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ABSTRACT

Previous research used a picture-word interference task to show that skilled and less skilled comprehenders in the third and fifth grades could retrieve the meaning of primer-level words equally well. With a similar task and comparable groups of children this study assessed the relationship between word difficulty and semantic access by using both the essay words and a new set of harder words. Retrieval of the meaning of these hard words was least apparent for the less skilled third graders, the group that had the most difficulty decoding these words. These results indicate that decoding ease and extraction of word meanings are related, and suggest that decoding ability must be considered a factor in reading comprehension. (Author)

The Relationship between Word Difficulty and Access of Single-word Meaning by Skilled and Less Skilled Readers

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Abstract

Previous research used a picture-word interference task to show that skilled and less skilled comprehenders in the third and fifth grades could retrieve the meaning of primer-level words equally well. With a similar task and comparable groups of children, this study assessed the relationship between word difficulty and semantic access by using both the easy words and a new set of harder words. Retrieval of the meaning of these hard words was least apparent for the less skilled third graders, the group that had the most difficulty decoding these words. These results indicate that decoding ease and extraction of word meanings are related, and suggest that decoding ability must be considered a factor in reading comprehension.

The Relationship between Word Difficulty and Access of Single-word Meaning

by Skilled and Less Skilled Readers

An important issue in research in reading comprehension is the complex relationship between decoding and comprehension. Decoding is defined here as a process of recognizing a written representation of a word and comprehension as the extraction of meaning from printed text (Gibson and Levin, 1975). One way to investigate this relationship is to see whether skilled and less skilled comprehenders differ on decoding or other word recognition tasks (Golinkoff, in press). For example, as early as 1920, Buswell noted that skilled comprehenders had better decoding skills than less skilled comprehenders. More recently, Katz and Wicklund (1971, 1972) found that, although good and poor comprehenders did not differ on a letter-scanning task, the skilled group was faster on a word-scanning task, a result which suggests that certain words may be more familiar to skilled than to less skilled comprehenders. Perfetti and Hogaboam (1975) offer evidence that skilled comprehenders may, in fact, have more "automatic control over decoding" than less skilled comprehenders. Such findings indicate that skilled comprehenders may have mastered basic word recognition or decoding processes more successfully than have less skilled comprehenders.

Cromer (1970), however, has claimed that at least some problems in comprehension are independent of decoding ability and result from failure to organize reading material into meaningful phrases. Other reading theorists argue that accurate word identification is not even necessary for the comprehension of text (Goodman, 1967, 1973, 1975; Smith, 1971, 1973, 1975). Indeed, Smith (1973, p. 59) asserts that word identification may occur as a "by-product of comprehension," in that it may follow rather than precede the extraction of meaning from the printed page. However, Goodman and Smith seem to base their claims on an analysis of the behavior of the skilled reader and may be underestimating the importance of accurate word identification in comprehension. The skilled reader may not need to recognize each successive word in text but probably can do so. The very ability to make use of the graphic, syntactic, and semantic redundancies in text, as Gibson and Levin (1975) suggest, may depend on decoding skills having reached that level of "automaticity" (LaBerge and Samuels, 1974) where they no longer require the attention of the reader. LaBerge and Samuels proposed that the reader who has mastered component subskills of reading may decode visual information automatically and thus may be able to concentrate attention on retrieving meaning. This does not imply that automatic decoding is a sufficient condition for comprehension of text, only, probably, a necessary one.

The present experiment was designed to examine one aspect of the relationship between decoding and comprehension - that between word difficulty, decoding ability, and access of single-word meanings. The ability to extract meaning from single printed words, a critical component of reading comprehension, was investigated by Rosinski, Golinkoff, and Kukish (1975). With a task designed to measure semantic interference, Rosinski et al. demonstrated that even second-grade children could extract the meaning of printed words easily, if not automatically. Students at two grade levels (second and sixth) and adults took longer to name pictures when non-matching primer words were superimposed on them then when nonsense trigrams appeared on the pictures. Thus, Rosinski et al. concluded that a significant portion of the interference effect was produced by the meaning of the real words which proved too compelling to ignore.

