creasing percentage of such signs is associated with increasingly high or low pressure readings. The lowest percentage of subjects showing signs of the onset of sleep in sample 2 has a higher barometric pressure reading than the lowest percentage in sample 1. Furthermore, the mean barometric pressure is higher for sample 2 than for sample 1.

The simplest interpretation of these data would appear to be that changes in barometric pressure away from the prevailing pressure are associated with sleep tendencies. This is to say that the occurrence of either high or low barometric pressures relative to the usual (average) pressure results in an increased tendency to sleep. This interpretation has its strongest support from the shift of the lowest sleep response with a shift of prevailing pressure in the two samples.

The results are quite different from those of Raboutet, Lesèvre, and Rémond who report a decreased tendency to sleep with increasing barometric pressure. The results were as follows (milibars of mercury, percentage showing signs of sleep, number in each group, respectively): 970 to 999 milibars = 27 percent (121); 1000 to 1019 milibars = 17 percent (467); 1020 to 1030 milibars = 5 percent (54). It should be pointed out that their study was based upon the relationship between signs of sleep on an EEG and a single barometric pressure reading taken at noon of the examination date.

WILSE B. WEBB
Department of Psychology, University of Florida, Gainsville
HARLOW ADES
U.S. Naval School of Aviation Medicine, Pensacola, Florida

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Children's Language: Word-Phrase Relationship

Abstract. *Unsystematic observations indicated that small children who could reverse the order of certain two-unit utterances had difficulty reversing utterances that formed common English sequences. Findings of this study indicate that the following factors are sources of difficulty in reversing pairs: (i) inability to separate English sequences into word units, and (ii) semantic absurdity of reversed pairs.*

A recent discussion of children's speech asserts that "the child's first two-word utterances are usually predicative statements painfully pieced together, with the words juxtaposed rather than connected" (*1*). This view suggests that the acquisition of language involves progressive addition of separate words into phrases and sentences. An opposing view suggests that the first multiple word utterances are learned as single units and only later differentiated into separate words. It has generally been assumed that children of 4 or 5 years of age who speak fluently can differentiate single words from multiple-word utterances. The demonstration that children have a tendency to define a single unknown word in terms of the entire context in which it occurs suggests, however, that each word is not endowed with a distinct meaning (*2*). A recent Russian study cited by Ervin and Miller (*3*) reports that children who are asked to indicate the words in a sentence pick units longer than single words. The results of the experiment described here provide more direct evidence that preschool children have difficulty in dividing common word sequences into separate words.

The experiment was designed to determine the reliability of the following observation and to investigate its sources: pairs of digits were read to children and they were taught to say them in reverse order. This skill, easily acquired by most children between 4 and 5 years of age, could be transferred to pairs of letters and pairs of nouns. But when commonly encountered "grammatical pairs" for example, ("he went" or "pretty doll") were presented, these children had great difficulty in reversing them.

A group of children was set the task of reversing pairs in each of five different categories. Difficulty of two types of "nongrammatical pairs"—(i) letters and numbers, and (ii) like parts of speech—was compared with that of three types of grammatical pairs: (iii) commonly encountered pairs that did not form a grammatical sequence when reversed, (iv) commonly encountered pairs that did form a grammatical sequence when reversed, and (v) anomalous pairs not commonly encountered (Table 1). Grammatical pairs were divided into these separate categories to permit further specification of sources of difficulty. Comparison of categories iii and iv made it possible to determine whether absurdity of solutions was a source of difficulty. Comparison of category v with categories iii and iv made it possible to determine whether all grammatical pairs were difficult, or only common English sequences.

The ability to separate the items making up a pair is prerequisite for reversing their order. That is, if one did not know where the first item ended and the second began, it would not be possible to say the second one first. In order to determine the extent to which difficulty of reversal results from inability to separate items, a second group of subjects was included. These subjects dealt with the same 15 pairs as the first group. Their task, rather than reversing the order of items in a pair, was to repeat the first item and await a tap before giving the second item (*4*).

Sixty-six children between the ages of 4½ and 5 years were included in the experiment, 33 in each group. Children were randomly assigned to one of the two groups. The 15 pairs of items were randomly ordered for each subject. Each subject was tested alone. A pair was presented, and, if the correct response was given, the experimenter said "fine" and continued with the next pair. If there was an incorrect response or no response in 20 seconds, the experimenter gave the answer: for group 1, saying the items in reverse order; for group 2, saying the first item, tapping, and then saying the final item.

Thirteen children in group 1 and ten children in group 2 were unable to do any pairs; three children in group 1 and four children in group 2 could do all

Table 1. Pairs of items in each of the five categories described in the text.

Category	Pairs
i	5–2; D–S; 3–7
ii	black–white; child–lady; foot–hand
iii	man–runs; red–apple; she–went
iv	I–do; you–are; it–is
v	table–goes; house–did; orange–cow

Table 2. Proportion of errors in each of the five categories.

