CHILDREN'S COMPREHENSION OF SENTENCES WITH CONTINGENT RELATIONS

by

Arlene Amidon

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date

Peter W. Carey
Chairman of Examining Committee

June 26, 1975
date

Florence L. Denmark
Executive Officer

The City University of New York

Abstract

Children aged five, seven, and nine were tested on two different tasks designed to assess their understanding of sentences with contingent relations. The first task consisted of nonverbal responses to heard sentences; the second task required verbal answers to questions about information in tape-recorded sentences. On both tasks, the test sentences contained the following temporal and conditional contingency terms: "when," "as soon as," "before," "after," "if," "unless," "if_not," and "unless_not."

The results indicated that performance varied significantly with sentence type and age level. Sentences containing the connectives "when," "as soon as," and "if" were understood as early as five years of age, whereas sentences with "unless" and "unless_not" were extremely difficult for all age groups. Sentences with "if_not," "before," and "after" were of intermediate difficulty. An analysis of error patterns revealed that the connectives "unless" and "unless_not" were systematically misinterpreted. The connective "unless" was interpreted as "if" or "when," and the connective "unless_not" was interpreted as "if_not" or "when_not." The difficulty in understanding these connectives was attributed to formal linguistic factors, rather than underlying conceptual complexity, for the functionally equivalent terms "if" and

"if_not" were relatively easy to interpret.

With regard to age differences, there was significant developmental improvement between the ages of five and seven. This improvement resulted, primarily, from an increased ability to use information contained in subordinate clauses. Five-year-olds, in contrast to older children, applied an inappropriate linguistic processing strategy in which information in subordinate clauses was selectively discarded. By age seven this strategy was no longer predominant, and the children performed quite well with most sentence types.

The implication of these findings is that the ease of understanding a given expression depends on formal linguistic complexity as well as underlying conceptual complexity. Even after the child has acquired the cognitive competence for understanding contingent relations, he may nonetheless misinterpret sentences which express those relations if he has not acquired appropriate linguistic processing skills.

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Table of Contents

List of Tables

List of Figures

Introduction

Comprehension of Temporal and Conditional Contingency Terms

The ability to understand contingency terms is essential to linguistic communication, for contingency terms express critical relations between different events, thoughts, and actions. The temporal contingency terms "before" and "after," for example, signal temporal ordering (sentences 1 and 2). Logical connectives such as "if" and "unless" signal conditionality (sentences 3 and 4).

(1) Henry will leave the party before the police arrive.

(2) Henry will leave the party after the police arrive.

(3) Henry will leave the party if the police arrive.

(4) Henry will leave the party unless the police arrive.

As these examples demonstrate, the meaning of a compound sentence is affected by the meaning of the contingency term. Sentences (1) through (4) contain propositions concerning the same two events, yet in each case these events are related in a different way. In sentences (1) and (2) the events are temporally related. In (1) the occurrence of the event in the main clause precedes the occurrence of the event in the subordinate clause. In sentence (2) this ordering of events is reversed: the event in the subordinate

clause precedes the event in the main clause. In sentences (3) and (4) the events are conditionally related. In (3) the event in the main clause will occur if the event in the subordinate clause takes place--i.e., Henry will leave the party if the police arrive. In sentence (4) the event in the main clause will occur if the event in the subordinate clause does not take place--i.e., Henry will leave the party if the police do not arrive.

It seems clear on intuitive grounds that the relations expressed by temporal and conditional connectives are conceptually complex. It may be expected, therefore, that these linguistic expressions would be difficult for children to understand. In fact, this hypothesis has received support from several empirical studies of language comprehension in children. Carey, Blake, and Amidon (1971), for example, observed that children aged five and seven made many errors in interpreting temporally ordered commands such as "Move a red checker one space after you move a black checker one space." Furthermore, these errors could not be attributed to memory limitations since two-event sentences with "and" were easily interpreted. Hatch (1971) and Amidon and Carey (1972) have reported similar results with children of the same age groups. Ferreiro and Sinclair (1971), moreover, have shown that children up to and even beyond the ages of eight or nine have difficulty understanding sentences with temporal relations. Since Ferreiro and Sinclair used French-speaking

children as subjects, we may rule out the possibility that the findings of Carey et al. are specific to the English language.

With regard to conditional connectives, the empirical evidence is limited. However, studies of speech production indicate that conditional connectives are rather late to appear in child speech and that during the elementary school years a high frequency of use correlates with verbal maturity (Loban, 1963).

The only study which measured children's comprehension of both temporal and conditional connectives is Olds' (1968) investigation of language skills in seven-, nine-, and eleven-year-old boys. The experimental task in this study consisted of a game in which wooden forms were moved in response to verbal instructions. Some of the instructions included sentences with temporal and conditional connectives, e.g., "You may move a triangle one space, if you have a circle." The subject's response to each instruction revealed his interpretation of the sentence.

It should be noted that this situation invites an interpretation of "if" as "if and only if." That is, for sentences containing "if," the event in the main clause is to be carried out only if the contingency expressed by the subordinate clause is met. The sentence "You may move a triangle one space, if you have a circle," for instance, indicates that the listener should move the triangle only if he has a circle; if he does not have a circle, he should

not move the triangle. A similar interpretation is required of sentences with "unless": the listener is to carry out the event in the main clause only if the proposition expressed in the subordinate clause is true. Although this interpretation is appropriate in everyday contexts (Springston and Clark, 1973), it has been argued that logically the conditional term says nothing about what action will occur if the proposition of the subordinate clause is false (Geis and Swicky, 1971). Consider, for example, the sentence "Milton will die if he is convicted." In this case, the action of the main clause may occur even if the proposition of the subordinate clause is false. In view of this, it should be recognized that the interpretation of conditional terms which was required in Olds' experiment is not necessarily appropriate in all situations.

The results of Olds' study indicated that the ability to understand sentences with temporal and conditional connectives varied with age as well as connective. In general, older children performed better than younger children on all connectives. However, regardless of age, some connectives were more easily understood than others. The affirmative conditional "if," for example, was more easily understood than the negative conditional "unless." Temporal contingency terms "before," "after," "when," and "as soon as" were also more easily understood than "unless." And, as expected, simple statements like "you may move a

circle one space" were more easily understood than sentences with contingency terms.

In addition to the above findings, Olds reported some surprising inconsistencies. The temporal terms "when," "as soon as," and "after" were equal in difficulty, but "before" was significantly more difficult than the others. This observation contrasts with Clark's (1971) finding that "after" is more difficult for young children than is "before." Olds' results are also incompatible with Ferreiro and Sinclair's (1971) claim that children first organize temporal relations in terms of simultaneous occurrence (e.g., "when"); notions of successive ordering emerge at a more advanced level. Thus, according to Ferreiro and Sinclair, "when" and "as soon as" should be more easily understood than "before" and "after."

A second inconsistency has to do with the children's understanding of affirmative conditionals "if" and "should." Olds predicted that conditional terms would be more difficult than temporal terms. However, this prediction derives from a peculiar line of reasoning which is grounded on neither linguistic nor cognitive evidence but rather on Olds' intuitions about conditional connectives. According to Olds, "the conditional may best be thought of as the result of combining two sentences, a question and a statement. Temporal contingency, on the other hand, is expressed within a single sentence by a sentence adverbial" (p. 49). As an example of Olds' analysis, consider sentences (5)

and (6):

(5) Abortion will be legalized if Mr. Schultz wins the election.

(6) Abortion will be legalized before Mr. Schultz wins the election.

Sentence (5), according to Olds derives from the question "Will Mr. Schultz be elected?" and the response "Abortion will be legalized." Sentence (6), in contrast, may be analyzed as "Abortion will be legalized and then Mr. Schultz will win the election" but not as "Will Mr. Schultz win the election? Abortion will be legalized." On the basis of this analysis, Olds reasoned that conditional terms should be more difficult to interpret than temporal terms, since the conditionals link two distinct sentence structures together whereas the temporal terms employ only a normal single sentence structure.

In opposition to Olds' contention, however, it could be argued that his linguistic assumptions are faulty. For instance, it is not obvious that sentences with conditional relations are derived from an underlying question-statement. Further, even if Olds' speculation were correct, it could just as easily be applied to sentences with temporal relations. For instance, the sentence "Abortion will be legalized before Mr. Schultz is elected" could be thought of as combining the question "When will abortion be legalized?" and the answer "Before Mr. Schultz is elected." In view of this, Olds' basis for differentiating conditional

connectives from temporal connectives may not be appropriate. Moreover, the data from Olds' experiment refuted his proposition. Sentences with the affirmative conditionals "if" and "should" were easily interpreted by all age groups, though sentences with the temporal terms "before" and "after" were relatively difficult.

Before considering the implications of Olds' data, it is necessary to mention some of the methodological flaws which could have influenced the results. First, the testing procedure was found to produce significant learning effects during the course of the experiment. This was probably due to the fact that subjects were tested in pairs, and verbal communication was permitted. Thus, a more knowledgeable subject could correct the responses of his partner. The resulting data, then, would be biased in favor of overestimating the child's linguistic competence. More significant, however, is the possibility that information was exchanged selectively so that some connectives and response types were more likely to be corrected than others. If this occurred, then the distribution of errors as well as the total number of errors would have been affected by the testing procedure, and the reported order of difficulty among connectives would be inaccurate. A second methodological problem is that Olds' analysis did not include a classification of error types, so there is no way to determine how certain constructions were misinterpreted.

Other methodological flaws include the confounding of

temporal connective with clause order and verb tense. In sentences containing "before," the first event was always included in the second clause (e.g., "Before you move a circle one space, you may move a diamond one space"). Thus, the order of occurrence violated the order of mention--the subject had to carry out the last command first. In sentences containing "after," however, the first event was always included in the first clause of the sentence (e.g., "After you move a diamond one space, you may move a circle one space"). In this case, the order of occurrence corresponded to the order of mention--the subject could carry out the commands in the order in which they were heard. Since there is evidence that the interpretation of sentences with temporally ordered events is facilitated by placing the first event in the first clause (Clark, 1971), the performance differences with "before" and "after" could have resulted from the ordering of clauses.

The comparison of error scores for "when" and "as soon as" with the error scores for "before" and "after" is confounded by verb tense. The connectives "when" and "as soon as" always occurred with present perfect verbs (e.g., "you may move a circle as soon as you have moved a diamond"). The connectives "before" and "after," however, always occurred with simple present tense verbs (e.g., "You may move a circle before you move a diamond"). Thus, the differences in the ease of understanding these connectives may have been due to the difference in verb tense. Furthermore,

the use of the present tense verb changes the meaning of the connectives "when" and "as soon as" so that they signal successive occurrence rather than simultaneous occurrence. In fact, when these terms are combined with a present perfect verb, they are functionally equivalent to the temporal order term "after." It is hardly surprising, therefore, that "when" and "as soon as" would be as difficult to understand as the temporal order term "after."

The finding that "if" was more easily understood than the temporal connectives may be explained by differences in response complexity. Sentences containing "if" required only one response whereas sentences with "before" and "after" required two responses. Thus, it could be argued that the temporally ordered instructions placed a greater demand on memory than did the conditional instructions.

Despite the shortcomings of Olds' experiment it is a provocative starting point for further research. It has demonstrated that the child's ability to understand sentences with temporal and conditional relations improves substantially between the ages of seven and eleven. Furthermore, Olds' data suggest that the connectives which express temporal and conditional relations vary widely in ease of interpretation. The question is how can such differences be explained? Why are some connectives acquired at an earlier age than others? Why are some connectives difficult for children of all ages?

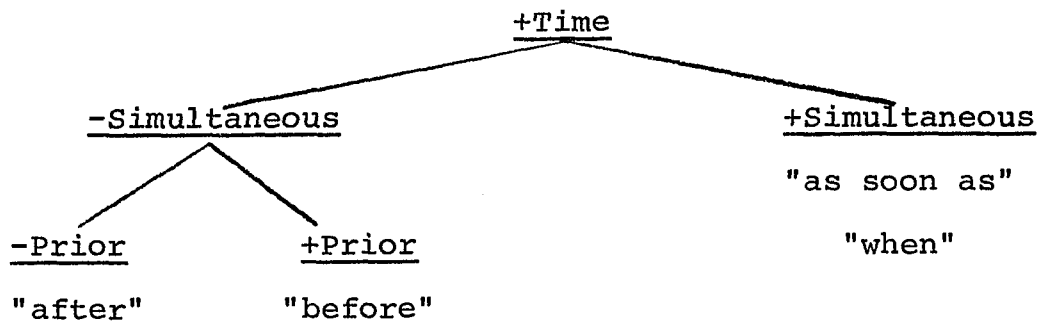
Clark's Semantic Feature Hypothesis

Eve Clark (1971) proposes that the differences in difficulty among connectives may be explained in terms of a linguistic analysis of semantic features. Although this view has been criticized on theoretical and empirical grounds (e.g., Bolinger, 1965; Amidon and Carey, 1972), a detailed description of Clark's theory is warranted in view of the fact that this is the only theory which provides both a linguistic analysis of word meaning as well as a developmental account of how words are learned. Following this description of Clark's view, opposing arguments and evidence will be considered.

According to Clark (1971), the meaning of a word can be represented as a set of components arranged hierarchically. In addition, each component has both a positive and a negative value. The first component for temporal terms is Time. +Time indicates that the words containing this feature refer to some aspect of time. The next feature is Simultaneous. +Simultaneous designates a punctual relation, and -Simultaneous designates a serial relation. The third feature for temporal terms is Prior. +Prior signifies that one event precedes another; -Prior signifies that one event follows another. Since these features are hierarchically related, +Time dominates Simultaneous, and -Simultaneous dominates ±Prior.

Using the above analysis, it is possible to categorize temporal connectives in terms of semantic features. Thus,

according to Clark, "when" and "as soon as" are +Time and +Simultaneous. "Before" is +Time, -Simultaneous, and +Prior; and "after" is +Time, -Simultaneous, and -Prior:



If we apply Clark's technique to the analysis of conditional connectives, the superordinate feature could be +Conditionality, and subordinate features could be +Occurrence and -Occurrence. Thus, "if" may be specified as +Conditionality and +Occurrence; "unless" may be specified as +Conditionality and -Occurrence.

Clark maintains, moreover, that the components described in the linguistic analysis have a psychological reality in actual language performance. That is, Clark proposes that the meaning of a word is learned one feature at a time, beginning with the most superordinate feature. Thus, Time is learned before Simultaneous, and Simultaneous is learned before Prior. Furthermore, the positive value of each component is learned before its negative value, e.g., +Simultaneous before -Simultaneous, and +Occurrence before -Occurrence.

It follows from this that "before" should be acquired earlier than "after" since "before" is +Prior rather than

-Prior. Similarly, "if" should be acquired earlier than "unless" since "if" is +Occurrence rather than -Occurrence. This analysis may explain the performance differences observed in children's understanding of conditional and temporal connectives: "If" is more easily understood than "unless" (Olds, 1968), and "before" is more easily understood than "after" (Clark, 1971).

Despite this empirical support, however, it has been argued that the semantic feature hypothesis is, in principle, inadequate both in defining the meaning of words as well as in describing how words are cognitively represented. Bolinger (1965), for instance, notes that the selection of semantic features is arbitrary. Thus, the feature hierarchies posited by Clark may reflect nothing more than the intuitions of a linguist. The temporal term "before," for example, could be specified as +Time, -Simultaneous, and -Subsequent rather than +Time, -Simultaneous, and +Prior. In addition, Bolinger maintains that there is no principled limit to the number of components used to define any given word. +Time, for instance, could be further subdivided into +Locative and -Place. In fact, these features are sometimes included in Clark's analysis of temporal terms (cf. Clark, 1969 and Clark, 1971).

Another problem relates to Miller's (1969) claim that semantic features do not describe the way in which lexical information is psychologically organized and stored. In understanding negations, for example, Miller argues that

the listener must have his lexical information organized in such a manner that he can determine which features of a definition are denied by the negation and which features are true despite the negation. In sentences such as (7), for instance, the noun "king" contains the features +Animate, +Male, and +Sovereign, but only the most specific feature (+Sovereign) is negated.

(7) Richard is not a king.

The problem becomes more complicated if we consider the fact that the semantic content of a given noun often depends on the context in which the noun occurs. In sentence (8), for example, none of the features of the noun "king" are negated. In this case, the negation denies only that Richard is a "good" king; it does not deny that Richard is +Animate, +Male, and +Sovereign.

(8) Richard is not a good king.

In order to understand negative sentences of this type, the listener must be able to organize the structure of his lexicon according to the information contained in the entire sentence. Thus, the particular semantic feature hierarchy for any given word will not describe how that word is understood when the listener actually hears a sentence.

Bransford makes a similar point in asserting that language comprehension typically involves the integration of extralinguistic knowledge (Bransford, Barclay, and Franks, 1972; Bransford and Franks, 1972). For example, if

the listener understands a sentence like (9), he also knows that the assertions in sentences (1), (11), and (12) are true.

(9) Janet's former secretary is now her husband.

(10) Janet's former secretary was a man.

(11) Janet is married.

(12) Janet's husband is not her secretary.

The information expressed in (10), (11), and (12), however, cannot be derived from a list of semantic features. The word "secretary," for instance, does not contain the feature +Masculine, yet the listener knows that the secretary was a man. Similarly, "Janet" does not contain the feature +Married, yet the listener knows that Janet is married. Such information can be derived only if the listener understands the relation between words in a given context. The semantic analysis of individual words, therefore, may be irrelevant to what the speaker-hearer actually does when he uses language. As Perfetti (1972) concluded in a recent review of research and theories of semantic structure: "There is no reason to suppose that semantic analysis is accomplished simply by a set of semantic features plus interpretive rules for combining the features of individual words.... Semantic features as abstract components of individual words seems a questionable notion" (p. 255).