Golinkoff and Rosinski (in press) extended this finding to third and fifth graders with different levels of comprehension skill. They found no difference in the extent to which skilled and less skilled comprehenders experienced semantic interference with these primer-level words. Both skill groups could decode these words readily, although they differed in time to pronounce the nonsense trigrams, an indication of the ability to utilize spelling-to-sound correspondences, presumably a component of decoding ability. Despite this difference, the less skilled comprehenders did not reveal a general semantic deficit which might have restricted their ability to get the meaning of single printed words. Thus, Golinkoff and Rosinski suggested that decoding ability and semantic processing may be separable skills to some extent in that even the less skilled group could retrieve single-word meanings. However, the real words used by Rosinski et al. (1975) and Golinkoff and Rosinski (in press) were highly familiar primer-level words. The possibility exists that these groups experienced an equivalent amount of semantic interference because they did not differ in their ability to decode the real words.

The main purpose of the present study was to specify the limits under which the semantic interference phenomenon holds. If extraction of single-word meaning is related to the automaticity of decoding skills (as LaBerge and Samuels suggest), then manipulating decoding difficulty should affect retrieval of single-word meaning. In particular, the authors wished to see whether the use of more difficult words would cause interference for the skilled comprehenders but not for the less skilled group. The expectation was that if students could not readily decode the harder words, little semantic interference should occur. Skilled comprehenders in each grade should experience more interference with real words than nonsense words, while less skilled comprehenders, at least at the third-grade level, might not. It was essential for this study that these harder words be present in the children's aural vocabulary. With the easier words, it was expected that all groups would experience semantic interference (Golinkoff and Rosinski, in press). These results would help to clarify the relationship between decoding skill and comprehension of words in isolation.

Decoding ability and decoding difficulty were assessed by having each subject read aloud all real and nonsense words used. Results which showed that less skilled readers took longer than skilled readers to read the harder words would indicate that these words were more difficult for the former group.

Method

Subjects

Thirty-two third-graders and 32 fifth-graders in a semi-rural elementary school participated. Eight girls and eight boys in each grade were randomly selected from those children who scored above the median on the Paragraph Meaning section of the Stanford Achievement Test given at the end of the previous school year, and the same number of boys and girls were chosen from those who scored below the median. Children in the top or bottom 10% of the distribution were not included, nor were children who were not native speakers of English. The average grade-equivalent score for the skilled comprehenders in the third grade was 3.48; that for the less skilled comprehenders was 2.46. For the fifth-grade students, the mean grade-equivalent scores were 5.89 and 4.01, respectively, for the skilled and less skilled comprehenders.

Materials

Decoding tests. All subjects read aloud four lists of words. The easy set consisted of 20 first-grade level nouns and 20 pronounceable consonant-vowel consonant (CVC) trigrams (see Rosinski et al., 1975, and Golinkoff and Rosinski, in press). Examples of the real words used are "key" and "sock;" trigrams included "yat" and "ven."

The hard set also had 20 real words and 20 nonsense words. The real words were selected from fifth- and sixth-grade basal readers on the basis of the ease with which they could be depicted and the fact that they discriminated (in pretesting on different subjects) between above and below average fifth-grade readers. Ten of these nouns were names of animals, and 10 named people or objects. The new nonsense words conformed to the English spelling-to-sound correspondence system and were matched with the real words by number of letters and syllables. (Examples are "widbolch" and "plimtabor.") Each of the four lists was typed on a separate sheet of 8½ x 11 in. (22 x 28 cm) paper in primer-sized type.

Interference tasks. Within each level of word difficulty, the interference materials were constructed by superimposing the real or nonsense words on pictures which were line drawings of the real words. At each difficulty level, there were four conditions: pictures alone, pictures with matching words (100% condition), pictures with non-matching words (0% condition), and pictures with nonsense words (nonsense condition). In the 0% condition, the drawings and words did not match, e.g., the picture of the dinosaur had the word "lobster" printed on it (see Figure 1). For the nonsense condition, nonsense words were superimposed on the pictures. The order of the pictures on the pages was counterbalanced across conditions.

Procedure

Each subject was tested individually by one of the authors in a single 20-minute session during the last two months of the school year. Within each grade, students were randomly assigned to one of 16 counter-balanced presentation orders. The easier set of stimuli were always presented first in order to prevent the younger readers from becoming frustrated on the more difficult task.

