Children's Comprehension of Relative Clauses

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A review of the literature on children's use of relative clause constructions reveals many contradictory findings. The suggestion is that some studies fail to take into account the two factors of embeddedness (role of complex noun phrase within the sentence) and focus (role of head noun in the relative clause). The experiment reported here attempted to reconcile the disparate findings and extend the range of constructions examined. 114 children between the ages of 3 and 7 served as subjects in a test of comprehension using an act-out procedure of 9 different relative clause sentences that exhaust the possible combinations of 3 roles of the complex noun phrase in the sentence and 3 roles that the head noun plays within the relative clause (in each case, subject, direct object, and indirect object). All constructions were understood better with increasing age of the children; sex and sentence set were nonsignificant variables. The results reveal a difficulty in ordering of the 9 types of construction that is in keeping with a prediction based on surface structure processing strategies.

INTRODUCTION

The present article aims to clarify some of the serious misunderstandings in the literature on relative clauses in child speech. As will be shown, there are more predictions about the complexity of the various types of

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relative clause construction than there are good studies to test them. After these predictions have been made precise and set in contrast, the second part of the article reports a research study specifically designed to test them.

One must specify at least two variables in the description of a relative clause construction in English. First is the position of the relative clause in the sentence, its *embeddedness*, which changes according to the constituent in the main sentence which it modifies. The second variable is the role that the head noun plays in the relative clause, called its *focus*. Consider as an illustration the four sentences below:

Embeddedness (role of complex noun phrase)	Focus (role of head noun)		
Subject	Subject	(SS)	The cat that bit the dog chased the rat.
Subject	Object	(SO)	The cat that the dog bit chased the rat.
Object	Subject	(OS)	The cat bit the dog that chased the rat.
Object	Object	(OO)	The cat bit the the dog that the rat chased.

The two subject relatives in English (SS and SO) are center-embedded; the two object relatives (OS and OO) are right-branching. In center-embedded sentences the main clause is interrupted by a relative clause, but in a right-branching sentence it remains uninterrupted.

Predictions about the complexity of various relative clause constructions in English can be divided into two types: predictions based on one of these variables and predictions based on a consideration of both variables. We will discuss each in turn.

One Variable: (a) The Embeddedness of the Relative Clause

It has been claimed by several researchers that center-embedded relative clauses are harder for adults to process than right-branching

relative clauses (Yngve, 1960; Miller, 1962). Presumably this is because of the increased memory load required during the interruption of the main clause. However, as Sheldon (1974) points out, most of the studies (e.g., Fodor and Garrett, 1967) used multiple-embedded relative clauses, and it is not clear that interruption by a single-embedded clause would cause any problem to an adult. Nevertheless, Slobin (1971) cites data from several studies of child speech which show that children have more difficulty repeating center-embedded subject relatives than the right-branchinbg object relatives.

Slobin's analysis is consistent with the results of Cook (1973), who also used elicited imitation with children aged between 3 and 5 years. Many more errors were made on center-embedded than on right-branching relative clauses.

Gaer (1969) used a picture-cued comprehension and delayed imitation task with young children between 3 and 6 years old and found right-branching sentences easier to produce than center-embedded sentences, although not significantly easier to comprehend. There are, however, problems with the use of a picture-cued comprehension task, as the alternative pictures must be small in number to be within the child's scanning pattern (Kennedy, 1970). In Gaer's study only one picture was presented and the child had to say whether or not it matched the spoken sentence. Although there are multiple possibilities for how the picture and sentence could fail to match, only one was presented to the child. For example, for the sentence "The boy sees the girl eating a cookie her mother baked" the only pictured contrast was the boy watching or not watching the event. Clearly in a picture-cued comprehension test only a limited set of the child's possible processing errors are represented.

Brown (1971) also used a picture-cued comprehension task with a choice of two pictures to match to a sentence. He found an interaction between embeddedness and age: center embeddeds were more difficult than right-branching for his 4- and 5-year-old children but easier for his 3-year-old subjects.

