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In English number agreement occurs between the surface subject and the verb of a sentence. Logically, the child must perform two operations to determine whether these lexical items agree. The child must first identify the surface subject and the verb, and secondly determine whether the number features of these items agree. Children are able to perform the first of these operations earlier than they are able to perform the second. To perform the second operation, the child must analyze the relation between the number features of these items.

The hypothesis was tested that children will be able to discriminate between agreeing and non-agreeing sentences when they are able to analyze the relation between the number features of lexical items in a sentence. Children were asked to judge the acceptability of various sentences. Two predictions were made. If this hypothesis is correct, children should be able to discriminate between agreeing and non-agreeing sentences at the first point they are able to derive information by analyzing the relation between the number features of lexical items. Secondly, if the point when children can discriminate between agreeing and non-agreeing sentences is contingent upon the acquisition of rules for analyzing the relation between the number features of lexical items, sentence structure should not affect the point at which children are able to do so.

Neither of these predictions were confirmed, suggesting that this hypothesis is incorrect. Ss' were able to decode semantic information earlier than they were able to decode agreement, even though both kinds of information are introduced by the relation between the number features of lexical items. Ss' judgements of sentences also indicated that sentence structure does affect the point at which children are able to discriminate
between agreeing and non-agreeing sentences.

It was suggested that the fact that agreement is a syntactic rule, as opposed to a semantic one, affects or determines the point when children are able to discriminate between agreeing and non-agreeing sentences. It was also suggested that sentence structure may act to constrain the accessibility of inflectional information in a sentence. It was suggested that these factors must be taken into account in a processing model of how children decode agreement.
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Introduction

Norman's (1973) model of questioning-answering has suggested that the process of answering questions is more complex than it was previously thought to be. Traditionally, Norman states, models of question-answering have assumed that this process consists of retrieving the relevant information from memory, and then responding with the appropriate answer. The algorithm for this process would be as follows:

(i) search memory for the structure equivalent to
the questioned item
(ii) if search is successful, respond with the appropriate
answer
(iii) if search is not successful, respond, "I don't know."

Norman suggests that this model oversimplifies the actual process of answering questions. In answering some questions, he states, people do not even bother searching memory for the relevant information. One example of such a question is:

(1) What is the telephone number of Charles Dickens,
the novelist?

If people do use the processing algorithm stated above to answer questions, they should respond to this question by searching memory files for an association between Charles Dickens and a telephone number. Because no such association will exist, people should respond by saying "I don't know."

People do not, however, respond in this way. They claim, conversely, not even to bother to search for an answer, and simply reject the question as illegitimate.

Norman states that the way in which people respond to questions like (1) indicates that a large amount of preprocessing occurs before a search
of memory is made. The way in which people respond to such questions suggests that people initially determine, among other things, whether the question is legitimate. If the question is legitimate, a search of memory is made. If it is not, no search is initiated.

The essential characteristic of Norman's model of question-answering is that the processing of questions occurs in sequential steps or stages. This assumption is shared by other researchers (e.g., Anderson & Bower, 1973; Smith, Shoben & Rips, 1974). Anderson and Bower emphasize that linguistic information is accessed in a particular order, and that it is processed in discrete steps. Perhaps the area in which a stage model has become most important is that of semantic memory. Smith, Shoben and Rips use a stage model to account for the finding that the amount of time necessary to disconfirm an anomolous sentence (e.g., All birds are chairs) is less than the amount of time necessary to confirm a non-anomolous sentence. This finding cannot be accounted for by the processing algorithm outlined above. That model predicts that the amount of time necessary to confirm a sentence will, on the whole, be less than the amount of time necessary to disconfirm a sentence. Smith, Shoben and Rips suggest that people seem to make a rapid initial search to determine if the information presented is anomolous, etc. If it is anomolous, no search of memory is made, thereby accounting for the finding mentioned above. The basic assumption of this model, like that of Norman, is that information is processed in sequential stages.

