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ABSTRACT

Two studies investigated the role of phonological activation in children's silent reading and listening comprehension. The first study addressed the interaction of reading skill level and phonological sensitivity. Subjects, 32 second-grade students, read eight short passages (four rhymed and four not rhymed) and chose one picture (out of three alternatives) to represent the meaning of the passage. The second study addressed the interaction of grade level and reading skill level with phonological sensitivity. Subjects, 34 kindergarten students and 26 second-grade students, listened to eight short passages (four rhymed and four not rhymed) and chose a picture (from three alternatives) to represent the meaning of the passage. Results of both studies indicated that phonological effects were evidenced in children's reading slowdowns and recall accuracy but not in situational comprehension accuracy as measured by the picture selection task. Children were less able to recall the exact sentences or even the gist of phonologically confusing texts that matched control texts. When recalling phonologically confusing texts, children were prone to make errors in which proper names and pronouns were misrecalled or forgotten, but all other semantic information was recalled correctly. The group of kindergarten less-skilled readers was the only group not to show phonological confusion in verbatim recall but showed phonological confusion in both gist recall and error patterns. Kindergarten children's reading scores and their performance on a standardized test of verbal short-term memory were correlated, suggesting that when memory is overloaded, phonological effects are not apparent in children's verbatim recall, but they are reflected in ability to recall gist. (Five figures of data are included.) (RS)

From Listening to Reading: Phonological Processes in Comprehension

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Abstract

In this study, the role of phonological activation in children's silent reading and listening comprehension was investigated with children at the kindergarten and second grade level. Phonological effects were evidenced in children's reading slowdowns and recall accuracy but not in situational comprehension accuracy as measured by a picture selection task. Children were less able to recall the exact sentences or even the gist of phonologically confusing texts than matched control texts. The type of errors in recall was also different in the two conditions. When recalling phonologically confusing texts, children were prone to make errors in which proper names and pronouns were misrecalled or forgotten, but all other semantic information was recalled correctly.

There was an interaction between grade level, reading skill and phonological confusion in verbatim recall. The group of kindergarten less skilled readers was the only group not to show phonological confusions in verbatim recall. These kindergarten children showed phonological confusion in both gist recall and error patterns, however. There was a significant correlation between kindergarten children's reading scores and their performance on a standardized test of verbal short-term memory, suggesting that when memory is overloaded, phonological effects are not apparent in children's verbatim recall, but they are reflected in ability to recall gist. Implications for a model of language comprehension are drawn.

From Listening to Reading: Phonological Processes in Comprehension

How does reading build on more general language processes? We understand that reading comprehension is related to listening comprehension (Curtis, 1980), but listening comprehension itself is not well understood. The first goal of my research is to provide insight into the relationship between listening and reading at the level of cognitive processes. Children come to school already able to speak and comprehend their native language. How do they learn to comprehend written text? Learning to recognize written words is certainly an important part of this transition. But even if a child can recognize every word in a sentence, that child still may not comprehend what was read.

One of the earliest points of failure in comprehension may result from an inability to remember words long enough to form meaning for a clause. We know that speech is perceived and immediately remembered through sound-based representations in memory (e.g. Holligan & Johnston, 1988). The sounds of words are activated during silent reading as well, even in skilled adult readers whose word recognition is fluent (McCutchen, Bell, France, & Perfetti, 1991). Perfetti and McCutchen (1982) suggested that the ability to form and maintain sound-based representations in short-term memory is causally related to children's reading comprehension ability. The second goal of my research is to investigate whether individual differences in reading ability are related to children's ability to activate sound-based representations of language when they listen.

This research is situated broadly in a model of language comprehension developed by Van Dijk and Kintsch (1983), and more specifically within a model of speech processes in reading first proposed by Perfetti and McCutchen (1982). In the broad model, three levels of representation are built by the comprehender. First, a verbatim level preserves the surface features of linguistic input. Using the words encoded at this verbatim level, the reader builds a propositional representation in which gist is retained but exact wording is not. In order to truly understand the text, the reader must also construct a situation model which is a mental representation of the situation which has been described. These three levels of representation interact with one another, although the exact nature of their interactions is not yet well understood.