Lahey (1974) compared coordinate, center-embedded, and right-branching sentences in a comprehension test which required the child to act out the sentences with toy animals. In this procedure, there are no constraints on the child's interpretation. In contradiction to all the above results, Lahey found that center-embedded sentences for her 4- and 5-year-old subjects were easier than right-branching sentences. However, her major concern was the relative importance of prosody and syntactic markers, and this finding held only after summing across conditions in

which prosody, syntactic markers, or both were deleted. The valid comparison is the condition in which both prosody and syntactic markers were present. For the 5-year-olds the center-embedded sentences were apparently still understood better than the right-branching (respective means 4.70 and 3.67), but for 4-year-olds there was no clear difference (respective means 3.43 and 3.52). Lahey stated that there were no significant differences between sentence types when they were presented normally.

We wish to claim that much of this confusion and contradiction are a result of concentrating on only one variable, embeddedness, while not controlling for the other major variable, focus. For example, in Cook (1973), in the center-embedded sentences the subject of the main clause played one of two different roles in the relative clause: either subject or object. The same was true for the right-branching sentences. Yet no attempt was made to do a separate analysis for each of the resulting four types. In addition the sentences sometimes included two nouns, sometimes only one, and sometimes three; thus the possible interpretations of the sentences were more limited in some cases than in others. Although Cook used an imitation task, the underlying assumption of the task is that children will have difficulty imitating what they do not understand. Hence it is just as important to control opportunities for ambiguity in sentences presented for imitation as for comprehension.

Gaer (1969) did not publish her complete list of sentences, but if the examples given are representative there is cause for concern. Judging from the examples presented, all of the right-branching sentences may have had the subject focus, all of the center-embeddeds may have had object focus, so the two variables could have been confounded. The examples given are

Center-embedded (SO): "The cat the girl sees is playing with a ball."

Right-branching (OS): "The girl sees the boy who is kicking the ball."

Notice also that there is no relative pronoun in the center-embedded case.

Brown (1971) made an explicit attempt to study focus as well as embeddedness, but his sentences were not ideally controlled. He did not, for example, distinguish between verbs that take an indirect object ("talk to") and verbs that take a direct object ("chase"). Because one of his concerns was the ambiguity of the sentences, one of the sets of object focus sentences with center-embedding contained four nouns, surely

beyond the limit of most children's (and probably adults') processing spans. His major finding was an interaction between focus and embeddedness such that, for both center-embedded and right-branching, subject focus was easier than object focus. The order of difficulty was thus: SS<OS<OO<SO. (Note that < implies "easier than.")

Lahey's (1974) study is methodologically the most sound but included only one type of focus: her center-embedded sentences were SS, her right-branching were all OS. This could account for why she found the opposite to Gaer, who apparently compared OS and SO.

One Variable: (b) The Focus of the Relative Clause

Only one study so far discussed attempted to examine the effects of focus, namely Brown (1971). He found that subject focus was significantly easier than object focus, independent of embeddedness.

This relates to a cross-linguistic study of relative clause formation by Keenan and Comrie (1972). These authors, after surveying over 40 different languages, concluded that there is a hierarchy of accessibility of noun phrases. The order of accessibility is subject<direct object<indirect object< object of preposition<possessive noun phrase<object of comparative particle. Some languages, for example, allow subject and direct object focus but no others lower in the hierarchy. English allows all of them, but French does not permit the object of comparative as the head noun of a relative clause. Thus we can say in English "The young man whom Mary is taller than . . . ," but it is not permissible to say in French *"Le jeune homme que Marie est plus grande que . . ."

If this hierarchy proves to be universal, the possibility arises that it has some relevance for psycholinguistics. Some have speculated (e.g., McNeill, 1966; Ross, 1973) that universal rules ought to appear early in child speech and language-specific rules only later. Alternatively, the hierarchy of accessibility in the world's languages may reflect a general processing difficulty, with focus on noun phrases which are low on the hierarchy. This may arise in discourse considerations; perhaps it is likely that the theme of the relative clause should be its subject rather than in a more obscure rule. To take the above example, it may be more natural to say "The young man who is shorter than Mary . . . " (subject focus) than "The young man whom Mary is taller than . . . " (object of comparative focus). Whatever the relation between universality and child speech, it suggests that studies of relative clauses in children should pay heed to the variable of focus.

