

Panel 3, Task by Direction at both Phases (TxD at P), reflects the significant differences (Scheffe, $p < .05$, c.v. = .349) obtained during Phases I and II between L-R comprehension and production scores, and between R-L comprehension and production scores.

Thus, at both levels of the task requirements, production responses exceeded those of comprehension. Therefore, children could correctly verbalize the sentence represented by a preconstructed puzzle more easily than they could construct a puzzle in response to a verbal stimulus.

The Phase by Task by Direction (PxTxD) triple interaction, therefore, indicated that production exceeds comprehension in the overall phase analysis, and that the R-L directional sequence resulted in more correct comprehension responses during Phase II than in Phase I.

Thus, in terms of the overall Phase by Phase comparison, when all three three-way interactions (GxPxT, GxTxD, and PxTxD) are considered, the following findings were obtained: (1) correct production responses exceeded correct comprehension responses; (2) neither phase variables nor direction variables interacted with production trials, except for the youngest children, for whom Phase II production responses were more difficult than Phase I production responses; (3) comprehension trials were easier during Phase II than during Phase I, but only during the R-L condition; (4) the youngest group consistently made more incorrect responses than either the intermediate or the oldest groups during comprehension trials for both directional stimuli. However, only the intermediate group found the R-L comprehension condition more difficult than the L-R comprehension condition; and (5) sentence type yielded no significant statistical effects for the percent correct data.

Phase I Analysis. A repeated measures analysis of variance for a one-between-subjects factor (Groups) by three-within-subjects factors (Task by Direction by Sentence Type) was performed on the arcsine transformations of the percent correct data, yielding a significant Group (G) main effect, *F* (2,12)=48.82, *p* $<$.001, and a significant Task (T) main effect, *F* (1,12) = 24.97, *p* $<$.001. Tukey's HSD formula (c.v. = .36, *p* $<$.05) applied to the group means showed that the youngest children (Group III) made more incorrect responses than either Groups I or II. Moreover, correct production scores were significantly greater than correct comprehension scores. These effects are plotted in Figure 27.

Thus, the Phase I analysis revealed that children found it easier to label a pre-constructed puzzle in the "to" sentences, than to construct a puzzle by choosing the correct subject-object alternatives which corresponded to "to" sentences. Moreover, the youngest children made significantly more errors than did the intermediate or oldest age groups, who did not differ from one another. Finally, no significant differential effects were found for any of the three levels of sentence type: (animate subject/inanimate object, inanimate subject/animate object, and inanimate subject/object + animate subject/object) on correct responses.

Production Analysis: Phases I and II. The production comparisons for Phases I and II were analyzed using a one-between subjects (Groups) by a three-within-subjects (Phase by Direction by Sentence Type) analysis of variance for repeated measures. This analysis, performed on the arcsine transformations of the percent correct data, yielded a significant Group (G) main effect, *F* (2,12) = 11.057, *p* $<$.01.

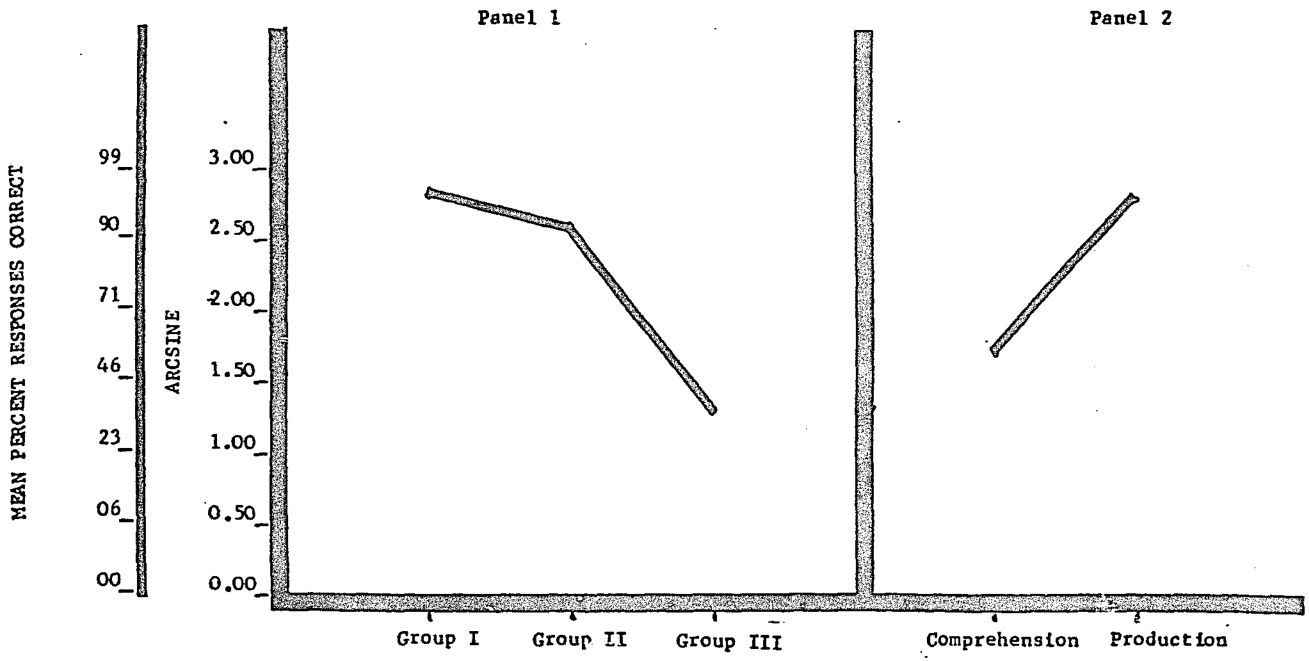

Figure 27. Phase I Analysis for total percent reponses correct. Panel 1 shows the significant Group main effect. Panel 2 shows the significant Task main effect.

Tukey's HSD formula applied to the group means ($p < .05$, c.v. = .53) showed that the youngest Group III children made significantly more errors than either Groups I or II.

As can be seen from Figure 28, correct production responses for both Phases I and II were near 100 percent for the two older groups, while for the youngest group, production responses were only about 71 percent correct.

Comprehension Analysis: Phase I. The comprehension analysis for Phase I involved a repeated measures analysis of variance for a one-between subjects (Groups) by a two-within-subjects (Direction by Sentence Type) design. This analysis, performed on the arcsine transformations of the percent correct data, yielded a significant Group (G) main effect, F (2,12) = 25.4, $p < .001$. Group means were compared using Tukey's HSD formula ($p < .05$, c.v. = .67), which indicated that Group III made significantly more errors than either Groups I or II (see Figure 29). This significant Group effect accounted for 41 percent of the variance in the data (ω^2).

Comprehension Analysis: Phase II. The comprehension analysis for Phase II involved a repeated measures analysis of variance for a one-between-subjects (Groups) by two-within-subjects (Direction by Sentence Type) design. For the arcsine transformations of the percent correct data, the analysis yielded a significant Group (G) main effect F, (2,12) = 15.673, $p < .001$, and a significant Direction (D) main effect, F (1,12 = 4.90, $p < .05$). Tukey's HSD formula applied to the

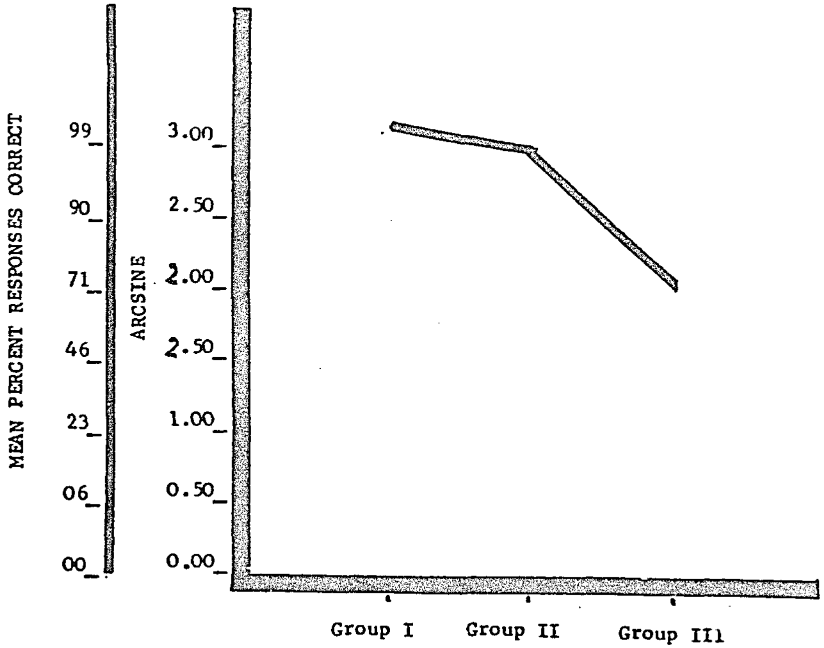

Figure 28. Production Analysis for total percent correct responses showing the significant Group main effect.

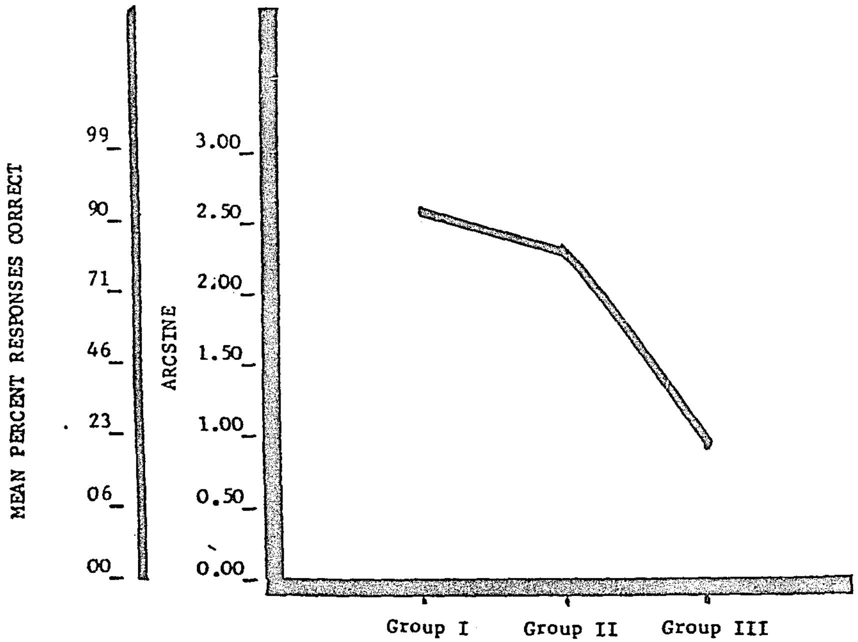

Figure 29. Phase I Comprehension Analysis for total percent responses correct showing the significant Group main effect.

group means (p .05, c.v. = .64) indicated that Group III made significantly more errors during Phase II comprehension than did the two older groups (see Figure 30). The strength of association index (ω^2) indicated that the Group main effect accounted for 30 percent of the variance. In Phase II comprehension, although significantly more correct response were given during the R-L puzzle constructions than during the L-R constructions, the effect accounted for less than one percent of the total variance (ω^2=.0004). The main effect due to direction is illustrated in Figure 30.

For the task in which both "to" and "away from" sentences had to be constructed from three subject and one object alternative, the youngest children made significantly fewer correct responses than the intermediate and older groups (Group III = 23 percent, Group II = 90 percent, Group I = 98 percent, respectively).

<u>Phase II: "To" Sentences</u>. The experimental design for Phase II "to" sentences involved a one-between-subjects (Groups) by three-within-subjects (Task by Direction by Sentence Type) repeated measures analysis of variance. The analysis performed on the arcsine transformations of the percent correct data for "to" sentences yielded the following significant effects:

Group (G), F (2,12) = 16.52, $p < .001$

Task (T), F (2,12) = 10.46, $p < .01$

Group by Task (TxT), F (2,12) = 4.08, $p < .05$

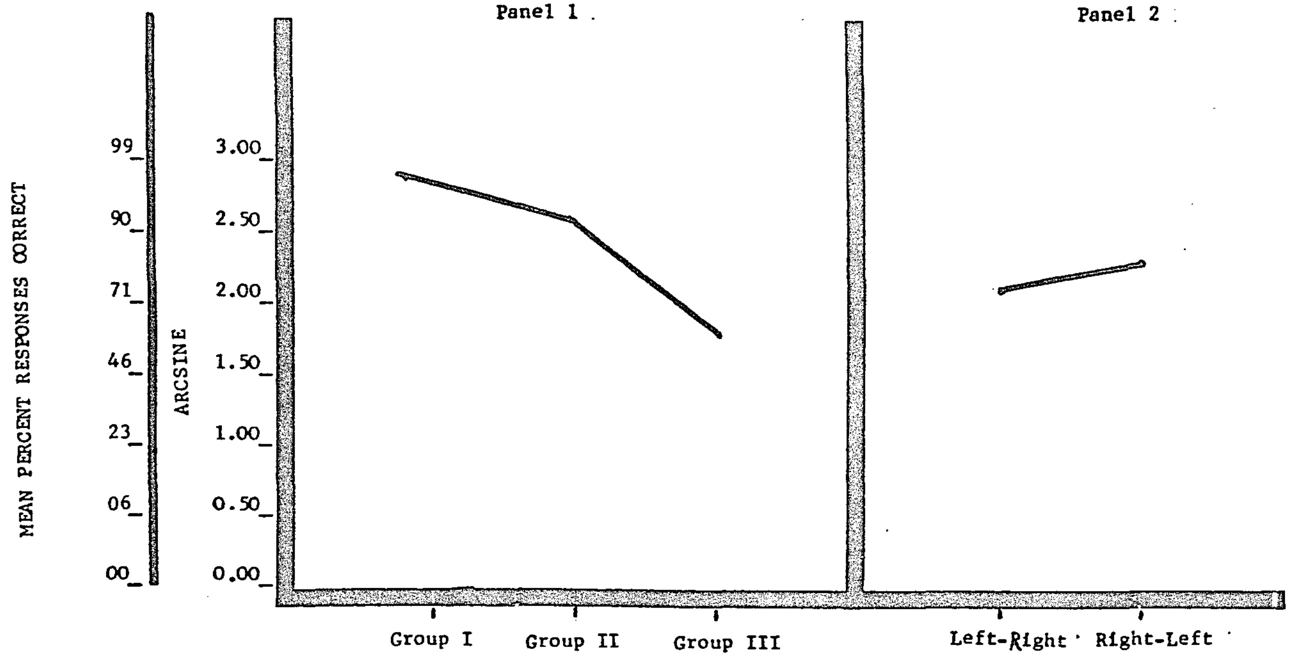

Figure 30. Phase II Comprehension Analysis for total percent responses correct showing the Group main effect (Panel 1) and the Direction main effect (Panel 2).

Group by Direction by Sentence Type (GxDxE), $\underline{F}$ (2,12) = 4.25, $\underline{p}$ <.05. The Group by Task and the Group by Direction by Sentence Type interactions will be discussed separately.

Figure 31 shows the Group x Task interaction where Panel 1 shows the group levels plotted at both comprehension (T_c) and production (T_p). Panel 2 shows the tasks plotted at the three group levels. Scheffe post hoc analyses of the group effect at the two task levels (Panel 1) indicated that Group III made significantly fewer correct responses during comprehension than either Groups I or II ($\underline{p}$ <.05, c.v. = 1.03). Panel 2 shows that correct production responses for Group III were greater than correct comprehension responses. This difference was also significant. The younger children performed significantly more poorly (42 percent) than the older groups (99 percent for both groups) in a task involving a three subject and one object alternative discrimination. Although for the oldest and intermediate age groups, comprehension and production responses did not differ, (100 percent versus 99 percent for Groups I and II), Group III performed significantly better on production tasts (85 percent) than on comprehension tasks (46 percent).