Questions as to how information is in fact processed may also be applied to the study of language acquisition. The single most important reason for doing so is that this kind of analysis may clarify how children acquire linguistic rules. Typically, when a child no longer violates a
given a linguistic rule, it is inferred that the child has acquired the rule, or added it to the knowledge component (Kaplan, 1973) of his grammar. Thus, speech comprehension, for example, is thought to consist of an operation whereby the input sentence is compared against the rules contained in the knowledge component of the child's grammar. These rules assign a "structural description" (Chomsky, 1965) to the sentence, thereby decomposing it. The shortcoming of this approach, from a processing or psychological point of view, is that it does not specify how comprehension in fact occurs. Although it formally accounts for speech comprehension, it does not indicate how this process actually takes place. That is, it does not indicate how the processing component (Kaplan) of the child's grammar applies the rules contained in the knowledge component to decompose sentences.

The purpose of this study is to examine some of the parameters which affect the decoding of agreement by children. In other words, what operations must the child perform to determine whether the subject and the verb of a sentence agree?

In English number agreement occurs between the surface subject and the verb of a sentence. It is introduced by a [±] plural morpheme or inflection on the surface subject and the verb. This feature on the surface subject and the verb will be referred to as their number feature. Logically, then, the child must perform two, ordered operations on a sentence to decode agreement. First, the child must determine which lexical item in the sentence is the surface subject, and which lexical item is the verb. Secondly, the child must analyze the relation between the number features of these items to determine whether or not they agree.

Previous studies have indicated that children, by about age four,
correctly mark or 'use' agreement in their spontaneous speech. Keeney and Wolfe (1972) report that the children they observed, aged three to four, correctly marked agreement in 94% of "obligatory contexts" (see also Brown, 1973). That is, they observed English agreement rules in 94% of those sentential contexts in which the use of these rules is obligatory. However, when these children were presented with verbs and with sentences marked singularly or plurally, and were instructed to point to the picture (singular/plural) which the verbs and the sentences depicted, the children performed at only chance levels. Keeney and Wolfe conclude that children correctly mark agreement in their spontaneous speech earlier than they comprehend the meaning of the singular and the plural inflection.

The first of the two operations that the child must perform to decode agreement is to identify the surface subject and the verb of the sentence. Several studies suggest that children can identify these items relatively early, or at least earlier than the point they use or can identify inflections (Brown & Fraser, 1963; Miller & Ervin, 1964). In the Brown and Fraser study, children, aged two to three, imitated simple English sentences. Whereas the children tended to preserve nouns, verbs and adjectives, they tended to omit, among other things, inflectional affixes. Brown and Fraser report that this was also true of the children's spontaneous speech. From the standpoint of adult English, these findings suggest that children acquire rules for identifying these items earlier than rules governing the use of inflections (Miller, 1973).

How the child actually identifies the surface subject and the verb of a sentence is unclear. There are several models, however, which account for this equally well. The rules required to identify the surface subject
and the verb are roughly equivalent to the phrase structure rules in a generative grammar, such as that of Chomsky. Alternatively, Kaplan has suggested that an augmented transition network grammar can account for this process. In this kind of grammar, lexical items in a sentence are assigned functional names—i.e., subject, verb, object—by means of sequential "transition arcs" which initiate naming actions. Thus, the child would identify the surface subject and the verb by means of assigning functional names to the lexical items in a sentence.

The second operation that the child must perform to decode agreement is to determine whether the number features of the surface subject and the verb agree. After identifying the surface subject and the verb, the child must determine whether or not the number features of these items agree. To do so, the child must analyze the relation between the number features of these items.

When, then, will the child be able to decode agreement? When will the child be able to discriminate between agreeing and non-agreeing sentences? Children are able, as mentioned above, to identify the surface subject and the verb of a sentence relatively early. To decode agreement, the child must also analyze the relation between the number features of these items. Thus, the simplest hypothesis is that children will be able to discriminate between agreeing and non-agreeing sentences when they have acquired rules for analyzing the relation between the number features of lexical items in a sentence. Hereafter, rules for analyzing the relation between the number features of lexical items in a sentence will be referred to as R (for relation) rules.

If the ability to discriminate between agreeing and non-agreeing sentences is contingent upon the acquisition of R rules, several predictions
follow. The first prediction follows directly from this hypothesis. It is that at the point when children demonstrate that they can derive information by analyzing the relation between the number features of lexical items, they will be able to decode agreement. Alternatively, the kind of information encoded by the relation between the number features of lexical items may determine the developmental point at which children are able to decode it. For example, agreement is a syntactic or arbitrary relation between constituents, as opposed to a semantic one. It is possible that the fact that agreement is an arbitrary relation between constituents may determine when children are able to decode it. Children might be able to decode semantic information earlier than they are able to decode agreement because of the differing status of these kinds of information.