Evidence from experiments with tongue-twisters in silent reading tasks suggests that phonological repetition influences children's speed during silent reading (e.g. Crain-Thoreson & McCutchen, 1989) and may influence comprehension as well (Hanson, Goodell, & Perfetti, in press). Evidence from experiments with rhyming sentence in listening tasks suggests that the sounds of words play a role at the verbatim level of representation, influencing verbatim recall (e.g. Jorm, Share, MacLean, & Matthews, 1984). Few, if any studies, have yet investigated the role of sound-based representations in the formation of propositional and situational representations of text. The present study investigates the role of phonological activation in the formation of these higher-level representations of text meaning.

The last decade of reading research has assigned a central role to children's facility with the sounds of language in the understanding of ability differences in children's reading (see Wagner & Torgesen, 1987, for a review). The relationship between children's skill in word recognition or in phonological awareness tasks and phonological activation as part of the comprehension process is not yet well understood. Perfetti and McCutchen (1982) hypothesized that the purpose of phonological activation during silent reading is to secure reference for lexical items,

and that good readers may employ phonological activation more effectively than poor readers. Evidence for this hypothesis is tenuous, however. Children's reading skill has not been shown to interact with phonologically induced reading slowdowns (Crain-Thoreson & McCutchen, 1989).

Although phonological confusions are evidenced in listening tasks (e.g. Conrad, 1964), the studies that have found relationships between children's reading skill and phonological confusion in verbatim sentence recall tasks have not been consistently replicated (cf. Mann, Liberman, & Shankweiler, 1980; Jorm, et al., 1984). Holligan and Johnston (1988) suggested that short-term memory limitations rather than reading skill *per se*, is the variable that interacts with phonological sensitivity in recall tasks. When short-term memory is overloaded, phonological effects are not in evidence. In the present study, both reading ability and short-term memory skill are examined as potential correlates of children's susceptibility to phonological confusion.

This research employs two experiments, each utilizing identical materials and similar methods. Sound is the manipulated variable in each experiment. Short passages describing events were constructed in sets: the experimental material contained phonological repetitions (rhymes), the control material was highly comparable to the experimental material except that it did not contain phonological repetitions. If subjects slow down to process, recall less, or understand less of the phonologically repetitive material than the control material, this is taken as evidence that the material has been stored phonologically.

Study 1

Study 1 investigated sound-based representations during silent reading comprehension, addressing the interaction of reading skill level and phonological sensitivity.

Method

Thirty-two subjects at the second grade level were blocked into two skill groupings based on standardized reading test scores (PIAT reading recognition and reading comprehension subtests). The children were asked to read 8 short passages (4 rhyme and 4 control) and choose one picture (from three alternatives) to represent the meaning of each passage. Both reading time and comprehension accuracy were collected as dependent measures.

Results and Discussion

Passage reading times and picture selection accuracy were each analyzed using repeated measures analysis of variance, with phonemic confusability as the repeated measure. Figure 1 illustrates that a significant main effect of confusability was evidenced in the reading times, $F(1,28) = 11.66$, $p < .01$. No effects of confusability were evidenced in the picture selection measure however. There were no significant interactions of confusability with reading skill.

The results of this study indicate that both skilled and less-skilled young readers are susceptible to phonological confusion. These findings replicate and extend previous work employing only alliterative stimuli in silent reading tasks with young readers (Crain-Thoreson & Mccutchen, 1989). The phonological confusions were evidenced

only in the children's reading time, not in their comprehension accuracy, indicating that children can compensate for phonological confusion by slowing down when they read. This strategic option is not available in listening and may be an important difference in how children process spoken versus written language.

Study 2

Study 2 investigated sound-based representations during listening comprehension, addressing the interaction of grade level and reading skill level with phonological sensitivity.

Method

Thirty-four children at the kindergarten level and 26 children at the second grade level participated in the study. They were blocked into less-skilled and highly-skilled groups based on performance on the PIAT reading recognition subtest. This test includes phonological awareness items as well as word reading items. A measure of short-term memory ability was also administered (Stanford-Binet IV, memory for sentences subtest).

