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DECIDING AMONG THEORIES OF THE DEVELOPMENT OF COORDINATION IN CHILD SPEECH[1]

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The research reported in this paper is on the development of sentence coordination in children. At the moment, our focus is on sentences conjoined by "and", based on the consideration that these sentences are the first forms of coordination to appear in child speech. The motivation underlying the studies reported here has been to test the adequacy of the transformationally-based derivational theory of complexity as an account of the acquisition of coordination.

Chomsky (1965) proposed that the deep structure of a coordinated sentence contains both propositions in full. In sentential coordinations, for example,

(1) The linguist saw the light and the linguist wrote a grammar.

all information present in the deep structure is also contained in the surface form. Phrasal coordinations, for example,

(2) The linguist saw the light and wrote a grammar.

share the same deep structure as sentence (1), but a deletion transformation has been applied, resulting in the contracted surface structure. Ross (1967) specified an additional constraint on the conjunction reduction transformation, namely the direction of deletion. If the identical elements are on left branches of the deep structure configuration, as in the above example, deletion is forward; if they are on right branches, deletion is backward. Thus,

(3) The psychologist understood the sentence and the linguist understood the sentence.

becomes:

(4) The psychologist and the linguist understood the sentence.

In this case deletion operates on the first occurence of the redundant element in the surface form.

There have since been additional linguistic modifications which argue that backward deletion is derived from forward deletion with a regrouping of the constituents and that forward deletion is the universal conjunction-reduction transformation (e.g. Harries, 1973).

The derivational theory of complexity, based on the above transformational arguments, makes at least two predictions with respect to the development of coordination in children. One prediction is that sentential coordinations should be acquired earlier and be easier to process than phrasal coordinations, since they do not require a deletion transformation, and so they are derivationally less complex. The second prediction is that forward coordinations should also be acquired earlier and be easier to process than backward forms, since the latter require a regrouping rule in addition to deletion.

The most complete acquisition research to date comes from experiments using elicited imitation as the methodological tool, (e.g. Slobin and

Welsh, 1971; Lust, 1974). The data collected fit the transformational model, with performance on sentential coordinations superior to that on the corresponding phrasal forms. Furthermore, the error data indicate the primacy of forward over backward coordinations.

Our research was designed to replicate and extend the acquisition data to other performance measures. In this paper, we briefly report on two experiments that have been completed, one on the imitation and the other on comprehension of coordinated sentences. Then we will turn to the analysis of spontaneous speech samples obtained from Adam, Eve, and Sarah. Finally we will report on some pilot data using an elicited production task.

The two cross-sectional experiments, both using the same set of eighteen sentence types, were conducted with children between the ages of three and five. One experiment used an elicited imitation procedure, the other, an act-out comprehension procedure.

All the sentences were of the basic SVO+SVO syntactic structure exhausting all the permissible well-formed forward, backward, sentential and phrasal coordinations, (See Table 1 for an example of a set used in the imitation experiment). The sentences in the imitation experiment were all irreversible, while those used in the comprehension experiment were reversible to increase the difficulty of the task.

Responses from both experimental tasks were scored as either correct or incorrect depending whether or not meaning was preserved. We tested the data from both experiments for a difference between sentential and phrasal coordinations. Using White's modification of the Mann Whitney test, there were no significant differences at $p=0.05$ in the number of correct responses to sentential or phrasal forms at any age level in either comprehension or imitation. Similarly there were no significant differences ($p=0.05$) between forward and backward sentences in either experiment, for any age level. However the children made sufficient errors in both tasks so that these results cannot be discounted as a ceiling effect.

In other words these results from the comprehension and imitation experiments do not support the predictions based on the derivational theory of complexity, that is, sentential coordinations were no easier than phrasal coordinations and furthermore, forward forms were not easier than backward forms.

A second analysis was carried out on the data from the imitation experiment. In this analysis, we scored the responses for elaborations and reductions, where an elaboration would be a response which included constituents that had been deleted in the surface structure of the model sentence. For example, given the model sentence:

(5) Anthony and Melanie cooked a hotdog.

many children responded:

(6) Anthony cooked a hotdog and Melanie cooked a hotdog.