Easy set. The children were first trained with 3 in. x 3 in. (7.6 x 7.6 cm) picture cards to name the pictures they were subsequently to see in the interference tasks. The picture cards were presented singly and in random order. Names were provided by the experimenter for pictures not identified or called by names other than those chosen to be used, e.g., "kitten" instead of "cat." After training, the students were told that they would see these same pictures on four different sheets of paper. They were instructed to name the pictures out loud as fast as possible and to ignore the superimposed words when present. In each condition, time to name the pictures was measured with a stopwatch to the nearest half-second. Errors were also recorded.

The children were then asked to read aloud, as rapidly as possible, lists of the real and nonsense words. Time to read each list of 20 words was noted to the nearest half-second by a stopwatch, and errors were recorded.

Hard set. The identical procedure was employed with the hard set of words. First, the children were trained to name the pictures correctly. Then they were given the four interference tasks, followed by the decoding tests.

Results

Preliminary analyses revealed no effect of sex in either the interference or decoding tasks. Thus, data from girls and boys were pooled. Log transformations were done on all latency scores in order to normalize otherwise skewed distributions and to meet the assumptions of the analysis of variance model. In those cases in which the homogeneity of variances assumption was still not met, a conservative *F*-test (indicated by *F**) was employed.

Interference Tasks

The interference tasks were analyzed with a 2 (school grade) x 2 (comprehension level) x 4 (picture condition) design, with repeated measures on the last factor. IQ scores were available for each student, but since the correlations of these scores with the repeated measures were not significant, IQ was not used as a covariate. Separate analyses were performed for the easy and hard tasks in order to see whether the Golinkoff and Rosinski results (in press) would be replicated with the easy set.

Easy set. To test the prediction that skilled and less skilled readers would experience interference, Kirk's (1968) *t*-statistic for a priori contrasts was used. The amount of semantic interference was measured by comparing the difference between means in the 0% and nonsense conditions for the skilled and less skilled comprehenders at each grade. None of the contrasts, tested at the .05 level, were significant, indicating that the less skilled comprehenders experienced as much semantic interference as their more skilled peers.

Results of an analysis of variance of the transformed scores paralleled results obtained by Golinkoff and Rosinski (in press). Main effects of grade, $F(1,60) = 17.20$, $p<.05$; comprehension level, $F(1,60) = 4.19$, $p<.05$; and interference condition, $F(3,180) = 304.21$, $p<.05$ were significant. Since the comprehension level by condition interaction was not significant, the skill groups experienced equivalent amounts of interference. The Newman-Keuls procedure showed each interference condition to be significantly different from each of the others at the .01 level. In addition, the 100% condition was faster than the picture condition, indicating that a word-picture match facilitates picture-naming. Too few intrusion errors (i.e., the word instead of the picture) were made on these tasks to analyze the error data.

Hard set. The prediction that skilled readers would experience more interference than less skilled readers was tested at the .05 level with a priori contrasts. The difference between comprehension groups was significant only at the third-grade level.

An analysis of variance of the transformed scores revealed significant main effects of grade, $F(1,60) = 26.21$, $p<.05$; comprehension level, $F(1,60) = 14.08$, $p<.05$; and interference condition, $F^*(1,180) = 97.78$, $p<.05$. Although the a priori contrasts reported above showed significant differences in degree of semantic interference between skilled and less skilled comprehenders at the third-grade level, none of the interactions in the overall ANOVA reached significance. Newman-Keuls tests, performed at the .01 level, indicated that each interference condition was significantly different from each of the others. Fastest times were for the 100% condition (mean = 1.36), followed by the picture condition (1.47), the nonsense condition (1.57), and the 0% condition (1.65). Means and standard deviations are shown in Table 1. Again, the paucity of errors did not permit analysis of the error data. Thus for both sets of words, fifth graders were faster than third graders across all conditions in the interference tasks, and skilled comprehenders were faster than less skilled comprehenders. The less skilled third-grade group confirmed the prediction that harder words would cause less semantic interference to occur.

Decoding Tasks

For both sets of words, a 2 (grade level) x 2 (comprehension level) x 2 (word type: real or nonsense) analysis of variance was performed, with repeated measures on the last factor.