The Group by Direction by Sentence Type interaction found in the Phase II analysis for the "to" sentences is shown in Figure 32. Panel 1 illustrates the Group by Direction interaction at both animate subject/inanimate object (E_1) and redundant subject/object (E_2) sentences (GxD at E). Panel 2

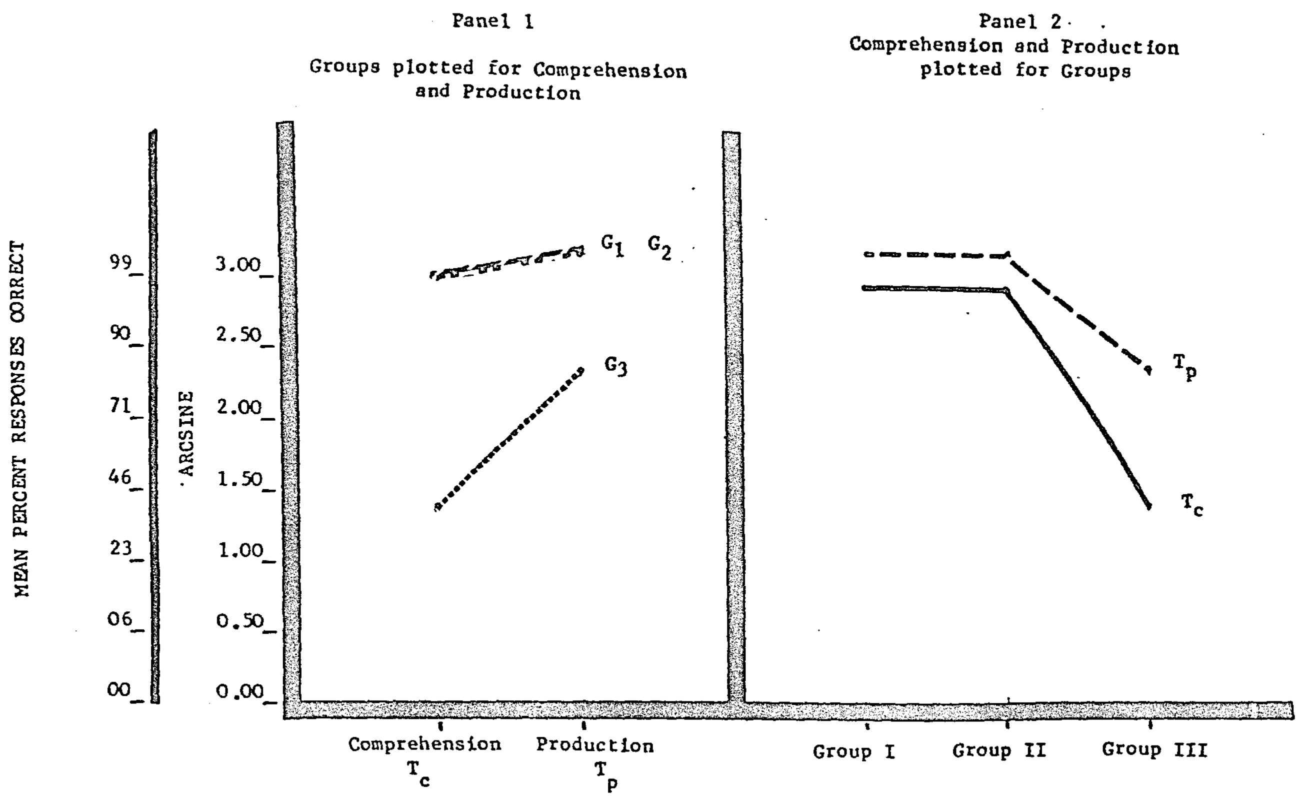

Figure 31. Phase II Analysis, "To" sentences for total percent responses correct, showing the significant Group by Task interaction.

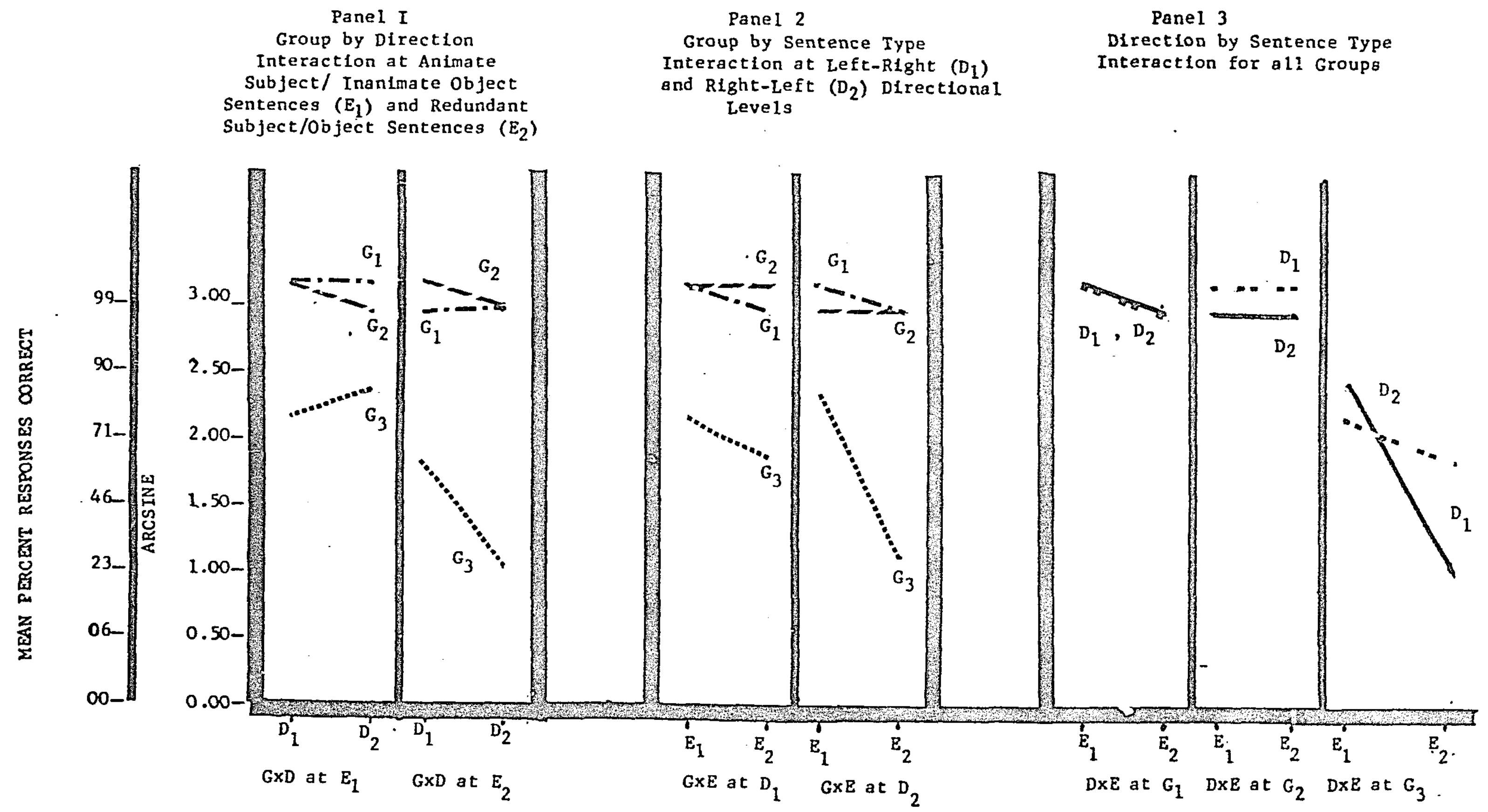

Figure 32. Phase II Comprehension Analysis, "To" sentences for total percent responses correct showing the significant Group by Direction by Sentence Type interaction.

illustrates the Group by Sentence Type interaction at both the L-R (D_1) and R-L (D_2) directional levels (GxE at D). Panel 3 shows the Direction by Sentence Type interaction at all group levels (DxE at G). Scheffe post hoc analyses indicated only two significant effects, both of which occurred for the redundant subject/object sentences which were presented in the L-R direction. Panel 1 shows that Group III made fewer correct responses (27 percent) than either Groups I or II (99 percent for both), ($p < .05$, c.v. = 1.45). This can also be seen in Panel 2 (Scheffe, $p < .05$, c.v. = 1.5). The interaction presented in Panel 3 was not significant (Scheffe, $p < .05$, c.v. = 1.00). Thus, for the Group by Direction by Sentence Type interaction, more errors were made by the youngest group during the R-L conditions of the redundant subject/object sentences.

<u>Phase II: "Away From" Sentences</u>. The Phase II analysis performed on the arcsine transformations of the percent correct data for the "away from" sentences yielded a significant Group (G) main effect, $F\ (2,12) = 19.04$, $p < .001$, with Group III making significantly more incorrect responses (32 percent) than either Groups I (99 percent) or II (97 percent), (Tukey's HSD, $p < .05$, c.v. = .708). A significant Task (T) main effect was also found, $F\ (1,12) = 5.55$, $p < .05$, where more correct responses were made during Production (92 percent) than during Comprehension (75 percent). These main effects are illustrated in Figure 33.

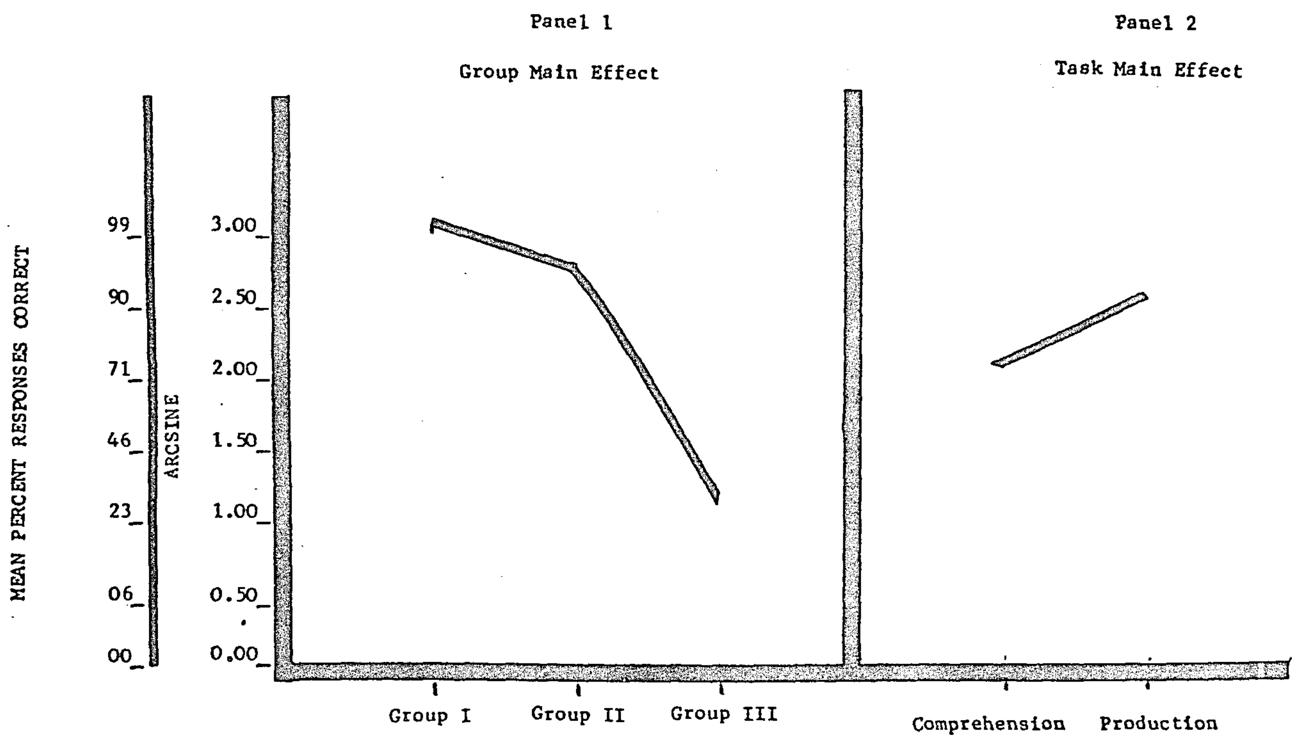

Figure 33. Phase II Analysis, "Away From" sentences for total percent responses correct. Panel 1 shows the significant Group main effect. Panel 2 shows the significant Task main effect.

Error Analysis

The children made a number of different types of response errors. As discussed in the method section of Chapter III, these errors were classified into three production error categories (reverse direction; reverse subject and object; reverse subject, object and direction) and five comprehension error categories (reverse direction; subject-subject; object-object; no-direction; other). Each category was analyzed. These analyses are presented in the subsequent sections.

Reverse Direction Errors: Phase by Phase Comparison. A repeated measures analysis of variance was performed on the arcsine transformations of the reverse direction error data. These data were instances when children said "to" instead of "away from" or "away from" instead of "to" during production tasks, and when children constructed "agent to object" instead of "agent away from object" and "agent away from object" instead of "agent to object" puzzles during comprehension trials. This analysis consisted of a one-between-subjects factor (Groups) by four-within-subjects-factors (Phase by Task by Direction by Sentence Type) design. This analysis yielded the following significant effects:

Group (G), F (2,12) = 13.342, $p < .01$

Group by Phase (GxP), F (2,12) = 5.48, $p < .05$

Phase by Task (PxT), F (1,12) = 5.514, $p < .05$

Group by Phase by Direction (GxPxD), F (2,12) = 5.42, $p < .05$

The Group and Group by Phase effects will be discussed in terms of the triple (GxPxD) interaction. The (PxT) interaction will be presented separately.

Figure 34 shows the Group by Phase by Direction (GxPxD) interaction. Panel 1 illustrates the Group by Phase interaction at the L-R (D_1) and the R-L (D_2) directional levels (GxP at D). Panel 2 illustrates the Group by Direction interaction at Phases I and II (GxD at P), and Panel 3 shows the Phase by Direction interaction at each of the three group levels (PxD at G).

A Scheffe post hoc analysis between the means ($p < .05$, c.v. = .664) shown in Panel 1 indicated that the youngest group (Group III) made more reverse direction errors than either Groups I or II during both directions of Phase II but not Phase I. Thus, when children had to choose among two subject and two object alternatives for "to" sentences, or when they had to emit a "to" sentence to a preconstructed puzzle, the number of reverse direction errors did not differ among the three groups. However, when children had to choose among three subject and one object alternatives for both "to" and "away from" sentences, or when they had to emit a "to" or "away from" sentence to a preconstructed puzzle, the youngest children (Group III) made significantly more reverse direction errors than either of the two older groups.