A reduction would be a response with elements deleted that were present in the model sentence. For example:

(7) Rosy flies a kite and Rosy flies a plane.

was often repeated as:

(8) Rosy flies a kite and a plane.

An examination of the number of elaboration and reduction responses revealed a strong age effect. There appeared to be a flowering of both elaborations and reductions at four years of age, across all sentence types. Using White's modified Mann Whitney test, there were significantly more elaborations and reductions in the four-year-olds than in either of the two other age groups, $p < 0.05$. We will return to the implication of these findings later in the discussion.

In themselves, the results from the imitation and comprehension experiments give few clues about the development of coordination in child speech. For this reason we turned to a third source of acquisition data, namely the spontaneous speech protocols from the longitudinal study of Adam, Eve, and Sarah.

The analysis of the speech from Adam, Eve, and Sarah, was carried out separately for each child. From the protocols every utterance with an "and" coordination that was non-temporal was noted, up to the point where the mean length of utterance was 4.25, which is the beginning of Stage V. From this complete set, all examples of phrasal coordinations and sentential coordinations with redundant elements were extracted and categorized into four groups: forward and backward phrasals, and forward and backward sententials. Incidentally, it is of interest that the very earliest forms of coordination to appear in the speech of all three children were simply Noun + Noun sequences, for example:

(9) Mommy and teddy.

It is difficult to imagine that these might be derived from conjoined sentences.

For each monthly time period we plotted the proportion of each of the four types of coordination classified above, relative to the total number of coordinations produced during that month. Thus for each child we have a graph depicting the developmental progression of the production of the four sentence types, and the degree to which each category dominates at different points during the acquisition of coordination. Figures 1 and 2 show the graphs from Eve and Sarah respectively.

The most striking feature of the graphs is the almost exclusive use of forward phrasal forms during the early samples. Sentential coordinations do not appear until relatively late, midway through Stage IV, where the mean length of utterance is around 3.80.

Incidentally, we also found sentential coordinations in the transcripts, that consist of two conjoined propositions but nevertheless have no potential for deletion since they do not contain any identical elements. These include sentences such as,

(10) You snap and he comes.

(11) We went to Foxboro and there were slides.

These sentential forms were also not evident in the protocols until the sentential forms with potential deletion began appearing in the speech of the children.

In the graphs of Eve and Sarah, notice also the large difference between the relative proportions of the forward and backward coordinations. Backward phrasal and sentential coordinations make up only a very small percentage of the total forms used by all three children. However, this does not necessarily mean that they are acquired later: rather, it may indicate a lack of opportunity in discourse to use backward coordinations as they generally involve coordinated subjects, and in child speech, subjects are typically absent or very simple, such as a pronoun. Within the backward forms, we again find, as in the forward forms, that phrasals appear earlier than sentential forms.

The major conclusion to draw from the spontaneous speech data is that phrasal coordinations appear earlier than the corresponding sentential forms, and furthermore that forward forms are more frequent than backward forms.

Given that the derivational theory of complexity does not predict the pattern of development of coordination, we have been looking at the input to see whether this might tell us something about the process of acquisition. So far, we have looked at the input provided by Eve's mother. We categorized her coordinations in the same way as we did for the children, and the graph of Eve's mother's relative proportions for each coordination type is in Figure 3.

The most striking feature of the graph is the almost uncanny way in which it parallels Eve's graph (Figure 1). The most obvious possibility, and perhaps the most uninteresting, is that either Eve was simply mimicking her mother's sentences, or that her mother was glossing Eve's sentences, and hence the proportions would be identical for this very simple reason. The samples were checked to see if the content of the coordinated sentences matched for Eve and her mother, but we found no evidence that the parallel was an artifact of this matching.

