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Children's and adults' use of spelling-sound information in three reading tasks

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This research examined the effects of irregular spelling and irregular spelling-sound correspondences on word recognition in children and adults. Previous research has established that, among skilled readers, these irregularities influence the reading of only lower frequency words. However, this research involved the lexical decision and naming tasks, which differ from the demands of normal reading in important ways. In the present experiments, we compared performance on these tasks with that on a task requiring words to be recognized in sentence contexts. Results indicated that adults showed effects of spelling and spelling-sound irregularities in reading lower frequency words on all three tasks, whereas younger and poorer readers also showed effects on higher frequency words. The fact that irregular spelling-sound correspondences affected performance on the sentence task indicates that access of phonological information is not an artifact of having to read a word aloud or perform a lexical decision. Two other developmental trends were observed: As children became more skilled in reading, the effects of irregular spelling were overcome before the effects of irregular spelling-sound correspondences; the latter effects were eliminated on silent reading tasks earlier than on the naming task.

Writing systems differ in the manner in which they represent phonological information (Henderson, 1982; Hung & Tzeng, 1981; Rozin & Gleitman, 1977). As a consequence, there are variations between orthographies in the extent to which written words represent their pronunciations. Because written English is based on an alphabetic principle, a skilled reader is likely to be able to pronounce correctly an unfamiliar word the first time it is seen. In Chinese, which is logographic, only a small proportion of characters represent phonological information, making it difficult for even a skilled reader to pronounce correctly an unfamiliar character (Hung & Tzeng, 1981). Orthographies have evolved toward a more direct representation of phonology, a fact that would be difficult to explain unless phonological information had a role in either skilled reading or learning to read.

Although the orthography of English encodes phonological information, there is a question as to whether this information is actually used in reading. Silent reading could be accomplished without any knowledge of orthographic-phonological correspondences, as is the case for nonspeaking deaf persons who read. Several facts nonetheless suggest that, under many circumstances, phonological information is used in reading. There is a strong phenomenological experience of hearing an inner voice while reading. Children are taught explicitly the correspondences between spelling and sound in learning to read, and their knowledge of these correspondences is positively correlated with reading skill (Perfetti & Hogaboam, 1975). Although nonspeaking deaf persons can learn to read, they tend to have poor reading skills (Conrad, 1979), and their use of speech-based coding in reading is the single best predictor of achievement level (Lichtenstein, 1983). Phonological coding in reading may facilitate working memory processes, enabling the reader to retain information concerning the literal sequence of words while other comprehension processes proceed (Baddeley, Eldridge, & Lewis, 1981; Slowiaczek & Clifton, 1980).

The use of phonological information in reading does not, however, necessarily implicate knowledge of how the orthography systematically represents phonology. The phonological code for each word could simply be associated with its orthographic entry in the lexicon (so-called "whole word" phonology). If the written and spoken codes are associated in this manner, nothing need be known about the manner in which particular symbols represent sounds. Such associations govern the pronunciations of many Chinese characters and of symbols such as "$" that are arbitrary with respect to pronunciation

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(Coltheart, 1978). It is possible that many words and symbols are recognized on a visual basis, with the phonological code subsequently read out of memory storage ("postlexical" phonological access), regardless of the manner in which they represent sound (Seidenberg, in press).

One way to investigate whether readers use knowledge of orthographic-phonlogical correspondences in reading is to determine whether orthographies with a regular and direct encoding of phonology are easier to read than orthographies for which the mapping between the two codes is irregular or indirect (Hung & Tzeng, 1981; Katz & Feldman, 1981; Seidenberg, in press). However, just as orthographies differ in the extent to which they encode phonological information, so do words in English. A large number of English words can be classified as having regular spelling-sound correspondences. These words, such as "made" or "best," are regular because their pronunciations are predictable on the basis of simple spelling-sound rules (Venezky, 1970), and all words with similar spelling patterns ("-ade," "-est") rhyme. A smaller but nonetheless substantial number of English words have common spelling patterns, but irregular pronunciations. These words, such as "have" or "give," have been termed exceptions; their pronunciations violate simple spelling-sound correspondences, and they have no rhymes with similar spelling patterns (Glushko, 1979). Exception words exist in English for several different reasons (e.g., because of diachronic changes in pronunciation that were not accompanied by changes in orthography, or borrowing from other languages). Although the alphabetic principle of written English makes it possible to derive the pronunciations of most words from their written forms, this is not always possible, because the correspondence between spelling and sound is not entirely consistent.