Similarly, as is apparent from Panel 2, post hoc analyses for the Group x Direction interaction at both Phases

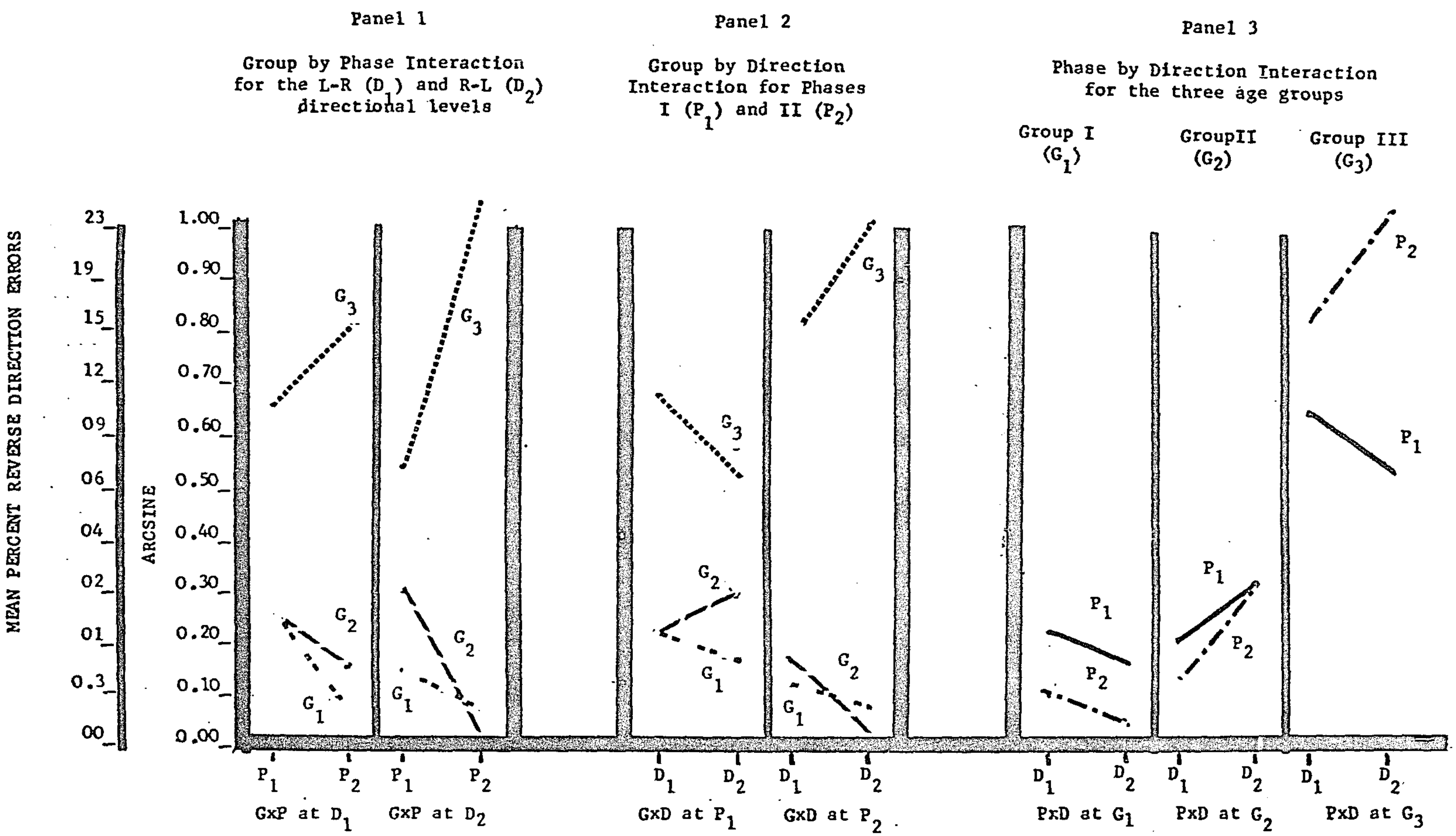

Figure 34. Phase by Phase Analysis for reverse direction errors showing the significant Group by Phase by Direction interaction.

(Scheffe, $p < .05$, c.v. = .482) revealed that Group III made more reverse direction errors in both the L-R and R-L conditions of Phase II, but not Phase I.

The Phase by Direction interaction at the three group levels is shown in Panel 3. A Scheffe post hoc test ($p < .05$, c.v. = .463) indicated that only Group III made more reverse direction errors in the R-L condition of the second Phase than in the R-L condition of the first Phase.

Thus, none of the groups made a large number of reverse direction errors when the verbal and visual stimuli matched (i.e., the first object named was also the first object of a L-R puzzle). When the verbal and visual stimuli did not match (i.e., the first object named was the second object placed in a R-L puzzle), Group III made significantly more reverse direction errors during Phase II than during Phase I.

The Phase by Task interaction for reverse direction errors is shown in Figure 35. Panel 1 shows the plot of comprehension (T_c) and production (T_p) at both phase levels. Panel 2 shows the plot of Phases I and II at the two task levels.

A Scheffe post hoc analysis ($p < .05$, c.v. = .26) between means in Panel 1 showed that during Phase I, more comprehension reverse direction errors were made than production reverse direction errors. Errors made during comprehension and production trials during Phase II, however, did not differ significantly. Panel 2 shows these differences (Scheffe, $p < .05$, c.v. = .43). These interactions were not significant.

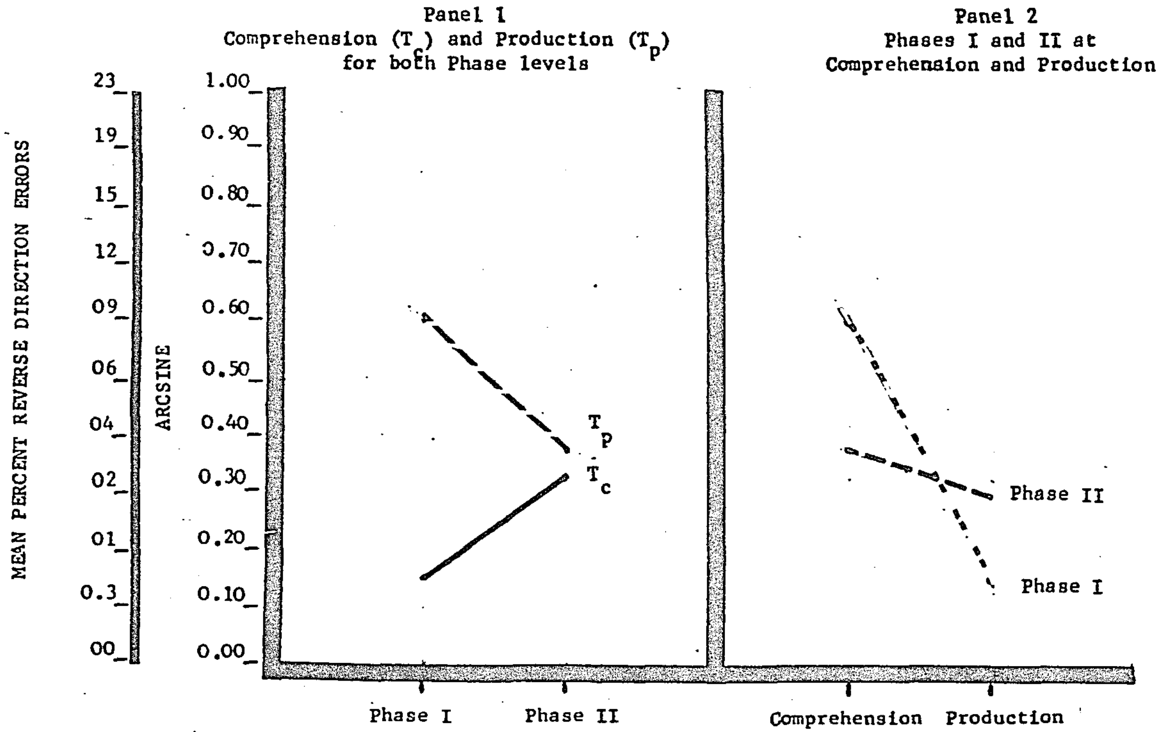

Figure 35. Phase by Phase Analysis for the percent reverse direction errors showing the significant Phase by Task interaction.

Hence, comprehension responses were more difficult than production responses in "to" sentences during Phase I in terms of the number of reverse direction errors made. In Phase II, however, reverse direction errors in "to" and "away from" sentences appear to be equally as frequent in both the comprehension and production conditions.

The general results of the (GxPxD) and (PxT) interactions can be summarized as: (1) More comprehension than production reverse direction errors were made during Phase I. In Phase II, comprehension and production were equally difficult. (2) More comprehension errors were made by the youngest group, and for comprehension and production, these occurred during the R-L conditions of Phase II. (3) Sentence type had no controlling effects on the number of reverse direction errors made.

Reverse Direction Errors: Phase I Analysis. The analysis for Phase I was repeated using arcsine transformations of the reverse direction error data, which yielded a significant Task (T) main effect, F (1,12) = 14.63, $p < .001$. As can be seen in Figure 36, more reverse direction errors were made during comprehension trials than during production trials.

Reverse Direction Errors: Production Analysis for Phases I and II. A production analysis was performed on the arcsine transformations of the reverse direction error data, yielding a significant Group (G) main effect, F (2,12) = 6.47,

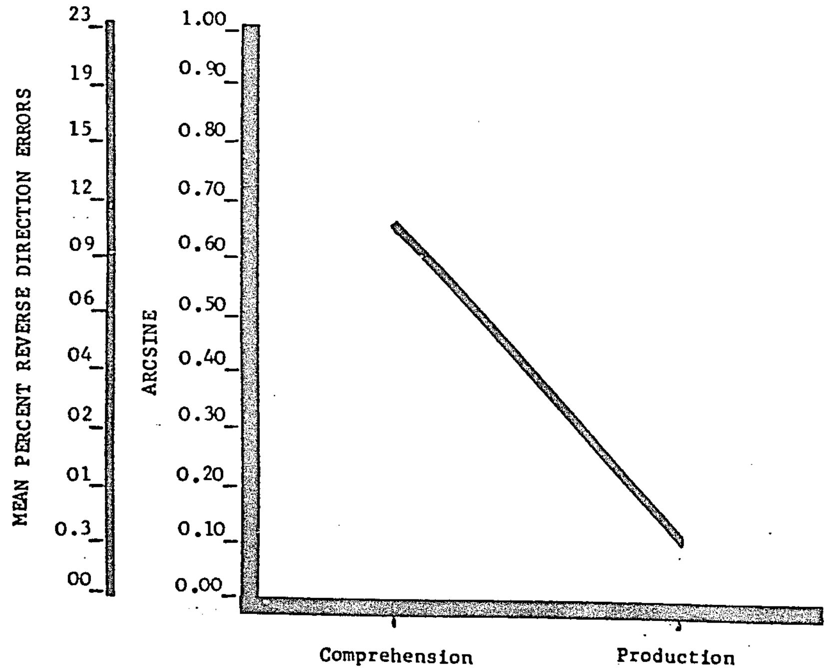

Figure 36. Phase I Analysis for total percent reverse direction errors showing the significant Task main effect.

$\underline{p} < .05$, and a significant Group by Phase interaction (GxP), $\underline{F}\ (2,12) = 4.56$, $\underline{p} < .05$.

Figure 37 shows the Group by Phase interaction, where Panel 1 illustrates the three levels of groups plotted at Phase I and II, and Panel 2 illustrates Phases I and II plotted at the three group levels. Scheffe post hoc analyses performed on the data shown in Panel 1 (G at P) indicated that Group III made significantly more reverse direction errors than either Groups I or II ($\underline{p} < .05$, c.v. = .42). Panel 2 shows that Group III also made more reverse direction errors in Phase II than in Phase I. This difference between phases was statistically significant (Scheffe, $\underline{p} < .05$, c.v. = .296).

Thus, during production trials, only the youngest children made more errors on the "to" and "away from" sentences (Phase II) than on the "to" sentences (Phase I).

<u>Reverse Subject-Object Errors: Production Analysis for Phases I and II</u>. The same production analysis was performed on the reverse subject-object data as on the reverse direction and percent correct data. Reverse subject-object errors involved those instances when children reversed the subject and object of a sentence, but appropriately named the subject as going "to" or "away from." These data yielded a significant Group (G) main effect, $\underline{F}\ (2,12) = 9.31$, $\underline{p} < .01$. Tukey's HSD formula applied to the group means indicated that Group III made significantly more reverse subject-object errors than did either of the other two groups ($\underline{p} < .05$, c.v. = .16).

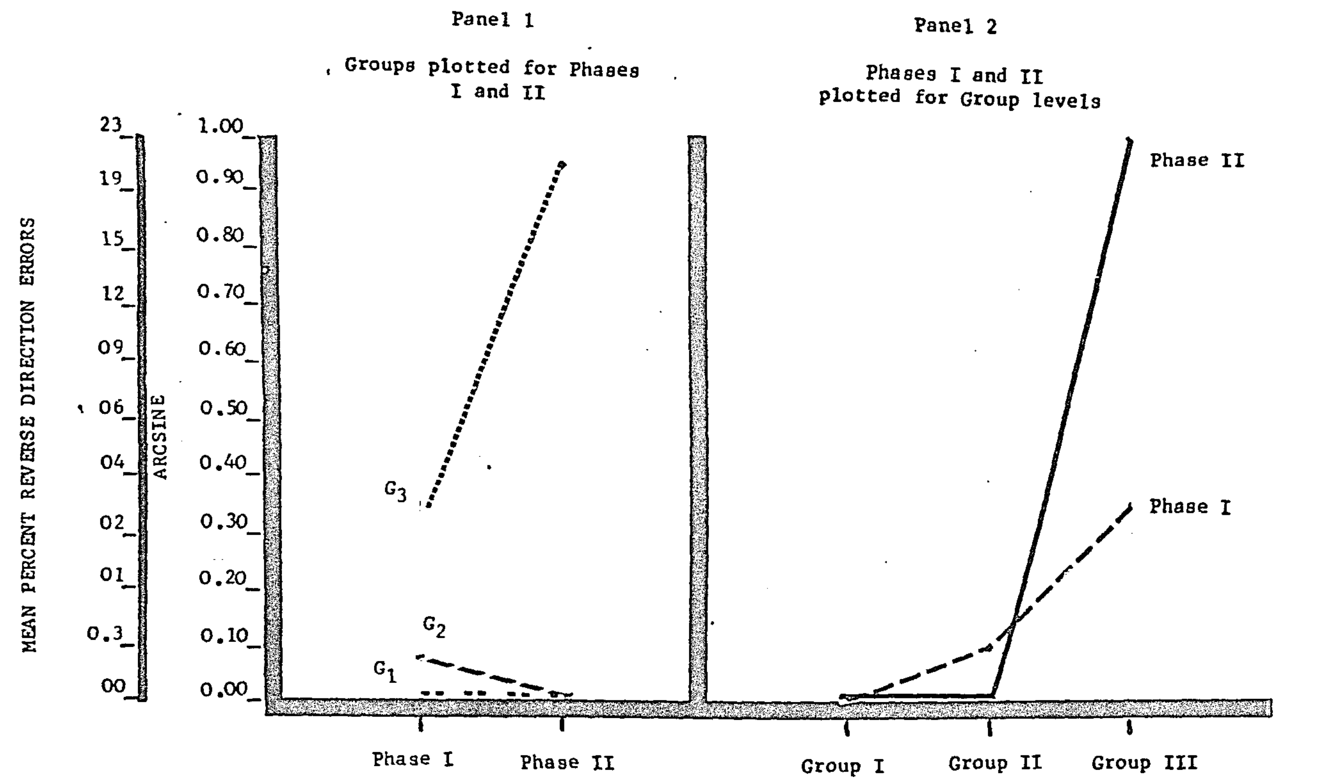

Figure 37. Production Analysis for percent reverse direction errors showing the Group by Phase interaction. Panel 1 shows Groups plotted at Phase levels, and Panel 2 shows Phases plotted at levels of groups.

These errors occurred very infrequently; only about 1 percent of the total possible errors made by Group III were reverse subject-object errors.

Reverse Subject-Object and Direction Errors: Production Analysis for Phases I and II. The error response class called reverse subject-object and direction combined both reversing the direction of "to" and "away from" sentences, as well as reversing the subject and the object. These instances were so infrequent that the production analysis for these types of errors yielded no statistically significant effects.

Reverse Direction Errors: Comprehension Analysis for Phase I. The comprehension analysis for Phase I yielded no significant effects when reverse direction errors were used as the dependent measure.

Subject-Subject Errors: Comprehension Analysis for Phase I. The dependent measure, subject-subject errors, included those comprehension responses made when the child constructed a puzzle of which both pieces represented the subject (e.g., Girl-Girl). The same Phase I comprehension analysis used for the percent correct data was performed on the arcsine transformations of the subject-subject error data, yielding a significant Group (G) main effect (see Figure 38), $F(2,12) = 9.28$, $p < .01$. Tukey's HSD formula applied to the group means indicated that the youngest group made significantly more subject-subject errors (25 percent) than either Groups I or II, who never made this type of error.