The second prediction that can be tested is a corollary of this hypothesis. If the point when children can discriminate between agreeing and non-agreeing sentences is contingent solely upon the acquisition of R rules, it follows that the ability of children to do so will not be affected by the structure of the input sentence. These predictions are examined in turn below.

Regarding the first prediction, consider the following sentences:

(2) Which bag are the apples in?
* (3) Which bag is the apples in?
* (4) Which bags is the apple in?
* (5) Which bags are the apple in?

In WH-questions such as these, the surface subject of the sentence is the postverbal noun phrase, i.e., "apples", or "apple". Thus, the number feature of the verb is to agree with that of the noun phrase following it. In this sense sentence (2) is syntactically well-formed. It is
also semantically well-formed, and hence grammatical. In sentence (3) the verb does not agree with the surface subject. The number feature of the verb agrees (incorrectly) with that of the object noun phrase. Sentence (3) is, however, semantically well-formed. Sentences (4) and (5) are both, under normal circumstances, semantically ill-formed or anomalous. Both violate restrictions that are entailed by the physical attributes of the items "bags" and "apple". Under normal circumstances, one apple cannot be in several different bags simultaneously. But in sentence (4) the surface subject and the verb do agree (syntactically well-formed), whereas in sentence (5) they do not (syntactically ill-formed).

To determine whether these sentences are syntactically well-formed—i.e., whether the surface subject and the verb agree—the child must analyze the relation between the number features of these items. To determine whether these sentences are semantically well-formed, the child must analyze the relation between the number features of the surface subject and the object noun phrase. If the child did not analyze the relation between the number features of the relevant lexical items in these sentences, the child would not be able to detect whether these sentences were syntactically well- or ill-formed, or semantically well- or ill-formed. Thus, both syntactic information and semantic information is derived by analyzing the relation between the number features of lexical items in these sentences.

Specifically, then, the first prediction to be tested is that children, in judging the acceptability of these sentences, will discriminate between sentences (2) and (3), i.e., decode syntactic information, at the same developmental point when they discriminate between sentences
(2) and (3) versus (4) and (5), i.e., decode semantic information. If the point when children can decode agreement is contingent upon the acquisition of R rules, they should be able to do so at the first point at which they demonstrate that they can derive information by applying these rules. Thus, children should be able to decode syntactic information at the same point or earlier than they are able to decode semantic information. If children were able to decode semantic information earlier than syntactic information, it would imply that the decoding of agreement is not contingent upon the acquisition of R rules alone.

The second prediction to be tested is that the structure of the input sentence will not affect the decoding of agreement. If the point when children can decode agreement is contingent upon the acquisition of R rules, the ability of children to do so should not be affected by the structure of a sentence. In other words, at the point when children are able to discriminate between agreeing and non-agreeing sentences, their ability to do so should not be restricted to sentences of, for example, only one surface-ordering.

Consider the following sentences:

(6) Which monkey bites the horses?

(7) Which monkeys bite the horse?

*(8) Which monkey bite the horses?

*(9) Which monkeys bites the horse?

Though all of these sentences are semantically well-formed, only (6) and (7) are syntactically well-formed. In sentence (8) and (9) the number feature of the verb agrees (incorrectly) with that of the object noun phrase, rather than with that of the surface subject.

In WH-questions such as these, the surface subject precedes the verb which in turn precedes the object noun phrase. This ordering preserves
what may be called the "canonical", i.e., base structure, form of English sentences (Fodor, Bever & Garrett, 1974). This ordering is also the most frequently used one in English. In contrast, sentences (2-5) do not preserve this ordering in their surface structures. In these sentences, the surface subject follows the verb.

If the decoding of agreement is contingent upon the acquisition of R rules, it should not be affected by the surface position of subject and verb. Thus, the second prediction states that at the point when children can discriminate between sentences (6) and (7) versus (8) and (9), they will also be able to discriminate between sentences (2) and (3), or vice-versa.

In summary, two predictions are to be tested. Each follows from the hypothesis that children will be able to discriminate between agreeing and non-agreeing sentences when they have acquired R rules. The first prediction is that children will be able to decode agreement at the first point they demonstrate they can decode information by applying these rules. The second prediction is that when children are able to decode agreement, their ability to do so will not be restricted to sentences of only one surface-ordering. If the point at which children can do so is contingent upon the acquisition of R rules, the structure of a sentence should not affect this.