Variations among English words in the correspondence between the written and spoken codes provide a way to investigate the use of knowledge of spelling-sound correspondences. If this knowledge is used in reading, words with regular correspondences should be easier to read than words with irregular correspondences, other factors (such as frequency, length, and orthographic regularity) being equal. An advantage for regular words over exceptions could result either from effects of inconsistent neighbors (Glushko, 1979; McClelland & Rumelhart, 1981) or from the incorrect application of a regular spelling-sound rule to an exception word (Coltheart, 1978). However, if readers do not rely upon this knowledge, either because they do not use phonological information in reading or because the phonological code is accessed postlexically, regular and exception words that are otherwise comparable should be read with equal facility.

Although there has been a great deal of research investigating skilled readers' processing of regular and exception words, the results of these studies have been inconsistent. Several studies have demonstrated that exception words are more difficult to read aloud than regular words (Baron & Strawson, 1976; Coltheart, Besner, Jonasson, & Davelaar, 1979; Glushko, 1979; Gough & Cosky, 1977; Stanovich & Bauer, 1978). However, this exception effect has not appeared consistently in experiments employing the lexical decision task (Coltheart et al., 1979). Because the exception effect is found more consistently with the pronunciation task than with lexical decision, some researchers have argued that use of spelling-sound information is a strategy that is specific to reading words aloud (Coltheart et al., 1979).

Seidenberg, Waters, Barnes, and Tanenhaus (in press) investigated several factors that may have contributed to the lack of consistent results in previous studies. A critical factor is word frequency. Seidenberg et al. provided evidence that irregular spelling-sound correspondences influence the reading of only lower frequency words. Thus, experiments that tend to include more uncommon words will produce greater effects of spelling-sound irregularity than will those that include a large proportion of high-frequency words. Seidenberg et al. also investigated the orthographic regularity of the stimuli. They noted that, whereas some researchers have defined exception words as those with common orthographic patterns but irregular spelling-sound correspondences (e.g., "have"), others have included words that have both unusual spellings and irregular spelling-sound correspondences (e.g., "aisle," "ache") in the exception category (e.g., Baron & Strawson, 1976; Bauer & Stanovich, 1980; Parkin, 1982). Seidenberg et al. labeled the latter class "strange" words and suggested that they may be processed quite differently from exceptions. Both regular and exception words have common spelling patterns, but the exceptions have irregular spelling-sound correspondences. Only the strange words have unusual spelling patterns; these are also often difficult to pronounce. The orthographic analysis of exception and regular words should be comparable, with derivation of the phonology more difficult for exception words. For strange words, however, both the orthographic analysis and the derivation of the pronunciation may be more difficult than for regular words.

Seidenberg et al. (in press) compared pronunciation and lexical decision latencies for high- and low-frequency regular and exception words in one experiment and regular and strange words in a second experiment. They found that, on the pronunciation task, there were no differences across word classes for high-frequency items, indicating that neither irregular spelling nor irregular spelling-sound correspondences influenced the recognition of common words. This suggested that subjects recognized higher frequency words on the basis of visual information and accessed their pronunciations postlexically. Pronunciation latencies for low-frequency exception and strange words were longer than those for low-frequency regular words; thus, the effects of irregular spelling and spelling-sound correspondences were limited to lower frequency words.

On the lexical decision task, there were again no differences among the latencies for higher frequency regular, exception, and strange words. In contrast to naming, however, there were no differences between the lexical decision latencies for lower frequency regular and exception words. Thus, the exception effect was limited to lower frequency words read aloud. Lower frequency strange words did, however, yield longer latencies than did regular words on this task. The different results for exception and strange words on this task suggests that it is the irregular spelling of the strange words that make them difficult to process. In naming, then, there were effects of both irregular spelling and irregular spelling-sound correspondences; in lexical decision, there was only an effect of irregular spelling. All of these effects were specific to lower frequency words. Seidenberg et al. concluded that the "exception" effect found using the lexical decision task in previous studies was due largely, not to irregular spelling-sound correspondences, but rather to the inclusion of a large number of orthographically irregular words in the exception category.