Two other possibilities are either that the relative proportions of coordinations in Eve's mother's speech reflect those of Eve, or vice versa, that is to say, that Eve is responding to the changes in her mother's relative frequency of coordination types. At present we have no way of distinguishing between these two possibilities. Perhaps a clearer picture of development will emerge when we look at the maternal input to Adam and Sarah.

Incidentally, our analysis is consistent with other input studies like that of Catherine Snow, in that we find that Eve's mother is somehow responding either to her child's earliest uses of coordination, or at least to her child's "readiness" to acquire coordination, with a sudden increase of those forms in her own speech. Table 2 displays the number of co-ordinations produced by Eve and her mother over time, summed across the four types of coordinations. At sample 13-14 both Eve and her mother show a sudden increase in the use of coordination in their speech.

One of the problems with spontaneous speech data is that there is no way to control the different kinds of sentences that the children produce. For example, as mentioned earlier, we found only a small number

of backward coordinations in the total sample. This might indicate a lack of opportunity in discourse for their use, or on the other hand, it might be the case that they in fact pose some kind of processing or planning difficulty in production which the child avoids by resorting to using a completely different grammatical construction.

One way to tease apart these alternative explanations is to use an elicited production task whereby the experimenter controls, to some degree at least, the different sentence types. This can be done by equalizing the opportunities for backward and forward coordinations. We have done this by having an equal number of pictures with multiple subjects and objects in an elicited production task, where children were asked to describe the pictures presented to them in a portable slide viewer. There were eight test slides, four of which contained multiple subjects and four of which contained multiple objects. To give an example of each, one of the slides with multiple subjects was a giraffe and an elephant drinking water. An example of multiple objects was a gorilla eating a banana and an apple. We have been piloting this elicited production technique with three- and four-year-old children.

From the complete set of utterances obtained, we extracted all examples of coordinations and classified them into the following categories:

Noun + noun sequences,	(N)
Sentential coordinations without potential deletion,	(S)
Forward phrasals,	(FP)
Forward sententials,	(FS)
Backward phrasals,	(BP)
Backward sententials.	(BS)

Table 3 shows the proportion of each type of coordination classified as above, relative to the total number of coordinations for each age group. One striking feature of the data is the success of this task in eliciting coordinations in young children. In both age groups the average number of coordinations produced by each child is approximately 7-8; however the different ways they are distributed over the various categories illustrates the developmental changes that take place during the age period under consideration. Specifically, while the percentage of Noun + noun sequences decreases dramatically from 50% to 16%, the percentage of backward phrasals increases from 5% to 28%. There is also a somewhat smaller increase in the percentage of forward phrasals from 24% to 39%.

In contrast, the overall percentage of sentential coordinations (backward sententials, and sententials without potential deletion) remains very low - 21% for the three-year-olds, and 14% for the four-year-olds. Surprisingly, perhaps, there is not one example of a forward sentential coordination among the total of 185 collected.

What light do these results shed on the acquisition of coordination? Essentially the data confirm the findings in our other studies on co-

ordination, namely that sentential coordinations are not developmentally prior to phrasal coordinations. As we saw in the spontaneous speech of Adam, Eve, and Sarah, the child progresses from producing noun + noun sequences immediately to a stage where these sequences are slotted into phrasal coordinations. There does not appear to be an intermediate stage of producing sentential coordinations which would be predicted by the derivational theory of complexity.

On the other hand the results of this study do support the argument that forward forms are easier for the younger children (i.e. more readily produced) than backward forms. The children in the elicited production study seem to be avoiding the use of backward coordinations, instead stringing together or listing the objects and/or animals present in the picture. It is not that they are not capable of forming a description containing a coordinated sentence since they are doing so for the pictures demanding forward coordination. Rather we think this avoidance of backward coordinations represents a planning difficulty. Backward phrasal coordinations generally involve compound subjects, which must be planned in advance to place at the beginning of a sentence. The planning difficulty interpretation is supported by the asymmetry between the results of the elicited production task and the results of the comprehension test reported earlier, where in the latter we found no evidence for the primacy of forward forms over backward forms. We certainly would not expect a planning difficulty for the backward forms in comprehension.