Method:

To test these predictions children were asked to judge the acceptability (or grammaticality) of a set of sentences similar to ones (2-9). Children were individually read one sentence at a time, and were instructed to respond by saying whether the sentence sounded "right" or "wrong".
Before testing began, the task was demonstrated to the child. First, the child was read a sentence in two contrasting forms: in the first, surface subject and verb agreed (e.g., Which boy goes to school?); in the second, surface subject and verb did not agree (e.g., *Which boy go to school?). The child was told that the two sentences sounded different; that the first one sounded "right", and that the second one sounded "wrong" or "funny". Several more contrasts were then made by the experimenter. The purpose of these instructions was to demonstrate to the child that he was to judge the grammaticality of the test sentence, rather than answer it (e.g., "Daniel goes to school."). The child was then presented with several more contrasting sentences, and asked if they sounded "right" or "wrong". Ss' who were able to judge (correctly or incorrectly) the acceptability of these sentences, i.e., tried to answer the questions or did not understand the task, were eliminated from further testing. (Three children, age five, were eliminated for this reason).

To test the first prediction Ss' were presented with 16 sentences similar to sentences (2-5) above (Cf. Appendix I). In all of these sentences the surface subject was the postverbal noun phrase. These sentences are called Type II sentences. Half of these sentences were semantically well-formed, and half were semantically ill-formed. In half of the semantically well-formed and the ill-formed sentences, the surface subject and the verb agreed. In the other half, the number feature of the verb agreed (incorrectly) with that of the object noun phrase, rather than with that of the surface subject. All test sentences were constructed so that the number feature of the surface subject and the object noun phrase differed from each other.

To test the second prediction Ss' were also presented with eight
sentences similar to sentences (6-9). In all of these sentences the surface subject was the preverbal noun phrase. These sentences are called Type I sentences. Each of these sentences was semantically well-formed. In half the surface subject and the verb agreed (syntactically well-formed); in the other half the surface subject and the verb did not agree (syntactically ill-formed). Like the Type II sentences, all sentences were constructed so that the number feature of the surface subject and the object noun phrase differed from each other. Thus, in half of the syntactically well-formed and the ill-formed sentences, the surface subject was singular and the object was plural. In the other half, the surface subject was plural and the object was singular.

Each child was also presented with eight sentences in which grammatical word order was destroyed (e.g., *Bird which snakes the watches?). (Thus, each child was presented with 32 sentences in all.) The reason for including these sentences was to determine whether the child could judge the test sentences on the basis of their grammaticality, as opposed to responding to them as propositions. Since the child was to judge the grammaticality of the test sentences, regardless of their propositional content, a measure of the child's ability to do so is necessary. Children, who were unable to correctly judge the acceptability of these sentences, were inferred to be unable to judge the other test sentences on the basis of their grammaticality, and were eliminated from further testing. No Ss' were eliminated for this reason. All Ss' were able to correctly discriminate (i.e., in the appropriate direction) between these sentences and Type I sentences, i.e., ones in which grammatical word order was preserved ($F(1,57)=117.90, p < .001$).

To counter the possible influence of a set effect, no noun was used
more than once in the test sentences. Nouns in the Type II sentences were drawn from a list of common containers and items (e.g., jar, basket, bananas, oranges). Nouns in the Type I sentences were drawn from a list of animals whose names children were assumed to be familiar with (e.g., tiger, bird, monkey). The verb in the Type II sentences was the singular or plural form of "be". The verbs in the Type I sentences were the singular or plural forms of "bite", "chase", "hear" and "watch". These verbs were balanced across the Type I sentences. Order of presentation of the test sentences was randomized across Ss'.

Ss' were 60 children at three age levels. The youngest group was chosen from children aged 5;0 to 6;6. A second group was chosen from children aged 7;0 to 8;6. The oldest group was chosen from children aged 10;0 to 11;6. The mean age of each group was 6;0;14, 8;0;3, and 10;10;6, respectively. The youngest group consisted of eight males and twelve females, the second group of nine males and eleven females, and the oldest group of six males and fourteen females.

All Ss' spoke English as a first language. The socio-economic status of the children ranged from lower-middle to middle class.