Children were asked to listen to eight short passages (four rhyming and four control). After hearing each passage, they were asked to choose a picture (from three alternatives) to represent the meaning of the passage. Half of the passages were then presented again, one sentence at a time, and the children were asked to recall each sentence of the passage as accurately as possible. Picture selection accuracy was used as one dependent measure, and the quality of the child's recall was used to derive the other dependent measures.

Children's recall protocols were scored using a four-way coding scheme. Each sentence was coded in terms of the level of comprehension evidenced, and then the number of sentences of each phonological type in each comprehension category were counted. The categories were: *perfect recall* (false starts, self-corrections, and minor articulation errors were allowed), *gist recall* (main predicate and all required arguments with close synonyms allowed), *name errors* (errors only in proper names or pronouns), *total misrecall* (all other responses).

Results and Discussion

Picture selection accuracy and the sentence recall categories were each analyzed using repeated measures analyses of variance, with phonemic confusability as the repeated measure. No effects of confusability were found in the picture selection task. Significant effects of confusability were found in recall, however. As Figure 2 illustrates, non-rhyming passages were more likely to be recalled either perfectly or with the gist intact, than rhyming passages, $F(1, 56) = 8.40$, $p < .01$. Although total misrecall (Figure 3) did not differ significantly between the two conditions, misrecall in which names and pronouns were the loci of errors were much more likely in the rhyming condition (Figure 4), $F(1,56) = 17.26$, $p < .01$.

A significant interaction between reading skill, grade level and confusability was reflected only in the number of sentences recalled verbatim (Figure 5), $F(1,56) = 5.14$, $p < .05$. All groups showed verbatim recall degraded by rhyme, except the less-skilled kindergarten group, which showed just the opposite phonological effect, recalling more sentences in the rhyme than in the control condition. The less-skilled

kindergarten group was further distinguished by an inability to read any words on the PIAT reading recognition subtest (mean = 13.12, min = 3, max = 17). Reading skill and short term memory ability, but not age, were highly correlated in the kindergarten groups ($r = .67$, $p < .01$), thus it is impossible to separate the effects of reading skill level with the effects of short-term memory limitations in the interaction with phonological confusability.

General Discussion

These findings add to existing evidence that there exists a phonological level of language representation in both listening and reading. Phonological effects were evidenced in slowdowns in a reading task and in recall errors in a listening task, using identical materials. An interaction among reading skill, grade level, and susceptibility to confusion in the listening task was found only in verbatim recall. The group of kindergarten non-readers did not show phonological confusion evidenced in ability to recall sentences verbatim, in contrast to all other groups in the study. Due to the high correlation between verbal short-term memory scores and reading scores, it is impossible to separate the effects of reading skill level from the effects of short-term memory limitations in interpreting this interaction. Indeed, Holligan and Johnston (1988) argued that short-term memory rather than reading skill is the more important variable in this type of interaction.

Although the less-skilled kindergarten children did not show phonological effects as measured by perfect recall, they did show phonological effects in gist recall and in the type of errors they made. Based on this, we cannot conclude that less-skilled kindergarten children did not activate the phonology of words when they listened. Rather, they showed a bias for retaining gist and sacrificing a verbatim representation, even when asked for perfect recall. The direction of causality between phonological activation, short-term memory capacity, and reading acquisition cannot be addressed by these data. Learning to read may change the way children hear and remember sentences, enabling them to secure reference and remember exact words more easily. Alternatively, the ability to activate the sounds of words in short-term memory may allow children to more accurately hear and remember words and sentences, and thus might facilitate reading acquisition.

Previous research into phonological activation during listening has primarily employed perfect recall accuracy as the only dependent measure. Phonological effects in perfect recall were indeed replicated in the present study. Phonological effects were also in evidence in children's ability to form a gist representation and in a certain type of error which retains gist except for proper names. There were no phonological effects apparent at the situational level as measured by the picture selection task, suggesting that listeners, like readers, are able to cope with phonological confusion in order to maintain global comprehension. These results shed light on how listeners cope with the demands of listening comprehension.