To summarize, from the data we have collected so far, we conclude that the ontogenesis of coordination is not well described by the derivational theory of complexity. The results from the imitation and comprehension experiments do not show a primacy of sentential over phrasal forms. The spontaneous speech data show that the earlier forms of coordination to appear in children are phrasal forms. The forward forms enjoy a primacy over the backward forms in both the spontaneous speech and elicited production data, but not in the comprehension and imitation data. We have suggested that this asymmetry is due to a planning difficulty for the backward forms.

One intriguing possibility is that a reorganization takes place at around age four. The claim is not necessarily that phrasals at this point become derived from sentential forms, but rather that the child recognizes the equivalence of the two, and in fact often confuses them in memory. Our evidence for such a reorganization comes from two sources.

First, recall that in the discussion of the results of the imitation experiment we pointed out the significant increase in the four-year-olds in the amount of elaboration and reduction responses. Children at this age are evidently confused about whether the model sentence was presented in phrasal or sentential form.

Second, in the analysis of the spontaneous speech data, we found that sentential forms with and without potentially deletable elements appear at approximately the same time, thus allowing for the possibility that one serves as the model for the other. Moreover the point at which these

forms emerge is very similar for the three children: for Adam MLU = 3.82; for Eve MLU = 3.85; and for Sarah MLU = 3.73. Chronologically, this is at about the same age that we obtained the flowering of elaborations and reductions in the elicited imitation experiment.

References

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Footnotes

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TABLE 1. Examples of different coordination types, taken from the elicited imitation study, constructed for the cross-sectional studies.

1.	Jim writes a letter and Jim writes a letter.	
2.	John ate a cookie and George rode a donkey.	
3.	Barry pushed a train and Barry pulled a truck.	FOR. SENT.
4.	Paula climbed a tree and Sally climbed a fence.	FOR. SENT.
5.	Rosy flies a kite and Rosy flies a plane.	FOR. SENT.
6.	Sammy wiped the floor and Billy swept the floor.	BACK. SENT.
7.	Judy sent a note and Philip sent a note.	BACK. SENT.
8.	Roger washed a cup and Roger dropped a cup.	FOR. & BACK. SENT.
9.	Joey played the piano and beat the drum.	FOR. PHRAS.
10.	Bobby drank the milk and Jane the lemonade.	FOR. PHRAS.
11.	Susy bought a necklace and bought a bracelet.	FOR. PHRAS.
12.	Marion chased the rabbit and the hamster.	FOR. PHRAS.
13.	Hilary made and Laurie wrapped a sandwich.	BACK. PHRAS.
14.	Charlie fixed and Tommy fixed the cabinet.	BACK. PHRAS.
15.	Anthony and Melanie cooked a hot dog.	BACK. PHRAS.
16.	Mickey rode and Mickey fed an elephant.	FOR. & BACK. PHRAS.
17.	Steven chased the balloon and hit the balloon.	FOR. & BACK. PHRAS.
18.	Benjamin painted and drove a motorboat.	FOR. & BACK. PHRAS.

FIGURE 1. Proportion of different coordination types over time (Eve).

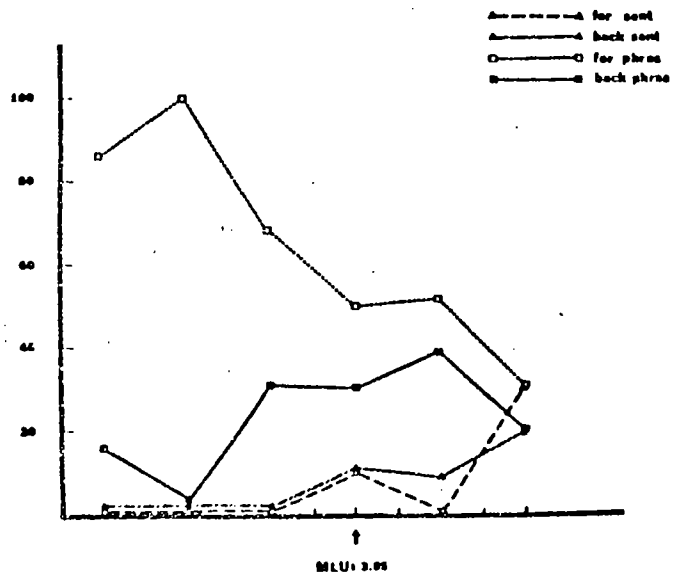

FIGURE 2. Proportion of different coordination types over time (Sarah).