Results:

Ss' judgments of the test sentences are presented in Table I. The values in Table I represent the mean number of sentences that Ss' judged to sound "right".

As can be seen in Table I, one cell in the design is missing. Ss' were presented with semantically well-formed and ill-formed Type II sentences, but only with semantically well-formed Type I sentences. The reason for this is as follows. First, semantically ill-formed Type I sentences cannot be constructed by permuting the number features of
### TABLE I

Mean Number of Sentences Judged to Sound "Right" as a Function of Sentence-Type, Semantic Well-Formedness and Syntactic Well-Formedness (Agreement)*

<table>
<thead>
<tr>
<th>Age I</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>5;0 - 6;6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.85</td>
<td>2.75</td>
<td>3.05</td>
</tr>
<tr>
<td></td>
<td>1.65</td>
<td>2.90</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.80</td>
<td>3.20</td>
</tr>
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<td></td>
<td></td>
<td>2.20</td>
<td>3.10</td>
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<tr>
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<td></td>
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<td>.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age II</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>7;0 - 8;6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.30</td>
<td>3.55</td>
<td>3.05</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td>3.15</td>
<td>.70</td>
</tr>
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<td></td>
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<td>.65</td>
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<td>1.25</td>
</tr>
</tbody>
</table>

* Children were presented with four sentences of each kind.
lexical items in them. Thus, in principle no comparison is possible between children's judgments of such sentences and the test sentences. Secondly, even if it were possible to construct semantically ill-formed Type I sentences in this manner, no predictions were made regarding children's judgments of them.

Since one cell is missing, two separate analyses of the children's judgments of the test sentences were made, corresponding to the two predictions made. Since two analyses were made, it is to be cautioned that some of the results of these analyses are, in a statistical sense, redundant. The results are, however, quite strong and in this sense relatively straightforward.

The first prediction was that children will be able to decode agreement at the point when they have acquired R rules. Thus, at the point when children demonstrate that they can derive information by applying these rules, they should, in judging the test sentences, also be able to discriminate between agreeing and non-agreeing sentences. To test this prediction, Ss' judgments of semantically well-formed and ill-formed agreeing and non-agreeing (Type II) sentences were compared, in a 3x2x2 factorial design (AGE=three levels, SEMANTIC=two levels, AGREEMENT=two levels). If this prediction is correct, Ss', in judging the test sentences, should discriminate between semantically well-formed agreeing and non-agreeing sentences at the same point or earlier (in terms of AGE level) than they discriminate between semantically well-formed and semantically ill-formed sentences. If, on the other hand, Ss' were able to discriminate between semantically well-formed and semantically ill-formed sentences earlier than they were able to discriminate between semantically well-formed agreeing and non-agreeing sentences, it would
suggest that this prediction is incorrect. This would suggest that the point when children can decode agreement is affected by the fact that agreement is a syntactic rule, as opposed to a semantic one.

The main effect for the SEMANTIC factor was significant ($F(1,57) = 141.48, p < .001$). The effects of this factor are clearly evident in Table I. The main effect for AGE was also significant ($F(2,57) = 3.92, p < .05$). Both effects are qualified by the AGE x SEMANTIC interaction ($F(2,57) = 21.97, p < .001$). Analysis of this interaction revealed that the youngest children, aged 5;0 to 6;6, did not discriminate between semantically well-formed and semantically ill-formed (Type II) sentences ($F(1,57) = 1.12, p < 1$). On the other hand, the two older groups of children did detect whether the Type II sentences were semantically well-formed or ill-formed ($F(1,57) = 40.29, p < .001; F(1,57) = 51.29, p < .001$). Significantly, no main effect for AGREEMENT was found ($F(1,57) = .01, p < 1$), nor was an interaction between AGREEMENT and the SEMANTIC factor found ($F(1,57) = .69, p < 1$). If the prediction made had been correct, the AGREEMENT factor, or at least the AGREEMENT x SEMANTIC interaction, should have been significant. The interaction between AGREEMENT and AGE was also non-significant ($F(2,57) = 1.63, p < 1$), as was the triple interaction between AGREEMENT, AGE and the SEMANTIC factor ($F(2,57) = 3.04, p < 1$).