Phonological confusion seems to produce a situation in which short-term memory is especially taxed. In reading, readers simply slow down in order to maintain comprehension. In listening, slowing down is not possible. Faced with the memory burden imposed by phonological confusion, comprehenders attempt to minimize memory load by moving from a verbatim to a gist representation as quickly as possible. Proper names are especially problematic, however, because there is no good "gist" representation for a name, unless it is quite familiar. It is not surprising then, that if a comprehender copes with the listening task by sacrificing verbatim memory in order to

retain gist that name errors will be a common phenomenon. This also accounts for the fact that listeners maintained their situational representation in the face of phonological confusion. The picture selection task did not require that the listener knew the characters' names.

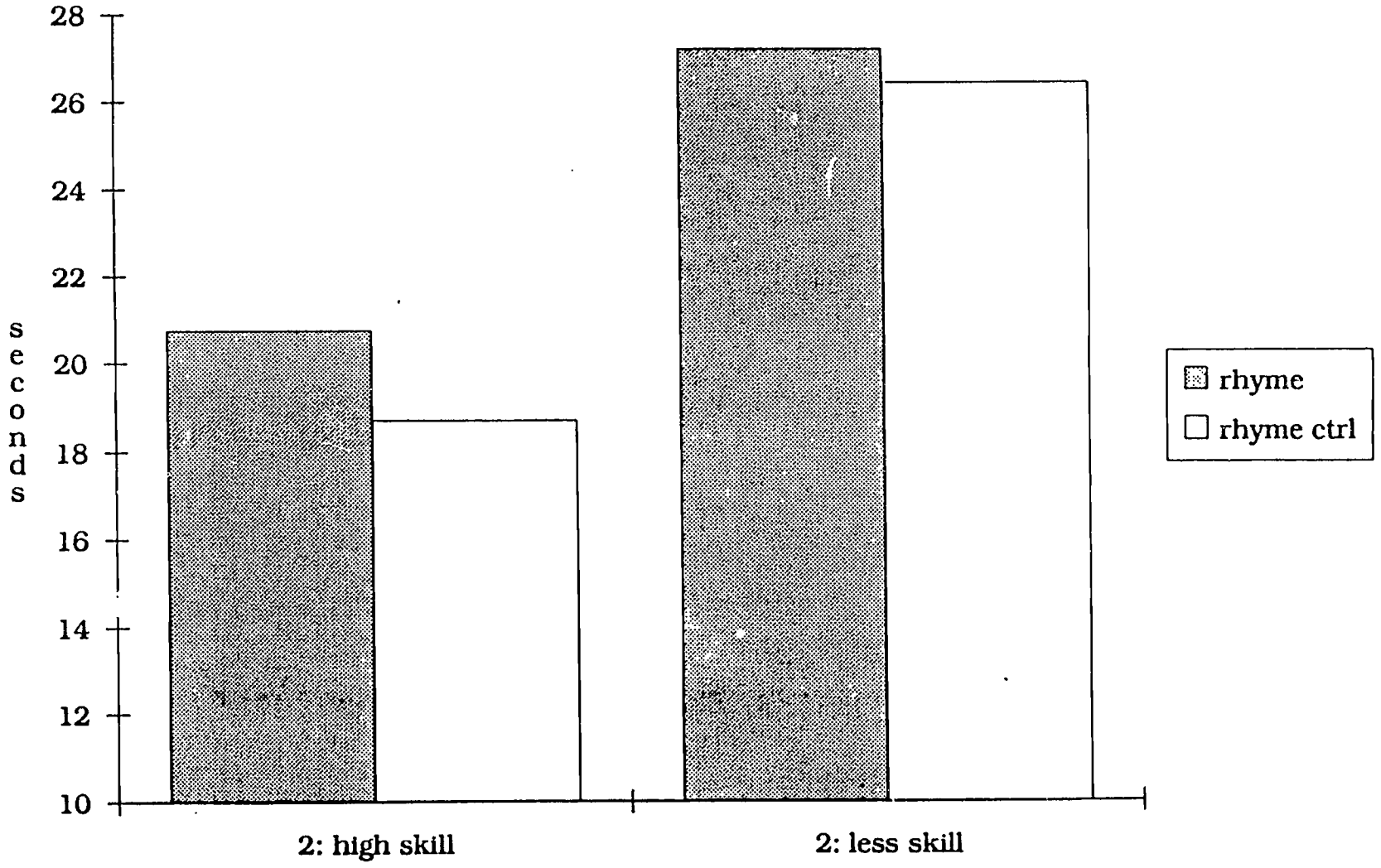

Figure 1. Reading Times: Rhyme vs Control

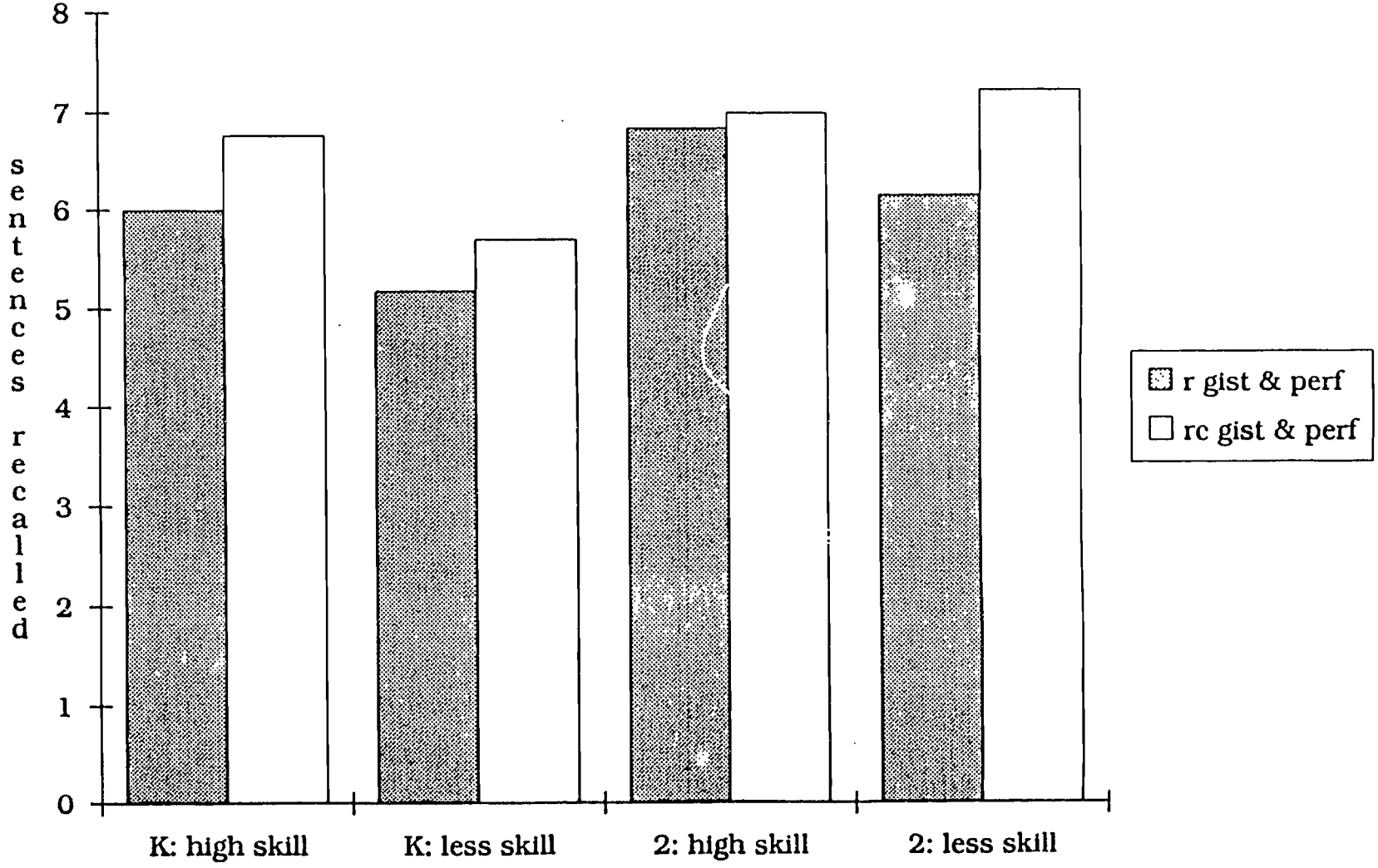

Figure 2. Gist and Perfect Recall: Rhyme vs Control

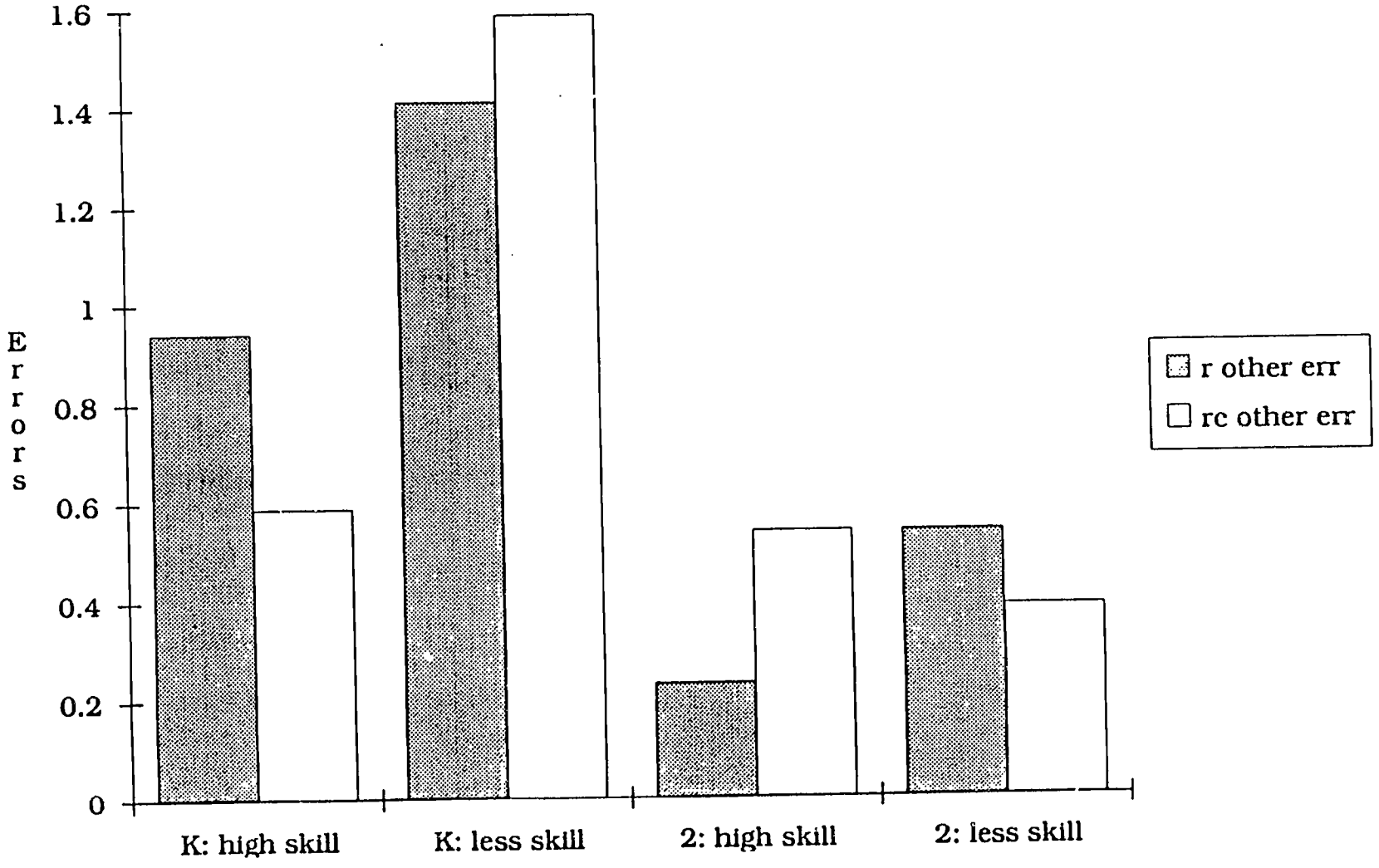

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Figure 3. Total Misrecall: Rhyme vs Control