Linguistic Processing Strategies

Slobin (1971) and Bever (1970a) have presented a view of language use which derives from general principles of

information processing. This approach does not attempt to specify the semantic structure of the lexicon, but rather offers an account of the processes involved in speech perception and production. The basic contention here is that language use is constrained by performance variables such as attention, memory, and strategies for organizing information. Thus, the ability to interpret or produce sentences depends not only on semantic knowledge, but also on general perceptual-cognitive skills. The relevance of this view to Clark's linguistic analysis of semantic features will become apparent in a later discussion of empirical research in language acquisition. Before considering the empirical data, however, the theoretical arguments of Slobin and Bever will be outlined in detail.

Slobin (1971) argues that since language is produced and received in rapid temporal sequence, the mechanisms for understanding and producing sentences must be related to general perceptual and performance programming principles: "The short term limitations under which children operate are universal human limitations on sentence processing, and they are based on general perceptual and information-processing principles. The nature of their development can be revealed by the general psychology of perceptual development" (1971, p. 341).

Similarly, Bever (197a) proposes that the child's linguistic competence is necessarily linked to his language

performance (as in talking and listening) and is therefore constrained by universal principles of perception and memory. As Bever argues: "Every specific strategy of speech perception is a special case of a general principle of perception, at least in the sense that no general perceptual laws may be violated by a language specific strategy" (1970a, p. 327).

Bever proposed, moreover, that language development may be characterized as the acquisition of perceptual strategies for organizing information contained in the external structure of language (the actual appearance of words in sentences) according to internal structure relations (underlying actor, action, object relations). Consider, for example, the following:

(13) The social worker hijacked the airplane.

(14) The airplane was hijacked by the social worker.

If the listener is to understand these sentences he must be able to determine the underlying relation between "social worker," "hijacking," and "airplane." That is, he must have the ability to derive internal actor-action-object relations from external word sequences. The above sentences differ in external form, but they nonetheless share a common internal structure. In both sentences "social worker" is the internal actor (or logical subject) and "airplane" is the object of the "hijacking" action. The listener must derive these internal relations in order to comprehend sentences in his language. Conversley, the

speaker must generate external word sequences from internal structure if he is to produce meaningful utterances.

These language skills, according to Bever, are essentially cognitive, and they may be described in terms of strategies for organizing linguistic information. Moreover, the particular strategies available to the listener at any given level of development will determine the way in which sentences are interpreted and produced. Two-year-olds, for example, sometimes reverse actor-object relations in simple passive sentences even though they correctly interpret simple active declarative (SAAD) sentences (Bever, Mehler, Valian, Epstein, and Morrissey, 1970). Specifically, two-year-olds can act-out with toy props SAAD sentences such as (15), but their performance is random with passive sentences such as (16).

(15) The girl kicks the boy.

(16) The boy is kicked by the girl.

The fact that sentences like (13) are correctly interpreted indicates that the two-year-old has required the notions of reference and predication. In addition, the random performance with passive sentences indicates that he can discriminate between SAAD sentences (which he understands) and simple passive sentences (which he does not understand). If this were not the case, he would treat passive sentences as though they were active sentences, and his performance would be poorer than random.

At three years of age the child consistently reverses

actor-object relations when interpreting passive sentences like (16). Thus, "The boy is kicked by the girl," is acted-out as "the boy kicks the girl" (Bever et al., 1970). These observations are surprising as they imply that the ability to interpret passive constructions actually declines between the ages of two and three. Nonetheless, Bever argues that the three-year-old's performance is more advanced developmentally than that of the two-year-old. Since the three-year-old's errors are systematic, they suggest the existence of an active information processing strategy in which the structural relations of the sentence are consistently analyzed in terms of sequential and syntactic information (i.e., Strategy A).

Strategy A: Any Noun-Verb-Noun (NVN) sequence within a potential internal unit in the surface structure corresponds to "actor-action-object."

Other observations have demonstrated that children's strategies often involve the selective omission of information. Children aged 1.5 to 2.5, for example, do not perform well in acting-out sentences like (17) and (18). Frequently, they omit the second action (Bever et al., 1970).

(17) The cow jumped and walked away.

(18) The cow that jumped walked away.

Since it is the first event which is consistently selected for the acting-out response, Strategy B seems to apply:

Strategy B: The first NVN sequence corresponds to

"actor-action-object."

Children who are able to act-out both events in sentence (17), however, act-out only the main clause in sentence (18). Apparently, these children have learned to discriminate main clauses from subordinate relative clauses, and they have modified Strategy B accordingly:

Strategy C: The NVN sequence of the main clause corresponds to "actor-action-object."

In a related experiment, Bever and Morrissey (forthcoming) observed that children aged 2.5 use Strategy C when asked to repeat sentences with subordinate clauses. Thus, sentence (18) is repeated as "The cow walked away." Furthermore, Smith and McMahon (1970) reported that Strategy C is effective in adult language functioning. In this experiment adult subjects were presented with compound sentences containing the connectives "before" and "after." A question such as "What happened first?" or "What happened second?" followed each sentence. Error scores as well as response latencies were measured, and the resulting data indicated that information in main clauses was more easily remembered than information in subordinate clauses.

This evidence suggests that the early strategies which dominate the child's language functioning may continue to operate throughout development. As new strategies emerge and become dominant, old strategies are subordinated but not replaced. If this view is correct, it may be possible to describe language acquisition as a developmental change

in linguistic processing strategies. By implication, an important task for the developmental psycholinguist is that of specifying the strategies used by children of different ages. How do strategies for speech perception and production change with development? Can these strategies account for variation in the ease of understanding different linguistic expressions?

Although the research is limited, there is some evidence that children's difficulty in understanding temporal connectives may be attributed to the application of inappropriate strategies for organizing information. For example, Clark (1972) observed that children aged 3.0 to 5.0 tended to apply an order of mention strategy (Strategy D) to the interpretation of sentences with "before" and "after."

Strategy D: The order of occurrence of events corresponds to the order of mention in the sentence.

Thus, sentences such as (19) and (20) were correctly acted-out, but sentences (21) and (22) were consistently misinterpreted.

(19) He jumped the gate before he patted the dog.

(20) After he jumped the gate, he patted the dog.

(21) Before he patted the dog, he jumped the gate.

(22) He patted the dog after he jumped the gate.

By the age of 5.5 or 6, however, Strategy D is no longer predominant. As Amidon and Carey (1972) observed,

kindergarten children applied Strategy C (attending to main clauses) to the interpretation of temporally ordered commands. Thus, sentences containing a subordinate clause (23-26) were consistently misinterpreted, as the subject carried out only the main clause event and ignored the subordiante clause event. Sentences which did not contain a subordinate clause (27 and 28), however, were correctly interpreted.

(23) Move a blue plane before you move a red plane.

(24) Move a red plane after you move a blue plane.

(25) Before you move a red plane, move a blue plane.

(26) After you move a blue plane, move a red plane.

(27) Move a blue plane first; move a red plane last.

(28) Move a red plane last; move a blue plane first.

Since all of the above sentence types expressed the same sort of relation between events, the poor performance with sentences (23) through (26) cannot be attributed to underlying conceptual complexity. Rather, the difficulty seems to be due to syntactic factors. Namely, sentences (23) through (26) contain a subordinate construction whereas sentences (27) and (28) contain two independent clauses

When subjects were given 20 training trials in which their responses to sentences with "before" and "after" were corrected, they showed significant improvement on a posttest with new materials. In fact, the error scores for these subjects were significantly lower than would have been predicted on the basis of chance responding. In

contrast, control subjects, who received 20 practice trials but no feedback, showed no improvement on the posttest.

Since the improvement of subjects receiving feedback was so rapid, we may conclude that the children possessed an underlying competence for interpreting sentences with "before" and "after." The effect of training with feedback, therefore, must have been to encourage a change in processing strategy. Once children were informed of their errors they applied a different strategy in which both commands were carried out. In the absence of feedback, however, performance was poor due to the predominance of an inappropriate strategy (i.e., Strategy C).

The above discussion demonstrates the way in which linguistic information processing strategies can account for difficulty in understanding various temporal markers. Clark's semantic feature hypothesis, by contrast, is inadequate. According to Clark's analysis "first" and "last," as they are used in sentences (27) and (28), are analogous to "before" and "after." That is, "first" and "last" can be specified in terms of Time, Simultaneous, and Prior, and therefore, they should be as difficult to interpret as "before" and "after." The fact that sentences with "first" and "last" were so much easier than sentences with "before" and "after" suggests that syntactic factors, rather than semantic features are relevant. However, if Clark's semantic feature hypothesis is rejected, then how can we account for the observed differences in performance with "before"

versus "after" (Clark, 1972) and "if" versus "unless" (Olds, 1968)?

A possible explanation for the differential difficulty of "before" and "after" is found in Bever's description of the perceptual-cognitive strategies used in organizing linguistic information. Bever (1970b) claims that in comprehending sentences with ordered events the listener organizes relations by starting with the first event; other events are subsidiary. It follows from this that if the first event is easily accessible, then interpretation of the sentence will be facilitated. Moreover, since information contained in the main clause of a sentence is primary (Strategy C), first events should be more accessible if they are contained in a main clause than if they are contained in a subordinate clause. As a consequence, sentences in which the first event is contained within the main clause will be more easily interpreted than sentences in which the first event is contained in the subordinate clause. Since sentences with "before" always contain the first event in the main clause, these sentences should be more easily understood than sentences with "after" in which the first event is always contained in the subordinate clause.

The differences in performance with "if" versus "unless" could also be explained in terms of linguistic processing principles. It has been shown, for example, that, ceteris paribus, negative information is more difficult to interpret than is affirmative information (Wason, 1959; Slobin,

1966). Thus, it is to be expected that the term "unless," which specifies a negative conditional relation between two events, would be more difficult than the term "if" which specifies an affirmative conditional relation. It should be noted, however, that this explanation does not distinguish what is linguistically complex from what is cognitively complex. A second argument, outlined below, provides a more detailed explanation and a possible means of differentiating linguistic factors from cognitive factors.

First, it seems reasonable to propose that understanding sentences with contingent relations implies knowing the circumstances in which the event in the main clause will take place. That is, the listener should know what proposition must be true in order for the main clause to be true. It could be argued further that such information is more accessible in sentences with "if" than in sentences with "unless." In sentence (29), for example, this information is obtained by simply deleting "if" from the subordinate clause, but in (30) by deleting "unless" and negating the subordinate clause.

(29) Mr. Waltham will move to Berkeley if the stock market crashes.

(30) Mr. Waltham will move to Berkeley unless the stock market crashes.

If the above explanation is correct, then it should follow that sentences with "if_not" would be easily interpreted, as in these cases the critical information as to

when the main clause event may occur is readily available in the surface structure. For example, in sentence (31) the proposition which must be true in order for the main clause to be true is "if the stock market does not crash."

(31) Mr. Waltham will move to Berkeley if the stock market does not crash.

An additional prediction, implied by the above argument, is that sentences with "unless_not" should be relatively difficult. In sentence (32), for example, the surface structure of the subordinate clause does not directly express the proposition "if the stock market crashes" (which must be true in order for the main clause to be true). Rather, this information must be derived through a recoding of information expressed in the subordinate clause.

(32) Mr. Waltham will move to Berkeley unless the stock market does not crash.

It should be noted that the linguistic processing argument outlined above has suggested predictions which are unexplained by a cognitive account. Namely, according to the linguistic processing view, "if" should be more easily interpreted than "unless_not" even though these expressions signal the same underlying conceptual relation. Also, "if_not" should be more easily interpreted than "unless" even though these terms signal the same conceptual relation.

The discussion, thus far, has focused primarily on the ability to effectively use a given linguistic expression;

the acquisition of concepts, independent of language has been largely ignored. Nevertheless, there is clearly a point at which general level of cognitive organization affects what is understood in language. For example, if the child has not acquired the concept of sequential ordering then he can hardly be expected to understand temporal contingency terms. Similarly, if he has no notion of conditionality, he is not likely to understand logical connectives. Slobin (1971) has proposed, moreover, that the rate and order of development of semantic notions proceeds in accordance with universal principles of congitive development. This proposition, of course, applies to the development of semantic intentions rather than the formal marking of intentions. In actual speech performance, there is often a lag between the child's semantic intentions and his ability to express those intentions in language. Similarly, there is often a discrepancy between the child's knowledge of the world and his ability to understand that knowledge when expressed in language. As Slobin (1971) states: "Cognitive development and linguistic development do not run off in unison. The child must find linguistic means to express his intentions. The means can be easily accessible ... or quite unaccessible .... The problem is: What makes a given linguistic means of expression more or less accessible to the child?" (p. 313).

It is this problem which was considered in the present study of children's understanding of sentences with temporal

and conditional relations. At what age are different temporal and conditional expressions understood? What is the order of difficulty among temporal and conditional connectives? What strategies do children use to interpret sentences with temporal and conditional relations? How do these strategies change with age?

Research Problem

In an attempt to answer the questions mentioned above, children aged 5, 7, and 9 were tested on two experimental tasks designed to assess comprehension of sentences with temporal and conditional connectives. The connectives selected for investigation included the temporal terms "when," "as soon as," "before," and "after," and the conditional terms "unless," "if not," and "unless not."

Although information about this aspect of language learning is limited, the findings of previous experiments and theoretical arguments suggest some useful hypotheses. For instance, most investigations have revealed a developmental trend toward improved psycholinguistic functioning. Therefore, it is to be expected that older children would perform better than younger children on the language tasks of the present research.

It is also expected, however, that, within age groups, there would be substantial variation in the ease with which different connectives are understood and used. This prediction derives from research demonstrating that the ease of understanding a given expression depends on the conceptual

complexity of the underlying relation as well as the formal linguistic complexity of the expression. For example, Ferreiro and Sinclair (1971) have shown that temporal order terms such as "before" and "after" are more difficult than simultaneous terms such as "when" and "as soon as." This finding is consistent with their argument that temporal order relations are cognitively more complex than simultaneous occurrence relations.

On the other hand, Clark (1971) reported that "after" is acquired at a later age than "before," and this finding is unexplained by general cognitive factors. As an alternative explanation, Bever (1970b) has offered an account based on two principles of psycholinguistic functioning: 1) listeners tend to organize temporal relations by beginning with the first event, and 2) information in main clauses is more accessible than information in subordinate clauses. Since sentences with "before" contain the first event in the main clause, such sentences should be more easily interpreted than sentences with "after," which contain the first event in the subordinate clause.

With regard to conditional connectives, Olds' (1968) research has shown that the negative conditional term "unless" is more difficult than the affirmative conditional term "if." This finding is compatible with the linguistic processing analysis outlined previously and also with the cognitive analysis detailed below.

In a cognitive analysis, the affirmative conditional

term may be thought of as expressing a conjunctive relation: if A then B. The negative conditional term, in contrast, expresses a disjunctive relation: if not A, then B. Since disjunctive concepts are, in general, more difficult than conjunctive concepts (Kofsky, 1966), it seems reasonable that the disjunctive relation specified by the negative conditional "unless" would be more difficult than the conjunctive relation specified by the affirmative conditional "if."

Another finding reported in Olds' (1968) study is that the conditional expression "unless" was more difficult than "if_not." Since these expressions are conceptually equivalent, the cognitive analysis cannot explain the differences in ease of comprehension. However, the lingiustic processing approach outlined previously can account for this finding in terms of differences in the accessibility of critical information. That is, information about when the event in the main clause can occur is more accessible in sentences with "if_not" than in sentences with "unless." With sentences containing "if_not," such information is derived simply by deleting the term "if" from the subordinate clause. With sentences containing "unless," however, the connective "unless" must be deleted and the action of the subordinate clause must be negated.

There has been no research comparing the comprehension of "unless_not" with "if," "if_not," and "unless." Nonetheless, it follows from the linguistic processing analysis

that "unless_not" would be more difficult than "if." This prediction derives from the argument that information about when the main clause event can occur is more accessible in sentences with "if" than with "unless_not." According to the cognitive analysis, however, there should be no difference in the ease of interpreting these terms. With regard to the comparison of "unless_not" with "unless" and "if_not," the linguistic processing account again leads to predictions which contrast with those of the cognitive analysis. For example, in the comparison of "unless_not" with "unless," the linguistic analysis predicts no difference in the ease of comprehension, since both expressions involve a recoding of surface structure information. The cognitive analysis, however, predicts that "unless_not" should be more easily understood than "unless," since "unless_not" expresses an affirmative conditional relation whereas "unless" expresses a negative conditional relation. In the comparison of "unless_not" with "if_not," the linguistic analysis suggests that "unless_not" should be more difficult than "if_not" since sentences with "unless_not" must be recoded in order to determine when the main clause event can occur. However, in the cognitive model, "if_not" should be more difficult than "unless_not," since "if_not" expresses a negative conditional relation whereas "unless_not" expresses an affirmative conditional relation. In view of these inconsistencies, any conclusions regarding the relative difficulty of "unless_not" seem unwarranted in

the absence of empirical data.

Considering the general comparison of temporal terms with conditional terms, it follows from the cognitive analysis that conditional terms would be more difficult. This prediction is based on the fact that conditional terms are often used to express logical propositions (e.g., if X then Y), which require advanced cognitive skills. Temporal terms, however, express time relations or sequential ordering notions (e.g., first X then Y), which are acquired relatively early in development. However, this prediction has been refuted by empirical evidence. In Olds' (1968) experiment, the conditional term "if" was no more difficult than the temporal term "when." In addition, "if" was more easily understood than the temporal order terms "before" and "after." These findings suggest that children, by the age of five or so, may have already acquired notions of conditionality. There is little reason, therefore, to predict differences in the ease of interpreting conditional terms versus temporal terms.

In addition to linguistic and cognitive complexity, other factors which have been shown to affect language comprehension include clause ordering, order of mention of events, and semantic constraint. With regard to clause ordering, Smith and McMahon (1970) observed that comprehension in adults was facilitated by presenting the main clause first in heard sentences. In view of this, it is reasonable to predict that clause ordering would have similar

effects on the language comprehension of children.