In further experiments, however, Waters and Seidenberg (1984) found that skilled readers do show an exception effect in lexical decision performance under certain conditions. The occurrence of the effect with this task depends upon the composition of the stimuli. The effect appears when the stimuli are a heterogeneous mix of several different types of words in a within-subject design. When the stimuli contain regular, exception, and strange words, an effect of irregular pronunciation appears. When the strange words are deleted, however, the exception effect does not occur. These variable results obtain because the composition of the stimuli affects the criteria that subjects establish for making word-nonword decisions. Occurrence of an effect of irregular spelling-sound correspondences in this task depends on how these criteria are set relative to the time course of phonological code activation. Results on the naming task are not, however, contingent upon the composition of the stimuli; the exception effect for lower frequency words occurs regardless of the presence or absence of strange words.

The results of the Seidenberg et al. (in press) and Waters and Seidenberg (1984) studies are important because they show that, for proficient readers, the effects of spelling-sound regularity are limited to lower frequency words. A remaining question, however, is whether performance on either the pronunciation or lexical decision tasks accurately reflects reading in the more natural task of reading words in context. Although very general conclusions about the reading process are often suggested on the basis of results from these tasks, both tasks differ from the demands of normal reading in important respects. Skilled reading seldom involves overt pronunciation or making lexical decisions. Furthermore, performance on lexical decision varies depending upon the experimental conditions. As a consequence, it is unclear which results reflect what is likely to occur under more natural conditions.

Also of concern was the fact that, although skilled readers may not rely heavily on spelling-sound information, the ability to use such information could play an important role in the acquisition of reading skill. Most children have good speaking and listening skills when they learn to read, allowing rapid access to the meaning of a word from its spoken form. By learning the correspondences between spelling and sound, the child would have a powerful tool for reading words, because words that are not in the child's sight vocabulary could be recoded into a familiar phonological code, permitting access to meaning in the same manner as in listening. It may be that it is only with practice that the reader is able to achieve direct visual access to meaning and pronunciation. The use of spelling-sound information may be characteristic not only of processing lower frequency words by skilled readers, but also of the processing of poor and beginning readers.

Several studies (e.g., Calfee, Venezky, & Chapman, 1969; Perfetti & Hogaboam, 1975; Shankweiler & Liberman, 1972; Venezky, 1976; Venezky & Johnson, 1972) have investigated children's ability to pronounce pseudowords as a means of assessing children's knowledge of spelling-sound correspondences. In general, these studies have shown that children do abstract information relating spelling and sound in English in the course of learning to read, and that they learn the simple correspondences between letters and sounds before they learn more complex relations. Poor readers abstract the rules relating spelling and sound at a slower rate than do good readers and have particular difficulty with complex correspondences. By about fourth grade, good readers have acquired knowledge of these rules comparable to that of skilled, older readers (Backman, Bruck, Hebert, & Seidenberg, in press).

Taken with the adult studies reviewed above, these studies indicate that reliance on spelling-sound information decreases as the reader becomes more skilled. The evidence is largely from studies using the pronunciation task, however, and these studies do not directly answer questions concerning the more natural tasks of reading words in context and silent reading. A shift in the child's decoding processes on the naming task might not be accompanied by a concomitant shift on other reading tasks.