Two Variables: (a) The Parallel Function Hypothesis

Sheldon (1974) hypothesized that relative clause sentences in which the head noun plays the same role in the relative clause and the main clause will be easier to understand than sentences in which the roles differ. Thus SS and OO should be easier than SO and OS types. That is exactly what Sheldon found for her 3- to 5-year-olds, using an act-out comprehension task with toy animals.

Sheldon states that the notion of parallel function is also clearly required to explain Brown's (1971) data and that this study independently confirms her findings. That is not the way we read Brown's statistics and his published figure showing the interaction between focus and embeddedness: the OS types were superior to the OO types. This result is not in agreement with the parallel function hypothesis.

Nevertheless, Sheldon has strong support for the parallel function hypothesis from her own data using a better methodology than Brown. Lahey's (1974) data could be construed as support since she found SS superior to OS sentences.

Two Variables: (b) Processing Heuristic Hypothesis

Smith (1974) formulated alternative predictions based on a consideration of the likely processing strategies used by young children. One such strategy (Bever, 1970) is to interpret any noun–verb–noun (NVN) sequence as subject–verb–object, which leads children to misinterpret passive sentences. The second is the minimal distance principle (MDP) which claims that in a relative clause construction the noun immediately preceding a syntactically marked embedded clause will be interpreted as the subject of that clause (Smith, 1974).

Referring back to the four basic sentence types, OS should be the easiest as the two strategies maximize the likelihood of correct interpretation. In the SS sentences, there is a NVN sequence in the main clause, but it is interrupted and so these sentences should be more difficult. The minimal distance principle fails for OO sentences, and finally both strategies fail for the interpretation of SO sentences.

Smith (1974) studied children who were younger (29–35 months) than those in any of the previous studies and used an elicited imitation task with nonsense syllables to minimize semantic strategies. Ten examples of each sentence type (SO, OS, OO, and SS) were presented to each child. The ten children studied confirmed the predicted order of complexity:

$OS < SS < OO < SO$. The data did not support the parallel function hypothesis, but there was a significant effect of embeddedness, i.e., OS and OO combined were easier than SS and SO combined. This was mostly due to the very poor performance on SO sentences.

Consistent with Smith's results are some data from Noizet et al., (1972) in a study of production of relative clauses in French by 11-year-olds and adults. The experimenters used an interesting technique for eliciting the relative clause sentences; they presented subjects with two kernel sentences with two coreferential noun phrases, e.g.,

"The clown watches the ballerina." $NP_1 \ V_1 \ NP_2$
"The musician hits the clown." $NP_3 \ V_2 \ NP_4$

Subjects had to produce a relative clause construction:

either   "The clown who the musician hits watches the ballerina."
or   "The musician hits the clown who watches the ballerina."

Notice that the form varies according to which clause is taken as main and which as subordinate. In the above example, NP_1 is coreferential with NP_4; other kernel sentences had $NP_1 = NP_3$, $NP_2 = NP_3$ or $NP_2 = NP_4$. In this way many different relative clause types were possible. The authors report the relative preference for producing each type of relative clause: whether it was right-branching or self-embedded, and whether the pronoun used was "qui" (who), "que" (whom), or "a qui" (to whom). This pronoun variation corresponds to our focus variable, although it is extended in this experiment to indirect object (I) cases for verbs, such as "talk to." Thus they also have the potential to compare two new types: SI and OI. The data they report show the same trend in adults and 11-year-olds: the order of preference is

$OS<SS<OO \ \ (<OI)<SO \ \ (<SI)$

This further substantiates Smith's position and is consistent with Keenan and Comrie's (1972) claim that indirect object focus is less "accessible " than direct object focus.

At this point, it may be helpful to summarize for the reader the results of all the experiments in Table I. The present study had two major aims: one was to collect more data on the four sentence types discussed above, using what is apparently the most sensitive methodology, that of having the child act out a sentence with no constraints on the role each noun might play. We were interested in testing out all the conflicting predictions of Table I.