Easy words. The main effects of grade, $F(1,60) = 21.13$, $p<.05$; comprehension level, $F(1,60) = 9.91$, $p<.05$; and word type, $F(1,60) = 1145.52$, $p<.05$; were all significant, as were the interactions between grade and word type, $F(1,60) = 14.51$, $p<.05$; and reader level and word type, $F(1,60) = 7.74$, $p<.05$. Simple effects tests; conducted at the .025 level, showed that the differences between third and fifth graders and between skilled and less skilled comprehenders on time to decode the real words were not significant, but, in both cases, the differences in time to decode the nonsense words were significant. Thus, with these easy words, time to read the nonsense words aloud appears to be a better indicator of decoding ability than time to read the real words. Many perfect scores precluded analysis of error data.

Hard words. There were significant main effects of grade, $F(1,60) = 24.56$, $p<.05$; comprehension level, $F(1,60) = 24.82$, $p<.05$; and word type, $F(1,60) = 786.14$, $p<.05$. Table 2 shows means and standard deviations for each group on the real and nonsense words. The two-way interaction between comprehension level and word type was found to be significant, $F(1,60) = 6.79$, $p<.05$, as was the three-way interaction between grade, comprehension level, and word type (real vs. nonsense), $F(1,60) = 5.03$, $p<.05$. Simple effects tests, performed at the .025 level, showed that skilled and less skilled comprehenders differed on time to decode both the real and the nonsense words, but the magnitude of this difference was greater for the real words. Thus, for the skilled comprehenders, the real words appear to have been comparatively easy, while for the less skilled comprehenders they seem to have been genuinely difficult.

Further support for this conclusion is given by simple effects tests of the significant three-way interaction. For each group of subjects, the nonsense words took significantly longer to read than the real words. However, the size of this difference was smallest for the less skilled readers in the third grade, or that group, which, according to the a priori tests, showed no semantic interference effect with the harder words. Although these children took longer to read the nonsense words than the real words, they still experienced considerable difficulty with the latter. A 2 (grade) x 2 (comprehension level) x 2 (word type) factorial analysis of the error data produced results parallel to those obtained for the latency data. Main effects of grade, $F(1,60) = 16.84$, $p<.05$; comprehension level, $F(1,60) = 18.38$, $p<.05$; and word type, $F(1,60) = 147.44$, $p<.05$; were all significant. In addition, the interaction between grade and comprehension level was significant, $F(1,60) = 9.30$, $p<.05$. Simple effects tests indicated that the fifth-grade skilled and less skilled comprehenders made similar numbers of errors, whereas the less skilled third graders made significantly more errors than the skilled group in that grade.

Discussion

Both by replicating the results obtained by Golinkoff and Rosinski (in press) with the easy set of words and by finding little semantic interference for the less skilled third-grade readers on the harder set of words, this study indicates that the access of single-word meanings may depend on the ease with which these words can be decoded. That is, if a word cannot be decoded readily, its meaning may not be retrieved.

This relationship between decoding difficulty and semantic access is supported by the complementary results of the decoding and interference portions of this investigation. Analyses of the decoding tasks showed that the hard set of real words were, in fact, most difficult for the less skilled third graders, who experienced the least semantic interference with these words. In addition, the difference in decoding time between the real and nonsense words was smallest for these readers. Differences between skill groups across grades on the hard set were greater for real than for nonsense words, a finding which indicates that these words did discriminate between the groups. Conversely, on the easy set, as Golinkoff and Rosinski (in press) had found previously, differences between third and fifth-graders and between skilled and less skilled comprehenders were only significant for the nonsense words, and all groups experienced an equivalent amount of semantic interference.

Thus, word difficulty seems to influence whether the meaning of a known word will be retrieved. In the ideal case, semantic access may be an "automatic process, given decoding (Perfetti, Note 1)." That is, if a word can be identified effortlessly, access of its meaning will occur. On the other hand, as the results for the less skilled third-graders show, if words are not recognized immediately, retrieval of their meanings may not follow.