In the present studies, we investigated children's and adults' use of spelling-sound knowledge in reading. Four questions were addressed: (1) Do children who differ in reading ability differ in their reliance upon spelling-sound information; (2) do children and adults differ in their use of such information; (3) does reliance on this information vary depending upon the frequency of the words being read; and (4) are children and adults more likely to use spelling-sound information with some reading tasks than with others? The basic strategy was to compare subject's ability to read words that differed in terms of the regularity of the correspondence between spelling and sound. Subjects read words that had (1) common spelling patterns and regular spelling-sound correspondences (regular words, such as "must"), (2) common spelling patterns but irregular spelling-sound correspondences (exception words, such as "have"), and (3) both uncommon spelling patterns and irregular spelling-sound correspondences (strange words, such as "ache"). Both high- and low-frequency items of each type were included. If readers are using phonological information derived from knowledge of spelling-sound correspondences, words that have irregular correspondences should be more difficult to read than words that have regular correspondences. This would yield longer latencies and/or more errors for exception and strange words than would occur with regular words. If irregular spelling-sound correspondences have no effect on a given reading task, performance on regular and exception words should be similar, because both classes of words have common orthographic patterns. However, strange words could still be more difficult to process than regular words, due simply to the atypicality of their orthographic patterns.

Subjects' ability to read these words was assessed using three tasks: pronunciation, lexical decision, and a sentence acceptability task. The intent was to determine whether or not reliance upon phonological information differed depending on (1) whether or not the task required overt pronunciation (pronunciation vs. lexical decision and acceptability) and (2) whether the stimuli were single words or meaningful text (pronunciation and lexical decision vs. acceptability).

EXPERIMENT 1

Method

Subjects. Thirty children participated in the study; 14 were poor readers and 16 were good readers. All children were tested on the comprehension subtest of the Stanford Diagnostic Reading Test. The children in the poor-reader group were reading at least 5 months below grade level, and those in the good-reader group were reading at least 5 months above grade level. The reading levels of the poor readers ranged from the 2.6 to the 3.1 grade level, with a mean of 2.9 (22nd percentile). The good readers' comprehension scores ranged from the 4.4 to the 7.0 grade level, with a mean of 4.8 (79th percentile). All children were native speakers of English.

All children participated in all tasks. However, the data of two poor readers were deleted from the analysis of the lexical decision task because they made errors on more than 60% of the nonword trials, indicating that they did not understand the task.

Stimuli. The same words were used in the pronunciation, lexical decision, and sentence acceptability tasks. Six classes of words were created by crossing two factors, frequency (high, low) and word type (regular, exception, or strange). There were 12 monosyllabic words in each class (Appendix A). Words within the spoken vocabularies of Grade 3 children were chosen. The words in each frequency group were matched as closely as possible for frequency and length. Strange words differed from the regular and exception words in that they had unusual spellings, since there were no or very few other monosyllabic words in English with the same ending (e.g., "-che"). The median word frequencies, based on the Carroll, Davies, and Richman (1971) word count, for the high-frequency regular, exception, and strange words were 2,061, 3,075, and 2,338, respectively. For the low-frequency stimuli, they were 167, 171, and 176, respectively. In the lexical decision task, an additional 24 filler trials of pronounceable nonwords were included. The nonwords were derived from real words by changing the initial consonant (e.g., "hope" to "bope"). All nonwords had regular orthographic patterns, and none were pseudohomophones. These stimuli were interspersed randomly among the word trials.

The target stimuli for the sentence acceptability task consisted of the words that were used in the pronunciation and lexical decision tasks. The words were presented in the context of a two-sentence frame. Each target word provided a meaningful completion to the sentence frame. For example, the word "break" was preceded by the frame "The glass fell on the floor. I hope it did not . . . ." There were also 25 filler trials in which the target word formed a nonsensical completion. For example, the word "black" was preceded by the sentence "The weather was nice yesterday. The sun was bright and the sky was . . . ." The target words on the filler trials did not include any of the regular, exception, or strange test words.

Procedure. The experiment was controlled by an Apple II microcomputer equipped with a real-time clock and a video monitor (Amdek Video-300). The clock operated on a timebase of .001 sec. A hardware modification was performed to eliminate the timing error associated with the 60-Hz scanning rate of the CRT (Reed, 1979). In the pronunciation and lexical decision tasks, each stimulus was presented singly in lowercase letters in the center of the video display. In the pronunciation task, the subject read the word aloud as quickly as possible into a microphone connected to a voice key interfaced to the computer. Mispronunciations were recorded by hand. In the lexical decision task, the subject indicated whether the stimulus was a word or a nonword by pressing microswitches interfaced to the computer. Latency was timed from the onset of the stimulus to the onset of the subjects' response. The stimulus remained on the screen until the subject responded. The intertrial interval was 2 sec.