The second aim was to extend the scope to include a contrast

Table I. Summary of Research on Children's Use of Relative Clauses

Variable	Prediction	Supported	Not supported	Experimental method
One variable: embeddedness	Slobin (1971) (OS, OO) < (SS, SO)	Cook (1973) Slobin (1971) Gaer (1969) Brown (1971)	Lahey (1974)(SS < OS) Sheldon (1974)	Elicited imitation Elicited imitation Picture-cued delayed imitation Picture-cued comprehension Act-out comprehension Act-out comprehension
One variable: focus	Keenan and Comrie (1972) (SS, OS) < (OO, SO)	Brown (1971)	Sheldon (1974)	Picture-cued comprehension Act-out comprehension
Two variables: parallel function	Sheldon (1974) (SS, OO) < (OS, SO)	Sheldon (1974)	Brown (1971) Smith (1974) Noizet et al. (1972)	Act-out comprehension Picture-cued comprehension Elicited imitation Elicited production (French)
Two variables: processing heuristics	Smith (1974) OS < SS < OO < SO	Smith (1974) Noizet et al. (1972) Brown (1971) (not OS < SS)	Noizet et al. (1972) (OS < SS) Sheldon (1974)	Elicited imitation Elicited production (French) Picture-cued comprehension Act-out comprehension

between direct and indirect objects. Once indirect objects are introduced as a possibility, the number of sentences increases from four to nine (see Table II). The sentences chosen had to be closely matched in length and number of nouns, so we chose to study a subset of indirect objects, those for verbs of communication such as "talk," and "whisper." These do not require a direct object in addition, unlike the verbs "give to," "throw to," etc.

Let us examine the predictions which follow from this increase in scope. The indirect object sentences are all right-branching, so the embeddedness (role of complex noun phrase) argument would treat them as equivalent to the direct object sentences. The developmental hypo-

Table II

Role of complex noun phrase	Role of head noun		Sentence
Subject	Subject	(SS)	The gorilla that bumped the elephant kissed the sheep.
Subject	Object	(SO)	The turkey that the gorilla patted pushed the pig.
Subject	Indirect object	(SI)	The giraffe that the turkey yelled to pushed the zebra.
Object	Subject	(OS)	The kangaroo kissed the camel that shoved the elephant.
Object	Object	(OO)	The turtle hit the pig that the giraffe touched.
Object	Indirect object	(OI)	The crocodile touched the gorilla that the zebra yelled to.
Indirect object	Subject	(IS)	The turtle shouted to the camel that pushed the kangaroo.
Indirect object	Object	(IO)	The horse spoke to the turtle that the sheep touched.
Indirect object	Indirect object	(II)	The kangaroo whispered to the turkey that the zebra shouted to.

Predictions

One variable: (a) Embeddedness
        (OS, OO, OI, IS, IO, II) < (SS, SO, SI)
One variable: (b) Focus
        (SS, OS, IS) < (SO, OO, IO) < (SI, OI, II)
Two variables: (a) Parellel Function
        (SS, OO, II) < (SO, SI, OS, OI, IS, IO)
Two variables: (b) Processing heuristics
        OS ≤ IS < SS < OO ≤ OI ≤ IO ≤ II < SO ≤ SI

thesis following from Keenan and Comrie would predict that indirect object focus is more difficult than direct object focus. Sheldon, using the parallel function argument, would predict II sentences to be easier than IS, IO, SI, and OI. Smith would presumably not distinguish them from the direct object sentences, although the particle "to" between verb and noun may make the NVN strategy less likely to apply. These predictions are summarized in Table II.

Method

Subjects

Subjects were 114 monolingual children, 62 boys and 52 girls, from two-preschools and a community day camp in the greater Boston area. The subjects were divided by age into four groups:

3-year-olds: $N = 21$ [11 males (M); 10 females (F)], mean age 3:6
4-year-olds: $N = 37$ (21 M; 16 F), mean age 4:7
5-year-olds: $N = 34$ (19 M; 15 F), mean age 5:5
6-year-olds: $N = 22$ (11 M; 11 F), mean age 6:5

Materials and Procedure

Two sets of sentences, each set containing one of each of the nine sentence types listed in Table II, were created. Subjects were assigned randomly to either set. Within each set, order of presentation of the nine sentences was randomized. To test for comprehension, following Sheldon's (1974) procedure, subjects were required to act out the sentences using toy animals. Twelve different animals were used in all (alligator, camel, elephant, giraffe, gorilla, horse, kangaroo, pig, sheep, turkey, turtle, zebra). The verbs used were "bumped," "hit," "kissed," "licked," and "pushed" (taking direct objects) and "shouted to," "spoke to," "whispered to," and "yelled to" (taking indirect objects).