The order of mention of events was investigated by Clark (1971). Using preschoolers as subjects, Clark found that sentences with temporal order terms were more easily interpreted if the order of mention corresponded to the actual order of occurrence of events. If these observations apply to older children as well, then sentences with "before" and "after" should be more easily understood if the first event heard is the first to occur.

Semantic constraint between events was found to facilitate the preschooler's comprehension of passive constructions (Bever, 1970a). That is, sentences such as "The mother patted the dog" were more easily understood than sentences such as "The dog patted the mother." It might be expected, therefore, that semantic constraint between events would facilitate comprehension of sentences with contingent relations.

The hypotheses discussed above may be summarized as follows:

1. The ability to interpret sentences with contingent relations will improve with age.
2. The ease of interpreting sentences with contingent relations will vary according to the surface device used to express those relations.
3. The ease of interpreting sentences with contingent relations will vary according to the conceptual complexity of the expressed relation.

4. Sentences in which the subordinate clause is first will be more difficult than sentences in which the subordinate clause is last.
5. Sentences in which the order of mention of events violates the order of actual occurrence will be more difficult than sentences in which the order of mention corresponds to the order of occurrence.
6. Sentences in which the degree of semantic constraint between events is low will be more difficult than sentences in which the degree of semantic constraint is high.

Specific hypotheses regarding the order of difficulty among connectives (predictions 2 and 3), may be outlined as follows:

	Predicted Order of Difficulty	
Contingency Terms	Linguistic Processing Analysis	Cognitive Analysis
"when" vs. "as soon as"	=	=
"when" & "as soon as" vs. "before" & "after"	?	"before" & "after"> "when" & "as soon as"
"after" vs. "before"	"after" > "before"	=
"if_not" vs. "if"	=	"if_not" > "if"
"unless" vs. "if"	"unless" > "if"	"unless" > "if"
"unless_not" vs. "if"	"unless_not" > "if"	=
"unless" vs. "if_not"	"unless" > "if_not"	=
"unless_not" vs. "if_not"	"unless_not" > "if_not"	"if_not" > "unless_not"

Contingency Terms	Linguistic Processing Analysis	Cognitive Analysis
"unless not" vs. "unless"	=	"unless" > "unless not"
conditional terms vs. temporal terms	?	conditional > temporal

In order to test the predictions listed above, the present investigation examined the error scores of two different language tasks according to age level and sentence type. In addition, a comparison of age-level differences within each sentence type was used to determine the age at which particular contingency terms were understood. If performance was found to improve significantly with some connectives and not with others, this would suggest an order of acquisition among different linguistic expressions. However, if performance improved uniformly among all connectives, this would suggest that the developmental change involved the acquisition of some general linguistic or cognitive skills rather than the learning of specific word meanings. For example, an increasing ability to remember information contained in subordinate clauses would affect all sentence types equally.

A detailed examination of specific error types was expected to provide information about the strategies children use when they misinterpret sentences with contingent relations. A comprison of error patterns across age levels would reveal the way in which interpretation strategies change with development. Moreover, if certain kinds of errors declined with age, whereas others did not, this would

indicate which specific skills underlie general psycholinguistic development during the elementary school years.

To minimize the effects of task-specific performance, two different comprehension tests were used. The first consisted of nonverbal responses to heard sentences; the second consisted of verbal responses to questions about information contained in heard sentences. Although these two tasks differed considerably, it was expected that they would nonetheless yield compatible results.

Method

Design

Children of three age groups were tested on two experimental tasks designed to assess their understanding of sentences with temporal and conditional connectives. The first task consisted of nonverbal responses to 32 test sentences. The second task was a question and answer game with 32 different test sentences. The order of presentation of these two tasks was randomized with the restriction that half of the female subjects and half of the male subjects in each age group received the comprehension task followed by the elicited production task; the remaining subjects received the tasks in reverse order.

Subjects

A total of 48 elementary school children served as subjects. There were 16 kindergarten children, 16 second-graders, and 16 fourth-graders. Within each age group half of the subjects were males and half were females.

Task 1:

Materials: Each of the following connectives appeared four times in a list of 32 test sentences: "when," "as soon as," "before," "after," "if," "if not," "unless," and "unless not." The basic sentence types were as follows:

(1) You move the car (when) the light comes on.

(2) (When) the light comes on, you move the car.

Connectives were assigned to the above sentence types in such a way that each connective appeared two times in sentence (1) and two times in sentence (2). The resulting test sentences were ordered randomly with the restriction that within each block of eight test sentences, each connective occurred once and each sentence type occurred four times. A second list of sentences was arranged in reverse-random order.

Each test sentence was printed on a three-by-five card for use in a game in which the experimenter read the sentence and the subject responded by moving a car along a specially designed gameboard. This gameboard contained a series of painted squares which formed a roadway. A small blue light, which could be switched on or off by the experimenter, was mounted on a corner of the gameboard.

Procedure: Each subject was tested individually by the same (female) experimenter. Instructions were as follows:

> (Subject's name), I'd like you to try a (another) new game. I'm going to put this car at the beginning of the road -- like this. And you're

> going to move the car along the road -- like this -- one square at a time. These cards, which I'll read to you, will tell you when you can move the car. Sometimes you move the car when the light is on (light turned on), and sometimes you move the car when the light is not on (light off). Sometimes you won't move the car at all. You have to listen to what I say and look at the light. Do you have any questions? O.K., let's try some for practice. This card says, 'The light comes on, and you move the car' (light comes on immediately after the sentence -- subject moves car). Fine. Let's try another one. 'The light does not come on, and you move the car' (light off -- subject moves car). O.K., now this one. 'The light comes on, and you move the car' (light off -- subject does not move car). O.K. 'The light does not come on and you move the car' (light on -- subject does not move car). Good. Do you understand the game now? All right, let's put the car back at the starting point, and I'll read the rest of these cards to you.

The subject's responses were corrected, if necessary, during the four practice trials. However, no feedback was provided during the actual testing session.

The light on the gameboard was turned on or off according to a prior assignment of stimulus conditions. In a positive stimulus condition the light was turned on immediately after the test sentence. In a negative stimulus condition the light remained off. The assignment of stimulus condition to test sentences was randomly determined with the following constraints: 1) In the list of 32 test sentences, each connective appeared two times when the light was turned on and two times when the light was not turned on; 2) within each block of eight sentences, the light was turned on four times; 3) each of the two sentence types appeared sixteen times when the light was turned

on and sixteen times when the light was not turned on. By manipulating the stimulus conditions in this manner, a nonresponse was appropriate on half of the trials for each connective. Thus, any response biases were evenly distributed among connectives.

Task 2:

Materials: As in the first task, the test materials consisted of 32 sentences, each of which contained one of the following connectives: "when," "as soon as," "before," "after," "if," "if_not," "unless," "unless_not." Of the 32 test sentences, no two sentences were the same. A typical sentence, for example, was "The elephant will eat the peanuts before the monkey climbs the rope."

The eight connectives were randomly assigned to the 32 sentences with the constraints that: 1) within each block of eight sentences each connective appeared one time; 2) between blocks of eight sentences, each connective appeared in two sentences in which the main clause was first and in two sentences in which the subordinate clause was first. This procedure was replicated seven times with the restriction that, between lists, each connective appeared one time with each of the 32 sentences (see Appendix A for List 1).

Procedure: The eight lists of 32 sentences were tape-recorded and assigned to subjects in a random manner. Each subject heard only one list; and each list was presented to two subjects in each age group (one male and one female).

Subjects were tested individually, as in Task 1. This task, however, consisted of a question-answer game in which the subject heard a tape-recorded sentence followed by a question about the information contained in the sentence.

Instructions were as follows:

> (Subject's name), I'd like you to try a (another) new game. This is a game where you listen to sentences and answer questions. When I turn on this tape-recorder, you'll hear a voice. When the voice stops, I'll ask you a question. You should listen carefully, and try to remember what you hear. Are you ready to begin? O.K., I'll turn on the tape-recorder.

After each sentence, the experimenter asked one of the following questions:

A) "What" question - question refers only to the event in the main clause of the sentence (e.g., "What will the elephant do?").

B) "When" question - question refers to the relation between the event in the main clause and the event in the subordinate clause (e.g., "When will the elephant eat the peanuts?"). In this case, only the subordinate clause is questioned.

The assignment of question type to sentence was randomized and balanced according to the following procedure:
1) Questions A and B appeared four times in each block of eight sentences (two times after a sentence in which the main clause was first, and two times after a sentence in which the subordinate clause was first); 2) between blocks

of eight sentences, questions A and B each appeared two times with each connective.

As each question was answered the experimenter recorded on paper the subject's response.

Results

Effects of Age Level and Sentence Type

Table 1 summarizes the results of Task 1 by presenting the error scores of each age group for each sentence type. Table 2 summarizes the error scores for "when" questions on Task 2. An inspection of these data suggests that the ease of understanding sentences with contingent relations varies with both age level and sentence type. As the column totals in Tables 1 and 2 indicate, there is a developmental decline in error frequency, with most of the improvement occurring between the ages of five and seven. In addition, a comparison of the row totals in Tables 1 and 2 reveals substantial variation in error frequency for different sentence types. Sentences containing the connectives "when," "as soon as," and "if" were easily understood, whereas sentences with "if_not," "after," and "before" were somewhat difficult. Sentences containing the connectives "unless" and "unless_not" were extremely difficult. Moreover, as can be seen in Table 1, the error frequencies on Task 1 were significantly higher than random for sentences with "unless" and "unless_not" ($p < .05$), though they were significantly lower than random for

sentences with "when," "as soon as," "if," "if_not," "before," and "after" ($p < .05$). The probability of a correct response on this task, given random performance, was .50.

It should be noted that the children's performance on the first task closely paralleled their performance on the second task with "when" questions. In both cases there was substantial improvement between the ages of five and seven and only slight improvement between seven and nine. More important, however, is the observation that the order of difficulty among connectives on Task 1 was approximately the same as that on Task 2. In fact, a Spearman's rank correlation comparing the order of difficulty among connectives on Task 1 with that of Task 2 was highly significant ($r = .94$, $p < .01$).

Table 3 summarizes the error scores for "what" questions on Task 2 according to age level and sentence type. These data suggest a developmental trend toward improved performance, although it is clear that "what" questions were relatively easy for all age groups. As Table 4 shows, "what" questions resulted in significantly fewer errors than did "when" questions.

In order to determine whether the age level and sentence type effects were significant, the data summarized in Tables 1, 2, and 3 were analyzed in separate two-factor analyses of variance for a split-plot design with fixed effects (Edwards, 1964). In this design, subjects are

nested within age levels, sixteen subjects per age. These analyses demonstrated that both age level and sentence type had a significant effect on the child's ability to comprehend sentences with contingent relations. As shown in Table 5, error scores on Task 1 varied significantly with age level ($p < .01$) as well as sentence type ($p < .01$). In addition, the interaction between age and sentence type was significant ($p < .01$). In Table 6 it can be seen that error scores for "when" questions in Task 2 also varied significantly with age level ($p < .01$) and sentence type ($p < .10$). The error scores for "what" questions, however, varied only with age level ($p < .05$) and not with sentence type (see Table 7).

Specific age level and sentence type effects were analyzed in separate post hoc Scheffé tests according to the procedure outlined by Hays (1963). With regard to age level, these tests indicated that most of the developmental improvement in understanding sentences with contingent relations occurs between the ages of five and seven. As shown in Tables 8 and 9, the five-year-olds' error scores were significantly higher than those of the seven- and nine-year-olds for Task 1 as well as for "when" questions of Task 2. The differences between seven- and nine-year-olds, however, were insignificant. For "what" questions of Task 2 the only significant age differences observed were between the five- and nine-year-olds.

A comparison of the mean error scores for each sentence

type on Task 1 is presented in Table 11a and summarized in Table 11b. The corresponding data for "when" questions of Task 2 are shown in Tables 12a and 12b. From these data it is apparent that the connectives "unless" and "unless_not" were significantly more difficult than all others, with the exception of "before" on Task 2. In this case, the difference in error scores for "unless_not" and "before" was not significant, though there was a tendency for "unless_not" to be more difficult than "before."

It is significant that "unless" and "unless_not" were found to be more difficult than "if_not" and "if," for these pairs of terms are functionally equivalent; i.e., "unless" and "if_not" both express an underlying negative conditional relation, and "if" and "unless_not" both express an underlying affirmative conditional relation.

The comparison of "if" with "if_not" yielded no significant differences, though there was a tendency on both tasks for "if_not" to be more difficult than "if." There was also a tendency on Task 1 for "unless_not" to be more difficult than "unless," but on Task 2 this trend was reversed.

The error scores for the terms "when," "as soon as," "if," "if_not," and "after" did not differ from each other to a significant degree. Although the temporal order terms "before" and "after" tended to be more difficult than the simultaneous occurrence terms "when" and "as soon as," this difference was significant only for the comparison of

"before" with "when" and "as soon as."

In order to specify which sentence types differentiated five-year-olds from older children, the mean error scores for different age groups were compared within each sentence type by means of separate Scheffé tests. Since the performance of seven-year-olds was so similar to that of nine-year-olds, the scores for these two age groups were pooled. Thus, for each sentence type, the mean error score of seven- and nine-year-olds was compared to the mean error score of five-year-olds. The results of these comparisons for Task 1 are presented in Table 13 and represented graphically in Figure 1. For Task 2, these comparisons are presented in Table 14 and graphed in Figure 2. As these data indicate, on both tasks, the error scores of five-year-olds were significantly higher than the error scores of seven- and nine-year-olds on all sentence types except those containing the connectives "if" and "unless_not." For sentences containing "if," the difference between the five-year-olds' mean error score and that of the seven- and nine-year-olds just missed significance on both tasks ($p < .10$). There was a trend toward developmental improvement with "unless," but, the age comparisons were significant only on Task 1. With "unless_not," there was a trend toward improvement with age on Task 2, but on Task 1 these age differences were reversed, i.e., five-year-olds made significantly fewer errors with "unless_not" than did seven- and nine-year-olds. It should be noted, however, that the

"superior" performance of five-year-olds was nonetheless significantly poorer than random. Thus, there is no indication that five-year-olds actually understood the connective "unless_not"; rather, they were merely less consistent in misinterpreting these sentence types than were older children.

Response Analysis

As an extension of the above observations, the subjects' responses on each task were categorized and examined for frequency of occurrence. For the first task, incorrect responses were classified into two kinds of errors. For the second task, answers to "when" questions were classified as either incorrect or correct. The incorrect responses were then categorized into two kinds of errors; correct responses were categorized according to the contingency term used by the subject. The results of these analyses are detailed in the following discussion.

In Task 1 there were two kinds of errors which could occur: (a) Commission errors, where the subject carried out the action of the main clause in inappropriate situations; and (b) Omission errors, where the subject failed to carry out the action of the main clause in appropriate situations. Table 15 presents the total number of commission and omission errors for each of the three age groups. As these data suggest, the difference between the frequency of commissions versus omissions was insignificant for both seven- and nine-year-olds. Five-year-olds, however, made

significantly more commission errors than omission errors ($z = 4.597$, $p < .01$). Furthermore, the frequency of commission errors showed a significant decline with age, whereas the frequency of omission errors remained relatively constant. As the analysis of variance in Table 16 demonstrates, age level significantly affected the number of commission errors ($p < .01$). Specifically, as shown in Table 17, the five-year-olds made significantly more commission errors than did seven- or nine-year-olds.

Table 18 presents the number of commission errors, omission errors, and correct responses for each sentence type at each age level. Here it can be seen that the five-year-olds' tendency to make commission errors appeared with all sentence types. That is, for each sentence type, the number of commission errors tended to be greater than the number of omission errors. Among seven- and nine-year-olds, however, the number of commission errors for each sentence type was approximately the same as the number of omission errors.

It should be noted, when examining the data in Table 18, that the commission and omission errors for each sentence type did not always occur in the same stimulus condition. Consider, for example, the following sentence: "You move the car if the light does not come on." This sentence indicates that the subject should respond only in a negative stimulus condition (i.e., "light off"). A response in a positive stimulus condition, in this case, is a commission

error; a nonresponse in a negative stimulus condition is an omission error. In contrast, the sentence "You move the car if the light comes on" indicates that the subject should respond only in a positive stimulus condition. For this sentence, a response in a negative stimulus condition is a commission error, and a nonresponse in a positive stimulus condition is an omission error.

In view of the relationship between stimulus condition and error type, sentences may be categorized according to when commission and omission errors can occur. That is, for sentences with "before," "if_not," and "unless," commission errors occur only in positive stimulus conditions, and omission errors occur only in negative stimulus conditions. For sentences with "when," "as soon as," "if," "after," and "unless_not," commission errors occur only in negative stimulus conditions; and omission errors occur only in positive stimulus conditions.

The importance of detailing these relationships is to determine whether the variation in error scores for different sentence types is attributed to the interaction of stimulus condition and response type. For example, if children always responded in a positive stimulus condition and never responded in a negative stimulus condition, this would result in perfect scores for "when," "as soon as," "if," "after" and "unless_not." An inspection of the data in Table 18 reveals that this distribution of errors did

not emerge in the results. In fact, the two most difficult sentence types "unless" and "unless_not" involved different stimulus-response relationships.

Although the interaction of stimulus condition and response type does not appear as a dominant factor, it could nonetheless have a limited effect on performance. Evidence supporting this hypothesis is found in a comparison of combined error scores for "if_not," "unless," and "before," with the combined error scores for "when," "as soon as," "if," "after," and "unless_not." It should be noted here that the terms "if_not," "unless" and "before" involve a stimulus-response relationship in which a response is appropriate only in a negative stimulus condition; a nonresponse is appropriate only in a positive stimulus condition. For the remaining terms, a response is appropriate only in a positive stimulus condition, and a nonresponse is appropriate only in a negative stimulus condition. The results of this comparison are presented in Table 19. It can be seen, from these data, that the combined error scores for "if_not," "unless," and "before" were significantly higher at all age levels than the combined error scores for the remaining sentence types. That is, sentences which required a response in a negative stimulus condition tended to be more difficult than sentences which required a response in a positive stimulus condition.