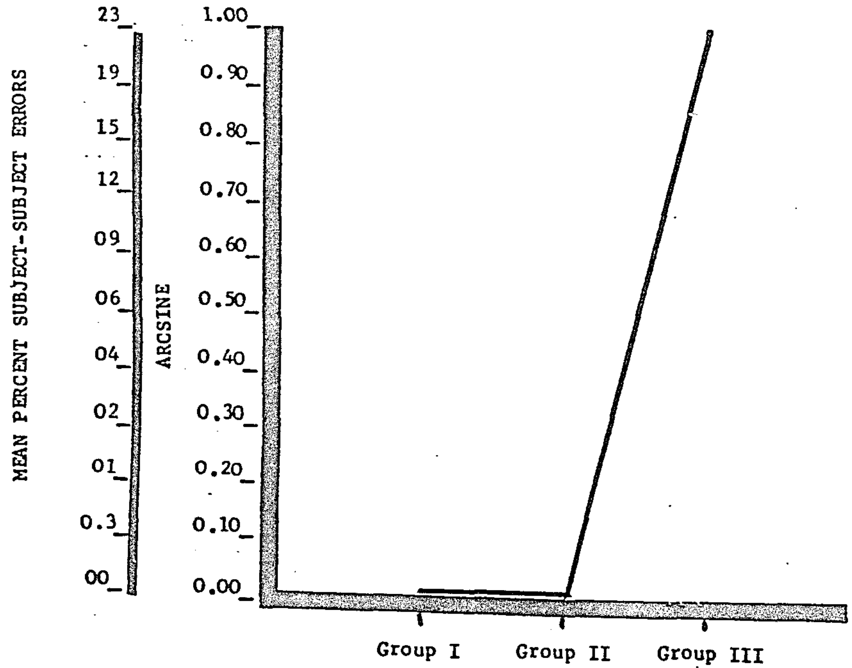

Figure 38. Comprehension Analysis for Phase I showing the significant Group main effect for subject-subject errors.

The strength of association index (ω^2) indicated that the Group main effect accounted for 27 percent of the variance in the subject-subject error data.

<u>Object-Object Errors: Comprehension Analysis for Phase I</u>. The error response class called object-object involved those instances in which the child constructed a puzzle from two object alternatives (e.g. Tree-Tree). The comprehension analysis performed on the arcsine transformations of the object-object error data yielded a significant main effect for Groups, F (2,12) = 7.08, $p < .01$, and a significant Group by Sentence Type interaction (GxE), F (4,12) = 4.10, $p < .05$.

The Group by Sentence Type interaction is represented by Figure 39. Panel 1 shows groups plotted at all three sentence types where E_1 = animate subject/inanimate object, E_2 = inanimate subject/animate object, and E_3 = inanimate subject/object, and animate subject/object sentences. As can be seen from Panel 1, Group III made significantly more object-object errors than either Groups I or II in the animate subject/inanimate object condition (E_1), as well as in the redundancy condition (E_3) where both subject and object are animate, or both are inanimate (Scheffe, $p < .05$, c.v. = .74). For the sentences containing an inanimate subject and animate object (E_2), the performance of the three groups did not differ significantly. As can be seen from Figure 39, Groups I and II almost never made object-object errors during the

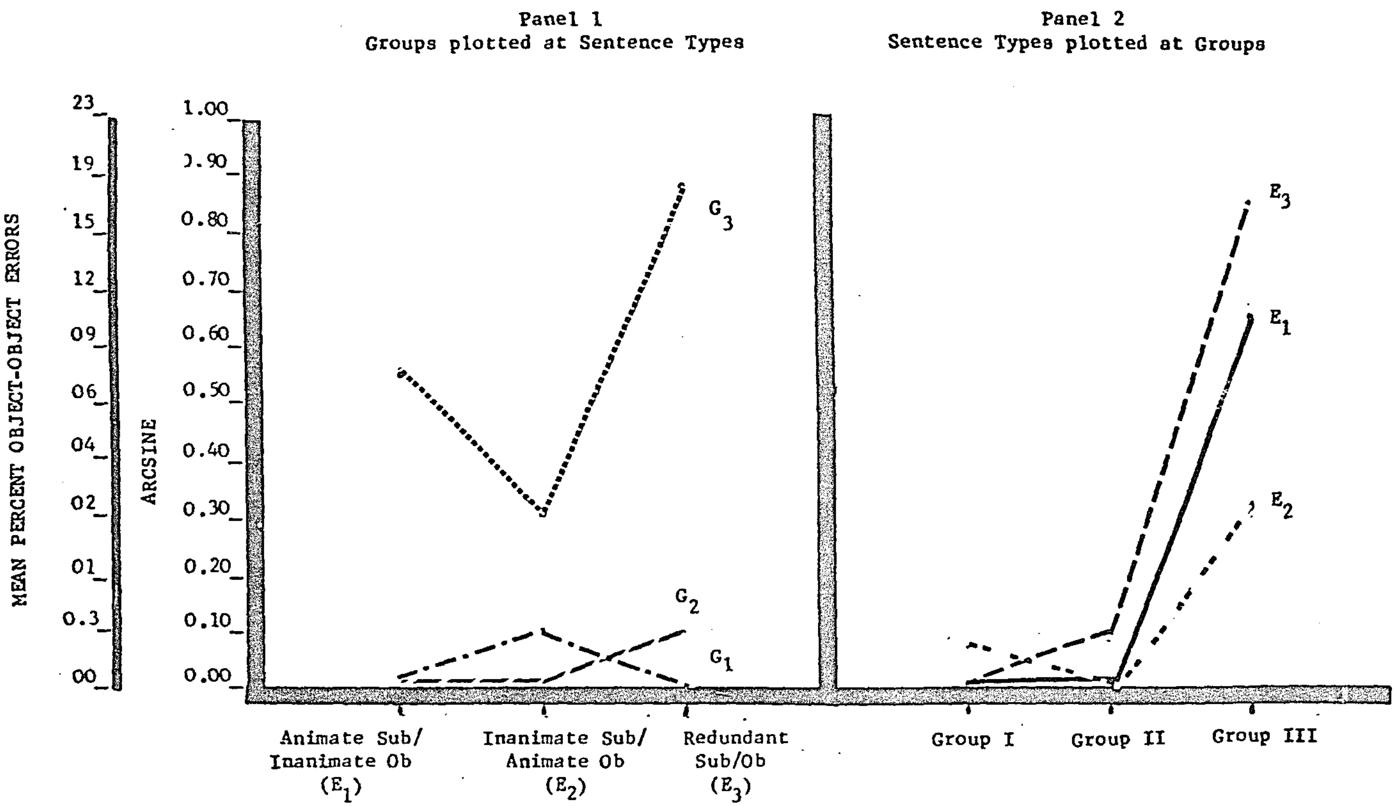

Figure 39. Group by Sentence Type interaction for Phase I Comprehension Analysis. Panel I shows Groups plotted at animate subject/inanimate object sentences (E_1), inanimate subject/animate object sentences (E_2), and redundant subject/object sentences (E_3). Panel 2 shows the three types of sentences plotted at the three age levels.

comprehension trials of Phase I. However, the youngest group did construct puzzles where both subject and object pieces were represented with only object pictures. This object-object strategy used by the youngest group was less frequent in the inanimate subject/animate object sentences than in the E_1 and E_3 sentences. This finding is again clearly seen in Panel 2, where object-object errors for the youngest group occurred 11 percent of the time in animate subject/inanimate object sentences (E_1), 3 percent of the time in inanimate subject/animate object sentences (E_2), and 17 percent of the time in the redundant subject/object sentences (E_3). This redundant sentence type differed from the other two at the .05 level of confidence (Scheffe, c.v. = .42). Although interesting, this Group by Sentence type interaction accounted for only 3 percent of the variance (as indicated by the ω^2 calculation). The Group main effect, however, accounted for 25 percent of the variance and is shown in Figure 40. Group III differed significantly from the other two groups (Tukey HSD, $p < .05$, c.v. = .385) in the number of object-object errors made during the comprehension condition of Phase I.

<u>Other Errors: Comprehension Analysis for Phase I</u>. The unscoreable responses comprising that class of errors termed "other" did not yield any significant effects. Thus, for the comprehension error analysis for Phase I, Group III made significantly more subject-subject, and object-object errors than

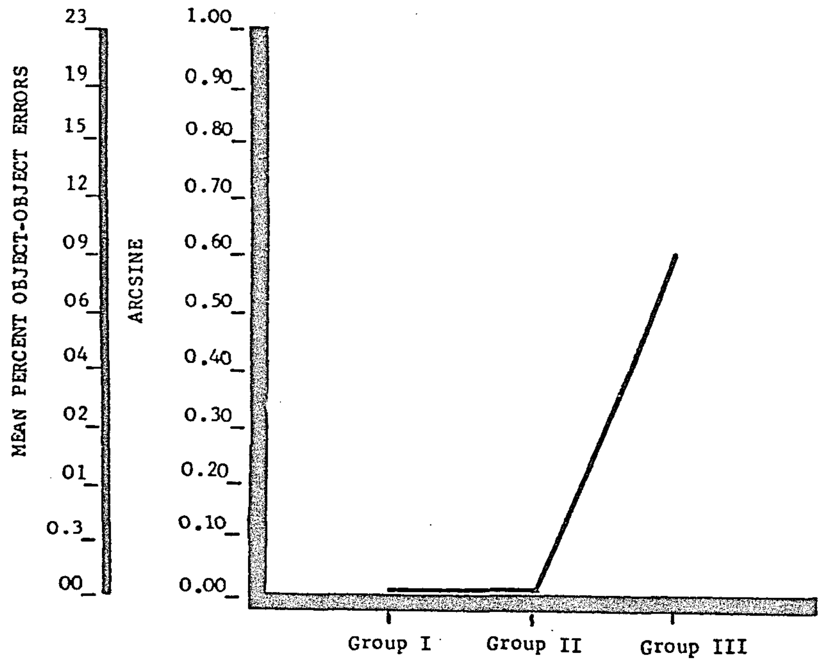

Figure 40. Comprehension Analysis for Phase I showing the significant Group main effect for object-object errors.

either of the older groups when constructing "to" sentences from puzzle pieces where the alternatives were two subjects and two objects. Moreover, the Group by Sentence Type interaction did not account for much of the variance in the data.

Reverse Direction Errors: Comprehension Analysis for Phase II. The Phase II comprehension analysis for the arcsine transformations of the reverse direction data yielded the following significant effects:

Group (G), $F(2,12) = 9.61$, $p < .01$

Group by Direction (GxD), $F(2,12) = 4.56$, $p < .05$

Group by Sentence Type (GxE), $F(2,12) = 4.07$, $p < .05$

Group by Direction by Sentence Type (GxDxE), $F(2,12) = 6.236$, $p < .05$

The strength of association index (ω^2) indicated that most of the variance was accounted for by the Group main effect ($\omega^2 = 16$ percent). The Group by Direction interaction accounted for 2 percent, and the Group by Sentence Type interaction accounted for less than 1 percent of the total variance. The three-way interaction only brought the omega squared (ω^2) value to 3 percent. These utility indices are understandably small, in light of the small proportion of reverse direction errors made through the comprehension condition of Phase II (no more than 23 percent).

The Group by Direction by Sentence Type interaction is shown in Figure 41. Panel 1 shows the Group by Direction interaction for the animate subject/inanimate object sentences (E_1) and for the redundant subject/object (E_2)

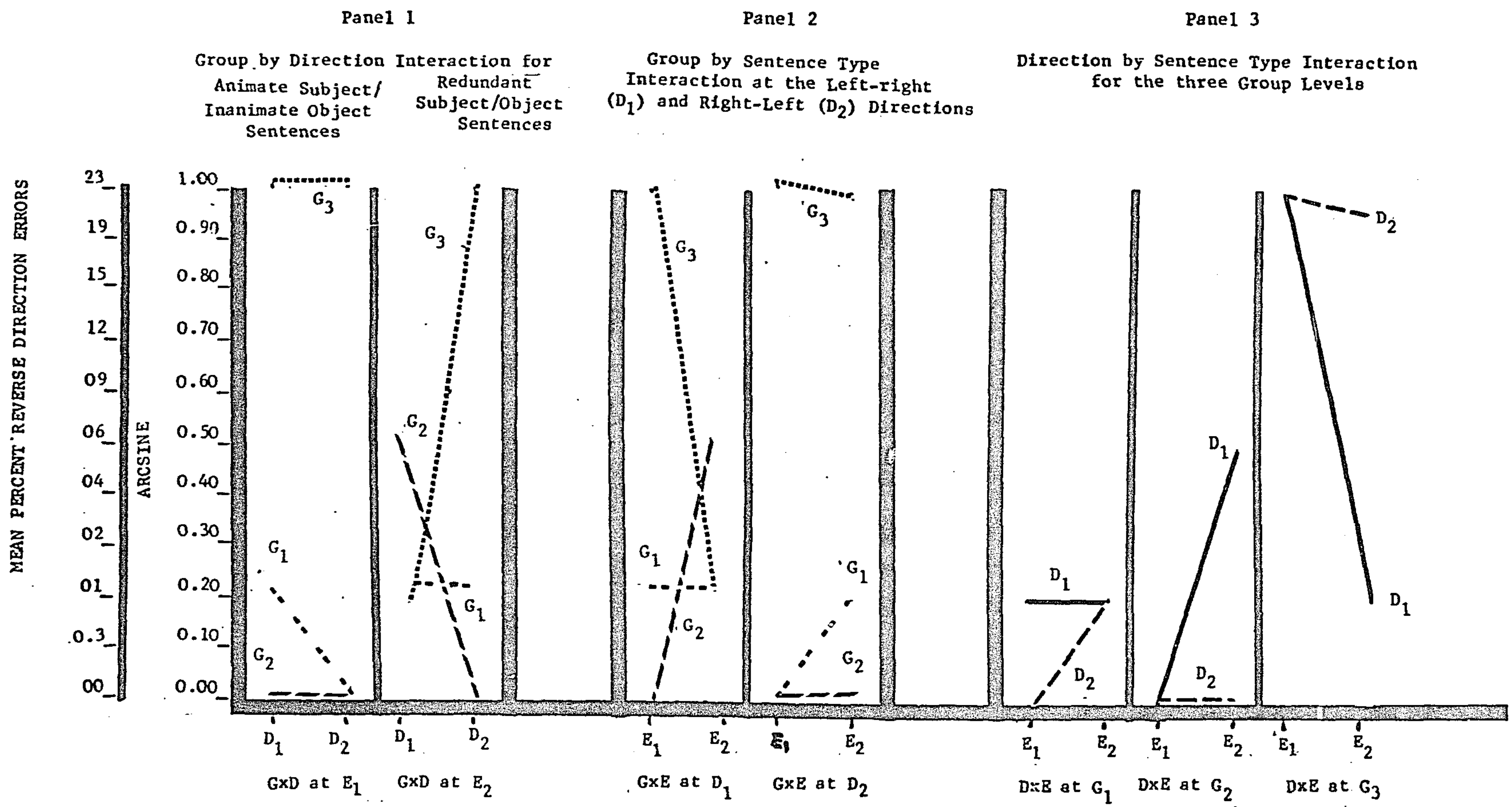

Figure 41. Phase II Comprehension Analysis for total percent reverse direction errors showing the significant Group by Direction by Sentence Type interaction.

sentences (GxD at E). Panel 2 shows the Group by Sentence Type interaction for both the L-R (D_1) and for the R-L (D_2) stimulus direction levels (GxE at D). Panel 3 shows the Direction x Sentence type interaction at all group levels (DxE at G).

Group III made significantly more reverse direction errors than either of the older groups when the stimulus sentences were of the E_2 form, irrespective of direction, as is illustrated in Panel 1 (GxD at E). Moreover, Group III made more reverse direction errors than the intermediate Group II in the R-L (D_2) condition, but did not differ from the other groups during the L-R (D_1) condition.