Each subject was tested individually. One experimenter presented the sentences and was the primary interactor with the subject, while a second experimenter coded the child's response. In order to familiarize the subject with the materials, each animal was introduced individually and the child was asked to name it. A puppet was then introduced. The subject was told that the puppet would tell him to act things out with the animals on a wooden stage. Three simple warmup sentences were given.

Only in rare instances were subjects unable to understand the directions. In such cases the experimenter modeled a response for the child. The nine sentences immediately followed. Only the relevant animals were placed on the stage for each sentence. On completion of the task, the subject was rewarded by being allowed to take the puppet's role, making the experimenter perform the actions. The entire procedure lasted about 15 min.

RESULTS

Scoring

The responses obtained from all the subjects were coded in the following way. Each noun in a sentence was designated a number corresponding to its position in the sentence. Thus, in the example of Fig. 1, elephant is labeled 1, sheep 2, and horse 3. Using these numbers, the correct response for the direction of action in the first clause is 1–2 and in the second clause is 1–3, so that sentence can be summarized as 1–2, 1–3. An incorrect response might have been to cause the elephant to kiss the sheep, and the sheep to push the horse, i.e., 1–2, 2–3. In addition, if the action did not correspond to the verb, the scorer noted this down.

Having coded all the data in this way, the major scoring scheme we used, following Lahey (1974), awarded 1 point for each of the six possible grammatical relationships correctly acted out in a given sentence (e.g.,
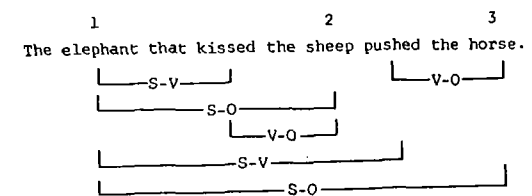
Fig. 1

see Fig. 1). Thus the maximum possible score for each sentence was 6 points; the minimum was 0.

A second scoring scheme was used to summarize the data in order to make our results comparable to Sheldon's (1974) analysis. Sentences were scored as either totally correct (score = 1) or incorrect (score = 0).

Outcome

The results of the experiment, using the major scoring scheme, are summarized across all age groups in Table III. A five-way analysis of variance was carried out on the data. Of the three between-subject variables (age, set, sex) only age was significant, $F(3, 98) = 35.152, p < 0.001$, indicating that performance significantly improved with age.

The two repeated measures factors, role of head noun (focus) and role of complex noun phrase (embeddedness), were both significant. For role of head noun, $F(2, 196) = 12.888, p < 0.001$, and for role of complex noun phrase, $F(2, 196) = 9.006, p < 0.001$. Neither of these factors interacted significantly with any of the between-subject variables.

From Table III we can see that the order of difficulty for the role of head noun follows the order predicted by Keenan and Comrie's accessibility hierarchy: subject<direct object<indirect object. For each complex noun phrase type this ordering is maintained. These results are complicated by the significant interaction between the two repeated measures factors, namely role of head noun and role of complex noun phrase, $F(4, 392) = 5.049, p < 0.001$. This interaction indicates that neither factor alone accounts for the order of difficulty of the nine sentences; both factors must be taken into account.

Table III. Mean Score for Each of the Nine Sentences Across All Ages (Maximum Score 6.0)

Role of complex noun phrase	Role of head noun			
	Subject	Object	Indirect object	Total mean
Subject	3.907	2.975	2.469	3.117
Object	3.897	3.736	3.565	3.733
Indirect object	3.608	3.433	3.351	3.464
Total mean	3.804	3.381	3.128	

A second analysis of variance was carried out on the data with sentences scored in accordance with Sheldon's scheme. Similar results were obtained but with lower overall significance levels because the scoring scheme is less sensitive. This indicates that our findings were not a special function of the major scoring system that we used.