The second prediction that was made was that at the point children can discriminate between agreeing and non-agreeing sentences, their ability to do so should not be restricted to sentences of only one surface-ordering. If the point when children can decode agreement is contingent solely upon the acquisition of R rules, their ability to do so should not be affected by the structure of a sentence. To test this prediction, Ss' judgments of (semantically well-formed) agreeing and
non-agreeing Type I and Type II sentences were compared, in a 3x2x2 factorial design (AGE=three levels, SENTENCE-TYPE=two levels, AGREEMENT=two levels). If this prediction is correct, the AGREEMENT main effect should be significant. Furthermore, if it is correct, the interaction between SENTENCE-TYPE and AGREEMENT should not be significant.

The main effect for AGREEMENT was significant \((F(1,57)=38.40, p<.001)\). By itself this suggests that the point when children can decode agreement is not affected by the structure of a sentence. However, the main effect for SENTENCE-TYPE was also significant \((F(1,57)=107.04, p<.001)\), as was the interaction between SENTENCE-TYPE and AGREEMENT \((F(1,57)=23.21, p<.001)\). Analysis of this interaction revealed that Ss' were able to discriminate between (semantically well-formed) agreeing and non-agreeing Type I sentences \((F(1,114)=20.03, p<.001)\), but not between (semantically well-formed) agreeing and non-agreeing Type II sentences \((F(1,114)=.17, p<1)\). The main effect for AGE was non-significant \((F(2,57)=.85, p<1)\), as was the interaction between AGE and SENTENCE-TYPE \((F(2,57)=1.85, p<1)\). The AGE x AGREEMENT interaction was significant \((F(2,57)=9.99, p<.01)\). Analysis of this interaction revealed that the youngest children were not able to discriminate between (semantically well-formed) agreeing and non-agreeing sentences \((F(1,57)=.01, p<1)\). Conversely, the two older groups of children were able to discriminate between (semantically well-formed) agreeing and non-agreeing sentences \((F(1,57)=9.10, p<.01; F(1,57)=20.07, p<.001)\). The triple interaction between AGE, SENTENCE-TYPE and AGREEMENT was also significant \((F(2,57)=5.68, p<.01)\). Analysis of this interaction indicated that the youngest children were not able to discriminate between (semantically well-formed) agreeing and non-agreeing Type I or Type II sentences \((F(1,114)=.49, p<1; F(1,114)=.28, p<1)\). Unlike the youngest children, Ss' aged 7;0 to 8;6 did discriminate between (semantically well-
formed) agreeing and non-agreeing Type I sentences ($F(1,114)=19.50$, $p < .001$). However, these children were not able to discriminate between Type II sentences of the same kind ($F(1,114)=1.99$, $p < 1$). This pattern was also true of the oldest Ss', aged 10;0 to 11;6. Although they were able to discriminate between (semantically well-formed) agreeing and non-agreeing Type I sentences ($F(1,114)=69.43$, $p < .001$), they were not able to discriminate between Type II sentences of the same kind ($F(1,114)=.12$, $p < 1$).

**Discussion:**

The results of the first analysis suggest that the first prediction made is incorrect. Specifically, they suggest that the point at which children can decode agreement is not contingent upon the acquisition of R rules alone. This is suggested by the finding that Ss' aged 7;0 to 8;6, in judging the test sentences, discriminated between semantically well-formed and semantically ill-formed (Type II) sentences, but did not discriminate between semantically well-formed agreeing and non-agreeing (Type II) ones. Thus, at the point when Ss' were able to discriminate between semantically well-formed and ill-formed (Type II) sentences, they still were not able to discriminate between semantically well-formed agreeing and non-agreeing (Type II) ones.

This suggests that the point at which children can decode information introduced by the relation between the number features of lexical items is affected by the status of the information encoded, namely whether it is syntactic or semantic in nature. The fact that both kinds of information are derived by the same operation does not seem to result in children decoding both kinds of information at the same developmental point. Thus, the point at which children can decode agreement is not contingent upon
the acquisition of R rules alone. At the point at which Ss' demonstrated that they could derive information by applying these rules, they still could not decode agreement. The results obtained suggest that at this point Ss' were still not able to detect any differences between (semantically well-formed) agreeing and non-agreeing Type II sentences. The fact that agreement is a syntactic phenomenon, as opposed to a semantic one, must in some way constrain the application of R rules to a sentence.