On the other hand, there is evidence that the

distribution of errors reflects an interpretation strategy rather than a response bias. Namely, children had a similar distribution of errors on Task 2 even though this task did not involve negative stimulus conditions. On Task 2, as on Task 1, the combined error scores for "if_not," "unless," and "before" were significantly greater for all age groups than the combined error scores for all other sentence types. These data are presented in Table 20. Such evidence indicates that the terms "if_not," "unless," and "before" are relatively difficult to interpret, regardless of task-specific factors such as the interaction between stimulus condition and response type. In addition, it should be mentioned that during the practice trials, children had little difficulty responding in negative conditions or not responding in positive conditions. That is, responses to sentences such as "The light comes on, and you do not move the car" or "The light does not come on, and you move the car" were easily carried out. It should be noticed that with these practice sentences, the appropriate response was either a nonresponse in a positive stimulus condition or a response in a negative stimulus condition. Moreover, a detailed analysis of errors in Task 2 reveals that the difficulty in understanding contingency terms is attributed to the child's mininterpretation of the sentences he hears rather than to the response complexity of a particular task. These results are described more extensively following a general description of the response

analysis for Task 2.

For Task 2, errors for "when" questions were classified into two categories: (a) Content errors, where the subject either failed to respond or provided incorrect information about the event contained in the subordinate clause; and (b) Relation errors where the subject expressed an incorrect relation between events. The latter category consisted of answers in which the subject accurately described the event in the subordinate clause but failed to use appropriate contingency terms to describe the relation between events. Examples of each type of error are presented in the sequence below.

Test sentence: Ken will read a book before Mary draws a picture.

Question: When will Ken read a book?

Content error: Before Mary bakes a cake.

Relation error: After Mary draws a picture.

Correct response: Before Mary draws a picture.

With respect to the correct responses for "when" questions, it should be mentioned that answers were scored as correct whenever appropriate information was expressed, regardless of whether the answer was a verbatim reproduction of material contained in the test sentence. Thus, the contingency term "when," for example, was acceptable in answering questions about sentences containing the connective "as soon as." Also, "when" was acceptable for sentences containing "if" since, as Anderson (1972) points out,

these two terms are often interchangeable in actual language use.

Table 21 presents the number of content and relation errors for each age group. These data were analyzed in two separate one-factor analyses of variance to determine the effects of age level on the frequency of errors in each category. As shown in Tables 22 and 23, age level had a significant effect on the frequency of both content errors and relation errors. It is notable, however, that as the frequency of content errors decreased with age, the frequency of relation errors increased. Specifically, five-year-olds made more content errors ($p < .01$) and fewer relation errors ($p < .01$) than did the combined groups of seven- and nine-year-olds (see Tables 24 and 25).

The developmental decline in content errors demonstrated that the ability to retain and verbalize information contained in subordinate clauses improved with age. However, the ability to express contingent relations between clauses did not improve with age; otherwise the frequency of relation errors would have decreased concomitantly with the decline in content errors. What the increase in relation errors suggests is that older children tended to express incorrect relations between events even though they had acquired the skills necessary for retaining and describing the events contained in subordinate clauses.

This point is clearly demonstrated if we examine, for each age group, the likelihood of a correct response,

given that the event in the subordinate clause was remembered. For five-year-olds, responses were correct in 61% (81/132) of the instances in which the subordinate clause event was described. For seven-year-olds the ratio was 64% (128/200), and for nine-year-olds it was 66% (121/198). Comparing the proportion of correct responses of five-year-olds (.61) with the combined mean proportion of seven- and nine-year-olds (.65) it can be seen that older children did not differ from the five-year-olds in their ability to express contingent relations ($z = 1.00$, $p > .05$).

Table 26 lists the total number of content and relation errors for each sentence type. Two separate analyses of variance, summarized in Tables 27 and 28, reveal that sentence type significantly affected the frequency of relation errors ($p < .01$), but did not affect the frequency of content errors ($p > .05$). Thus, it can be seen that the ability to retain and express a relation between events in a heard sentence varied according to the connective introducing the subordinate clause. The ability to retain and express information about the event in the subordinate clause, however, was unaffected by the connective.

Another way of analyzing these data is to compare sentence types in terms of the frequency with which subjects expressed an appropriate relation, given that the event contained in the subordinate clause was remembered and expressed.

These data are reported in Table 29. For sentences containing "when," subjects were more likely than not to express a correct relation if they described the event in the subordinate clause ($z = 6.84$, $p < .01$). Similar findings were observed in subjects' responses to sentences containing "if" ($z = 6.70$, $p < .01$), "as soon as" ($z = 5.83$, $p < .01$). "after" ($z = 3.68$, $p < .01$), and "if_not" ($z = 2.63$, $p < .01$). For sentences containing "before," however, subjects were no more likely to express a correct relation than an incorrect one ($z = .52$, $p > .05$). With "unless" ($z = 7.00$, $p < .01$) and "unless_not" ($z = 4.04$, $p < .01$), subjects were more likely to express an incorrect relation than a correct one.

The finding that some sentence types resulted in incorrect responses even when the event in the subordinate clause was accurately described suggests that the contingency terms contained in these sentences may have been systematically misinterpreted. This hypothesis is supported by the analysis of specific relation errors for each sentence type. As can be seen in Table 30, certain sentence types resulted in a consistent use of incorrect contingency terms. For example, when children answered questions about sentences containing "unless," they typically expressed relations in which the event in the main clause was contingent on the occurrence of the event in the subordinate clause; i.e., they verbalized a relation which was opposite in meaning to that of the test sentence.

Frequently, subjects used the contingency terms "if" and "when" in their answers. In fact, these terms comprised 72% (43/60) of the relation errors for sentences containing "unless." This frequency is greater than that of all other types of relation errors combined (X^2 = 11.27, $p < .001$). For sentences containing "unless_not," children tended to express relations in which the occurrence of the event in the main clause was contingent on the non-occurrence of the event in the subordinate clause. Specifically, subjects used the connectives "if_not" and "when_not" to describe the relation between events. The frequency of occurrence of these two connectives was 69% (38/55), significantly greater than the frequency of all others (X^2 = 8.04, $p < .01$). For sentences containing "if_not," relation errors consisted of the terms "if," "when" and "as soon as" in 83% of the instances (X^2 = 10.67, $p < .01$). Thus, there was a tendency for "if_not" to be remembered and expressed as a relation in which the event in the main clause was contingent on the occurrence of the event in the subordinate clause. Of the relation errors for sentences with "after," 100% (21/21) consisted of the term "when" (X^2 = 10.00, $p < .01$). There were no instances in which "after" was recalled and expressed as "before." Relation errors for sentences with "before" consisted of the simultaneous terms "when" and "as soon as" in 75% (21/28) of the cases (X^2 = 7.00, $p < .01$). The frequency of relation errors for "if" and "when" was extremely low,

and, in consequence, no error type predominated. Errors for "as soon as," however, consisted of the temporal order term "after" in 100% (10/10) of all instances ($X^2 = 6.40$, $p < .01$).

Table 31 presents a classification of all correct responses according to sentence type and contingency term used by the subject. Here it can be seen that the connective "when" was always used for sentences containing "when" and frequently used for sentences containing "as soon as," "if," and "unless_not." Similarly, the connective "when_not" was frequently used for sentences containing "if_not" and "unless." The connective "if," however, occurred only with sentences containing "if" and "unless_not"; and the connective "if_not" occurred only with sentences containing "if_not" and "unless." The connective "as soon as" was used only for sentences containing "as soon as" and "when." Thus, although "when" was frequently used to answer questions about the relation between events in a heard sentence, it is clear that subjects discriminated between the eight different connectives included in the test sentences. Had this not been the case, the contingency terms used by the subjects would not have varied according to the contingency term of the test sentence.

Semantic Constraint

In order to assess the effect of semantic constraint on the ease of comprehension, two independent judges were asked to score each test sentence for Task 2 in terms of plausi-

bility of the relation between events. The scores could range from one to ten, with a score of one indicating a highly improbable relation (e.g., "The customer will buy the vase if it is broken") and a score of ten indicating a highly probable relation (e.g., "The customer will buy the vase unless it is broken"). The interjudge correlation of the resulting scores was .51, significant beyond the .01 level. It was appropriate, therefore, to combine the two sets of scores so that each test sentence received a single semantic rating based on the mean of two independent judgments. The semantic scores for each sentence type were then computed and analyzed in a single-factor analysis of variance. Table 32 reports the mean semantic rating for each of the eight sentence types. As these data indicate, the differences between connectives were very small; there were no mean scores below 4.00 and none above 5.56. Furthermore, the analysis of variance in Table 33 demonstrates that the semantic scores did not vary significantly with different connectives ($p > .05$). Thus, the variation in error scores for different connectives could not be attributed to systematic variation in the semantic constraint of different sentence types.

Table 34 presents the error scores and correct response scores of each age group for sentences which were high versus low in semantic constraint. Sentences high in semantic constraint were those which received a rating above the overall mean score of 5.03; sentences low in semantic

constraint were those which received a rating below the mean. The data in Table 35 were analyzed in three separate chi-square tests, one for each age level. The results indicated that semantic constraint had no effect on performance.

Clause Order

The effect of clause order on the ease of comprehension was analyzed in separate t-tests for correlated measurements. For each age group on each task, the mean error score for sentences in which the main clause occurred first was compared to the mean error score for sentences in which the main clause occurred second.

These results indicated that the effects of clause ordering varied with age level as well as the type of task used. On Task 1, clause order had no effect on the error scores of five- and nine-year-olds, but it significantly affected the error scores of seven-year-olds. For seven-year-olds, sentences were more easily interpreted if the main clause occurred first than if it occurred second ($p < .05$).

Tables 36 and 37 summarize the error scores, according to clause order, for Task 2. In Table 36 it can be seen that for "what" questions, clause order significantly affected the performance of five- and seven-year-olds: sentences in which the main clause occurred second were easier than sentences in which the main clause occurred first. The

performance of nine-year-olds, however, was unaffected by clause order as "what" questions were easily answered regardless of the order in which clauses were presented. For "when" questions, clause order significantly affected the performance of children in all age groups: sentences in which the main clause occurred first were easier than sentences in which the main clause occurred second.

The results for Task 2 are related, in part, to recency effects. Since "what" questions referred to the event contained in the main clause of the test sentence, it is expected that these questions would be more easily answered when the main clause was the last clause heard by the subject. Similarly, since "when" questions referred to information contained in the subordinate clause of the sentence, it should follow that these questions would be more easily answered when the subordinate clause occurred last.

Order of mention of events

The effect of order of mention of events on the ease of comprehension was analyzed according to the procedure described above, i.e., separate t-tests for correlated measurements. In this case, however, the data were limited to the error scores for temporal order terms "before" and "after." These were the only connectives in which events were ordered in time, and therefore, the only sentence types for which an order of mention analysis was appropriate. Sentences in which the order of mention corresponded

to the order of occurrence of events included: (1) sentences with "after" in which the main clause was second, and (2) sentences with "before" in which the main clause was first. Sentences in which the order of mention violated the order of occurrence of events included: (1) sentences with "after" in which the main clause was first, and (2) sentences with "before" in which the main clause was second.

Table 38 summarizes the error scores of Task 1 for each age group according to the order of mention of events in the test sentences with "before" and "after." Tables 39 and 40 summarize the error scores, according to order of mention, for Task 2. These results clearly demonstrate that the order of mention of events had no significant effect on children's ability to understand and use sentences with temporal order relations.

Task Order

Table 41 compares error frequencies according to the ordering of experimental tasks. As these data indicate, Task 1 was no more difficult if it was presented first rather than second. Similarly "when" questions of Task 2 were no more difficult if they were presented first rather than second.

Discussion

Overview of Results

The child's understanding and use of sentences with temporal and conditional connectives varies with both

sentence type and age level. Some sentence types, such as those containing "unless" and "unless_not," are difficult at all age levels. Even nine-year-olds systematically misinterpret these conditional connectives. Other connectives, in contrast, are understood as early as five-years of age. These include the connectives "when," "as soon as" and "if." The temporal order terms "before" and "after" and the negative conditional "if_not" are of intermediate difficulty. With regard to age differences, there is substantial improvement between the ages of five and seven. This improvement, moreover, is attributed primarily to an increased ability to use information expressed in subordinate clauses.

The ordering of clauses was found to affect performance in some situations, but these results were attributed to recency effects rather than clause order per se.

Variables which did not affect the child's ability to understand and use sentences with contingency terms included the order in which events were mentioned and the degree of semantic constraint between events.

The results mentioned above are considered here in relation to the specific hypotheses presented in the introduction. Further analyses of these results and relevant theoretical implications are discussed in subsequent sections.

Hypothesis 1: The ability to interpret sentences with contingent relations will improve with age.

This hypothesis is supported by the findings of both experimental tasks. In general, older children performed better than younger children, with most of the developmental progress occurring between the ages of five and seven. For Task 1 as well as for "when" questions of Task 2, seven- and nine-year-olds made significantly fewer errors than did five-year-olds. That is, older children were more skilled in interpreting and using sentences with contingent relations than were five-year-olds.

This developmental change cannot be attributed to general memory factors, for performance with "what" questions of Task 2 failed to show similar improvement between the ages of five and seven. In fact, error scores for "what" questions did not decline significantly until nine years of age. This suggests that factors other than general memory skills are responsible for the developmental differences observed with Task 1 and with "when" questions of Task 2. If this were not the case, then the rate of improvement would have been parallel in all three situations.

An examination of age differences in error scores for each connective revealed significant improvement on Task 1 for all connectives except "if" and "unless_not." With regard to "if," there was a trend toward improvement with age which just missed significance. With "unless_not," however, there was a significant increase in errors with age. That is, seven- and nine-year-olds made more errors with sentences containing "unless_not" than did five-year-olds.

This finding is probably attributable to the fact that five-year-olds were simply less systematic in misinterpreting "unless_not" than were seven- and nine-year-olds. That is, although all age groups tended to misinterpret "unless_not" as "if_not," the five-year-olds were inclined to disregard the negative marker "not." Thus, they correctly interpreted "unless_not" as "if" on thirty-three percent of the trials. It should be noted, further, that five-year-olds made similar responses to "if_not." That is, they occasionally disregarded the negative marker "not" and interpreted "if_not" as "if" on thirty-one percent of the trials.

For "when" questions of Task 2, performance improved with age on all connectives except "if" and "unless." Although there was a developmental trend toward reduced errors, the age differences for "if" and "unless" did not reach statistical significance.

Hypothesis 2: The ease of interpreting sentences with contingent relations will vary according to the surface device used to express those relations.

As predicted, the contingency term "unless" was significantly more difficult than the term "if_not," despite the fact that these two expressions are functionally equivalent in underlying meaning. Similarly, the term "unless_not" was significantly more difficult than the term "if." There were no significant differences observed, however, in the error scores for "before" versus "after." In fact, there was a trend in a direction opposite to that predicted by Bever

(1970b). Possible explanations for these findings will be considered shortly.

With respect to the conditional terms, an analysis of error patterns for Task 1 indicated that performance with "unless" and "unless_not" was significantly poorer than random for all age groups. In addition, the analysis of errors for "when" questions of Task 2 revealed that children were more likely to make an incorrect response than a correct one for sentences containing "unless" and "unless_not." What these high error scores suggest is that the connectives were systematically misinterpreted. This proposition receives further support from the response analysis for "when" questions: the connective "unless" was often remembered and expressed as an affirmative conditional (e.g., "if") or a simultaneous temporal term (e.g., "when"); "unless_not" was often remembered and expressed as a negative conditional (e.g., "if_not") or nonsimultaneous temporal term (e.g., "when_not").

The reason for these systematic misinterpretations is unclear. However, it seems reasonable that such errors might be related to the availability of negative markers in the surface structure. For instance, sentences with "if_not" and "unless" both express negative conditional relations in which the occurrence of the event in the main clause is contingent on the nonoccurrence of the event in the subordinate clause. In sentences with "if_not" the negation is signaled by the negative marker "not," which immediately

precedes the verb of the subordinate clause. In sentences with "unless," however, the negation must be derived as part of the meaning of "unless" and then applied to the verb (or action) of the subordinate clause. As a result of this difference, it could be that the negative marker in "if_not" is more easily noticed and interpreted than is the negation expressed by "unless." If this is the case, then it is to be expected that errors in interpreting sentences with "unless" would reflect a tendency to disregard the negation, i.e., "unless" would be interpreted as an affirmative conditional term.

For the reasons outlined above, the negative marker in "unless_not" would be easily noticed, due to the presence of "not" in the subordinate clause. Thus, there would be a tendency to misinterpret "unless_not" as a negative conditional term.

The finding regarding temporal order terms could perhaps be explained by task-specific factors. As noted previously, children tended to misinterpret temporal order terms as signaling simultaneous relations. On Task 1 this would have the effect of facilitating performance with "after," since in these cases the correct response was to carry out the main clause event when the subordinate clause event occurred. Thus, if the child interpreted "after" as "when," his responses would be appropriate. On the other hand, if he interpreted "before" as "when" his responses would be inappropriate, since in these cases the correct

response was to carry out the main clause event when the subordinate clause event did not occur.

The problem with the above explanation is that it does not account for the fact that "before" tended to be more difficult than "after " even in answering "when" questions. In this situation, the tendency to misinterpret temporal order terms as signaling simultaneous occurrence would have resulted in increased errors for "after" as well as "before." Thus, the observed difference in error frequency for these terms on Task 2 could not be attributed to the child's tendency to substitute the simultaneous term "when" for the temporal order terms "before" and "after." In view of this, it might be proposed that sentences with "after," were more easily comprehended than sentences with "before." It should be remembered, however, that the differences in error frequency were not statistically significant, so any definite conclusion regarding the relative difficulty of these terms is unwarranted.