In order to directly compare the various hypotheses presented in the introduction, it was important to analyze the order of the means for the nine sentences, presented in Table III. While we have *a priori* hypotheses for the different orderings predicted by Sheldon and Smith, we could not use contrasts as a method of comparing means since we cannot make predictions about the magnitude of the differences between the means. Instead a *post hoc* test of the order of means for the nine sentences was carried out. Using the Duncan Multiple range test at the 0.05 level of significance, an order was obtained which most closely approximates the order predicted by the strategies hypothesis.

Obtained: OS = SS < OO = IS = OI < IO = II < SO < SI.
Predicted: OS ≤ IS < SS < OO ≤ OI ≤ IO ≤ II < SO < SI.

On the other hand, these data do not support Sheldon's parallel function hypothesis, particularly II sentences were poorly understood, contrary to what would be predicted by the parallel function hypothesis.

Error Analysis

One of the advantages of using the act-out procedure lies in the fact that it does not severely constrain the child's choice of response in the way that other procedures such as picture-cued comprehension might. The only constraint seemed to be that most children saw the task as requiring them to perform two actions involving the three toy animals on stage, although some children, especially in the younger age range, performed only one action. The above analysis, using the Lahey scoring procedure, has told us only the overall extent to which children correctly acted out the various sentences. A correct response for each sentence requires two actions, and it would be revealing to see which of the two responses children tended to act out correctly. An analysis of the systematic errors made by the children should also prove informative.

Table IV provides a breakdown of the types of responses made by the children. Each cell indicates the percentage of children who made that particular response to the sentence type. For example, the cell in the uppermost left indicates that 75% of the children performed the action 1–2

Table IV. Breakdown of Response Types for Individual Sentences[a]

Sentence		1–2	1–3	2–1	2–3	3–1	3–2
SS	N_1 that $V_1N_2V_2N_3$	75%*	46%*	7%	32%	6%	12%
SO	N_1 that $N_2V_1V_2N_3$	29%	33%*	44%*	46%	5%	3%
SI	N_1 that $N_2V_1V_2N_3$	16%	37%*	25%*	36%	10%	4%
OS	$N_1V_1N_2$ that V_2N_3	75%*	36%	6%	39%*	6%	11%
OO	$N_1V_1N_2$ that N_3V_2	74%	8%	8%	10%	28%	43%*
OI	$N_1V_1N_2$ that N_3V_2	75%*	3%	7%	4%	19%	35%*
IS	$N_1V_1N_2$ that V_2N_3	62%*	25%	7%	47%*	6%	5%
IO	$N_1V_1N_2$ that N_3V_2	61%*	14%	4%	14%	18%	45%*
II	$N_1V_1N_2$ that N_3V_2	68%*	10%	6%	9%	12%	39%*

[a]An asterisk indicates a correct response.

for the SS sentence. Ideally, each row should add up to 200% since two responses are required for each sentence; however, because not all children made two responses, the row totals are always less than 200%.

Consider first the right-branching sentences OS, OO, OI, IS, IO, and II, as well as the center-embedded SS. All have an initial NVN (noun verb noun) sequence, where the correct response is 1–2. There are three points worth mentioning. First, correct performance of this initial NVN sequence is remarkably high (61–75%). Second, NVN sequences involving verbs taking indirect objects (IS, IO, II) are somewhat lower than those taking direct objects (SS, OS, OO, OI). And, third, despite the fact that the NVN sequence in SS sentences is interrupted by the relative pronoun "that," as many children responded correctly on this item as in the others where NVN is uninterrupted. This means that comprehension of an initial NVN sequence is good regardless of whether it is contained in a subordinate clause or in a main clause.

The sequence of constituents for OS and IS sentences is $N_1V_1N_2$ that V_2N_3 and for SS is N_1 that $V_1N_2V_2N_3$. We just saw that performance was high for the initial $N_1V_1N_2$. How do children interpret the remaining V_2N_3 sequence? It might be regarded as a situation in which children had to make a choice for a noun to be the agent of this action, and there are two possibilities, N_1 or N_2. For SS, N_1 would be the correct choice, whereas, for OS and IS, N_2 is correct. The results show that, for SS, 46% of the children responded with N_1 as agent (1–3) and 32% with N_2 (2–3). For OS, 39% of the children responded with N_2 as the agent (2–3), while 36% erroneously responded with N_1 (1–3). For IS the respective percentages were 47% and 25%.