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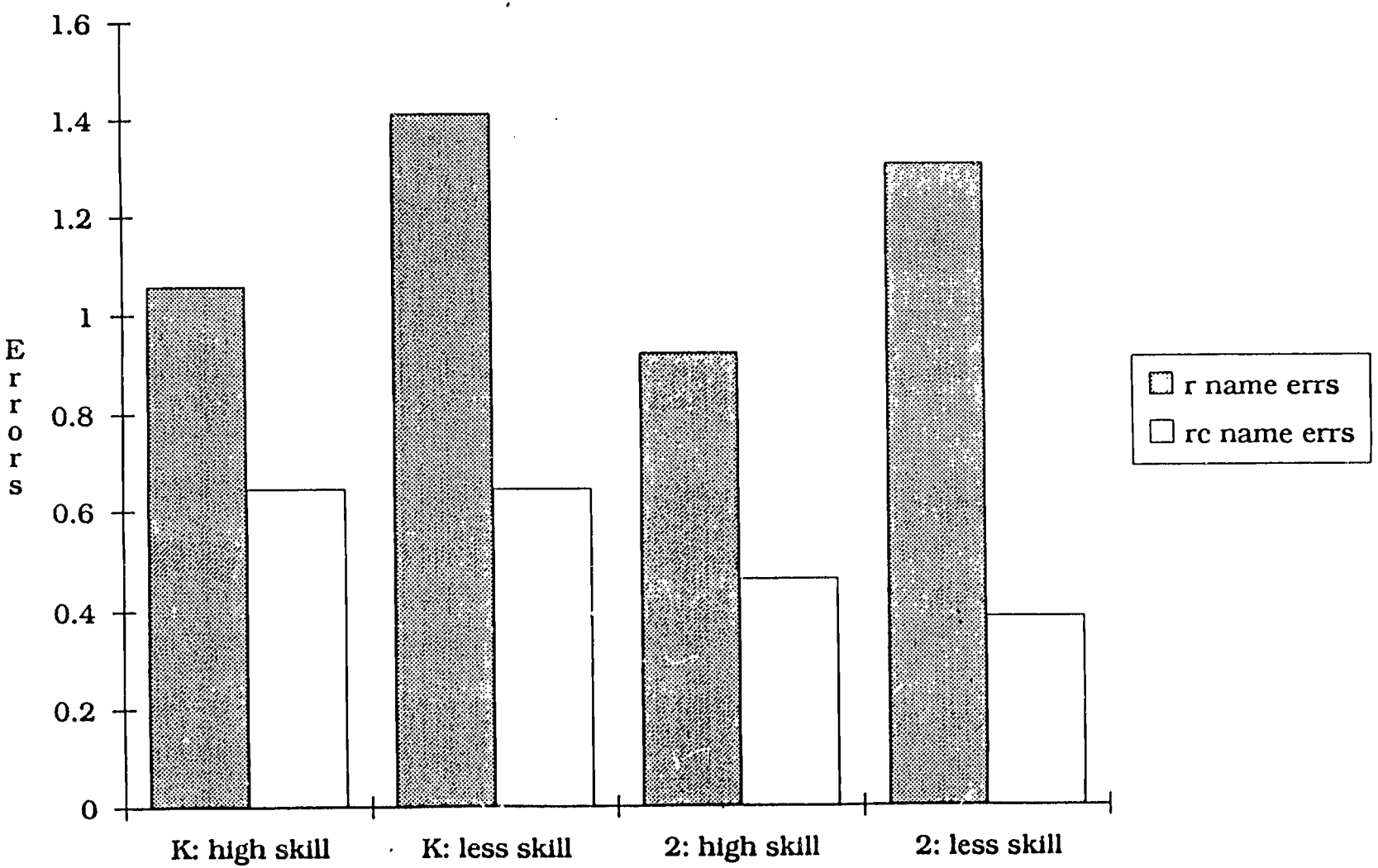