Thus, it appears that sentences of the redundant subject/object form are more difficult for the older groups to construct when the verbal and visual stimuli match in direction. This difficulty accounts for the similarities in group performance (Group I = 1 percent, Group II = 6 percent, and Group III = 1 percent). In the verbal and visual stimulus mismatch condition, however, the youngest group made more errors (25 percent) than the intermediate group (0 percent). Although the reverse direction errors made by the oldest group only comprised 1 percent, the difference between Group I and the youngest group did not reach statistical significance.

For the animate subject/inanimate object sentence forms, the youngest group had more reverse direction difficulty in both the L-R (Group I = 1 percent, Group II = 0 percent, Group III = 30 percent) and R-L (Groups I and II = 0 percent, Group III = 30 percent) conditions.

Inspection of Panel 2 (GxE at D) discloses that Group III made significantly more reverse direction responses than Group II for the animate subject/inanimate object sentences (E_1) in the L-R condition (30 percent versus 0 percent). However, Group III did not differ from the other groups when the sentences were of the redundant subject/object form (E_2), (Scheffe, $p < .05$, c.v. = 1.17). Similar findings were seen when the stimuli were presented in the R-L direction: the youngest group differed significantly from both groups during E_1 sentences, but not for E_2 sentences.

Again, the redundant subject/object sentences were more difficult than the animate subject/inanimate object sentences at both directions of stimulus presentation. The (DxE at G) interaction, shown in Panel 3, did not reach significance (Scheffe, $p < .05$, c.v. = 1.04).

The Group by Direction by Sentence Type interaction for reverse direction errors shows that the youngest group consistently made more reverse direction errors than did the other groups. However, the number of reverse direction errors made by Groups I and II increased in sentences of the redundant subject/object form, while the number of these errors made by Group III decreased. This resulted in similar performances in the L-R and R-L conditions.

Other Errors: Comprehension Analysis for Phase II. The Phase II analysis for the arcsine transformations of "other" errors yielded a significant main effect for Groups, F (2,12) = 6.429, $p < .05$). The Tukey HSD formula was applied to the group means ($p < .05$, c.v. = .274) resulting in the finding that Group III (18 percent) differed significantly in the number of "other" errors made by Group II (4 percent) and Group I (less than 1 percent), and that Groups I and II also differed significantly. This effect is represented in Figure 42.

No Direction Errors: Comprehension Analysis for Phase II. When choosing among three subject alternatives in the Phase II comprehension task, the child could make two types of errors. He could choose a subject moving in the wrong direction (a reverse direction error), or he could choose a subject portrayed as having no observable action and could therefore not be the "agent" in the sentence. Selection of such a subject resulted in a "no-direction" error.

The Phase II comprehension analysis performed on the arcsine transformations of the "no direction" errors yielded a significant main effect due to sentence type, F (1,12) = 12.7762, $p < .01$ (refer back to Figure 42). More no-direction errors occurred during the redundant subject/object sentences (10 percent) than during the animate subject/inanimate object sentences (1 percent).

Thus, it appears that the no-direction error is peculiar to the type of sentence presented to the child, namely the

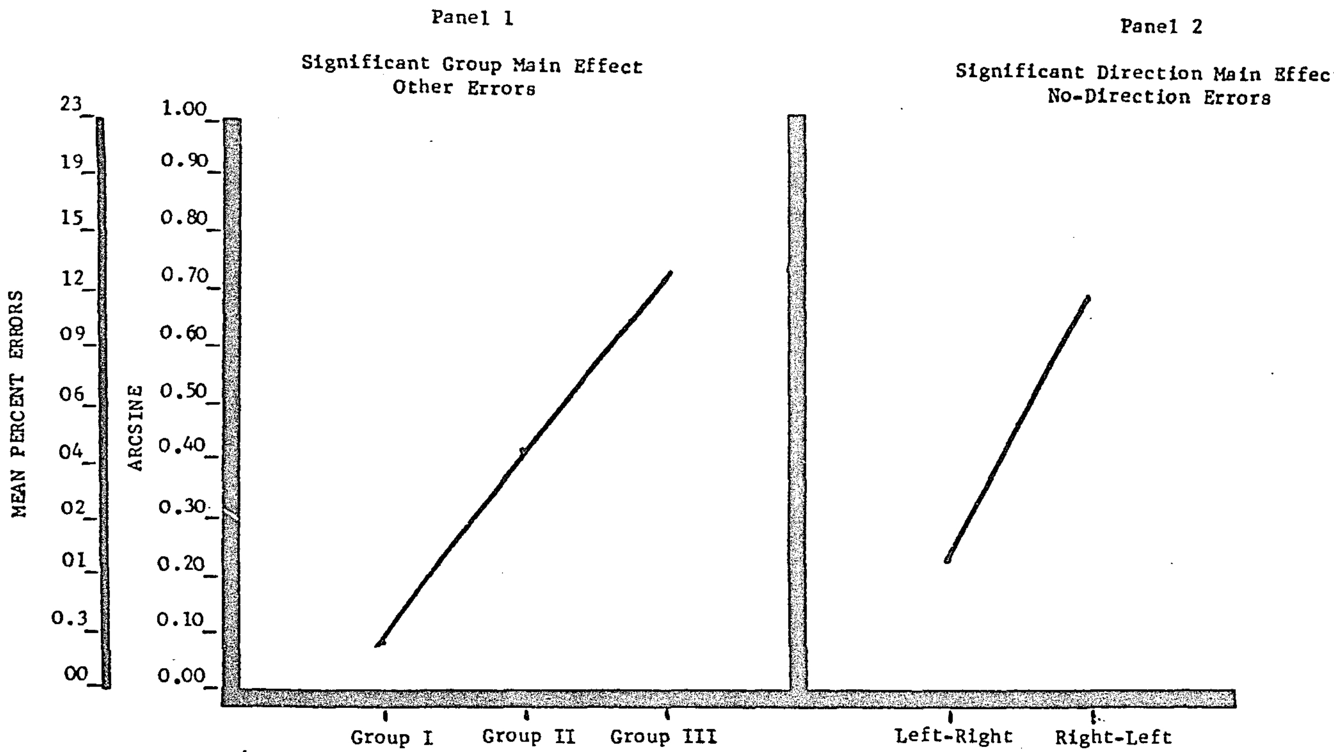

Figure 42. Phase II Comprehension Analysis for total percent "other" errors (Panel 1) showing the significant Group main effect, and total percent no-direction errors (Panel 2) showing the significant Direction main effect.

redundant subject/object sentence. Although this effect is statistically significant, it has limited utility in accounting for the data variance (ω^2 = 5 percent).

Reverse Direction Errors: Phase II "To" Sentences. The Phase II analysis performed on the arcsine transformations of the reverse direction error data for the "to" sentences yielded a significant Group (G) main effect, F (2,12) = 10.86, $p < .01$, a significant Task by Direction by Sentence Type (TxDxE) interaction, F (1,12) = 4.99, $p < .05$, and a significant Group by Task by Direction by Sentence Type (GxTxDxE) interaction, F (2,12) = 4.99, $p < .05$).

For the four-way (GxTxDxE) interaction, only the significant three-way interactions are plotted in Figure 43. These involved Panel 1, showing Group by Task at levels of Sentence Type (Scheffe, $p < .05$, c.v. = .16); Panel 2, showing Task by Direction at levels of Sentence Type (Scheffe, $p < .05$, c.v. = .16); Panel 3, showing Direction by Sentence Type at levels of comprehension and production (Scheffe, $p < .05$, c.v. = .34); and Panel 4, showing Direction by Sentence Type at levels of comprehension and production (Scheffe, $p < .05$, c.v. = .34).

Panel 1 illustrates the Group by Task interaction at both the animate subject/inanimate object sentences (E_1) and the redundant animate subject/object, inanimate subject/object sentences (E_2). Group III made significantly more errors than Group II, and Group I made significantly more errors than Group II, during the E_1 sentences when the task was production.

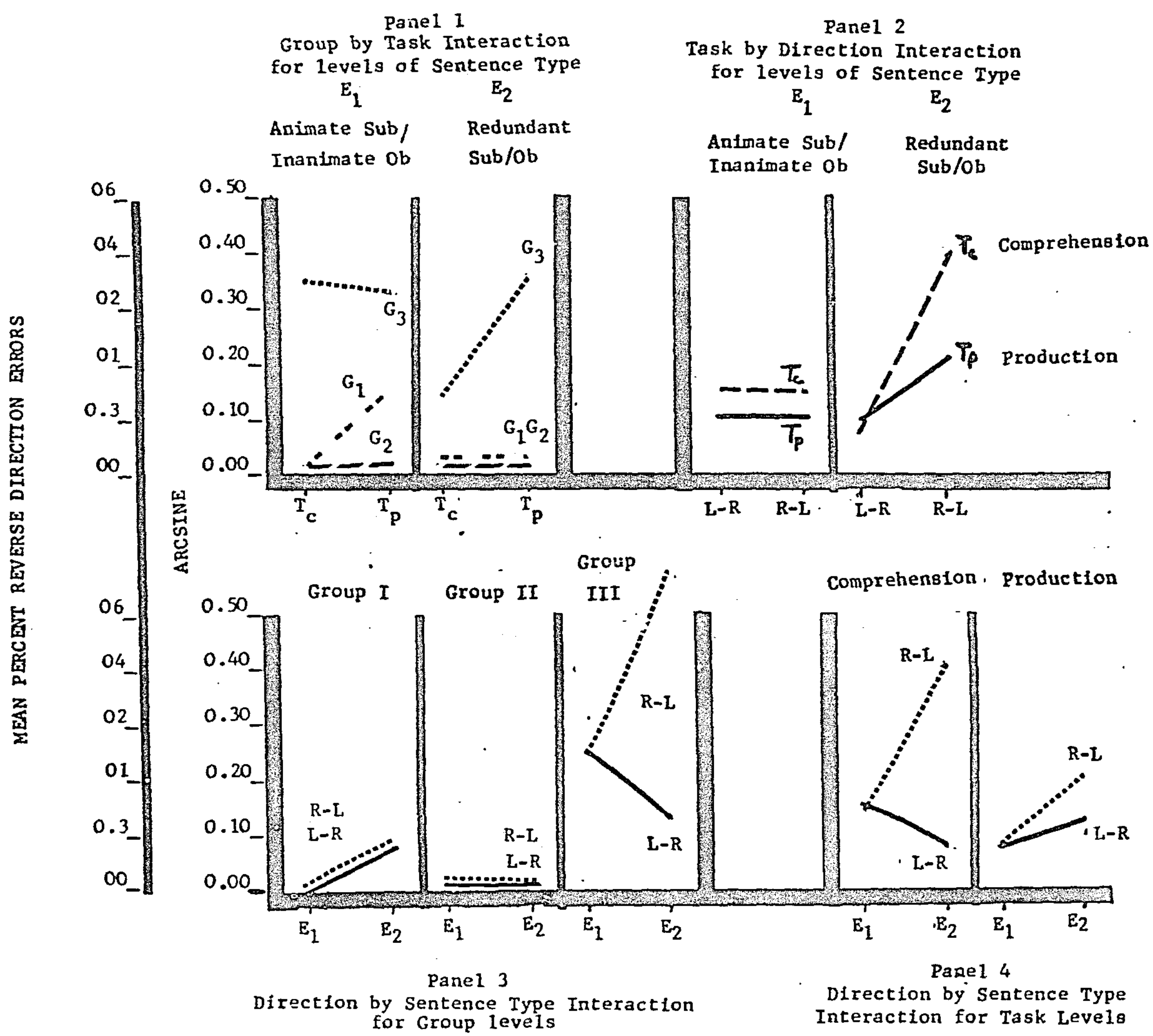

Figure 43. Phase II Comprehension Analysis, "To" sentences for percent reverse direction errors showing the significant three way interactions. Panel 1 = GxTxE, Panel 2 = TxDxE, Panel 3 = DxExG, Panel 4 = DxExT.

However, for the redundant E_2 sentences, both Groups I and II made fewer errors than Group III on both comprehension and production tasks.

Panel 2 shows the Task by Direction interaction for both sentence types. The only statistically significant difference in reverse direction errors in the redundant subject/object sentence condition was that more reverse direction errors were made when the task was comprehension than when the task was production.

Panel 3 shows the Direction by Sentence Type interaction at the three age groups. The redundant subject/object sentences were more difficult for Group III when the verbal and visual stimuli were mismatched (R-L) than when they were matched (L-R).

Panel 4 shows the Direction by Sentence Type interaction at Comprehension (T_c) and Production (T_p) task levels. In the comprehension tasks, redundant sentences were more difficult to construct in the R-L stimulus presentation condition than in the L-R stimulus presentation condition.

Thus, the Group by Task by Direction by Sentence Type interaction for the reverse direction error data for "to" sentences shows that the youngest group consistently made more reverse direction errors when comprehending and producing both sentence types than the other groups with one exception. The oldest group had more difficulty in producing animate subject/inanimate object sentences than did the intermediate group, and performed at about the same level as the youngest group. Although these differences are statistically significant, inspection of the percentages involved discloses that the number of errors were, in fact, quite small (0.3 percent for Group I, 0 percent for Group II, and 3 percent for Group III). Moreover, redundant sentences were more difficult to construct (comprehend) than animate subject/inanimate object sentences, only when the visual and verbal stimuli were mismatched in terms of directional presentation.

Reverse Direction Errors: Phase II "Away From" Sentences. The Phase II analysis for reverse direction errors performed on the arcsine transformations of these errors for the "away from" sentences yielded a significant Group main effect, $\underline{F}$ (2,12) = 25.948, $\underline{p} < .001$), and a significant Group by Task by Sentence Type (GxCxE) interaction, $\underline{F}$ (2,12) = 4.60, $\underline{p} < .05$. The Group by Task by Sentence Type interaction is represented in Figure 44. Panel 1 shows the Group x Task interaction at both sentence types, where the Scheffe critical value at $\underline{p} < .05$ was .728. Panel 2 shows the Group x Sentence Type interaction at both the comprehension (T_c) and production (T_p) task levels, where the Scheffe critical value at the .05 level was 1.2. For Panel 3, the Task x Sentence Type interaction at the three group levels required a critical value of 1.4 to reach statistical significance at the .05 level (Scheffe).