The fact that the adult speaker will judge semantically ill-formed sentences to be unacceptable (or less acceptable) implies that during the process of sentence-decoding a person performs operations which determine whether a sentence is semantically well-formed. The fact that the adult speaker will judge sentences, in which surface subject and verb do not agree, to be unacceptable implies that a person also performs operations which determine whether a sentence is syntactically well-formed. This implies that the adult speaker analyses every sentence, be it grammatical or ungrammatical, on each of these dimensions. In fact, such operations account for speech comprehension or sentence decomposition. The two older groups of Ss' judgments of the Type II test sentences suggest that children acquire rules for decoding semantic information, introduced by inflections, earlier than they acquire rules for decoding syntactic information, introduced by inflections.

The finding that the older Ss' were able to decode semantic information, but not syntactic information, is consistent with what Siegler (1976) calls the "encoding hypothesis". Briefly, Siegler suggests that younger children encode stimuli on fewer dimensions than older children do. He found that younger children benefited less from experience (or
learning trials) than older children did, not because they were slower or misunderstood the experimental task, but because they encoded the task stimuli on fewer dimensions. The implication of this finding is that with age the child analyzes and encodes information presented to him on an increasing number of dimensions.

The reason why Ss' were able to decode semantic information, but were not yet able to decode syntactic information, may ultimately be "functional", or have what may be called a "pragmatic" basis. Usually, sentences refer to real events and situations. Since this is the case, it seems likely that the child, in learning a language, would be sensitive to semantic constraints on sentences earlier than he would be sensitive to syntactic or arbitrary constraints on sentences. In the sense that sentences refer to real events and situations, semantic information in a sentence is more informative than syntactic information. For example, sentences in which surface subject and verb do not agree seem, intuitively, to be ungrammatical in only a trifling sort of way. Semantically ill-formed sentences seem to be ungrammatical in a much more significant way. Violations of semantic constraints alter a sentence's meaning in a much more significant way than do violations of syntactic constraints (Chomsky, 1961). Thus, there may be "functional" or "adaptive" reasons for acquiring rules for decoding semantic information earlier than rules for decoding syntactic information. Semantic information is simply more informative than syntactic information.

In fact, this is consistent with results reported by de Villiers and de Villiers (1972). They found that children were able to appropriately judge semantically well-formed and ill-formed sentences (e.g., Throw the stone vs. Throw the sky) earlier than they were able to appropriately judge syntactically well-formed and ill-formed sentences (e.g., Brush your teeth vs. Teeth your brush).
From a processing point of view, however, it is unclear why the two older groups of Ss' were able to discriminate between semantically well-formed and semantically ill-formed (Type II) sentences, but not between semantically well-formed agreeing and non-agreeing (Type II) ones. The fact that they did discriminate between semantically well-formed and ill-formed Type II sentences demonstrates that they did apply R rules to these sentences. Thus, why were these children unable to discriminate between semantically well-formed agreeing and non-agreeing Type II sentences.

The reason for this may be that during sentence decoding a person makes two (and presumably more) 'passes' on a sentence— one to determine whether inflectional information violates semantic constraints, and another to determine whether this information violates syntactic constraints. During the first pass a person would apply R rules to the sentence. The purpose of this operation would be to determine whether semantic constraints have been violated. During a second pass a person would perform the same operation, but in this case to determine whether syntactic constraints have been violated. If the decoding of inflectional information is thought to consist of several different stages, the finding that the older Ss' discriminated between semantically well-formed and ill-formed (Type II) sentences, but not between semantically well-formed agreeing and non-agreeing (Type II) sentences is easily interpretable. It would mean that at this age Ss' had not yet acquired mechanisms to make a second pass on inflectional information in these sentences.

Although this model is admittedly ad hoc, it can account for the results obtained. If it is thought that R rules are applied only once to inflectional information, these results cannot be explained. These
results suggest that the processing component (Kaplan) of the child's grammar applies R rules to a sentence in at least two discrete stages; first to determine whether semantic constraints have been violated, and secondly to determine whether syntactic constraints have been violated.

The second prediction that was made was that when children are able to decode agreement, their ability to do so will not be restricted to sentences of only one surface-ordering. The results of the second analysis do not confirm this prediction, as is evident in Table I.