A more interesting issue is that these findings are inconsistent with the prediction of Bever (1970b) and Clark (1972). According to their views, "after" should be more difficult than "before." The fact that this was not observed in the present study may indicate that previous results were specific to certain age groups or to certain experimental conditions. For instance, Clark used preschool children as subjects, and her experimental task required carrying out two temporally ordered responses. It may be

that the advantage of hearing the first event in the main clause (as in sentences with "before") is effective only during the early stages of language learning or only when two ordered responses are required. This argument is supported by the fact that several recent studies with elementary school children have failed to find significant differences in the ease of interpreting sentences with "before" versus "after" (Hatch, 1971; Ferreiro & Sinclair, 1971; Amidon & Carey, 1972).

Hypothesis 3: The ease of interpreting sentences with contingent relations will vary according to the conceptual complexity of the underlying relation.

Hypotheses based on the conceptual complexity of the contingent relation received little support from the present investigation. In fact, certain findings seem to contradict the cognitive analysis. On both tasks, the temporal order terms "before" and "after" tended to be more difficult than the simultaneous occurrence terms "when" and "as soon as," but the differences in error scores were significant only for the comparison of "before" with "when" and "as soon as." The negative conditional term "unless," as predicted, was more difficult than the affirmative conditional term "if." Also, there was a tendency for "if_not" to be more difficult than "if," but the difference was not significant.

A finding which was clearly inconsistent with the cognitive analysis was that "unless" and "unless_not" were of

equal difficulty, even though "unless" expresses a negative conditional relation and "unless_not" expresses an affirmative conditional relation. Another problem for the cognitive analysis is the finding that "unless" was significantly more difficult than "if_not," and "unless_not" was significantly more difficult than "if." Since these pairs of terms express the same underlying relation, such differences in the ease of comprehension are unexplained by conceptual complexity.

The cognitive analysis is also unable to explain the finding that the conditional terms "if" and "if_not" were no more difficult than the temporal terms "when" and "as soon as." Since the conditional connectives are often used to express logical propositions, it is reasonable to suppose that they would be more difficult than connectives which express time relations. The fact that this was not the case indicates that the analysis of conceptual complexity used here is inadequate as a predictor of the ease with which conditional and temporal terms will be understood.

In general, the findings described above lead to the conclusion that the underlying conceptual complexity of temporal and conditional relations had very little effect on the elementary school child's ability to use sentences which express such relations. A possible explanation for this is that the children tested in this study had already acquired many of the concepts expressed by temporal and conditional connectives. Thus, the variation in performance

with different sentence types was attributed, primarily, to the formal linguistic complexity of the expression rather than the cognitive difficulty involved in understanding those relations per se. It is significant, in this regard, that on Task 1 performance was better than random for all connectives except "unless" and "unless_not." Thus, the children must have had a fairly complete understanding of the temporal and conditional relations signaled by the remaining connectives ("when," "as soon as," "before," "after," "if," and "if_not ").

Hypothesis 4: Sentences in which the subordinate clause is first will be more difficult than sentences in which the subordinate clause is last.

The effect of clause order depended on the age of the listener as well as the type of language task used to assess comprehension. In answering questions about information contained in the subordinate clause of a heard sentence (i.e., "when" questions), children of all age levels performed better when the subordinate clause occurred last than when it occurred first. On the other hand, if the question referred to information contained in the main clause (i.e., "what" questions), then performance of five- and seven-year-olds was improved by placing the subordinate clause first and the main clause last. For nine-year-olds, however, the ordering of clauses had no effect on the ability to express information contained in the main clause of a sentence. On Task 1 the ordering of clauses affected

performance only in seven-year-olds. In this case, as predicted, sentences in which the subordinate clause occurred last were more easily interpreted than sentences in which the subordinate clause occurred first.

To some extent these clause order effects may be attributed to general memory factors -- the most recent information (i.e., the last thing heard) is expected to be the most accessible. Thus, questions about information contained in subordinate clauses are easier if the subordinate clause occurs last in a heard sentence than if it occurs first. Similarly, questions about information contained in main clauses are easier if the main clause occurs last than if it occurs first. The only exception is the observation that clause order had no effect on the nine-year-old's retention of information contained in main clauses. This exception is probably attributed to a general improvement in memory. By nine years of age main clauses are easily remembered regardless of their ordering within a heard sentence.

Task 1 differed from Task 2 in that the amount of new information contained in each test sentence was minimal (i.e., in Task 1 each sentence was identical except for the connective introducing the subordinate clause). Thus, general memory factors, such as recency effects, should not have had a significant effect on performance. In this situation, however, the effects of clause order appeared only in seven-year-olds. With this age group, the error scores

increased when the subordinate clause was placed first in a heard sentence. This finding is consistent with Bever's (1970b) argument that listeners organize clause relations by beginning with the primary information of the main clause. Information in the subordinate clause is secondary. Therefore, performance should be facilitated when the primary information of the main clause is presented first in the sentence.

The absence of such findings with five- and nine-year-olds is difficult to explain. One possibility is that five-year-olds do not organize clause relations in such a way that the subordinate clause is psychologically subsidiary to the main clause. For instance, they may ignore the subordinate clause entirely, as Amidon and Carey (1972) have shown, or they may regard the subordinate clause as a complete sentence. In either case, the information contained in the main clause would not be primary in relation to the subordinate clause. Thus, performance would not be facilitated by placing the main clause first.

With regard to nine-year-olds, it seems likely that the clauses were easily organized, regardless of the order in which they were heard. As a consequence, sentences in which the main clause was second were no more difficult than sentences in which the main clause was first.

Hypothesis 5: Sentences in which the order of mention of events violates the order of actual occurrence will be more difficult than sentences in which the order of

mention corresponds to the order of occurrence.

The order in which events are mentioned had no effect on either the ease of comprehension or on the capacity to remember and express information contained in sentences with temporal relations. That is, the child's ability to use sentences with temporal contingency terms was unaffected by the order in which he heard the temporally related events. Sentences in which the first event heard is actually the first to occur were no easier than sentences in which the first event heard is the last to occur.

These results suggest two possible interpretations. One interpretation is that the children tested in the present study were no longer at the stage in which an order of mention strategy was predominant. It should be noted, in this regard, that previous evidence for an order of mention strategy was based on research with preschool children (Clark, 1971). An alternative explanation is that the order of mention strategy reflects a system for organizing responses rather than a mechanism of speech comprehension. Clark's experimental task, for instance, required that the child act out two separate responses to each sentence whereas the present study required only one. Thus, Clark's finding could have been attributed to the increased response complexity involved in carrying out two responses in a temporal sequence that is inconsistent with the order of mention.

Hypothesis 6: Sentences in which the degree of semantic

constraint between events is low will be more difficult than sentences in which the degree of semantic constraint is high.

The degree of semantic constraint between events (i.e., the "plausibility" of the contingent relation") had no effect on the child's interpretation and use of heard sentences. This conclusion, however, may apply only to sentences such as those used in the present experiment in which the degree of semantic constraint was neither extremely high nor extremely low. Thus, previous evidence (Bever, 1970a) suggesting a relation between semantic constraint and ease of comprehension is not contradicted by the present findings.

Development of Linguistic Strategies versus Acquisition of Word Meaning

This issue considered in this section is how to explain the developmental change in linguistic performance that occurs between the ages of five and nine. Specifically, how can we account for the observation that older children are more skilled than younger children in interpreting, remembering, and expressing sentences with temporal and conditional relations? Is it that older children have learned the definitions of individual contingency terms, or have they simply acquired more advanced, general strategies for organizing linguistic information? If the learning of individual words does not explain the developmental improvement, then what linguistic strategies or cognitive skills

are involved in the child's psycholinguistic behavior? In considering such questions, it seems useful to pay particular attention to the kinds of language errors, as well as the frequency of errors, which characterize the performance of children of different age levels.

Regarding the overall error scores of children tested in the present experiment, it is clear that the most dramatic developmental improvement occurs between the ages of five and seven. Although there is some improvement between seven and nine, the gains are small and statistically insignificant. In fact, the performance of seven-year-olds is very similar to that of nine-year-olds in terms of both frequency and type of errors made when interpreting and using sentences with contingent relations. The most interesting analysis, from a developmental perspective, therefore, is a comparison of the performance of five-year-olds with that of seven- and nine-year-olds. Specifically, it is important to determine whether five-year-olds make different kinds of errors than children in older age groups.

It is useful, in this context, to distinguish between "semantic errors," in which the child confuses the meaning of particular contingency terms, and "linguistic processing errors" in which the child selectively discards relevent information. The results from the present study demonstrate that children in all age groups make consistent semantic errors when interpreting and expressing certain contingent relations. For example, "unless" is often interpreted and

expressed as an affirmative conditional or simultaneous temporal term. "Unless not" is interpreted as a negative conditional or nonsimultaneous temporal term. Also, "before" and "after" are sometimes interpreted as simultaneous temporal terms.

It is significant that these semantic errors do not differentiate younger children from older children: five-year-olds make the same kinds of semantic errors as do the seven- and nine-year-olds. In other words, five-year-olds do not differ substantially from seven- and nine-year-olds with respect to the semantic structures they assign to individual contingency terms. They do, however, seem to differ in terms of the linguistic processing strategies used to interpret sentences with subordinate clauses. The evidence supporting this explanation, which is detailed below, derives from the consistencies in error patterns observed on two different language tasks.

On Task 1, five-year-olds tended to carry out the event mentioned in the main clause of the test sentence regardless of the constraint expressed in the subordinate clause. That is, they made many "commission" errors in which responses occurred in inappropriate situations. By age seven, however, this tendency was no longer predominant, as indicated by the fact that older children were no more likely to make commission errors than omission errors. Moreover, the improvement observed between ages five and seven was attributed almost entirely to a reduction in the number of

commission errors; the number of omission errors remained fairly constant across age levels.

It might be argued that the high frequency of commission errors among five-year-olds reflects a "game strategy" such as playing to win rather than a strategy for organizing linguistic information. This interpretation does not seem reasonable, however, in view of the children's performance during the practice trials, in which sentences did not contain subordinate clauses. In this case, children had little difficulty with sentences requiring nonresponses. In other words, the high frequency of commission errors occurred only with sentences containing subordinate clauses. Furthermore, Amidon and Carey (1972) observed that five-year-olds ignored subordinate clauses even when such a strategy violated the "winning principle." In this study, five-year-olds were presented with sentences like "Move a red plane before you move a blue plane," and the children tended to move only the plane mentioned in the main clause.

It should be noted, in addition, that the predominance of commission errors among five-year-olds appeared with all sentence types, including those which required a response in negative stimulus conditions. Thus, the high frequency of commission errors cannot be explained by the interaction of stimulus condition and response complexity.

Considering such evidence, it seems unlikely that the present results could be attributed to task-specific-

strategies. Rather, the high frequency of commission errors seems to reflect a tendency to disregard information expressed in subordinate clauses. That is, five-year-olds tend to apply a linguistic processing strategy in which they attend to the main clause of a sentence and often ignore the subordinate clause. This interpretation is consistent with the findings of Amidon and Carey (1972) and is also supported by the data from Task 2 of the present study.

On Task 2, a comparison of error types across age groups indicated that the ability to remember and express information contained in the subordinate clause improved significantly between the ages of five and seven: Seven- and nine-year-olds made significantly fewer errors in describing the subordinate clause event than did five-year-olds. The ability to express contingent relations between events, however, did not improve substantially with age, as some connectives were consistently misinterpreted by all age groups. In fact, the five-year-old's ability to use appropriate contingency terms did not differ significantly from that of seven- and nine-year-olds, given that the five-year-old was able to retain information about the event contained in the subordinate clause. Although there was a trend toward developmental improvement in the ability to use contingency terms, the difference between five-year-olds and older children was very slight.

These results are not explained by a general

improvement in memory for linguistic information, for had this been the case, then the ability to retain information about the main clause event should have increased, developmentally, at the same rate as the ability to retain information about the subordinate clause event. In fact, however, five-year-olds did not differ from the seven-year-olds in their ability to remember and express information contained in the main clause, though they did differ in their ability to remember and express information in the subordinate clause.

It cannot be claimed that the five-year-olds' poor performance on Task 2 resulted from a failure to understand "when" questions, for in no case was the linguistic form of a child's response inappropriate to the question asked. In addition, there were many instances in which five-year-olds answered the questions correctly, provided they had access to the information contained in the subordinate clause. Moreover, the ability to understand "when" questions has been demonstrated independently by Ervin-Trip (1970), who used preschoolers as subjects.

Considering the above evidence and arguments, it is apparent that an important aspect of psycholinguistic development between the ages of five and nine involves the acquisition of advanced linguistic processing skills for utilizing information expressed in subordinate clauses. Moreover, the emergence of such skills is relatively independent of the child's semantic comprehension of

individual contingency terms. This is demonstrated by the observation that the ability to interpret and remember information about the subordinate clause event did not vary with different connectives. That is, in Task 2 the frequency of content errors (in which the subordinate clause event was inaccurately described) was no greater for sentences containing difficult connectives than for sentences containing easily understood connectives. Thus, the ability to retain subordinate clause information seems to be unaffected by the connective introducing the subordinate clause.

Semantic Feature Hypothesis

The problem considered in this section is the differential difficulty among sentence types. Why are some connectives more easily understood and expressed than others? Why are some connectives consistently misinterpreted? Specifically, can the semantic feature hypothesis, as outlined by Eve Clark, account for the variation in performance with different sentence types? In discussing these questions, the findings of the present investigation will be contrasted with specific predictions derived from Clark's semantic analysis.

According to Clark's (1971) model, the linguistic specification of semantic features predicts the ease with which different expressions are actually acquired and used by the child. For example, the simultaneous occurrence terms "when" and "as soon as" are specified as +Time and

+Simultaneous; "before" is specified as +Time, -Simultaneous, and +Prior; "after" is specified as +Time, -Simultaneous, and -Prior. Since these features are supposedly learned one at a time, beginning with the most superordinate features, and since positive features are acquired before negative features, the above semantic analysis predicts the order in which temporal terms will be acquired. For example, the terms "before" and "after" should be more difficult than the terms "when" and "as soon as," since the former contain the negative feature -Simultaneous and the subordinate features +Prior and -Prior. In addition, the term "after" should be more difficult than "before," since "after" contains the negative feature -Prior.

Using a similar analysis, the conditional terms "if" and "unless_not" could be specified as +Conditionality and +Occurrence; the terms "if_not" and "unless" could be specified as +Conditionality and -Occurrence. Thus, the terms "if_not" and "unless" should be more difficult than the terms "if" and "unless_not," since the former contain the negative feature -Occurrence. There should be no difference in performance between the terms "if" and "unless_not," however, as these connectives are functionally equivalent and share a common semantic feature analysis. For the same reason, there should be no difference in performance between the terms "if_not" and "unless."

Considering the results of the present investigation

in relation to the above predictions, it is evident that Clark's specification of semantic features is inadequate to account for the differences actually observed in the ease of understanding and using sentences with temporal and conditional contingency terms. Although there was a tendency for the temporal order terms "before" and "after" to be more difficult than the simultaneous occurrence terms "when" and "as soon as," this difference was significant only for the comparison of "before" with "when" and "as soon as." Furthermore, the difference in performance between the terms "before" and "after" was in a direction opposite to that predicted by Clark. Namely, there was a tendency for "before" to be more difficult than "after." These results are not attributed to some peculiarity in the experimental procedure, for they were observed on two different kinds of tasks. Also, compatible findings have been reported by other investigators using experimental procedures which differed considerably from those of the present study (e.g., Olds, 1968; Barrie-Blackley, 1973).

With regard to the conditional terms, the predictions derived from Clark's model received only partial support from the present findings. That is, the negative conditional term "unless" was significantly more difficult, on both tasks, than the affirmative conditional term "if." In addition, there was a tendency for "if_not" to be more difficult than "if," though this difference was not statistically significant. On the other hand, however, the terms

"unless_not" and "if" differed significantly in ease of comprehension, despite the fact that these terms are equivalent in the specification of semantic features. As indicated by the data for both tasks, sentences containing "unless_not" resulted in significantly more errors than sentences with "if." Similarly, sentences containing "unless" resulted in significantly more errors than sentences with "if_not."

It might be argued that the variation in difficulty among different contingency terms is attributed to frequency of use. For instance, according to Thorndike's (1932) data, the connective "if" appears in written language more often than the connective "unless." On the basis of this observation, one might propose that the difference in performance with "if_not" and "unless" is simply a result of the fact that children have less experience with the term "unless" than they have with "if_not."

This word frequency argument, however, is inadequate for several reasons. First, the argument does not actually explain why it is that certain linguistic expressions are more difficult than others. As Bever (1970a) notes, the invocation of word frequencies in accounting for language behavior simply raises additional questions as to why some expressions are more accessible (i.e., used more often) than others. Second, word frequency is an unreliable predictor of the ease with which words are acquired. For example, several studies have shown that temporal order

terms "before" and "after" tend to be more difficult than the simultaneous temporal term "when" (e.g., Clark, 1971), yet these connectives do not differ in word frequency. A similar point is demonstrated by Olds' (1968) observation that the affirmative conditional "should" was no more difficult for children to understand than the term "if," despite the fact that "should," as it is used here, has a very low frequency of use. The third problem with the word frequency explanation is that it cannot account for the observation that some connectives, such as "unless" and "unless_not," are systematically misinterpreted.

Since the word frequency argument cannot account for the systematic misinterpretation of certain connectives, it may be useful to consider the hypotheses advanced by Clark regarding children's assignment of semantic structures to linguistic expressions. According to Clark (1971), the type of semantic information children have about "before" and "after" at particular stages will be reflected in the different kinds of errors they make as they come to understand constructions containing the two conjunctions. This order of acquisition will be related to a linguistic analysis of the semantic components that characterize "before" and "after." More specifically, Clark posutlates a stage at which the child has acquired the features +Time and +Simultaneous but has not yet acquired ±Prior. At this stage he will treat "before" and "after" as though they express the same thing as "when." At the next stage,

the child acquires +Prior but not -Prior. During this period he will treat "after" as though it means the same thing as "before."