The post hoc analyses of the Group by Task interaction at the two sentence types (Panel 1) indicated that Group III

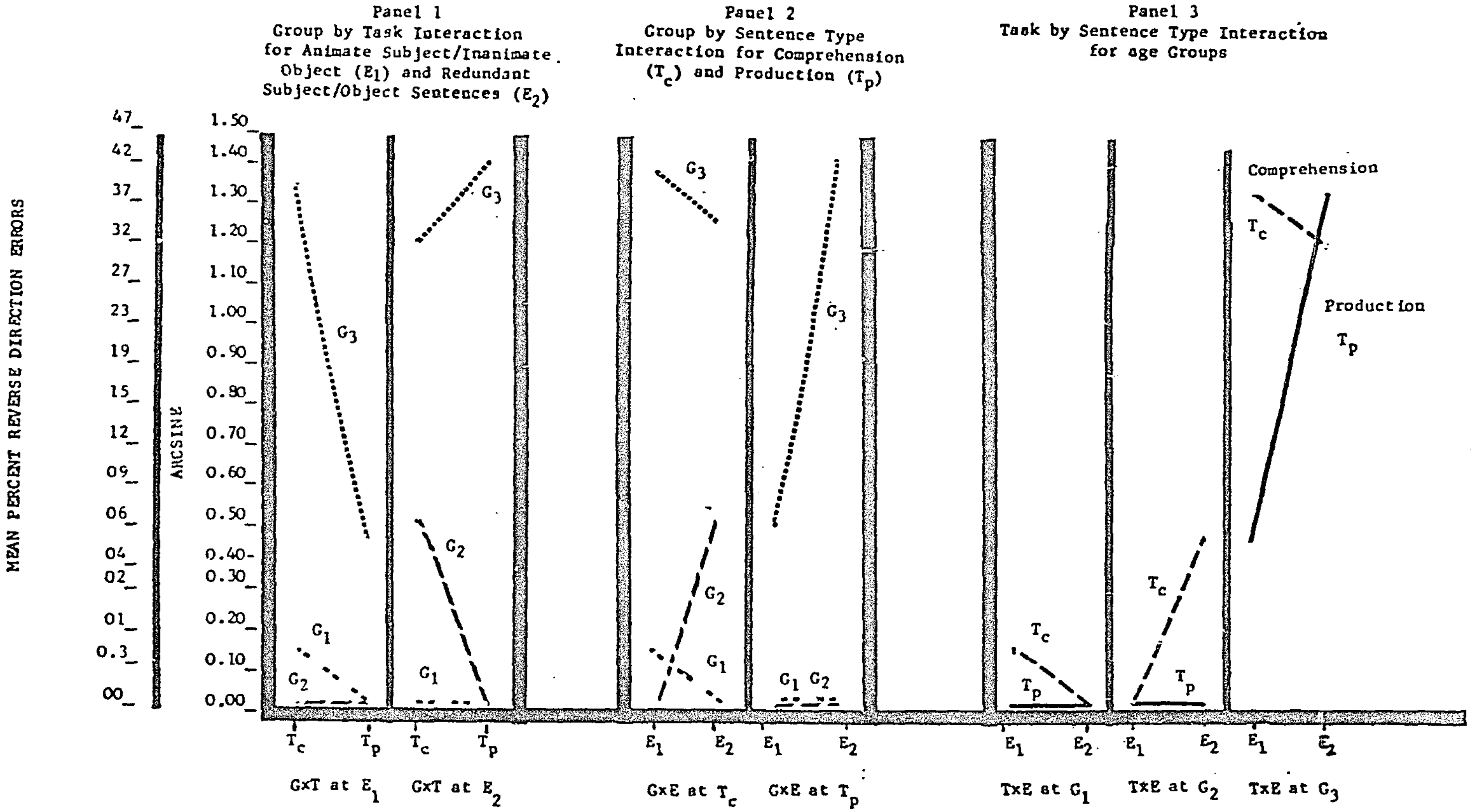

Figure 44. Phase II Comprehension Analysis, "Away From" sentences for total percent reverse direction errors showing the significant Group by Task by Sentence Type interaction.

made significantly more reverse direction errors than Groups I or II in comprehension of animate subject/inanimate object sentences (Group III = 42 percent, Group II = 0 percent, Group I = .7 percent, and in comprehension (Group III = 34 percent, Group II = 6 percent, Group I = 0 percent) and production (Group III = 42 percent, Group II = 0 percent, Group I = 0 percent) of the redundant subject/object sentences. The groups did equally well when the task was to produce animate subject/inanimate object sentences correctly.

The post hoc analyses of the Group by Sentence Type interaction at comprehension and production task levels (Panel 2) indicated that Group III differed from Groups I and II in comprehension of animate subject/inanimate object sentences (Group III = 42 percent, Group II = 0 percent, Group I = 0.7 percent), and production of redundant subject/object sentences (Group III = 42 percent, Group II and Group I = 0 percent). However, in comprehension of redundant sentences, Group I (0 percent) made significantly fewer reverse direction errors than either Groups II (6 percent) or III (34 percent).

The Task by Sentence Type interaction shown in Panel 3 did not reach significance. Thus, analysis of the Group Task by Sentence Type interaction found in the reverse direction data for "away from" sentences indicated that the direction of the verbal and visual stimuli had no significant effect. Moreover, the youngest children consistently performed at a lower level than either the intermediate or the oldest age groups when constructing puzzles of both animate subject/inanimate object sentences, and when constructing and labeling redundant subject/object sentences. Labeling the animate subject/inanimate object sentences was no more difficult for the younger children than for the older age groups.

The intermediate group performed as well as the oldest group, except when puzzle construction of redundant subject/object sentences was required. On this task, the intermediate group performed like the youngest group of children.

Experimental Post Test Results

The post test for L-R--R-L equivalence was performed to ascertain whether the children found the L-R and R-L puzzle construction tasks logically equivalent. Bias for one direction or the other would have been incorporated into a correction formula for those particular data had a direction main effect been found. Since directionality interacted with several other variables and did not solely control either comprehension or production responses, no correction formula was employed. Since a correction was unnecessary, no further analyses were performed on the post test data. The results of the post test data are shown in Appendix A.

Strategy Analysis Results

Although each child's strategy was carefully coded, significant data were lost when the children either (a) moved too quickly for accurate coding, or (b) visually scanned the puzzle alternatives for long periods of time, not touching any of them until ready to make a final construction. Due to these coding obstacles, the strategy analysis was not examined further.

CHAPTER V

DISCUSSION

The present investigation was designed to answer two inter-related questions. The first question dealt with the nature of the developmental sequence postulated to exist between the processes of comprehension and production of language by the non-fluent child. Specifically, these processes were investigated with reference to sentences having the syntactic form: Subject-Verb-Object of the prepositional phrase, when two relational terms, "to" and "away from" were used as the sentence prepositions. Answers to this question were sought through the examination of possible performance differences for comprehension and production tasks, by children who were in developmentally different linguistic stages, but who demonstrated subject-verb-object forms in their own productions.

On the basis of previous research, it was predicted that the production of sentences having correct syntactic subject-verb-object orderings would precede the comprehension of sentences having this ordering, when the syntactic structure itself (word order) was used as the sole cue for deep structure subject and object relations, in less linguistically developed children.

The second question dealt with the type of variables controlling correct comprehension and production responses in children of different stages of linguistic development (defined by age and cognitive development scores). Answers to this question were sought through examination of the number and type of errors made to extralinguistic (semantic) factors such as animacy of the subject and object, extra-semantic factors such as directional correspondence between verbal and visual sentence presentations, and the complexity of non-linguistic cues such as having to choose among three subjects and one object, or among two subjects and two objects. Finally, the effect of linguistic (syntactic) variables such as word order was assessed through the comprehension-production score comparisons.

<u>Comprehension and Production</u>

Correct productions of subject-verb-object orderings were found to exceed correct comprehension of such sentences, when the form of the sentence was Subject-Verb-"to"-object, and the comprehension task involved choosing the correct puzzles from two subject and two object alternatives. This main effect due to task for the Phase I analysis (see Figure 27) was significant ($p < .001$). Children made 97 percent correct labeling responses, but only 59 percent correct construction responses.

However, when the form of the sentence was Subject-Verb-"to"-object, but the comprehension task involved choosing the correct puzzles from three subject and one object alternative, correct productions of subject-verb-object orderings were not found to exceed comprehension of these sentences for the two older groups of children. For these children, comprehension and production scores did not differ significantly. Group III, the youngest group, however, performed significantly better on production tasks (85 percent) than on comprehension tasks (46 percent). These findings can be seen in Figure 31 for the Phase II analysis, where the Group by Task interaction for "to" sentences was significant at the .05 level of confidence.

When the comprehension task involved choosing the correct puzzles from among three subject and one object alternative, correct productions of subject-verb-object orderings were found to exceed correct comprehension of such sentences when the relational term "away from" was the preposition. This significant Task main effect ($p < .05$) in the Phase II analysis for the "away from" sentences can be seen in Figure 33. Children made 92 percent correct labeling responses but only 75 percent construction responses during this experimental phase.

Thus, the conclusion that production exceeds comprehension in children between the ages of 3-5 must be qualified. In sentences containing a prepositional phrase employing the relational term "to," the comprehension-production gap seems to be a function of the type of comprehension task required of the child. When the task requires the child to choose among three subjects and one object, the comprehension-production gap closes for children above the age of 3 years, 10 months. For children below this age, however, production exceeds comprehension. However, although the three subject-one object comprehension task produced no comprehension-production differences for the "to" sentences in the older children, significant comprehension-production differences were found for all children when the relational term was "away from." Moreover, when the task required the child to discriminate among two subjects and two objects, comprehension in all age groups lagged behind production. Thus this task appears to increase the comprehension difficulty.

In summary, whether correct productions of subject-verb-object orderings exceed the correct comprehension of sentences containing subject-verb-object orderings depends on (a) the type of comprehension task employed, (b) the specific relational term used in the sentence, and (c) the age and cognitive development of the child (as measured by the McCarthy Scales of Children's Ability). This conclusion is reflected in the significant Group by Phase by Task interaction derived from the Phase by Phase analysis, reflected in Figure 24, where the "to" sentences in Phase I were compared with both the "to" and "away from" sentences in Phase II. The Group by Task interaction was found to be significant.

Semantic Control of Comprehension and Production

Animacy of Subject and Object. Sentences having (a) animate subject/inanimate object, (b) inanimate subject/animate object, and (c) redundant subject/object (i.e., animate subject/

animate object, or inanimate subject/inanimate object) exerted no differential semantic control of either comprehension or production responses for groups during Phase I "to" sentences. For Phase II "to" sentences, and Phase II "away from" sentences, where only (a) animate subject/inanimate object and (b) redundant subject/object sentences were compared, comprehension and production responses were not differentially affected. Thus, the semantic control exercised by "animacy of the subject-factors" for younger children (Bever, 1970; Bloom, 1974; Chapman & Miller, 1975) was not found with children aged 3-5 years when comprehension and production responses were compared.

Extra-semantic Control of Comprehension and Production by Directionality

Directionality was not found to exercise differential control of comprehension and production for Phase I "to" sentences, or Phase II "away from" sentences. For Phase II "to" sentences, however, the significant Group by Direction by Sentence Type interaction (cf. Figure 32) showed that the youngest children made significantly fewer correct comprehension and production responses (27 percent) than either Group I (99 percent) or Group II (99 percent), when sentences contained redundant semantic variables (i.e., animate subject/object, or inanimate subject/object), in the R-L condition. Although this same trend occurred for the L-R condition for the redundant sentences and for the L-R and R-L conditions of the animate subject/inanimate object sentences, these latter differences between the younger and older children were not significant. Thus, when the verbal stimulus followed a L-R progression but the puzzle construction required a R-L progression, directionality interacted with sentence type to depress responding in children between the ages of 3 years 0 months and 3 years 10 months.

Extra-semantic Control of Comprehension and Production by Non-linguistic Cues

When Phase I "to" sentences and the combined "to" and "away from" sentences in Phase II were compared, significant interactions were found for Group by Phase by Task (cf. Figure 24), Group by Task by Direction (cf. Figure 25), and Phase by Task by Direction (Figure 26). Appendix B summarizes the correct response data for the two phases at comprehension and production tasks. Inspection of this Appendix shows that the younger children performed significantly more poorly than both older groups in Phase I comprehension. Although the comprehension scores in Phase II followed the same trend as those in Phase I, only the Group I and III response differences were significant. Production scores for the three groups were not significantly different for the first experimental phase, but the younger groups made significantly more incorrect production responses in the second experimental phase than did either of the older groups.

Although the comprehension differences for the youngest group implied that Phase I was the more difficult a task, the percentages did not reach statistical significance. Appendix C summarizes the response data for the Group by Task by Direction interaction. The youngest children made significantly more comprehension and production errors in the L-R sentences and more production errors in the R-L sentences than the older children. During comprehension of R-L sentences, however, all three groups differed significantly, but only the intermediate group made more errors during the R-L condition than the L-R condition for comprehension. Thus, for the intermediate group of children, (mean age 4 years, 1 month), the mismatching of verbal and visual stimuli had a disruptive effect on comprehension, regardless of Phase (task alternatives). Correct comprehension for the youngest group was already so much below chance that the introduction of a directional stimulus change had no appreciable effect. The oldest group, who performed at almost 100 percent in both directions of comprehension, was not controlled by a directional change.

The Phase by Direction by Task data are summarized in Appendix D. Comprehension lags behind production for both experimental phases. Furthermore, production responses are not controlled by direction in either phase: the only phase difference occurred during R-L Comprehension. More correct comprehension responses were made when the child had to choose among three subjects and one object, than among two subjects and one object. Thus, in the condition where verbal and visual stimuli were in opposite directions, i.e., in the Phase I two-subject and two object alternative comprehension task, the task provided nonlinguistic cues which served to decrease correct comprehension responses.

Thus, in summary extra-semantic cues such as direction of the verbal and visual stimuli were found to control comprehension performance in the intermediate aged children, and extra-semantic cues such as task complexity, in interaction with stimulus direction, were shown to control overall comprehension performance.

Production

Production responses in both phases of the experimental task were found to be controlled solely by age variables. Both Phase I and II production responses for the two older groups was near 100 percent correct. On the other hand, the youngest group had significantly fewer correct production responses. Thus, production of correct subject-verb-object orderings was not affected by the particular relational term used as the preposition since there was no Group by Phase interaction, nor did Sentence Type or Direction affect production.

Comprehension

Phase I comprehension which required the child to choose among two subject and two object alternatives for sentences with the relational term "to" was controlled primarily by age variables. Both Groups I (97 percent) and II (93 percent) made significantly more correct responses than did the youngest group (38 percent). Neither verbal and visual directional factors nor sentence type had any significant effects on comprehension in this Phase.

Phase II comprehension which required the child to choose among three subject and one object alternatives for sentences involving both the relational terms "to" and "away from" were similarly controlled by age factors. Both Groups I (98 percent) and II (90 percent) made significantly more correct responses than Group III (23 percent) Moreover, although a significant Direction main effect indicated that more correct responses were made in the R-L condition (87 percent) than in the L-R condition (75 percent), this effect accounted for less than 1 percent of the variance in the data. Nonetheless, since most language studies on children have not reported the percentage of variance accounted for in their data, consideration of the percentages *per se* are in order if data comparisons are to be made with other language studies.

Comprehension and Production Strategies

Production. The production analysis yielding a significant Group by Phase interaction for reverse direction errors and a significant Group main effect for reverse subject and object errors is summarized by Appendix E. As Appendix E shows, Group III made significantly more reverse direction errors than either of the other groups, and significantly more reverse direction errors were made during Phase II than during Phase I. Group III also made significantly more reverse subject and reverse object errors than either of the other groups. However, in the case of the Phase I reverse direction errors and in the case of the reverse subject and object errors, these results are somewhat misleading since Group III had an error rate of only 3 percent in each case, while the remaining children had no such errors.

Nevertheless, the errors made during Production trials were made by the youngest group. These errors consisted of saying "to" when "away from" was appropriate, or saying "away from" when "to" was appropriate. Particularly in Phase II, where both "to" and "away from" stimulus constructions were employed, having both prepositions served to confuse the children who possibly did not understand the meaning of "away from," even though they were introduced to this preposition during pretesting.

Reverse subject and object errors were made less frequently, but when they occurred, they were made by the youngest group. This type of error involved reversing the subject and the object, but using the preposition correctly. It was possible to make a third type of error, which happened so infrequently that no significant statistical effects were found. This error involved the youngest group and consisted of making a reverse direction error in conjunction with reversing the subject and the object.

Comprehension Strategies

Phase I. Although the Phase I analysis indicated that significantly more reverse direction errors were made during comprehension trials (11 percent) than during production trials (0.5 percent), the Comprehension Analysis for Phase I yielded no significant effects when reverse direction errors were measured.

Appendix F summarizes the significant Group Main effect for both subject-subject errors and object-object errors. The Group by Sentence Type interaction for object-object errors is also shown in Appendix F, although this effect was very small (ω^2 =.03%). As can be seen from the appendix, only the youngest group made subject-subject and object-object errors, both of which would have been highly improbable had the child been attending to both the subject and the object terms and recognized that subject and object had a specified relation to one another. The Group by Sentence Type interaction for object-object errors showed that significantly more errors were made by the youngest group during redundant subject-object sentences and animate subject/ inanimate object sentences than during inanimate subject/ animate object sentences. These results were not expected in light of Chapman and Miller's (1975) findings that very young children made fewer responses in the animate subject/inanimate object category than in the inanimate subject/animate object category. These sentence types are probably more frequently represented in the speech the child normally hears, and therefore carry more semantic probability information (Chapman & Miller, 1975). The present findings are in direct opposition to those reported by Chapman and Miller when object-object errors are made. However, these errors were made only 9 percent of the time during Phase I comprehension, as Appendix F shows.