First, the finding that the youngest Ss' did not discriminate between (semantically well-formed) agreeing and non-agreeing Type I or Type II sentences suggests that these children did not use inflectional information in judging the test sentences. This is also suggested by the finding that these children did not discriminate between semantically well-formed and semantically ill-formed Type II sentences. If these children had used inflectional information in the test sentences to judge them, it follows that they would have discriminated between semantically well-formed and ill-formed Type II sentences, and between (semantically well-formed) agreeing and non-agreeing sentences of each sentence type. In this sense, these results are consistent with (though do not confirm) the hypothesis that children will be able to decode agreement when they have acquired R rules. The youngest Ss' judgments of the test sentences provide no evidence that they were able to analyze the relation between the number features of lexical items in these sentences, or that they were able to discriminate between agreeing and non-agreeing sentences.

But at the point when Ss' were able to discriminate between (semantically well-formed) agreeing and non-agreeing Type I sentences, they were still not able to discriminate between Type II sentences of the
same kind. Thus, the results obtained for the two older groups of Ss' indicate that this prediction is incorrect. The surface-ordering of a sentence does affect the decoding of agreement.

The fact that the two older groups of children were able to discriminate between (semantically well-formed) agreeing and non-agreeing Type I sentences, but only between semantically well-formed and ill-formed Type II sentences, may demonstrate how sentence structure affects the decoding of information introduced by inflections.

Each of the Type I sentences is semantically well-formed. Since Ss' were asked whether the test sentences sounded "right" or "wrong", it may be inferred that Ss' considered the Type I sentences they judged to sound "right" to be semantically and syntactically well-formed. Ss' were not asked to judge whether the test sentences were semantically well- or ill-formed, or syntactically well- or ill-formed. They were asked to judge whether the sentences sounded "right" or "wrong". If this inference is correct, the results obtained suggest that the older Ss' were able to appropriately judge the semantic and the syntactic well/ill-formedness of the Type I sentences, but only the semantic well/ill-formedness of the Type II sentences. If this is correct, these results suggest that the way in which sentence structure affects the decoding of information is to limit the extent to which the sentence is processed, or the number of operations that are performed on it. The reason why the older groups of Ss' did not discriminate between semantically well-formed agreeing and non-agreeing Type II sentences may simply be that they did not perform operations on them to determine whether the surface subject and the verb agreed. The results obtained suggest that they only performed operations to determine whether these sentences were semantically well-formed or
semantically ill-formed. They suggest that at this age children are only able to decode agreement in sentences in which the surface subject is the preverbal noun phrase.

In summary, there are two logical requirements that must be fulfilled to decode agreement. Logically, the child must identify the surface subject and the verb of a sentence, and secondly determine whether the number features of these items agree. Thus, in the course of development, the child must acquire rules to perform these operations and add them to the "knowledge component" of his grammar. Clearly, if the child did not acquire these rules, the child would not be able to decode agreement.

The results obtained in this study suggest that the way in which these rules are applied is, however, somewhat more complex. These results suggest that the decoding of agreement by children—and the point at which they are able to do so—is more complex than these logical requirements would indicate. First, the fact that agreement is a syntactic rule, as opposed to a semantic one, seems to increase the difficulty of learning it. Before children can decode agreement, they can already decode semantic information—even though this information is derived in the same way as information regarding agreement. It seems that the point at which children can decode agreement is affected by the arbitrary nature of agreement rules. Secondly, the structure of a sentence seems to constrain the accessibility of inflectional information in it. Children are able to decode agreement in sentences in which the surface subject is the preverbal noun phrase earlier than they are able to do so with sentences in which the surface subject is the postverbal noun phrase. These findings suggest that an adequate model of how children decode agreement must take into account the arbitrary nature of agreement rules and the constraining effect of sentence structure.


APPENDIX I

Type I sentences

Which monkey bites the horses?
Which cow chases the dogs?
Which pigs hear the chicken?
Which cats watch the mosquito?

*Which gorilla chase the lions?
*Which bull hear the ducks?
*Which foxes watches the tiger?
*Which turtles bites the lizard?

Type II sentences

Which cup are the bananas in?
Which box are the pears in?
Which pot are the apples in?
Which bag are the oranges in?

*Which closet is the books in?
*Which room is the cherries in?
*Which basket is the potatoes in?
*Which corner is the flowers in?

*Which bowls is the peach in?
*Which jars is the plum in?
*Which drawers is the toy in?
*Which pans is the tomato in?

*Which pails are the apricot in?
*Which caves are the rock in?
*Which buckets are the brush in?
*Which plates are the melon in?