Category	Group 1	Group 2
i	0.20	0.14
ii	.12	.14
iii	.47	.30
iv	.53	.49
v	.25	.18

pairs. Consideration of the relative difficulty of the different types of pairs was restricted to those subjects who had at least one pair correct and at least one error. The proportions of errors for the different categories in Table 2 were therefore based on 17 subjects for group 1 and 19 subjects for group 2. A separate Friedman two-way analysis of variance by ranks was done for each group. Differences between categories were highly significant in each case. Chi square for group 1 was 320 and for group 2 it was 353. Significance at .001 in each case required a chi square of only 18.5.

As in the observations that led to this experiment, group 1 had more difficulty reversing common English sequences than other pairs; the proportions of items missed in categories iii and iv were far greater than in categories i and ii. The anomalous pairs in category v, however, were not much more difficult than pairs in categories i and ii. Thus, the fact that a pair forms a grammatical sequence seems to contribute relatively little to its difficulty if it is not a common English sequence. From a consideration of group 1 alone, it would appear that the absurdity of a pair when reversed does not contribute to its difficulty; pairs that were grammatical when reversed (category iv) seemed about as difficult as those that were not (category iii). As we shall see, this conclusion is unjustified when group 2 is also considered.

In group 2, as in group 1, greatest difficulty was encountered in categories iii and iv. The proportion of items missed in categories i and ii was much lower. As in group 1, anomalous pairs were almost as easy as those in categories i and ii.

The similarity in pattern of error in groups 1 and 2 suggests that the ability to separate items in a pair is of primary importance in the ability to reverse them. In addition, it should be recalled that the number of complete failures and complete successes was very similar in the two groups. Further evidence of the overlap of the abilities to separate items and to reverse them was obtained by testing the 23 failures on the other task 1 week later. Of the 13 children who failed in group 1, two were able to do the task of group 2. Of the ten children who failed in group 2, one was able to do the task of group 1. All of these measures indicate that the task set group 2 was slightly easier than that set group 1. This would be expected, since reversal of pairs is an additional operation after separation of the items in a pair.

Only in category iii was reversal far more difficult than separation of items. This is the category in which group 1 had to transform common English sequences into absurd pairs. Thus absurdity of the resultant pair also seems to be a factor in the difficulty of reversing the order of items.

The experiment was not designed to distinguish the relative difficulty of separating different English sequences into their component words. It would be expected, however, that difficulty would vary in different sequences, and in fact, categories iii and iv were not equivalent. Very small children are taught certain words singly, particularly object names. Even certain verbs and adjectives may be taught separately. On the other hand, certain words are probably rarely used in isolation; examples would be forms of the verb "to be," and personal pronouns. The confusion of the small child as to exactly what is a single word might be expected to be greatest with sequences made up of words that have not been used in isolation. The attempt to find pairs that were grammatical when reversed (category iv) led to exclusive use of such words, and this could account for the fact that these were more difficult to separate than pairs in category iii.

JANELLEN HUTTENLOCHER
Center for Cognitive Studies,
Harvard University,
Cambridge 38, Massachusetts

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4. The crucial suggestion to include this group was made by George A. Miller.
5. Supported in part by grant No. MH 05120-03 from the National Institutes of Health to Harvard University, Center for Cognitive Studies, and in part by grant No. MH 06626-02 from the National Institutes of Health.

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Student Performance in New High School Biology Programs

Abstract. *Data on the effectiveness of the Biological Sciences Curriculum Study course were obtained from several sources, including experimental use with 65,000 students. Any of the three versions of this biology course can be taught to average and above-average 10th-grade students. Achievement on the associated comprehensive test is more closely related to the ability and sex of the student, the salary of the teacher, the proportion of graduates of the school who go to college, the size of the class, and the adequacy of laboratory facilities than to the version of the course.*

The Biological Sciences Curriculum Study (BSCS) High School Biology Blue, Green, and Yellow Versions are parallel 1-year courses intended for use with average and above-average 10th-grade biology students in American schools. These versions were developed and written over a 4-year period by more than 100 outstanding research biologists and high school biology teachers organized into writing teams (*1*). Each version includes text, laboratory manual, and teachers' guide for a balanced first course in high school biology. While all versions include the same nine basic themes, each has different emphases on the various topics of biology. Preliminary editions of each of the versions were written in the summer of 1960 and were used experimentally as a complete course in 1960–61 by 118 teachers with 14,000 students; the materials used for making the texts, manuals, and guides were revised in the summer of 1962 and were tested by 350 teachers with 52,000 students in 1961–62, prior to writing a final edition.

The evaluation made in 1960–61 was in the nature of a "feasibility" study, to determine whether the material included the proper topics to be taught to high school biology students and whether these were useful for teaching basic biologic concepts. The evaluation was derived from reviews by specialists, reports from BSCS experimental students, visits of observers to schools, and performance of students on new BSCS tests. The evidence indicated that the content and grade of the materials were appropriate although considerable revision was needed (*2*).

In 1961–62 the same type of evalua-