Comprehension Strategies

Phase II. Appendix G summarizes the Group by Direction by Sentence Type interaction obtained from the Phase II comprehension analysis when both "to" and "away" sentences were combined for the reverse direction errors. This appendix also summarizes the Group main effect for the Phase II comprehension analysis for other errors. As can be seen in this appendix, the youngest group made significantly more reverse direction errors than the other groups during animate subject/inanimate object sentences in both the L-R and R-L conditions. However, for the redundant subject/object sentences, Group II made more errors, and Group III fewer errors in the L-R condition, thus resulting in equal performances by all three groups. Again, all three groups had very few (less than 10 percent of these types of errors). In the R-L condition for the redundant sentences, Group III differed significantly only from the intermediate Group. However, the Group III - Group I difference approached significance since the two older groups only differed by 1 percent.

Thus the youngest group made significantly more reverse direction errors than the other groups in all but the L-R condition for redundant sentences. Appendix G also shows that the youngest children made significantly more non-scoreable "other" response errors than Groups I or II, and the intermediate group made significantly more nonscoreable response than Group I. However, the two older groups only differed by 4 percent. The factors controlling this weak but significant developmental trend are not obvious.

A significant Sentence Type main effect for No Direction errors (the selection of a non-action subject in place of an action subject) indicated that these errors were sentence specific. They occurred 10 percent of the time during redundant subject-object sentences, and only 1 percent of the time during animate subject/inanimate object sentences. Thus semantic cues such as animate subject/inanimate object components of the sentence seemed to help the child avoid making "no direction" errors.

Phase II Analysis: "To" Sentences. The four way interaction (Group by Task by Direction by Sentence Type) for the reverse direction data yielded significant findings. However, the percentage differences under discussion never exceeded 4 percent. Therefore, these results will not be discussed further, in light of the limited and questionable amount of information to be derived from such small response differences.

Phase II Analysis: "Away from" Sentences. The Group by Task by Sentence Type interaction derived for the reverse direction data indicated that Group III made significantly more errors than Groups I or II when producing redundant sentences, when constructing redundant sentences, and when constructing animate subject/inanimate object sentences. Indeed, the youngest group used the preposition "to" in place of "away from" almost half the time, during comprehension and production trials. Moreover, during comprehension of redundant sentences, Groups II and III did not differ significantly (6 percent versus 34 percent), although more errors were made by the youngest group.

Thus, semantic cues influenced the intermediate group in the redundant sentences, as evidenced by an increase in the number of reverse direction errors made in the presence of these sentences. The oldest group's performance did not change as a function of sentence type or task level (i.e., comprehension or production). Thus one might conclude for the oldest group, (as have Strohner & Nelson, 1974), that by the time the child is five, he is responding on the basis of syntactic cues.

Phase by Phase Comparison. The Phase by Phase comparison for reverse direction errors supplied additional information as to the effects of extra-linguistic cue complexity (Phase Task variables) on the numbers of reverse direction errors made. The signifcant Group by Phase by Direction interaction is summarized in Appendix H. The youngest group made more reverse direction errors than either of the other two groups during Phase II, regardless of direction. Moreover, the differences between the performance of Group III in the R-L direction, when Phases I and II were compared, were also significant.

Thus, the extralinguistic cue of task complexity exerted significant effect on the youngest children, as reflected in the Phase comparisons of the R-L condition, that is, choosing among three subjects and one object produced more reverse direction errors in the youngest group than choosing among two subjects and two objects. Moreover, reverse direction error differences were significant among the youngest and older groups during the Phase II task, but not the Phase I task.

The significant Phase by Task interaction for the Phase by Phase comparison showed that during Phase I, more comprehension reverse direction errors were made than production errors (7 percent versus 0.4 percent), but errors made during comprehension and production trials for Phase II did not differ (4 percent versus 2 percent). Thus, in terms of comprehension-production comparisons, comprehension was more difficult in terms of reverse direction errors when the task was choosing among two subjects and two objects for "to" sentences than for choosing among three subjects and one object for "to" and "away from" sentences. However, this comprehension-production gap disappeared in Phase II.

General Summary of Response Strategies

The strategy analysis based on the production error data agrees with other studies (Chapman & Miller, 1975; Guess et al., 1969, 1973, 1974, 1968; Sailor, 1971) in that older children systematically rely less on strategies *per se*. In the present study, children above the age of three years produced syntactically correct descriptions appropriate to the stimulus conditions. This appropriate and correct production is presumably under stimulus control of situations and contexts in the presence of which such productions have been previously reinforced (Segal, 1975; Skinner, 1957; Staats, 1968, 1971, 1974), as well as being influenced by the child's earlier learning. Such correct discriminative responding was true to a lesser extent for the three year olds, whose errors included reversing the preposition and reversing the subject and object. These errors occurred very infrequently and when they did occur, they occurred in Phase II. Nonetheless, even for the youngest group, production responses were not statistically affected by semantic or extra semantic variables.

The comprehension-production gap found in this study supports the contentions of several researchers (Bloom, 1970, 1973, 1974; Bowerman, 1973, 1974; Chapman, 1974; Chapman & Miller, 1975; Whetstone & Friedlander, 1973) that the controlling variables for comprehension and production are not necessarily identical. Whether comprehension and production are different processes, however, can not be answered on the basis of data obtained in this study.

A developmental progression in comprehension of sentences containing subject-verb-object of the preposition was demonstrated. Three-year-olds made significantly fewer correct responses and used significantly more reverse direction strategies and non-logical strategies (e.g., subject-subject, object-object, or no-direction) than the older children. The relatively sharp performance differences between three-year-olds (mean age 3 years, 6 months), and children aged four to five did not provide a group category demonstrating transitional performances. That is, children having a mean age of 4 years, 1 month never differed significantly from children whose mean age was 4 years, 9 months on any of the comprehension tasks. Thus, since the intermediate group did not show transitional performance changes (that is, differ significantly from both Groups I and III), the present findings do not show exactly what age ranges are involved in this transition and, therefore, exactly when non-syntactic variables are replaced by syntactic variables. However, given the limited age differences between Groups II and III (8 months), the present study provides a valuable clue as to when the transition must occur.

Bever suggested that young children use an "actor-action-object" strategy to the extent that any noun-verb-noun sequence is assumed to refer to an actor-action-object sequence of events. This suggestion was tested by Strohner and Nelson (1974), who found that three-year-olds did employ an actor-action-object strategy for reversible sentences. These findings also related to the performance of young four-year-old children.

The findings of the present study are not in total agreement with these previous studies. Phase I, which required the child to choose among two subject and two object alternatives for "to" sentences, did not produce a significant statistical effect when reverse direction errors were measured.

This finding is consonant with findings of Strohner and Nelson (1974) who reported performance by three-year-olds on reversible sentences that was near mastery. However, when the three-year-olds in the present study made errors, 25 percent of the errors were subject-subject errors, and 9 percent of them were object-object errors. Thus, 34 percent of the time that errors were made, the three year olds appeared to be using no logical comprehension strategy. When the object-object strategy was analyzed in terms of sentence type, fewer such errors were made in inanimate subject/animate object sentences than in animate subject/inanimate object sentences or in redundant subject/object sentences. This is in conflict with reports by Chapman and Miller (1975), Bloom (1974), and Bever (1970) who have suggested that young children make the most errors in response to the inanimate subject/animate object sentences. In these studies, however, versions of inanimate subject/animate object sentences were of the form: "The boat is hitting the girl," "The car is pushing the boy" (Chapman & Miller, 1975). In the present study, these same sentences were of the form: "The truck is going to the boy." Thus in the former versions, inanimacy of subject and animacy of object is confounded by the use of an animate verb for the inanimate subject, resulting in improbable sentences. However, the present study used a verb going which was consonant with the inanimate subject. Therefore, the present study used sentences which were (a) of the form inanimate subject/animate object, (b) probable, and (c) reversible

("Boys can also go to trucks"). The present findings suggest that the semantic variable of animacy needs to be qualified in terms of the appropriate verb used. Thus, in Chapman and Miller's study, children appear to be responding less to the animacy of the subject than to the improbability of the sentence. Such an effect would result in the children's incorrect reversibility of subject and object.

Therefore, Strohner and Nelson's findings that three-year-olds perform poorly (i.e., 90 percent incorrect), to improbable sentences supports the present contention that Chapman and Miller's sentences were viewed as improbable. Moreover, Strohner and Nelson's findings that three-year-olds perform at 100 percent correct levels for probable active sentences would help explain the present results that three-year-olds had little trouble with inanimate subject/animate object sentences when object-object errors were measured. Why the three-year-olds in the present study made approximately one-third of their errors in the object-object category is not clear since all three types of sentences retained probability information which should have facilitated not making these types of errors. Since the overall percentages of correct responses in Phase I were not significantly affected by this animacy factor, however, the error analysis may be an artifactual result of low error rates. If so, the error data would not provide an accurate account of the strategies employed by younger children when both subject and object alternatives were free to vary, and the stimulus sentences contained a "to" preposition.

The extralinguistic cue of task complexity controlled more reverse direction responses in the youngest children when the verbal and visual stimuli did not match than in the older groups. The Phase comparison, however, does not show whether these errors were due to having to choose among three subject alternatives when the object was fixed, or due to the use of two prepositions ("to" and "away from"). The Phase II analysis for "away from" sentences, however, confirmed that the younger children had a great deal of difficulty with the "away from" preposition but not with the "to" preposition, suggesting that the appropriate use and comprehension of the "away from" relational term appears at a developmentally later time than the "to" preposition. Thus, the youngest group may have performed at lower levels to both sentence types as a function of the prepositional term "away from" rather than the sentence type. The intermediate group (mean age 4 years, 1 month) however, made 34 percent more reverse direction errors on the redundant sentences than on the animate subject/inanimate object sentences. These children made no reverse direction errors on the latter sentences. Since these children demonstrated comprehension of the "away from" sentences during the animate subject/inanimate object sentences, semantic variables were operating to increase the number of reverse direction errors made to redundant sentences.

Interestingly, semantic variables were operating to decrease the number of reverse direction errors for the youngest group when the visual and verbal stimuli matched in direction and the stimuli were of the redundant subject/ object form. These children had less difficulty in constructing puzzles of cars going to trucks and boys running to girls in the L-R condition (1 percent reverse direction errors) than in constructing puzzles of boys running to trucks in both the L-R and R-L conditions (30 percent reverse direction errors). Possibly these redundant sentences were viewed as being more probable, given the three-year-olds' experiential histories. However, this was not found for the R-L condition of redundant sentences.

CHAPTER VI

GENERAL DISCUSSION

The present investigation confirmed the findings of Chapman and Miller (1975) that for young children (three year olds), non-syntactic cues may be the only sources of control for comprehension responses. Moreover, the present results also supported Chapman's (1974) claims that the relationship between comprehension and production may vary for different linguistic structures, for different aged children and for different tasks. These findings then, are in sharp disagreement with the Imitation-Comprehension-Production hypothesis proposed by Fraser, et al., (1963), and the Comprehension-Imitation-Production hypothesis of Whitehurst and Vasta (1974), both of which propose a single relationship to exist between comprehension and production. That is, these theories have suggested that comprehension always precedes production, in the young child's development of language. The present findings preclude the search for any unitary relationship between the processes of comprehension and production.

Several researchers have suggested that language comprehension may require a correspondence between the form of a linguistic description and the extra-linguistic stimulus situation (Bloom, 1973, 1974; Clark, 1973; de Villiers & de Villiers, 1973b; Huttenlocher, et al., 1968, 1971; Whetstone & Friedlander, 1973). When the correspondence between a linguistic description and an extra-linguistic description involved equal and opposite directional components, however, the lack of correspondence was found to interact with sentence type (redundant subject or object sentences) to depress correct responding in children between the ages of 3 years, 0 months, and 3 years, 10 months. However, in the overall analysis, directionality did not exert significant differential control of comprehension or production for any of the groups, suggesting that directionality was not a critical extra-linguistic factor controlling production or comprehension.

Both the percent correct data and the error data obtained in response to sentences having semantically varied components suggests that comprehension strategies employed by young children reflect, to a large extent, their knowledge about the world. Why a sentence having the inanimate subject/inanimate object form as in "cars going to trucks" should produce higher comprehension correct scores than sentences having an animate subject/inanimate object form as in "boys running to trucks" in the youngest children is not apparent. Possibly, semantic probability information (Bever, 1970; Chapman & Miller, 1975; Strohner & Nelson, 1974) or expectations about particular relations between agent and recipient of the action in a sentence (Gowie, 1974; Gowie & Powers, 1972; Powers & Gowie, 1975) may have been controlling factors for the comprehension scores of the youngest children, and to a lesser extent the intermediate aged children. Thus, future research might well focus on questions regarding the child's experiential knowledge of the world and the semantic encoding of that knowledge. Indeed, "cars going to trucks" may be considered a more probable event by the child than "boys running to trucks," if the child's experience with trucks and boys is jointly considered.

The work of both Chapman and Miller (1975) and Huttenlocher and Strauss (1968) has provided support for the idea that sentence comprehension is facilitated when the sentence to be understood was of the order: Subject-verb-object. In the Chapman and Miller study animacy of the subject appeared to be important; in the Huttenlocher and Strauss study, the mobility of the grammatical subject appeared to be critical. In either case, children appeared to attribute the role of actor to the grammatical subject, suggesting that children were responding on the basis of the logical semantic relationship between agent, action, and object, rather than to the syntactic relations between subject-verb-object.

However, when comprehension tasks were complicated in the present study by having the child choose among two objects and two subjects or three subjects and one object which varied only in directional respects, the youngest children demonstrated strategies showing no logical relationships between agent, action, and object (e.g., subject-subject, object-object, and no-direction errors). Thus, the logical strategies attributed to the comprehension skills of three year olds may in fact be overrated, when the experimental situation requires discriminations of multiple subjects and objects differing in directional orientation. Casual observations of three year olds constructing "real" puzzles in the nursery school reflected strategies which included not looking at the puzzle pieces while constructing the puzzles. These children appeared to be just matching the puzzle shapes. Perhaps puzzle construction behavior in the nursery school generalized to the testing situation. Thus, if the child matched two subjects or two objects which happened to interlock, he or she may have considered the task completed, regardless of instructional input (i.e., "Make a picture of..."). However, what still remains unresolved is the question of what happens to the variables controlling comprehension strategies between 3 years, 6 months and 4 years, 1 month (for this study). Between these mean ages, children shift from making numerous illogical error responses to not making any of these illogical responses. A qualitative developmental progression in comprehension strategy was not found among all three groups, possibly because the age cut-offs employed for the present comparisons were not optimal for this type of research design. Had different age cut-offs been employed, then a more marked and more informative progression may have been identified, permitting a careful analysis of the corresponding controlling variables. To interject the possibility that the youngest children were in one stage of cognitive development while both the intermediate and older groups were in a different stage of cognitive development does not provide any additional information which would explain the variables controlling strategy shifts in the children's comprehension performances. The changes occurring between the ages of Groups II and III do, therefore, provide a viable research area for future study.

A final experimental consideration raised by the present research involves the procedural utility of MLU to assess linguistic development in children (Brown, 1973; de Villiers & de Villiers, 1973b). The present study may not have found MLU predictive because of the population employed. Children of the day care center were not experimentally naive. The fact that they were the subject of many observational studies and were therefore in constant interaction with adults, may support the idea that verbally these children were more advanced than the average nursery school aged child. To test this notion, a replication of this experiment might be done with a non-day care population, using MLU as a linguistic index.