Figure 4. Name Errors: Rhyme vs Control

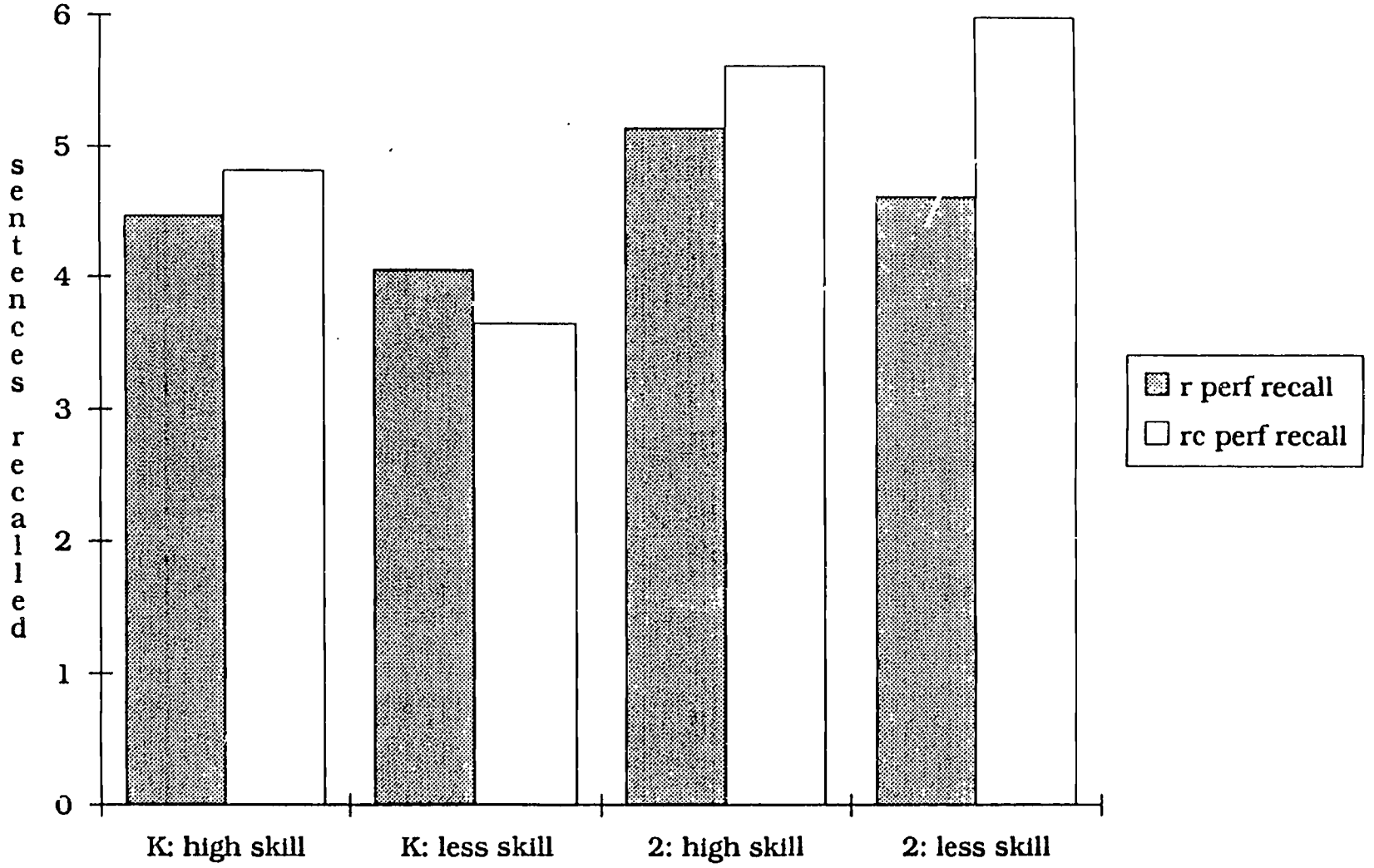

Figure 5. Verbatim Recall: Rhyme vs Control

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