If Clark's assumptions are correct, then children's performance in the present experiment should reflect the following kinds of errors: 1) "before" and "after" are interpreted as "when," and 2) "after" is interpreted as "before." The first type of error would be revealed in Task 1 as a higher than random error score for "before" and a lower than random error score for "after." On Task 2 there would be a predominance of errors in which "before" and "after" were expressed as "when." The second type of error would be revealed in Task 1 by a higher than random error score for "after" and a lower than random error score for "before." On Task 2 there would be a tendency to interchange the terms "after" and "before" when answering questions about heard sentences.

Applying Clark's analysis to the conditional connectives, there should be a stage at which the child has acquired the features +Conditionality and +Occurrence but has not yet acquired -Occurrence. At this stage, he will treat negative conditional terms as though they mean the same thing as affirmative conditional terms. In the present study, therefore, there should be a predominance of errors in which the connectives "unless" and "if_not" are interpreted and expressed as affirmative conditional terms. That is, on Task 1 the error scores for the terms "unless"

and "if_not" would be significantly greater than chance, whereas the error scores for "if" and "unless_not" should be significantly lower than chance. On Task 2, errors in answering "when" questions should reflect a tendency to replace the negative conditional terms "unless" and "if_not" with affirmative conditional terms.

For the most part, the semantic feature model described above is incompatible with the observed pattern of error types. Nonetheless, there was some support provided by the analysis of errors for "before" and "after." On Task 2, the predominant type of relation error for these terms involved replacing "before" and "after" with "when." Also, on Task 1 there was a tendency for "after" to be more easily interpreted than "before." In Clark's analysis, these kinds of errors should occur when the child is first beginning to understand temporal terms. That is, if the child has learned +Time and +Simultaneous, but does not know -Simultaneous or ±Prior, then he may be expected to confuse the temporal order terms with simultaneous terms.

The problem with this account is that there was no evidence of a stage at which "after" was interpreted as "before." In Clark's analysis, this should occur at an intermediate period after -Simultaneous and +Prior have been acquired, but before -Prior is acquired. In the present experiment, however, the results of Task 2 indicate that there were no instances in which "after" was expressed as "before," although there were several instances in which

"before" was expressed as "after."

The absence of evidence for the intermediate stage described above might be explained by the argument that children in the present study had not progressed beyond the first stage in which only +Time and +Simultaneous had been learned. This argument is untenable, however, in view of the fact that most children performed quite well with sentences containing "after." For instance, on Task 2, the number of correct responses to sentences with "after" was significantly greater than the number of incorrect responses, given that the subordinate clause was remembered. Sentences with "before," however, were no more likely to be correct than incorrect.

What these results suggest is that many children in the present study had progressed to the most advanced stage in which they understood +Time, -Simultaneous, and -Prior (i.e., "after"). Thus, the tendency to interpret "before" and "after" as "when" is not attributed to a failure to understand ±Prior. In view of this, it may be argued that the specific feature hierarchies used to describe "before" and "after" are inadequate as predictors of developmental progress in language learning. The evidence outlined below, regarding performance with conditional terms, will support a stronger claim that Clark's semantic feature analysis is, in principle, inadequate as a model of language acquisition.

Of the conditional terms, children made relatively few

errors with "if_not," yet they consistently misinterpreted the functionally equivalent term "unless" as an affirmative conditional or simultaneous temporal term. On the comprehension task, error scores for "if_not" were significantly lower than random, whereas error scores for "unless" were significantly higher than random. Similarly, on the elicited production task, the term "if_not" was usually correctly expressed as "if_not" or "when_not," yet the term "unless" was often replaced with "if" or "when." The same pattern of results was found with the functionally equivalent terms "if" and "unless_not." The term "if" was usually correctly interpreted and expressed as "if" or "when," yet the term "unless_not" was consistently misinterpreted and expressed as "if_not" or "when_not."

What these findings demonstrate is that the difficulty in understanding and using the conditional terms "unless" and "unless_not" cannot be attributed to the linguistic complexity of the semantic components, for if this were the case, then the functionally equivalent expressions "if_not" and "if" would have been equally difficult.

The basic problem with the semantic feature hypothesis, then, is that it cannot explain differences in the ease of understanding expressions which signal the same relation. This problem cannot be resolved through an alternative specification of semantic components, for these components would not differentiate functionally equivalent expressions. In view of this, it may be contended that the semantic feature

hypothesis proposed by Clark is, in principle, inadequate as a model of language functioning.

For similar reasons, however, the cognitive analysis is incomplete as an account of language use. That is, conceptual complexity of the meaning of an expression does not necessarily predict the ease with which the expression will be understood. This was clearly demonstrated in the comparison of performance with functionally equivalent terms. Moreover, although general cognitive skills may be necessary for understanding the meaning of a given expression, they are not sufficient. Rather, the surface structure device used to express a relation may either facilitate or interfere with comprehension. An important question for research, therefore, is what constitutes linguistic complexity? That is, "ceteris paribus," what kinds of surface devices are difficult to interpret?

Such questions may be answered through the systematic comparison of performance with expressions which differ in form but not in meaning. Slobin (1971), for example, has integrated numerous cross-cultural investigations as an initial attempt to determine what surface structure characteristics are universally difficult. The present study contributes to this effort by providing some specific information about the use of functionally equivalent conditional terms in English. This type of approach seems to be necessary to understand the discrepancies between the course of cognitive growth and psycholinguistic development.

The analysis of semantic features, in contrast, is, at best, an abbreviated description of the semantic structures available to the child at different stages of development. It does not explain variation in the ease of using different linguistic constructions to express those semantic notions.

Summary and Conclusions

Young children often have difficulty understanding sentences with contingent relations because they fail to utilize information contained in subordinate clauses. Five-year-olds, for example, are often unable to remember the event expressed in the subordinate clause of a heard sentence. In addition, when five-year-olds respond nonverbally to sentences with contingent relations they tend to carry out the event expressed in the main clause regardless of the constraint expressed in the subordinate clause. By age seven, however, there is significant improvement in the child's ability to remember subordinate clause events. Furthermore, there is a significant decline, by age seven, in the tendency to carry out the main clause event in inappropriate situations.

The above findings could not be attributed to a developmental improvement in general memory skills, for there was no difference between five- and seven-year-olds in their ability to remember events expressed in the main clause of heard sentences. Also, the results could not be explained as an increased capacity to understand the meanings of temporal and conditional connectives, for if five-year-olds

remembered the subordinate clause event, then they did not differ from seven- and nine-year-olds in their ability to express contingent relations.

The implication of these findings is that five-year-olds tend to apply an inappropriate linguistic processing strategy in which the main clause of a sentence is attended to while the critical information of the subordinate clause is selectively discarded. With development, this tendency declines so that it is no longer apparent at age seven. In view of such observations, it could be proposed that the developmental improvement occurring between five and nine involves the acquisition of fairly general linguistic processing skills, i.e., skills for interpreting and retaining information expressed in subordinate clauses. Such skills, moreover, seem to be acquired independently of semantic development, since the tendency to disregard subordinate clauses is relatively constant across different sentence types.

In explaining why the main clause strategy is dominant in the child's interpretation of sentences, it could be proposed that, in the early stages of language acquisition, the child's general memory limitations constrain the amount of linguistic information which is retained. Thus, the two-year-old remembers the most important part of the sentence, the main clause, and forgets the rest. The problem with this explanation is that, according to Bever's (1970a) findings, the young child does not selectively disregard

subordinate clauses until he has acquired the ability to retain equally long sentences with two independent clauses. Related findings have been reported by Amidon and Carey (1972). These researchers compared the five-year-old's performance with sentences containing a subordinate clause to his performance with sentences containing two independent clauses (for both sentence types, the underlying meaning was identical). Although the sentences with two independent clauses were actually longer in terms of number of words, these sentences were easily understood and remembered. Sentences with subordinate clauses, however, were consistently misinterpreted due to the tendency to ignore the subordinate clause. This evidence suggests that the primacy of main clauses cannot be explained as memory overload resulting from the increased length of complex sentences.

It could be argued, nonetheless, that it is the syntax of the subordinate construction, rather than sentence length, which takes up space in memory. Thus, of two sentences equal in word length, the sentence with the subordinate construction would be more difficult to remember. This argument receives indirect support from Savin and Perchonock's (1965) finding that the grammatical complexity of a sentence is inversely related to the amount of verbal information which can be retained. There are difficulties, however, in applying this explanation to the selective disregarding of subordinate clauses. First, as

Amidon and Carey (1972) have shown, five-year-olds do have the capacity to recall subordinate clause information if they are encouraged to do so. Second, the main clause strategy appears even when sentences are short and contain a minimum of new information (Amidon and Carey, 1972). Third, in Savin and Perchonock's (1965) analysis, the complexity of a grammatical construction affected the absolute number of words recalled; there was no evidence for the selective processing of certain linguistic segments such as the subordinate clause. Thus, although it is reasonable that the subordinate construction increases the overall memory load, this argument does not explain why information contained in the main clause is so much more accessible than information in the subordinate clause.

An alternative explanation is that the child disregards subordinate clauses because he has not learned how to use language to organize relations between different events. In detailing this explanation it is perhaps useful to mention the kinds of interrelated skills which would be necessary to understand events and relations when they are expressed in language. To begin, the listener must be able to conceptualize each event as well as the relation existing between those events. Furthermore, he must be able to derive that information from the surface structure of the heard sentence. In addition, however, the listener must adjust his interpretation of each individual event according to information contained in the rest of the

sentence. As an example, consider the following sentence: "The horse will jump the fence if the hunters arrive." In order to comprehend such a sentence, the listener must derive the underlying actor-action sequences of each clause, and he must also conceptualize the contingent relation between events. The complete understanding of the sentence, moreover, requires that the listener interpret each event in terms of the other. That is, the actual meaning of the word sequence "The horse will jump the fence" is significantly altered by the subordinate clause "if the hunters arrive." As a complete sentence, "The horse will jump the fence" is an assertion about an event which will definitely occur. However, as a main clause in the sentence "The horse will jump the fence if the hunters arrive," the event may or may not take place, depending on whether the hunters arrive.

As the above example demonstrates, the comprehension of sentences with subordinate clauses depends on the listener's capacity to organize his interpretation of the main clause according to information expressed in the subordinate clause. It is this skill which the young child seems to lack. Thus, when he hears a sentence in which the occurrence of the primary event in the main clause is constrained by the occurrence of another event expressed in the subordinate clause he simply disregards that information, for he does not know how to integrate it with his conceptualization of the primary event. In terms of the linguistic

processing strategies available to the young child, the information contained in the subordinate clause is irrelevant.

It might be proposed further that the continued application of this strategy establishes a basic listening habit in which certain linguistic information (i.e., the subordinate clause) is selectively ignored. At later stages of language development, then, this strategy continues to operate even though the child has acquired the necessary skills for integrating linguistic information about different events. As Amidon and Carey (1972) have shown, five-year-olds tend to disregard subordinate clauses even though they can easily alter their listening habit to take account of subordinate clause information. Moreover, as the child becomes more skilled in manipulating linguistic information and in using language to conceptualize relations between events, the tendency to disregard subordinate clauses declines. However, this basic strategy is still present even in adult functioning in that the information contained in main clauses is more accessible in memory than is the information in subordinate clauses (Smith and McMahon, 1970).

Thus far the discussion has focused on the child's strategies for organizing language on the basis of syntactic information. It is clear, however, that a description of such linguistic processing strategies does not provide a complete account of language learning, for the child's

interpretation of heard speech must also depend on his semantic knowledge of the words and sentences he hears. Moreover, certain expressions may be difficult to understand even after the child has acquired advanced linguistic processing skills. As the present study has demonstrated, the connectives "unless" and "unless_not" are systematically misinterpreted even at nine years of age. The difficulty in understanding these connectives is not explained by the conceptual complexity of the conditional relations, however, for the connectives "if_not" and "if" were easily understood. For the same reason, the semantic feature analysis is inadequate in accounting for the difficulty with "unless" and "unless_not."

As an alternative, Slobin's (1971) notion of "operating principles" for psycholinguistic functioning may provide a useful analysis. According to Slobin, language learning and use is closely tied to perceptual and performance-programming principles. Since we communicate through a rapidly fading, temporally ordered auditory modality, we must have strategies for quickly deriving meaning from the sentences we hear. As a consequence, certain linguistic expressions may be more easily decoded and expressed than others. Slobin maintains, for example, that one of the "operating principles" used by listeners is to pay attention to the ends of words. As a result, morphological markers are more easily noticed when they occur at the end of a word than elsewhere in the sentence. Specifically, verb

tenses and pluralizations are more easily derived when markers appear at the ends of verbs and nouns. A similar explanation may account for differences in the ease of interpreting "unless" and "if_not." It was argued previously that the negation signaled by "unless" is inaccessible in the surface structure of the sentence. The negation signaled by "if_not," however, is easily accessible (or, in Slobin's terms "perceptually salient"). Due to these differences in the accessibility of negative markers, the expression "if_not" will be easily interpreted, but "unless" will be difficult as listeners will tend to interpret "unless" as an affirmative conditional term. In addition, it follows that "if" will be easily interpreted whereas "unless_not" will be difficult, since listeners will tend to interpret "unless_not" as a negative conditional term.

There is still the question of why the negative marker in "if_not" is more salient than is the negation expressed by "unless." This is perhaps explained by the fact that in sentences with "if_not" a negative marker immediately precedes the negated action of the subordinate clause, whereas in sentences with "unless" the negation is expressed at the beginning of the subordinate clause. In other words, the following general rule, regarding the interpretation of negations, may apply: the ease of interpretation increases with an increase in proximity of the negative marker to the negated information.

It should be noted that negative conditional connectives do not negate the entire subordinate clause of a sentence. Rather, they typically express a constraint in which only the action of the subordinate clause is negated; the existence of the subject and object are presupposed. Consider, for example, sentence (33).

(33) Marya will open the wine unless Nelson has borrowed the corkscrew.

It is clear, from this sentence, that the negative constraint signaled by "unless" applies only to the action of "borrowing." Both "Nelson" and "the corkscrew" are assumed to exist. In sentence (34), this relation is clearly indicated by the negative marker "not" which immediately precedes the negated action.

(34) Marya will open the wine if Nelson has not borrowed the corkscrew.

One way to test the general hypothesis about the interpretation of negations would be to compare performance across a variety of sentences with different kinds of negative constructions. If the hypothesis is correct, then sentences such as (35) would be more easily interpreted than sentences like (36). Similarly, sentences like (37) would be easier than sentences like (38).

(35) It is true that he did not sail to Paris.

(36) It is not true that he sailed to Paris.

(37) He insists that Marvin is not very honest.

(38) He denies that Marvin is very honest.

If the predictions regarding such sentences were confirmed, there would be strong support for the proximity hypothesis. Until these predictions are tested, however, there can be no certain explanation as to why some negative constructions are more difficult than others.

One factor which has not been considered in detail in the present study is how the ease of comprehension is affected by what the listener must do with the language he hears. That this factor is important, however, is well-established in the literature (e.g., Huttenlocher and Strauss, 1968) and may be useful in explaining some of the discrepant results reported by different experimenters. For example, the strategies children use to organize temporal order relations seems to vary according to the type of task used. When two independent responses are required, young children may apply an order of mention strategy (Clark, 1971). However, this strategy was not observed in the present experiment, where only one response was required.

With respect to the relative difficulty of "before" and "after," Clark (1971) has reported that "before" is more easily understood than "after." The present study, however, suggested a trend in the opposite direction. Perhaps this discrepancy, like the order of mention effects, can be explained in terms of how the child must use the sentences he hears.

As mentioned previously, Clark's experimental task

consisted of acting out sentences with two temporally ordered events. It seems reasonable that, in this situation, the child's strategy for organizing the events would be to begin with the first event. Thus, interpretation would be facilitated by placing the first event in the main clause, as the information in main clauses is more accessible than information in subordinate clauses. Moreover, since sentences with "before" always contain the first event in the main clause, these sentences should be more easily interpreted than sentences with "after." Consider, in contrast, the tasks used in the present study. In these cases, the child was never required to carry out two separate responses as in Clark's experiment. Rather, he had to determine when the event in the main clause would occur, relative to the occurrence of the subordinate clause event. In Task 1, for instance, he responded nonverbally by carrying out the event in the main clause of a sentence according to the constraint expressed in the subordinate clause. In Task 2 he answered questions about when the main clause event of a heard sentence could occur. For tasks such as these, it seems likely that sentences might be more easily interpreted when the occurrence of the main clause event is contingent on the occurrence of the subordinate clause event than when it is not. Moreover, in sentences with "after," the occurrence of the subordinate clause event signals the occurrence of the main clause event, whereas in sentences with "before" this is not the case. As a

consequence, sentences with "before" may tend to be more difficult than sentences with "after."

Consider, as an example, a situation in which the listener must determine "When should I stop the car?" In sentence (39) the answer is clear; the occurrence of the subordinate clause event signals the occurrence of the main clause event. In sentence (40), however, the answer is somewhat ambiguous, as the main clause event could occur at any point in time prior to the occurrence of the subordinate clause event.

(39) You should stop the car after you pass the Metropole.

(40) You should stop the car before you pass the Metropole.

If the above argument is correct, then it suggests that the ease of interpreting a given sentence will depend, to some extent, on what specific information is to be derived from the sentence and on how this information is to be used. Thus, it is expected that performance might vary not only with different types of sentences but also with different experimental tasks.

A second factor which was not investigated in the present study was the extent to which children understood the underlying presuppositions signaled by various contingency terms. For example, the temporal term "when" signals a presupposition that the related events will, in fact, occur. Sentence (41) makes no sense unless it is

assumed that each of the events will take place. The conditional term "if," however, makes no specification as to whether the events will actually occur. In sentence (42), the events may or may not occur.