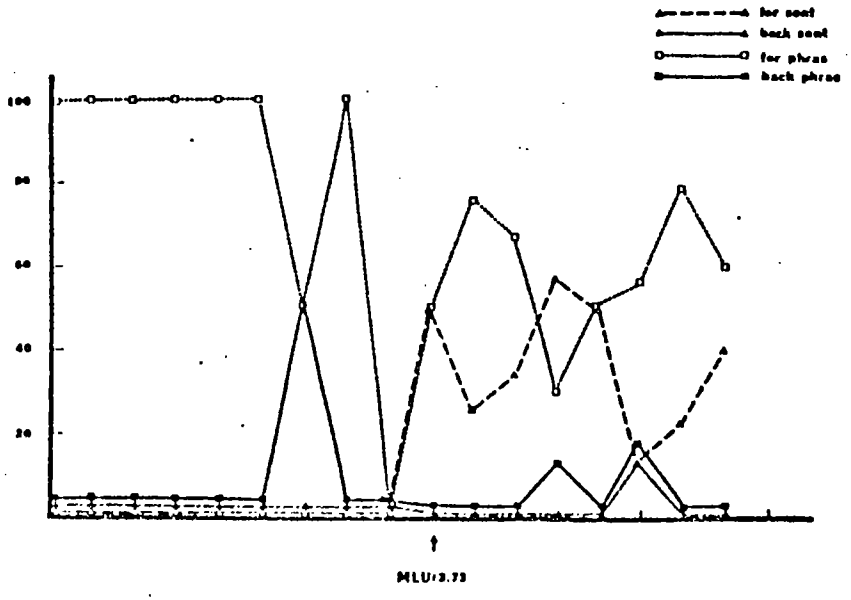

FIGURE 3. Proportion of different coordination types over time (Eve's mother).

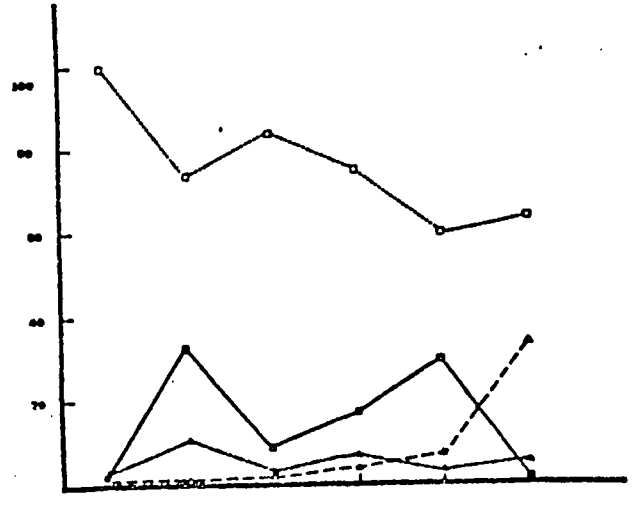

TABLE 2. Total number of coordinations, across the four types, in the protocols of Eve and her mother.

SAMPLE	EVE	EVE'S MOTHER
7-8	0	2
9-10	6	1
11-12	1	9
13-14	16	32
15-16	30	29
17-18	23	30
19-20	10	21

TABLE 3. Relative percentages used in the elicited production task, of the different coordination types.

Age	N	S	FP	FS	BP	BS
3	50%	12%	24%	0%	5%	9%
4	16%	9%	39%	0%	25%	5%