In summary, while the present investigation has provided important data regarding (a) the relationship between comprehension and production of sentences having a particular syntactic form, and (b) the nature and extent of syntactic, semantic, and extra-semantic control of comprehension and production in the young child, as many issues were raised as were answered. The area of language development, both receptive and expressive, requires much more systematic and well controlled experimentation than currently exists, before any general conclusion can be drawn regarding the exact variables controlling a development progression in the child's early language behavior. A major difficulty in this area of investigation has been the design of an optimal comprehension instrument or procedure which would facilitate the assessment of the child's language abilities more fully. The present study has been but a first step in this design.

BIBLIOGRAPHY

Baird, R. On the role of change in imitation-comprehension-production test results. _Journal of Verbal Learning and Verbal Behavior_, 1972, _11_, 474-477.

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

Beilin, H. _Studies in the cognitive basis of language development_. New York: Academic Press, 1975.

Bever, T. G. The cognitive basis for linguistic structures. In J. R. Hayes (Ed.), _Cognition and the development of language_. New York: Wiley, 1970.

Bever, T. G., Mehler, J. R., Valian, V., Epstein, J., & Morrissey, H. Linguistic capacity of very young children. In T. G. Bever & W. Weksel (Eds.), _The acquisition of structure_. New York: Holt, in press.

Bloom, L. _Language development: Form and function in emerging grammars_. Cambridge, Mass.: The MIT Press, 1970.

Bloom, L. _One word at a time: The use of single word utterances before syntax_. Hague: Mouton, 1973.

Bloom, L. Talking, understanding, and thinking. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), _Language perspectives: Acquisition, retardation, and intervention_. Baltimore, Md.: University Park Press, 1974, 285-311.

Bowerman, M. F. Structural relationships in children's utterances: Syntactic or semantic? In T. E. Moore (Ed.), _Cognitive development and the acquisition of language_. New York: Academic Press, 1973.

Bowerman, M. F. Discussion summary: Development of concepts underlying language. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), _Language perspectives: Acquisition, retardation, and intervention_. Baltimore, Md.: University Park Press, 1974, 191-209.

Bricker, D. D., Vincent-Smith, L., & Bricker, W. A. Receptive vocabulary: Performances and selective strategies of delayed and non-delayed toddlers. _American Journal of Mental Deficiency_, 1973, _77_, 529-584.

Bricker, W. A., & Bricker, D. D. An early language training strategy. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 432-468.

Brown, R. A first language. Cambridge, Mass.: Harvard University Press, 1973.

Brown, R., Cazden, C., & Bellugi, U. The child's grammar from I to III. In J. P. Hill (Ed.), Minnesota symposia on child psychology (Vol. 2). Minneapolis, University of Minnesota Press, 1969, 28-73.

Chapman, R. S. Discussion summary: Developmental relationship between receptive and expressive language. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 335-344.

Chapman, R. S., & Miller, J. F. Word order in early two and three word utterances: Does production precede comprehension? Journal of Speech and Hearing Research, 1975, 18, 355-371.

Chomsky, N. Aspects of the theory of syntax. Cambridge, Mass.: MIT Press, 1965.

Chomsky, N. Language and mind. New York: Harcourt Brace Jovanovich, 1968.

Clark, E. What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Clark, E. Some aspects of the conceptual basis for first language acquisition. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 105-128.

De Villiers, J. G., & De Villiers, P. A. A cross-sectional study of the acquisition of grammatical morphemes in child speech. Journal of Psycholinguistic Research, 1973, 2, 267-278. (a)

De Villiers, J. G., & De Villiers, P. A. Development of the use of word order in comprehension. Journal of Psycholinguistic Research, 1973, 2, 331-341. (b)

Etienne, A. S. Developmental stages and cognitive structures as determinants of what is learned. In R. A. Hinde & J. S. Hinde (Eds.), _Constraints on learning: Limitations and predispositions_. New York: Academic Press, 1973, 371-395.

Fernald, C. Control of grammar in imitation, comprehension, and production: Problems of replication. _Journal of Verbal Learning and Verbal Behavior_, 1972, _11_, 606-613.

Fodor, J. A., Bever, T. G., & Garrett, M. F. _The psychology of language_. New York: McGraw Hill, 1974.

Fraser, C., Bellugi, U., & Brown, R. Control of grammar in imitation, comprehension, and production. _Journal of Verbal Learning and Verbal Behavior_, 1963, _2_, 121-135.

Friedlander, B. Z. Receptive language development in infancy. _Merrill-Palmer Quarterly_, 1970, _16_, 7-51.

Gowie, C. J. Semantics and syntax in sentence processing: Children's comprehension of an exceptional linguistic structure. _Journal of the Association for Research in Growth Relationships_, 1974, _6_ (1), 21-43.

Gowie, C. J., & Powers, J. E. Effect of children's expectations on comprehension of the passive transformation. _Research in the Teaching of English_, 1972, _6_ (1), 5-16.

Guess, D. A functional analysis of receptive language and productive speech: Acquisition of the plural morpheme. _Journal of Applied Behavior Analysis_, 1969, _2_, 55-64.

Guess, D., & Baer, D. M. An analysis of individual differences in generalization between receptive and productive language in retarded children. _Journal of Applied Behavior Analysis_, 1973, _6_, 311-329.

Guess, D., Sailor, W., & Baer, D. M. To teach language to retarded children. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), _Language perspectives: Acquisition, retardation, and intervention_. Baltimore, Md.: University Park Press, 1974, 529-563.

Guess, D., Sailor, W., Rutherford, G., & Baer, D. M. An experimental analysis of linguistic development: The productive use of the plural morpheme. _Journal of Applied Behavior Analysis_, 1968, _1_, 297-306.

Hutson, B. A. How abstract is a young child's knowledge of syntax? _The Journal of Genetic Psychology_, 1975, _126_, 19-26.

Hutson, B. A. The study of syntax and cognition: An idea whose time has come. Paper presented at the Fifth Interdisciplinary Conference on Structural Learning, Philadelphia, Pa., April 1974.

Hutson, B. A., & Powers, J. E. Reversing irreversible sentences: Semantic and syntactic factors. Journal of Reading Behavior, 1974, 6 (1), 99-110.

Hutt, S. J. Constraints upon learning: Some developmental considerations. In R. A. Hinde & J. S. Hinde (Eds.), Constraints on learning: Limitations and predispositions. New York: Academic Press, 1973, 457-467.

Huttenlocher, J. The origins of language comprehension. In R. L. Solso (Ed.), Theories in cognitive psychology. Potomac, Md.: Lawrence Earlbaum, 1974.

Huttenlocher, J., Eisenberg, K., & Strauss, S. Comprehension: Relation between perceived actor and logical subject. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 527-530.

Huttenlocher, J., & Strauss, S. Comprehension and a statement's relation to the situation it describes. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 300-304.

Huttenlocher, J., & Weiner, S. L. Comprehension of instructions in varying contexts. Cognitive Psychology, 1971, 2, 369-385.

Ingram, D. The relationship between comprehension and production. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 313-334.

Keeney, T., & Wolfe, J. The acquisition of agreement in English. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 698-705.

Lenneberg, E. Biological foundations of language. New York: Wiley, 1967.

Lovell, K., & Dixon, E. The growth of the control of grammar in imitation, comprehension, and production. Journal of Child Psychology and Psychiatry, 1967, 8, 31-39.

MacCorquodale, K. B. F. Skinner's Verbal Behavior: A retrospective appreciation. Journal of the Experimental Analysis of Behavior, 1969, 12, 831-841.

Mac Corquodale, K. On Chomsky's review of Skinner's _Verbal Behavior_. _Journal of the Experimental Analysis of Behavior_, 1970, 13, 83-99.

Macnamara, J. Cognitive basis of language learning in infants. _Psychological Review_, 1972, _79_, 1-13.

McCarthy Scales of Children's Abilities. New York: The Psychological Corporation, 1972.

McNeill, D. Developmental psycholinguistics. In F. Smith & G. A. Miller (Eds.), _The genesis of language: A psycholinguistic approach_. Cambridge, Mass.: MIT Press, 1966.

McNeill, D. _The acquisition of language: The study of psycholinguistics_. New York: Harper & Row, 1970. (a)

McNeill, D. The development of language. In P. Mussen (Ed.), _Carmichael's manual of child psychology_ (Vol. 1). New York: John Wiley & Sons, Inc., 1970, 1061-1161. (b)

McNeill, D. The capacity for the ontogenesis of grammar. In D. I. Slobin (Ed.), _The ontogenesis of grammar_. New York: Academic Press, 1971, 17-40.

Miller, J. F., & Yoder, D. E. An ontogenetic language strategy for retarded children. In R. L. Schiefelbusch & L. L. Loyd (Eds.), _Language perspectives: Acquisition, retardation, and intervention_. Baltimore, Md.: University Park Press, 1974, 505-528.

Moerk, E. Piaget's research as applied to the explanation of language development. _Merrill-Palmer Quarterly_, 1975, _21_, 151-169.

Morehead, D. M., & Morehead, A. From signal to sign: A Piagetian view of thought and language during the first two years. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), _Language perspectives: Acquisition, retardation, and intervention_. Baltimore, Md.: University Park Press, 1974, 153-190.

Piaget, J. _The origins of intelligence in children_. New York: Norton, 1952.

Piaget, J. _Plays, dreams, and imitation in childhood_. New York: Norton, 1962.

Piaget, J. Piaget's theory. In P. Mussen (Ed.), _Carmichael's manual of child psychology_. New York: John Wiley & Sons, Inc., 1970, 703-732.

Piaget, J., & Inhelder, B. _Mental imagery in the child_. New York: Basic Books, Inc., 1971.

Powers, J. E., & Gowke, C. J. The passive transformation on its own. Presented at the 1975 meeting of the Society for Research in Child Development, Denver, Colorado.

Premack, D. Two problems in cognition: Symbolization, and from icon to phoneme. In T. Alloway, L. Kramers, & P. Pliner (Eds.), Communication and affect: A comparative approach. New York: Academic Press, 1972.

Premack, D. Cognitive principles? In F. J. McGuigan & D. B. Lumsden (Eds.), Contemporary approaches to conditioning and learning. Washington, D. C.: V. H. Winston & Sons, 1973, 287-311.

Premack, D., & Premack, A. J. Teaching visual language to apes and language deficient persons. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 347-376.

Sailor, W. Reinforcement and generalization of productive plural allomorphs in two retarded children. Journal of Applied Behavior Analysis, 1971, 4, 305-310.

Schlesinger, M. Production of utterances and language acquisition. In D. I. Slobin (Ed.), The ontogenesis of grammar. New York: Academic Press, 1971, 63-101.

Schlesinger, M. Relational concepts underlying language. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 129-151.

Segal, E. F. Psycholinguistics discovers the operate: A review of Roger Brown's A first language: The early stages. Journal of the Experimental Analysis of Behavior, 1975, 23, 149-158.

Sherman, J. A. Imitation and language development. Advances in Child Development and Behavior, 1972, 239-272.

Shipley, E. F., Smith, C. S., & Gleitman, L. R. A study in the acquisition of language: Free responses to commands. Language, 1969, 45, 322-342.

Siegel, Sidney. Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill Book Company, 1956.

Sinclair-de Zwart, H. Developmental psycholinguistics. In D. Elkind & J. H. Flavell (Eds.), Studies in cognitive development. New York: Oxford University Press, 1969.

Sinclair-de Zwart, H. Sensori-motor action patterns as a condition for the acquisition of syntax. In R. Huxley & E. Ingram (Eds.), Language acquisition: Models and methods. New York: Academic Press, 1971.

Sinclair-deZwart, H. Language acquisition and cognitive development. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973 (a).

Sinclair-de Zwart, H. Some remarks on the Genevan point of view on learning with special reference to language learning. In L. L. Hinde & H. C. Hinde, (Eds.), Constraints on learning: Limitations and Predispositions. New York: Academic Press, 1973 (b).

Skinner, B. F. Verbal behavior. New York: Appleton-Century-Crofts, 1957.

Soderquist, D., & Gaebelein, J. Statistical principles. Unpublished manuscript, University of North Carolina-Greensboro, 1976.

Staats, A. W. Language, learning, and cognition. New York: Holt, Rinehart & Winston, 1968.

Staats, A. W. Linguistic-mentalistic theory versus an explanatory S-R learning theory of language development. In D. I. Slobin (Ed.), The ontogenesis of grammar: A theoretical symposium. New York: Academic Press, 1971.

Staats, A. W. Behavior and cognitive theory in the study of language: A neo-psycholinguistics. In R. L. Schiefelbusch & L. L. Lloyd (Eds.), Language perspectives: Acquisition, retardation, and intervention. Baltimore, Md.: University Park Press, 1974, 615-646.

Strohner, H., & Nelson, K. The young child's development of sentence comprehension: Influence of event probability, non-verbal context, syntactic form, and strategies. Child Development, 1974, 45, 567-576.

Vincent-Smith, L., Bricker, D., & Bricker, W. Acquisition of receptive vocabulary in the toddler-age child. Child Development, 1974, 45, 189-193.

Whetstone, H. S., & Friedlander, B. Z. The effect of word order on young children's responses to simple questions and commands. Child Development, 1973, 44, 734-740.

Whitehurst, G. J., & Vasta, R. Is language acquired through imitation? Journal of Psycholinguistic Research, 1975, 4(1), 37-59.

Appendix A

Experimental Post-Test Results

Both L-R and R-L Constructions Correct

Trial One Instructions: Make a picture of X running to Y.

	Percent Correct Constructions		
	L-R	R-L	Other
Group I	40%	60%	0%
Group II	60%	40%	0%
Group III	20%	20%	60%

Trial Two Instructions: Make a picture of X running to Y another way.

	L-R	R-L	Other
Group I	40%	40%	20%
Group II	20%	60%	20%
Group III	20%	0%	80%

Both L-R and R-L Constructions Correct

Trial One Instructions: Make a picture of X running to Y.

				"It can't be done"
Group I	0%	0%	0%	100%
Group II	20%	20%	0%	60%
Group III	20%	20%	60%	0%

Appendix B

Percent Correct Responses for Phases I and II Comprehension and Production

	Comprehension			Production	
	Phase I	Phase II		Phase I	Phase II
Group I	97	99		100	100
Group II	88	93		99	100
Group III	06	36		83	67

Appendix C

Percent Correct Responses for L-R and R-L Comprehension and Production Tasks

	Comprehension		Production	
	L-R	R-L	L-R	R-L
Group I	96	99	100	100
Group II	94	86	99	100
Group III	19	19	77	73

Appendix D

Percent Correct Responses for the Phase by Direction Interaction for Comprehension and Production Tasks

	Comprehension		Production	
	L-R	R-L	L-R	R-L
Phase I	72	60	96	98
Phase II	79	85	96	94

Appendix E

Percent Reverse-Direction and Reverse-Subject/Object Er rs
for Production Phases I and II

	Reverse Direction		Reverse Subject/Object
	Phase I	Phase II	Phases I and II
Group I	0	0	0
Group II	0	0	0
Group III	3	21	3

Appendix F

Percent Subject-Subject, Object-Object Errors for Phase I Comprehension and Object-Object Errors for Group by Sentence Type Interaction for Phase I Comprehension

Phase I Comprehension Strategies		
	Subject-Subject	Object-Object
Group I	0	0
Group II	0	0
Group III	25	9

	Animate Sub/ Inanimate Object	Inanimate Sub/ Animate Object	Redundant Sub/Object
Group I	0	0	0
Group II	0	0	0
Group III	12	2	17

Appendix G

Percent Correct Reverse Direction Errors and Other Errors
for the Phase II Comprehension Analysis

Reverse Direction Errors					Other Errors
Animate Sub/Inanimate Object			Redundant Sub/Object		
	L-R	R-L	L-R	R-L	
Group I	1	1	1	1	0
Group II	0	0	6	0	4
Group III	30	30	1	25	17

Appendix H

Percent Reverse Direction Errors for the Group by Phase by Direction Interaction for Phase II Comprehension

	Phase I		Phase II	
	L-R	R-L	L-R	R-L
Group I	1	0.7	0	0
Group II	1	2	0	0
Group III	10	8	15	24