(41) He will pay his taxes when the subpoena is delivered.

(42) He will pay his taxes if the subpoena is delivered.

In actual language use, however, this subtle distinction is often blurred, and the terms "if" and "when" are interchangeable (Anderson, 1972). Consider, for example, sentences (43) and (44).

(43) He will pay his taxes when the world ends.

(44) He will pay his taxes if the world ends.

In these instances "when" is functionally equivalent to "if" in terms of the underlying presupposition of the sentences -- the obvious interpretation is that the events will not occur. As these examples demonstrate, simultaneous temporal terms can be acceptable substitutes for the conditional terms. Thus, in most situations, including the experimental tasks used in the present study, the child's failure to distinguish between these temporal and conditional terms will be undetected since they are functionally so similar.

In view of the above, there is a need for further research to investigate the question of how extralinguistic factors interact with language use. For example, how does

the child's knowledge of the world affect his ability to understand information that is implied or presupposed in language? And, how does the child's language functioning vary in different performance situations? Answers to such questions would be of theoretical value in clarifying the processes which underlie psycholinguistic behavior. A developmental approach to such issues, moreover, could extend our knowledge about how language is acquired and why language use changes with age.

The contribution of the present research has been to provide detailed information about the developmental changes in children's understanding of sentences with contingent relations. The general conclusions from this study may be briefly summarized as follows: 1) the ability to comprehend and express sentences with contingent relations improves substantially between the ages of five and nine; 2) the developmental improvement occurring during this period is attributed, primarily, to the emergence of advanced linguistic processing strategies which enable the child to utilize information contained in subordinate clauses; 3) the linguistic complexity of the surface device affects the ease with which contingency terms are interpreted and used.

Table 1

Absolute and Mean Error Scores for Children on Eight Sentence Types at Three Age Levels (Task 1) [1]

Sentence Type	Age 5	Age 7	Age 9	Totals
"when"	10 (.16)*	1 (.02)*	0 (.00)*	11 (.06)*
"if"	9 (.14)*	3 (.05)*	1 (.02)*	13 (.07)*
"as soon as"	13 (.20)*	1 (.02)*	0 (.00)*	14 (.07)*
"if_not"	20 (.31)*	6 (.09)*	0 (.00)*	26 (.14)*
"after"	18 (.28)*	5 (.08)*	6 (.09)*	29 (.15)*
"before"	27 (.42)	13 (.20)*	12 (.19)*	52 (.27)*
"unless"	54 (.84)**	48 (.75)**	43 (.67)**	145 (.76)**
"unless_not"	43 (.67)**	55 (.86)**	57 (.89)**	155 (.81)**
Totals	194 (.38)*	132 (.26)*	119 (.23)*	445 (.29)

*significantly lower than random at the .05 level
**significantly higher than random at the .05 level

[1] The mean error score in each cell indicates the percentage of errors which occurred out of a total of 64 trials.

Table 2

Absolute and Mean Error Scores for Children on Eight Sentence Types at Three Age Levels ("When" Questions - Task 2)[1]

Sentence Type	Age 5	Age 7	Age 9	Totals
"when"	16 (.50)	5 (.16)	10 (.31)	31 (.32)
"if"	14 (.44)	9 (.28)	10 (.31)	33 (.34)
"as soon as"	17 (.53)	11 (.34)	10 (.31)	38 (.40)
"if_not"	21 (.66)	15 (.47)	14 (.44)	50 (.52)
"after"	20 (.63)	13 (.41)	12 (.38)	45 (.47)
"before"	27 (.84)	19 (.59)	18 (.56)	64 (.67)
"unless"	32 (1.00)	32 (1.00)	28 (.88)	92 (.96)
"unless_not"	29 (.91)	24 (.75)	23 (.72)	76 (.79)
Totals	176 (.69)	128 (.50)	125 (.49)	429 (.56)

[1]The mean error score in each cell indicates the percentage of errors which occurred out of a total of 32 trials.

Table 3

Absolute and Mean Error Scores for Children on Eight Sentence Types at Three Age Levels ("What" Questions - Task 2)[1]

Sentence Type	Age 5	Age 7	Age 9	Totals
"when"	7 (.22)	8 (.25)	2 (.06)	17 (.18)
"if"	8 (.25)	3 (.09)	3 (.09)	14 (.15)
"as soon as"	8 (.25)	6 (.19)	4 (.13)	18 (.19)
"if_not"	10 (.31)	2 (.06)	1 (.03)	13 (.14)
"after"	6 (.19)	3 (.09)	3 (.09)	12 (.13)
"before"	9 (.28)	4 (.13)	0 (.00)	13 (.14)
"unless"	9 (.28)	4 (.13)	7 (.22)	20 (.21)
"unless_"not"	10 (.31)	8 (.25)	2 (.06)	20 (.21)
Totals	67 (.26)	38 (.15)	22 (.09)	.27 (.17)

[1] The mean error score in each cell indicates the percentage of errors which occurred out of a total of 32 trials.

Table 4

Comparison of Mean Error Scores for "What" Questions versus "When" Questions for Each Age Group (Task 2)

	Question		
Age	"What"	"When"	t
5	.26	.69	4.07*
7	.15	.50	5.07*
9	.09	.49	4.99*

T-ratio required for significance at .01 level: 2.947

*significant at or beyond the .01 level

Table 5

Summary of Analysis of Variance of Scores (Task I)

Source	SS	df	MS	F
Rows (sentence type)	539.23	7	77.03	102.71*
Columns (age)	26.36	2	13.18	15.88*
Interaction	27.64	14	1.97	2.63*
Error (within columns)	37.43	45	.83	
Error (within cells)	235.98	315	.75	
Totals	366.64	383		

DF for Rows: 7, 315; for columns: 2, 45; for interaction: 14, 315. F-Ratios required at .01 for rows: 2.73; for columns: 5.12; for interaction: 2.17.

*significant at or beyond the .01 level.

Table 6

Summary of Analysis of Variance of Scores

("When" Questions - Task 2)

Source	SS	df	MS	F
Rows (sentence type)	70.25	7	10.04	27.19*
Columns (age)	17.41	2	8.71	9.07*
Interaction	6.54	14	.47	1.25
Error (within columns)	43.17	45	.96	
Error (within cells)	117.95	315	.37	
Totals	255.32	383		

DF for Rows: 7, 315; for columns: 2, 45; for interaction: 14, 315. F-Ratios required at .01 for rows: 2.73; for columns: 5.12; for interaction: 2.17.

*significant at or beyond the .01 level.

Table 7

Summary of Analysis of Variance of Scores

("What" Questions - Task 2)

Source	SS	df	MS	F
Rows (sentence type)	2.33	7	.33	1.73
Columns (Age)	8.52	2	4.26	4.74*
Interaction	3.35	14	.24	1.26
Error (within columns)	40.56	45		
Error (within cells)	60.56	315		
Totals	115.32	383		

DF for Rows: 7, 315; for columns: 2, 45; for interaction: 14, 315. F-Ratios required at .01 for rows: 2.73; for columns: 5.12; for interaction: 2.17.

*significant at or beyond the .05 level

Table 8

Comparison of Mean Error Scores for Age Level (Task I)

			Age Level	
		Mean	7	9
	Mean		.26	.23
Age Level	5	.38	-.12*	-.15*
	7	.26		-.03

Difference required for significance at .05 level: .09
Difference required for significance at .01 level: .12

*significant at or beyond the .01 level

Table 9

Comparison of Mean Error Scores for Age Level

("When" Questions - Task 2)

			Age Level	
		Mean	7	9
	Mean		.50	.49
Age Level	5	.69	-.19*	.20*
	7	.50		.01

Difference required for significance at .05 level: .15
Difference required for significance at .01 level: .19

*significant at or beyond the .01 level.

Table 10

Comparison of Mean Error Scores for Age Levels

("What" Questions - Task 2)

			Age Level	
		Mean	7	9
	Mean		.15	.09
Age Level	5	.26	-.11	-.17*
	7	.15		-.06

Difference required for significance at .05 level: .15
Difference required for significance at .01 level: .19

*significant at or beyond the .05 level

Table 11a

Comparison of Mean Error Scores for Sentence Types (Task 1)

		Sentence Type						
		"if"	"as soon as"	"if not"	"after"	"before"	"unless"	"unless not"
	Mean	.07	.07	.14	.15	.27	.76	.81
Sentence Type								
"when"	.06	.01	.01	.08	.09	.21*	.70*	.75*
"if"	.07		.00	.07	.08	.20*	.69*	.74*
"as soon as"	.07			.07	.08	.20*	.69*	.74*
"if_not"	.14				.01	.13	.62*	.67*
"after"	.15					.12	.61*	.66*
"before"	.27						.49*	.54*
"unless"	.76							.05

Difference required for significance at .05 level: .16
Difference required for significance at .01 level: .19

*significant at or beyond the .01 level

Table 11b

Summary of the Comparison of Mean Error Scores for Sentence Types (Task 1)

	Sentence Type							
	"when"	"as soon as"	"if"	"if not"	"after"	"before"	"unless"	unless not"
Mean	.06	.07	.07	.13	.16	.27	.75	.81

Note.--Uninterupted lines indicate that the difference between mean error scores is insignificant ($p > .05$)

Table 12a

Comparison of Mean Error Scores for Sentence Type

("When" Questions - Task 2)

		Sentence Type						
		"if"	"as soon as"	"if not"	"after"	"before"	"unless"	"unless not"
	Mean	.34	.40	.52	.47	.67	.96	.79
Sentence Type								
"when"	.32	.02	.08	.20	.15	.35*	.67*	.47*
"if"	.34		.06	.18	.13	.33*	.62*	.45*
"as soon as"	.40			.12	.07	.27*	.56*	.39*
"if not"	.52				-.05	.15	.44*	.27*
"after"	.47					.20	.59*	.32*
"before"	.67						.29*	.12
"unless"	.96							-.17

Difference required for significance at .05 level: .24
Difference required for significance at .05 level: .27

*significant at or beyond the .01 level.

Table 12b

Summary of the Comparison of Mean Error Scores for Sentence Type ("When" Questions - Task 2)

	Sentence Type							
	"when"	"if"	"as soon as"	"after"	"if not"	"before"	"unless not"	"unless"
Mean	.32	.34	.40	.47	.52	.67	.79	.96

Note.--Uninterupted lines indicate that the difference between mean error scores is insignificant ($p > .05$).

Table 13

Comparison of Mean Error Scores for 5- versus 7- and 9-year-olds on Eight Sentence Types (Task 1)

	Age		
Sentence Type	5	7 & 9	Difference
"when"	.16	.01	.15*
"if"	.14	.04	.10
"as soon as"	.20	.01	.19*
"if_not"	.31	.05	.26*
"after"	.28	.09	.19*
"before"	.42	.20	.22*
"unless"	.84	.71	.13*
"unless_not"	.67	.88	-.21*

Difference required for significance at .05 level: .12
Difference required for significance at .01 level: .14

*significant at or beyond the .01 level

Table 14

Comparison of Mean Error Scores for 5- versus 7- and 9-year-olds on Eight Sentence Types ("When" Questions - Task 2)

	Age		
Sentence Type	5	7 & 9	Difference
"when"	.50	.24	.26**
"if"	.44	.30	.14
"as soon as"	.53	.33	.20**
"if_not"	.66	.46	.20**
"after"	.63	.40	.23**
"before"	.84	.58	.26**
"unless"	1.00	.94	.06
"unless_not"	.91	.74	.17*

Difference required for significance at .05 level: .17
Difference required for significance at .01 level: .19

*significant at or beyond the .05 level
**significant at or beyond the .01 level

Table 15

Number of Commission and Omission Errors for each Age Group (Task 1)

	Error Type		
Age	Commission	Omission	z
5	129	65	4.597*
7	65	67	.087
9	53	66	1.289

*significant at or beyond the .01 level

Table 16

Summary of Analysis of Variance of Commission Errors (Task 1)

Source	SS	df	MS	F
Between	212.25	2	106.13	14.53*
Within	329.00	45	7.31	
Totals	541.25	47		

F-Ratio required at .01: 5.12.

*significant at or beyond the .01 level

Table 17

Comparison of Mean Number of Commission Errors for Age Levels (Task 1)

		Mean	7	9
	Mean		4.06	3.25
Age Level	5	8.06	4.00*	4.71*
	7	4.06		.71

Difference required for significance at .05 level: 2.40
Difference required for significance at .01 level: 3.04

*significant at or beyond the .01 level

Table 18

Number of Commission Errors, Omission Errors, and Correct Responses According to Age Level and Sentence Types(task 1)

Sentence Type	Commission Errors	Omission Errors	Correct Responses
		5-Year-Olds	
"when"	8	2	54
"as soon as"	13	0	51
"before"	17	10	37
"after"	10	8	46
"if"	7	2	55
"if_not"	15	5	44
"unless"	31	23	10
"unless_not"	28	15	21
Total	129	65	318
		7-Year-Olds	
"when"	1	0	63
"as soon as"	1	0	63
"before"	7	6	51
"after"	4	1	59
"if"	0	3	61
"if_not"	3	3	58
"unless"	23	25	16
"unless_not"	26	29	9
Total	65	67	380
		9-Year-Olds	
"when"	0	0	64
"as soon as"	0	0	64
"before"	3	9	52
"after"	1	5	58
"if"	0	1	63
"if_not"	0	0	64
"unless"	21	22	21
"unless_not"	28	29	7
Total	53	66	393

Table 19

Comparison of the Combined Error Scores for "if_not," "unless," and "before" versus "when," "as soon as," "if," "unless_not," and "after" (task 1)

	Error Score		
Age	"if_not," "unless," & "before"	"when," "as soon as," "if," "unless_not," & "after"	z
5	.53 (101/192)	.29 (93/320)	5.53*
7	.35 (67/192)	.20 (65/320)	3.82*
9	.29 (55/192)	.20 (64/320)	2.39*

*significant at or beyond the .01 level.

Table 20

Comparison of the Combined Error Scores for "if not," "unless," and "before" versus "when," "as soon as," "if," "unless not," and "after" ("when" questions - task 2)

	Error Score		
Age	"if not," "unless," & "before"	"when," "as soon as," "if," "unless not," & "after"	z
5	.83 (80/96)	.60 (96/160)	3.52*
7	.69 (66/96)	.39 (62/160)	4.24*
9	.63 (60/96)	.41 (65/160)	3.11*

*significant at or beyond the .01 level

Table 21

Number of Content and Relation Errors for Each Age Group ("When" Questions - Task 2)

	Error Type	
Age	Content	Relation
5	124	52
7	56	72
9	38	87

Table 22

Summary of Analysis of Variance of Content Errors

("When" Questions - Task 2)

Source	SS	df	MS	F
Between	257.16	2	128.58	13.50*
Within	428.76	45	9.53	
Totals	685.92	47		

F-ratio required at .01 level: 5.12

*significant at or beyond the .01 level

Table 23

Summary of Analysis of Variance of Relation Errors

("When" Questions - Task 2)

Source	SS	df	MS	F
Between	38.48	2	19.24	7.05*
Within	123.00	45	2.73	
Total	61.48	47		

F-ratio required for significance at .01 level: 5.12

*significant at or beyond the .01 level

Table 24

Comparison of the Mean Number of Content Errors for Two Age Groups ("When" Questions - Task 2)

			Age Level
		Mean	7 & 9
	Mean		2.94
Age Level	5	7.75	-4.81*

Difference required for significance at .01 level: 2.395

*significant at or beyond the .01 level

Table 25

Comparison of the Mean Number of Relation Errors for Two Age Groups ("When" Questions - Task 2)

		Mean	Age Level 7 & 9
	Mean		4.97
Age Level	5	3.25	1.72*

Difference required for significance at .01 level: 1.63

*significant at or beyond the .01 level

Table 26

Number of Content and Relation Errors for Each Sentence Type ("When" Questions - Task 2)

	Error Type	
Sentence Type	Content	Relation
"when"	24	7
"if"	26	7
"as soon as"	28	10
"if_not"	26	24
"after"	25	20
"before"	36	28
"unless"	32	60
"unless_not"	21	55

Table 27

Summary of Analysis of Variance of Relation Errors According to Sentence Type ("When" Questions - Task 2)

Source		SS	df	MS	F
Between Ss		20.19	47		
Within Ss		171.88	336		
Sentence	53.86		7	7.69	
Residual	118.02		329	.36	21.44*
Total		192.07	383		

F-ratio required for significance at.01 level: 2.73

*significant at or beyond .01.