Consideration of how this group of third-grade readers may differ from the other groups, particularly from their more skilled peers, may be instructive. They do not seem to differ either in access of single-word meanings or in knowledge of the words used. Both this investigation and that by Golinkoff and Rosinski (in press) showed that extraction of single-word meanings per se was not a problem for any group of readers. With the easy, primer-level words, all groups experienced semantic interference. Thus the possibility that less skilled comprehenders have some basic difficulty retrieving the meaning of a known word from print is not supported by these studies. Further, inadequate knowledge of word meanings cannot account for the absence of an interference effect with the hard words since most subjects could name all the pictures used. When necessary, subjects were trained to recognize pictures not initially identified.

The disparate results for the two groups of third graders, however, suggest that they may differ in their knowledge and utilization of fundamental decoding skills. Presumably, the hard set of real words, taken from fifth- and sixth-grade basal readers, would have been too difficult for both groups of third graders. Apparently, though, they were much more difficult for the less skilled group. The procedures used in the present study do not permit analysis of how these groups may differ in decoding skills, but several possibilities exist. The better readers might read more and have a larger sight vocabulary. Consequently, they might be able to recognize more words immediately than can less skilled readers. The studies by Katz and Wicklund (1971, 1972) indicated that skilled and less skilled readers differed only on a word-scanning task, not on a similar letter-scanning task. Thus, the more skilled group may be better able to use the information available in a word. Some research evidence supports this conclusion. Golinkoff (Note 2), for example, has shown that better readers may be more familiar with English spelling patterns; perhaps, therefore, they can utilize them more readily in a decoding task. Moreover, Mason, Katz, and Wicklund (1975) found that better readers had greater knowledge of the positional redundancies of letters in printed English. Additional studies that can demonstrate knowledge or abilities differentially utilized by skilled readers in identification of single words may help clarify in what way some readers are better at decoding than others.

The present study has disclosed a relationship between decoding ability and access of single-word meanings. However, the results reported here have implications for the comprehension of connected text as well. As Guthrie

(1973) has argued, decoding and comprehension skills are interdependent. It is worth considering, therefore, what may happen to comprehension of text if decoding of words already present in a reader's aural vocabulary is not automatic. A reader may attempt to decode the word, and, if successful, retrieve its meaning. However, the specific attention to the decoding process thus required (LaBerge and Samuels, 1974) may interfere with the retrieval of meaning from text due to short-term memory restrictions or limited processing capacity. Alternatively, the reader may be unsuccessful in the decoding effort or ignore the word completely. In either case, the meaning of that word would not be retrieved. Goodman (1967, 1973) has argued that accurate word-by-word identification is not necessary for comprehension of text since meaning can usually be inferred from the surrounding context. However, comprehension may be impaired if too many words cannot be decoded readily. Aids to comprehension which exist in the syntactic and semantic redundancies of connected text are only useful to a reader if they are available. The more easily a portion of text can be decoded, the more information the text provides to assist comprehension.

The proposition that accurate and rapid decoding may be essential for the efficient utilization of the redundancies in text should be explored in future research. Since comprehension of text involves more than the processing of individual words in isolation, further studies might profitably focus on determining how deficits in decoding ability may interference with adequate processing of connected text.

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Table 1

Means and Standard Deviations of Time to Name Pictures on Hard Set of Interference Tasks for Each Reader Group

Condition	Grade 3				Grade 5				Total mean
	Less Skilled		Skilled		Less Skilled		Skilled		
	M	SD	M	SD	M	SD	M	SD	
Picture	1.677	0.222	1.445	0.184	1.400	0.123	1.359	0.126	1.470
100%	1.476	0.150	1.346	0.138	1.337	0.119	1.270	0.087	1.357
0%	1.773	0.218	1.677	0.157	1.613	0.130	1.536	0.071	1.650
Nonsense	1.753	0.165	1.567	0.144	1.523	0.181	1.453	0.068	1.574
Total mean	1.670		1.509		1.468		1.404		

Note. Values listed are log transformations of time in seconds.

Table 2

Means and Standard Deviations of Time to Decode Hard Set of Words for Each Reader Group

Condition	Grade 3				Grade 5				Total mean
	Less Skilled		Skilled		Less Skilled		Skilled		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Real	1.637	0.298	1.288	0.158	1.305	0.206	1.160	0.091	1.347
Nonsense	2.036	0.180	1.867	0.147	1.851	0.142	1.719	0.097	1.868
Total mean	1.836		1.577		1.578		1.439		

Note. Values listed are log transformations of time in seconds.