For OO, OI, IO, and II, the sequence is $N_1V_1N_2$ that N_3V_2. Here again, the initial $N_1V_1N_2$ was interpreted correctly by a large proportion of the children. The remaining N_3V_2 sequence presents the problem of finding an appropriate direct or indirect object. The choice is between N_1 and N_2; N_2 leads to the correct response, N_1 results in an error. For OO, 43% chose N_2 (3–2) while 28% chose N_1 (3–1); for OI, 35% and 19%; for IO, 45% and 18%; for II, 39% and 12%, respectively.

In sum, the analysis thus far reveals that for these sentences most children tended to interpret the initial $N_1V_1N_2$ sequence correctly. It also suggests that for the second action the difficulty was in finding the missing constituent for the remaining sequence, either V_2N_3 or N_3V_2. This interpretation is supported by the fact that the children tended to correctly interpret the sequence (either VN or NV) that was supplied in the sentence, which is to say that when VN was supplied (SS, OS, IS) the children generally responded with the correct verb and object, and when NV was supplied (OO, OI, IO, II) they responded with the correct subject and verb. Although this should be clear from the analysis above, it is particularly striking when we restrict our analysis to those children who correctly interpreted the initial NVN sequence (1–2) and performed the second action. For the sentences ending with VN (SS, OS, IS), 90% correctly acted out the action-object part of the response (either 1–3 or 2–3). For those ending with NV (OO, OI, IO, II), 83% correctly acted out the agent-action part of the response (either 3–1 or 3–2). The result indicates that the children were highly responsive to the order in which words were presented.

In contrast to the above sentences, SO and SI take the configuration N_1 that $N_2V_1V_2N_3$ and do not have an initial NVN sequence on which children might capitalize. Notice that there is a sequence $N_2V_1V_2N_3$, which might be interpreted as an agent-action-object sequence, but it would lead to an erroneous response (2–3); 46% of the children for SO and 36% for SI made this error. The lack of an initial NVN sequence combined with a deceptive NVN sequence seems to have contributed to an overall poor performance of the SO and SI sentences.

The parallel function hypothesis predicts that sentences containing relative clauses where the role of the head noun in the relative clause matches the role of the complex noun phrase within the sentence (embeddedness) would be easiest. The corollary in terms of errors would be that in sentences where the two functions do not match, the child would change either of the two in order to match the other. Predictions for errors under this hypothesis can only be made in terms of two responses

per sentence. For SO and SI the predicted errors are 1–2 1–3 or 2–1 3–1; for OS and IS, 1–2 3–2 or 2–1 2–3. Table V presents the percentage of children who made these responses consistent with parallel function. The only response which occurred with some frequency was 1–2 1–3 for SO (13%), but this prediction is confounded with the previous analysis consistent with the strategy hypothesis. Otherwise, parallel function accounts for a very small percentage of the responses made by the children.

One consequence of the procedure that we used is that the relative clauses have to be nonrestrictive. In most relative clause sentences, one of the propositions is subordinate to the main proposition, as in "The man who wore a blue hat shot the policeman." In such a sentence, the relative clause serves to restrict the possible reference class for "the man." In the nonrestrictive relative clause, the propositions have equal value, one being an incidental comment marked by punctuation: "The man, who wore a blue hat, shot the policeman." The latter type is much closer to a simple conjunction with "and." The limitation of the act-out procedure is that the child is required to act out both propositions, rather than having the subordinate clause restrict the choice of referent for the main clause. In fact, no child consistently acted out the relative clause first, suggesting that they were treating the clauses as equal propositions. The question can be raised as to whether the children's performance could be explained by assuming they were interpreting the sentences as "and" conjunctions, as proposed by Tavakolian (1975). Our error analysis suggests that children were more prone to ignore the syntactic marker for embedding in their search for NVN sequences than they were to interpret "that" as meaning "and."