Table 28

Summary of Analysis of Variance of Relation Errors According to Sentence Type ("When" Questions - Task 2)

Source	SS	df	MS	F
Between Ss	85.74	47		
Within Ss	119.50	336		
Sentence	3.28	7	.47	1.34
Residual	116.22	329	.35	
Total	205.24	383		

F-ratio required for significance at 105 level: 2105

Table 29

Proportion of Correct Responses for Answers in which the Subordinate Clause Event was Described ("When" Questions - Task 2)

Sentence Type	Proportion of Correct Responses
"when"	.90
"if"	.90
"as soon as"	.85
"if_not"	.66
"after"	.72
"before"	.53
"unless"	.06
"unless_not"	.27

Table 30

Frequency of Relation Errors According to Error Type and Sentence Type ("When" Questions - Task 2)

Type of Relation Error	Sentence Type: "when"	"if"	"as soon as"	"if not"	"after"	"before"	"unless"	"unless not"
"when"	0	0	0	15	20	19	32	0
"if	0	0	0	5	0	0	9	0
"as soon as"	0	0	0	2	0	2	2	0
"when not"	1	0	0	0	0	1	0	20
"if not"	0	0	0	0	0	0	0	18
"after"	6	6	10	2	0	6	3	2
"before"	0	1	0	0	0	0	2	0
"unless"	0	0	0	0	0	0	12	9
"unless not"	0	0	0	0	0	0	0	5
"until"	0	0	0	0	0	0	0	1
Totals	7	7	10	24	20	28	60	55

Table 31

Frequency of Correct Responses According to Sentence Type and Contingency Term Used by Subject ("When" Questions - Task 2)

	Sentence Type							
Cont. Term	"when"	"if"	"as soon as"	"if not"	"after"	"before"	"unless"	"unless not"
"when"	65	41	31	0	0	0	0	17
"if"	0	20	0	0	0	0	0	2
"as soon as"	0	2	27	0	0	0	0	0
"when not"	0	0	0	21	0	0	0	0
"if not"	0	0	0	25	0	0	4	0
"before"	0	0	0	0	0	32	0	0
"after"	0	0	0	0	51	0	0	0
Totals	65	63	58	46	51	32	4	19

Table 32

Mean Semantic Rating for Each Sentence Type

("When" Questions - Task 2)

Sentence Type	Semantic Rating
"when"	5.38
"if"	4.75
"as soon as"	5.38
"if_not"	4.00
"after"	5.56
"before"	5.31
"unless"	4.88
"unless_not"	4.94

Table 33

Summary of Analysis of Variance of Semantic Ratings

(Task 2)

Source	SS	df	MS	F
Between	28.72	7	4.10	1.57
Within	313.93	120	2.61	
Total	341.65	127		

F-ratio required for significance at .05 level: 2.10

Table 34

Number of Correct and Incorrect Responses

According to Semantic Rating ("When" Questions - Task 2)

	5-year-olds	
	High Semantic Rating	Low Semantic Rating
Correct Responses	32	48
Incorrect Responses	84	92

	7-year-olds	
	High	Low
Correct Responses	58	70
Incorrect Responses	58	70

	9-year-olds	
	High	Low
Correct Responses	58	78
Incorrect Responses	63	62

Table 35

Comparison of Mean Error Scores According to Clause Order for Each Age Group (Task 1)

Age	Clause Order: Main Clause First	Clause Order: Main Clause Second	t
5	.38	.38	0
7	.23	.29	2.50*
9	.22	.24	.94

t-ratio required for significance at .05 with 15 df: 2.131

*significant at or beyond .05

Table 36

Comparison of Mean Error Scores According to Clause Order for Each Age Group ("What" Questions - Task 2)

	Clause Order		
Age	Main Clause First	Main Caluse Second	t
5	.19	.07	4.62*
7	.13	.02	4.94*
9	.06	.03	1.68

T-ratio required for significance at .001 level: 4.073

*significant at or beyond the .001 level

Table 37

Comparison of Mean Error Scores According to Clause Order for Each Age Group ("When" Questions - Task 2)

	Clause Order		
Age	Main Caluse First	Main Clause Second	t
5	.64	.73	2.81*
7	.40	.60	3.84*
9	.41	.56	5.25*

T-ratio required for significance at .05 level: 2.13

*significant at or beyond the .05 level

Table 38

Comparison of Mean Error Scores

According to Order of Mention of Events

for Each Age Group (Task 1)

	Order of Mention		
Age	Corresponds to Occurrence	Violates Occurrence	t
5	.40 (24/64)	.32 (21/64)	.812
7	.12 (8/64)	.16 (10/64)	.806
9	.12 (8/64)	.16 (10/64)	.806

t-ratio required for significance at .05 with 15 df: 2.13.

Table 39

Comparison of Mean Error Scores

According to Order of Mention of Events

for Each Age Group ("What" Questions - Task 2)

	Order of Mention		
Age	Corresponds to Occurrence	Violates Occurrence	t
5	.28 (9/32)	.19 (19/32)	.95
7	.09 (3/32)	.13 (4/32)	.30
9	.09 (3/32)	00	1.90

T-ratio required for significance at .05 level: 2.13

Table 40

Comparison of Mean Error Scores

According to Order of Mention of Events

for Each Age Group ("When" Questions - Task 2)

	Order of Mention		
Age	Corresponds to Occurrence	Violates Occurrence	t
5	.81 (26/32)	.65 (21/32)	2.10
7	.50 (16/32)	.50 (16/32)	0
9	.44 (.4'32)	.50 (16/32)	.52

T-ratio required for significane at .05 level: 2.13

Table 41

Mean Error Frequencies for Task 1 and for "when" Questions of Task 2 According to Order of Presentation

	Order of Presentation	
Task	First	Second
Task 1	.29	.29
Task 2	.56	.56

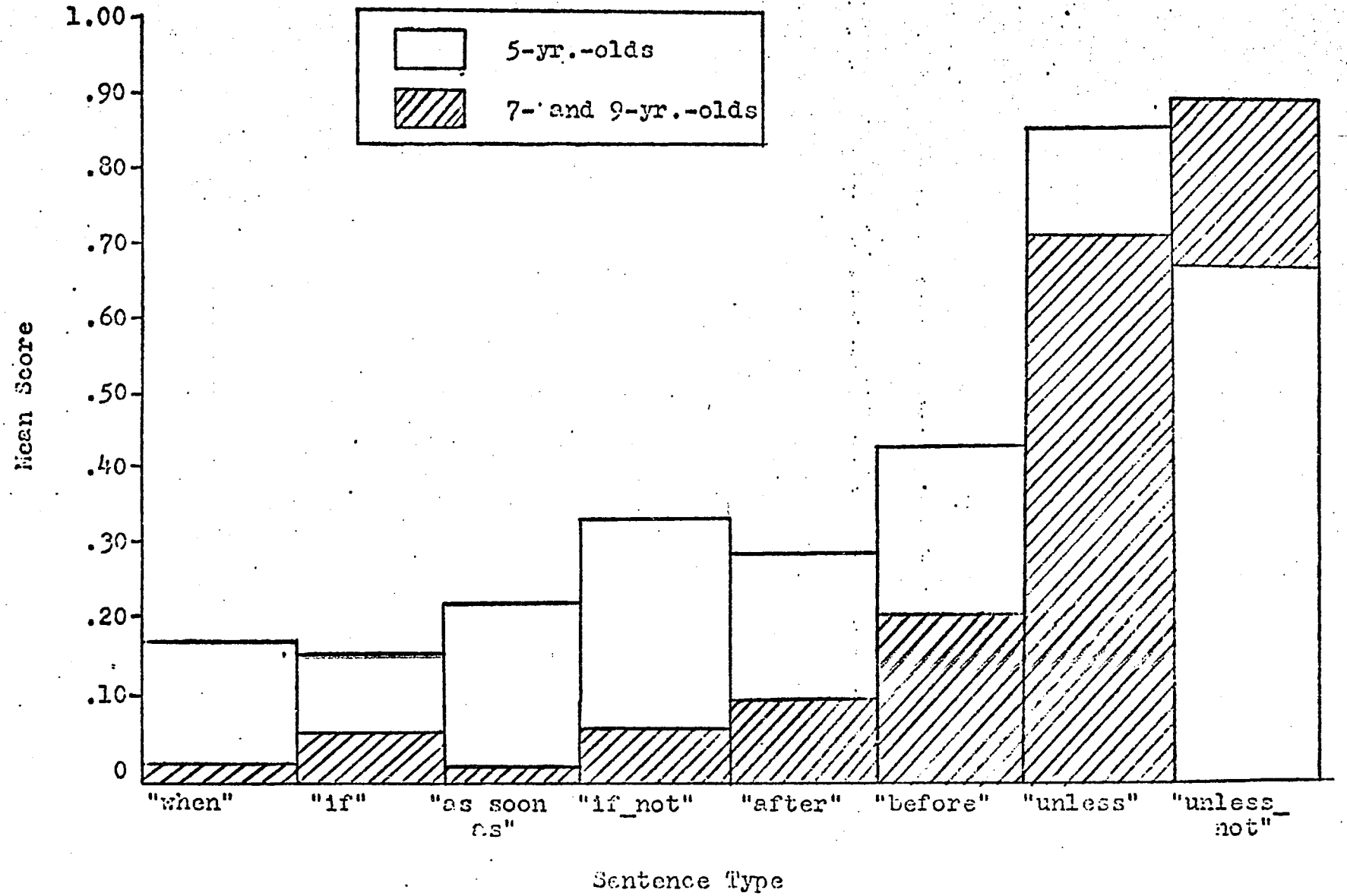


Fig. 1. Mean error scores for five- versus seven- and nine-year-olds as a function of sentence type (Task 1).

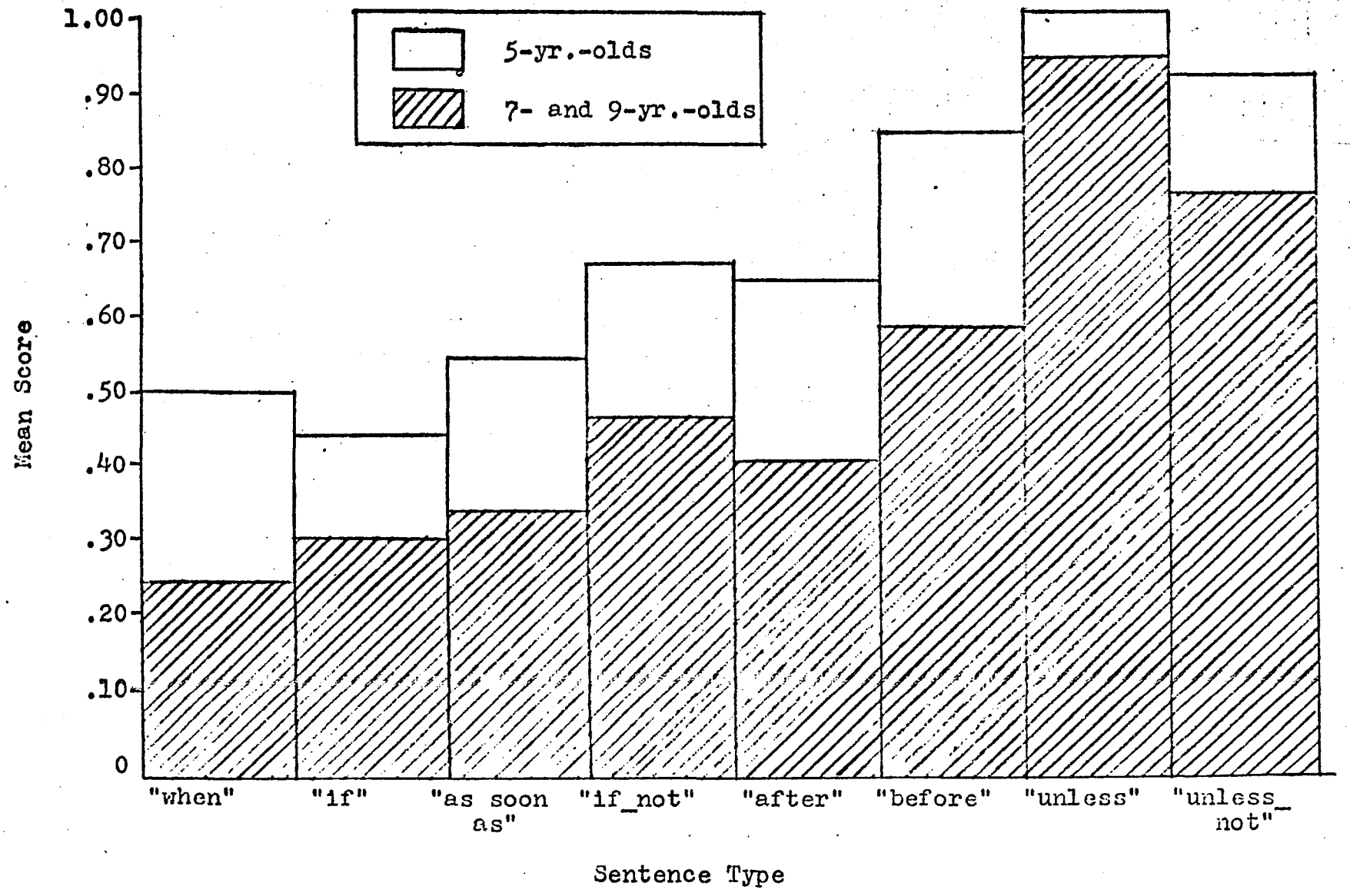


Fig. 2. Mean error scores for five- versus seven- and nine-year-olds as a function of sentence type ("When" Questions - Task 2).

Appendix A

1. If the painter sells the house, the plumber will fix the sink.

2. The fireman will ring the bell if the policeman does not flash the light.

3. After Tom goes to work, Jane will pick some flowers.

4. Carol will light the fire unless Peter does not chop the wood.

5. The man will take the bicycle when the lady drives the car.

6. Before the cat goes to sleep, the bird will sing a song.

7. The lawyer will tell the story as soon as the judge signs the paper.

8. Unless the baby opens his eyes, the mother will lift the blanket.

9. Janet will cook the dinner if Steven buys the food.

10. As soon as Michael waters the grass, Kathy will have a picnic.

11. When the cow kicks the bucket, the horse will jump the gate.

12. Ken will read a book, unless Sue draws a picture.

13. If the duck does not build a nest, the frog will leave the lake.

14. Mary will buy a toy before John gets a haircut.

15. Unless the rabbit does not find the carrot, the lamb will eat the grass.

16. The clown will blow the horn after the bear rolls the ball.

17. After the elephant eats the peanuts, the monkey will climb the rope.

18. The cat will drink the milk if the dog does not eat the dinner.

19. If the farmer burns the leaves, the neighbor will pick the fruit.

20. Unless Frank does not come to visit, Mark will open the present.

21. The baker will make a pie as soon as the butcher cuts the meat.

22. The nurse will see the patient unless the doctor does not take a trip.

23. Before the passenger leaves the bus, the driver will call the police.

24. The pilot will land the plane when the reporter takes a picture.

25. Eva will pick some flowers if Paul goes to work.

26. When the maid opens the window, the janitor will clean the floor.

27. The teacher will have a party before the man paints the school.

28. The woman will clean the clothes after the actor takes a bath.

29. If Karen does not go to school, the cook will wash the dishes.

30. As soon as Andy wins the game, Dick will go to bed.

31. The boy will take the boat unless the girl flies the kite.

32. Unless the waitress does not bring the coffee, the cowboy will play the guitar.

References

Amidon, A., and Carey, P. Why five-year-olds cannot understand before and after. Journal of Verbal Lerning and Verbal Behavior, 1972, 11, 417-423.

Anderson, L. Subordinating adverbial conjunctions. Gothenburg Papers in Theoretical Linguistics, May, 1972.

Barrie-Blackly, S. Six-year-old children's understanding of sentences adjoined with time adverbs. Journal of Psycholinguistic Research, 1973, 2, 153-166.

Bever, T. The cognitive basis for linguistic structures. In Hayes, J. (Ed.), Cognition and language learning. New York: Wiley, 1970a.

Bever, T. The comprehension and memory of sentences with temporal relations. In D'Arcais, G. and Levelt, W. (Eds.), Advances in psycholinguistics. London: North Holland, 1970b.

Bever, T., Mehler, J., Valian, V., Epstein, J., and Morrissey, H. Linguistic capacity of young children. Cited in Bever, T., 1970a.

Bolinger, D. The atomization of meaning. Language, 1965, 41, 533-575.

Bransford, J., Barclay, J., and Franks, J. Sentence memory: a constructive versus interpretive approach. Cognitive Psychology, 1972, 3, 193-209.

Bransford, J., and Franks, J. The abstraction of linguistic ideas. Cognitive Psychology, 1971, 2, 331-350.

Carey, P., Blake, J., and Amidon, A. When do children understand subordinate clauses? Unpublished paper. City University of New York, 1970.

Clark, E. V. Language acquisition: The child's spontaneous descriptions of events in time. Unpublished doctoral dissertation, University of Edinburgh, 1969.

Clark, E. V. On the acquisition of the meaning of before and after. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 266-275.

Ervin-Tripp, S. Discourse agreement: How children answer questions. In Hayes, J. R. (Ed.), Cognition and language learning. New York: Wiley, 1970.

Ferreiro, E., and Sinclair, H. Temporal relationships in language. International Journal of Psychology, 1971, 6, 39-47.

Geis, N. L., and Zwicky, A. N. On invited inferences. Linguistic Inquiry, 1971, 2, 561-566.

Hatch, E. The young child's comprehension of time connectives. Child Development, 1971, 42, 211-213.

Hays, W. Statistics for psychologists. New York: Holt, Rinehart, and Winston, 1963.

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

Kofsky, E. A scalogram study of classificatory development. Child Development, 1966, 37, 191-204.

Loban, W. D. The language of elementary school children. Champaign, National Council of Teachers of English, 1963.

Miller, G. A psychological method to investigate verbal concepts. Journal of Mathematical Psychology, 1969, 6, 169-192.

Olds, H. An experimental study of syntactical factors influencing children's comprehension of certain complex relationships. Report No. 4, Harvard Center for Research and Development on educational differences, 1968.

Perfetti, C. A. Psychosemantics: Some cognitive aspects of structural meaning. Psychological Bulletin, 1972, 28, 241-259.

Savin, H., and Perchonock, E. Grammatical structure and immediate recall of English sentences. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 348-353.

Slobin, D. Grammatical transformations and sentence comprehension in childhood and adulthood. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 219-227.

Slobin, D. Cognitive prerequisites for the development of grammar. In Dingwall, W. (Ed.), A survey of linguistic science. College Park, Md.: University of Maryland, 1971, 298-412.

Smith, K., and McMahon, L. Understanding order information in sentences: Some recent work at Bell Laboratories.

In D'Arcais, G. F. and Levelt, W. J. (Eds.), Advances in psycholinguistics. London: North Holland, 1970, 253-274.

Springston, F., and Clark, H. And, and or, or the comprehension of pseudoimperatives. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 258-272.

Thorndike, E. L. A teachers' word book of the twenty thousand words found most frequently and widely in general reading for children and young people. New York: Teachers College, Columbia University, 1932.

Wason, P. The processing of positive and negative information. Quarterly Journal of Experimental Psychology, 1959, 11, 92-107.