Figure Caption

Figure 1. 0% condition for the hard set of words.

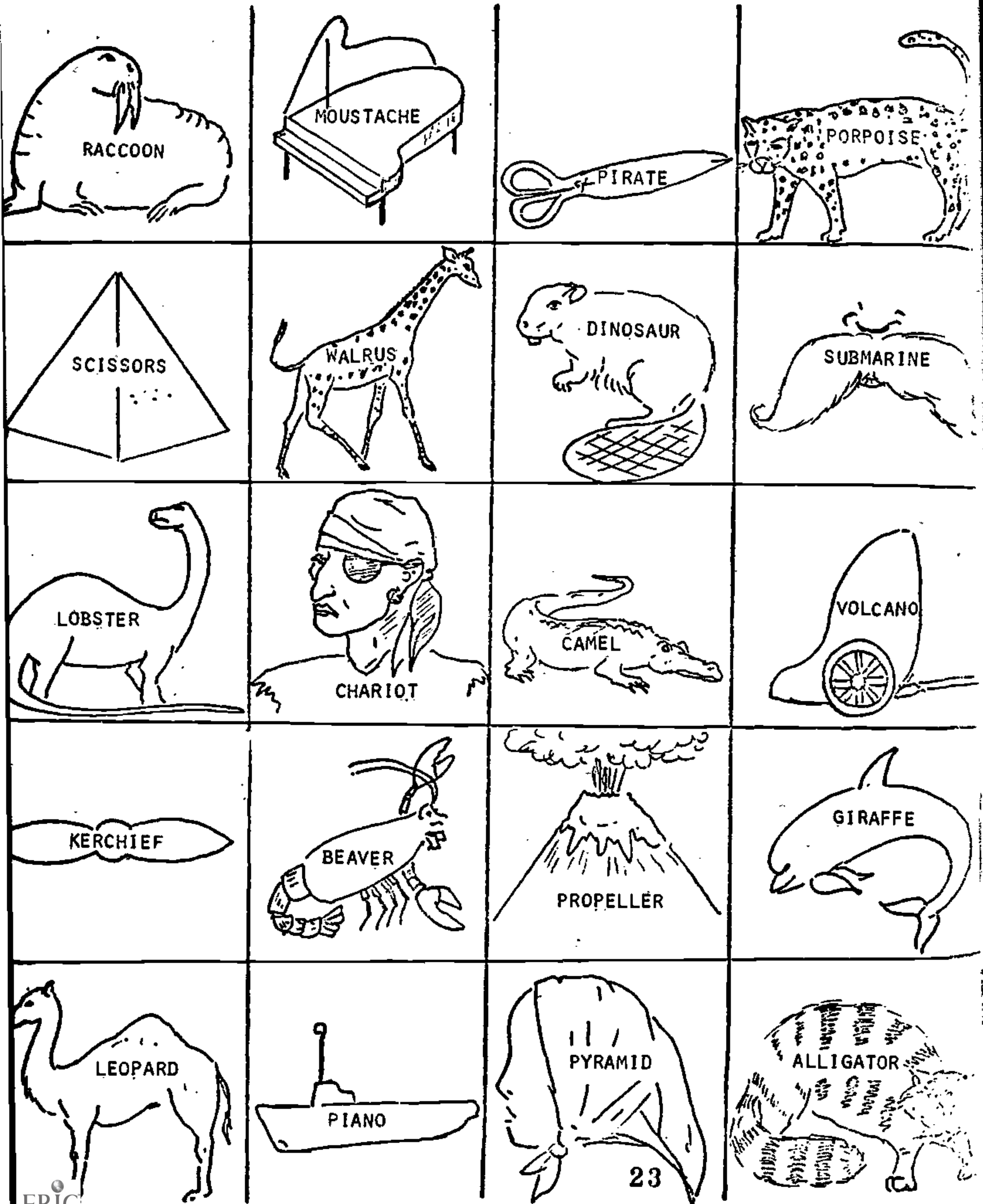

FIGURE 1. 0% Condition for the Hard Set of Words