Table V. Percentage of Errors Across All Ages Consistent with the Parellel Function Hypothesis

Sentence	Role of head noun changed			Role of complex noun phrase changed		
SO	1–2	1–3	13%	2–1	3–1	1%
SI	1–2	1–3	4%	2–1	3–1	2%
OS	1–2	3–2	6%	2–1	2–3	4%
IS	1–2	3–2	1%	2–1	2–3	2%

DISCUSSION

In the introduction we set up several alternative theories of relative clause comprehension by young children. The results of our own study indicate that the processing heuristic hypothesis is superior in accounting for both the relative difficulty of the sentences used and the types of errors the children made. The parallel function hypothesis of Sheldon did not fare so well with the present data.

It is necessary at this point to examine critically the strategies that were proposed to see if they have more general usefulness than solely in the understanding of relative clauses. Consider first the NVN strategy. It has widespread utility in dealing with simple active declarative sentences, and its overapplication by children to passive constructions has been extensively documented (e.g., Bever, 1970; Sinclair et al., 1971; de Villiers and de Villiers, 1973).

The minimal distance principle (MDP) proposed by Smith deserves further examination. The term was originally used by Rosenbaum in 1965 as a principle for determining the deletion of subjects in the surface structure of embedded sentences in complement constructions, by counting the number of phrase structure nodes separating noun and verb. Chomsky (1969) borrowed the term in studying agent assignation, i.e., the recognition of semantic relations in complementizers of the sort "Bill asked Mary to leave." She argued convincingly that children between the ages of 5 and 10 years overapply a minimal distance principle which assumes that the noun most closely preceding the complement verb is the agent of that verb. This leads to correct interpretation of the above sentence but an error in interpreting a sentence like "Bill promised Mary to leave."

In contrast, Smith's MDP is not concerned with complementizers but with syntactically marked relative clauses, and seems to be a considerably weaker principle. In fact, it reduces to a more limited version of the NVN strategy, namely that the noun most closely preceding a verb will be treated as the agent of that verb. We have shown evidence from the errors children make that this is a common assumption, as is the treatment of a VN sequence as action-object. It appears that isolated portions of the NVN sequence also cohere into meaningful semantic relations for children in this age range. This is not a new finding, for Sinclair and Bronckart (1972) reported an extensive study of children's interpretation of all possible orderings of two nouns and a verb

in which both strategies were quite frequent. We do not, therefore, see the need to invoke a special minimal distance principle, with its own theoretical and empirical history, to account for the present results or those of Smith.

The above strategies have wider utility than in interpreting relative clause constructions. They are evidently heuristics which depend on the surface structure regularities of particular languages and hence would not be expected in children whose languages have different surface regularities. Yet Keenan and Comrie proposed a universal hierarchy of accessibility of noun phrases which must, therefore, be independent of the particular surface forms for relative clause constructions. The present data for English children provide some support for this hierarchy, and future research should determine how far down the hierarchy the parallel extends. In general, sentences involving a head noun in subject role were easier than those where the head noun was an object, and both these were easier than the sentences in which the head noun was an indirect object. By studying languages other than English, it may be possible to determine whether this principle holds true irrespective of the surface changes in the language.

There are currently being developed some sophisticated models of adult language processing such as augmented transition networks (Wanner et al., 1974). The principal aim of these models is to describe the actual processes adults go through in interpreting complex sentences as they receive them in a linear left-to-right manner. It would be advantageous to know more about the strategies children use for decoding sentences, not just for bridging the gap to the adult models but also for more practical applications, such as studying the reading process and how to optimize it. The present study is one attempt to provide data for such a model. However, we recognize that the model deals only with comprehension, and there is a serious lack of information about the planning and production of complex sentences by children. The few studies that have been reported on relative clause production under natural circumstances agree that the first relative clauses produced are right-branching—in other words, elaborating the object (Menyuk, 1969; Limber, 1973). It is not clear to what extent this is an artifact of the opportunities provided by natural environments, for many researchers have reported that children's sentence subjects are relatively impoverished (Brown et al., 1969; Limber, 1973). Before it is possible to conclude anything about the generality of the present results to other

performances, it is necessary to develop a goood elicitation technique for all the varieties of relative clause constructions.

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