In the sentence acceptability task, the two-sentence frame first appeared on the screen. The experimenter read the sentence frame aloud and then pressed a key, which resulted in erasure of the sentence frame and presentation of the target word on the screen. The subject was then required to indicate whether or not the target word made sense, given the preceding sentence context, by pressing one of two microswitches. Latency was timed from the onset of the target word to the onset of the subject's response.

The stimuli for each task were preceded by a block of practice trials. The experimental trials were presented in two blocks for the pronunciation and lexical decision tasks and in three blocks for the sentence acceptability task, with words from each class randomly ordered within blocks. The subjects performed the three tasks on separate days in the order: lexical decision, pronunciation, sentences.

Results

Two sets of scores were computed for each task, one based on the subjects' correct median reaction times and the other on the square root of the number of errors (Myers, 1972). Separate analyses of variance were computed for each task, using both error and latency data and with the factors being reader group (good or poor), word frequency (high or low), and word class (regular, exception, or strange). Whenever there was a significant main effect or interaction, Newman-Keuls tests were used to compare differences between conditions. The critical comparisons between word classes were the following. Regular words were compared with both exception and strange words to determine if there was an exception or strange effect. When there was a word class x frequency interaction, these differences were examined within each frequency group (e.g., high-frequency regular vs. exception). Differences between means that were significant at the $p < .05$ level are reported. Data for the nonwords in the lexical decision task and for the semantically anomalous sentences in the sentence task were excluded from the analyses.

Pronunciation task. The means of the good and the poor readers' median pronunciation times and percentages of errors are presented in Table 1. In the analysis of the error data, there were significant main effects of group [$F(1,28) = 44.51$, $p < .001$], frequency [$F(1,28) = 224.51$, $p < .001$], and word class [$F(2,56) = 50.06$, $p < .001$], as well as significant interactions between word class and group [$F(2,56) = 3.89$, $p < .05$] and word class and frequency [$F(2,56) = 8.75$, $p < .001$]. For both groups, higher frequency words produced fewer errors than lower frequency words. The post hoc analysis of the word class x frequency interaction showed that for low-frequency words there were both exception and strange effects, whereas for high-frequency words there was only an exception effect. Post hoc analyses of the word class x group effect failed to show that there were differences between the word-class effects obtained for good and poor readers. The interaction resulted because of specific between-group comparisons that are not of interest in the present paper.

The analysis of the reaction time scores again resulted in significant main effects of group [$F(1,28) = 17.76$, $p < .001$], frequency [$F(1,28) = 17.76$, $p < .001$], and word class [$F(2,56) = 7.23$, $p < .01$], as well as significant two-way interactions between group and frequency [$F(1,28) = 11.86$, $p < .01$], word class and group [$F(2,56) = 4.99$, $p < .01$], and word class and frequency [$F(2,56) = 7.08$, $p < .01$] and a three-way interaction among word class, frequency, and group [$F(2,56) = 5.01$, $p < .01$]. For both groups, higher frequency words were read more quickly than lower frequency words; however, the frequency effect was larger for less skilled readers. Post hoc tests indicated that only the poor readers showed a low-frequency strange effect, whereas neither reader group showed an exception or a strange effect for high-frequency words.

To summarize, both good and poor readers made more errors on low-frequency exception and strange words than they did on regular words, and on high-frequency exception words than on regular words. In terms of pronunciation latencies, the good readers showed no word-class effects, whereas the poor readers read low-frequency strange words more slowly than low-frequency regular words.

Lexical decision task. The mean of the subjects' median reaction times and percentages of errors on the lexical decision task are shown in Table 2. An analysis of the error data revealed significant main effects of group [$F(1,26) = 21.84$, $p < .001$], frequency [$F(1,26) = 122.50$, $p < .001$], and word class [$F(2,52) = 14.65$, $p < .001$]. In addition, there were significant two-way interactions between frequency and group [$F(1,26) = 23.08$, $p < .001$] and frequency and word class [$F(2,52) = 5.17$, $p < .001$], as well as a significant three-way interaction among group, frequency, and word class [$F(2,52) = 4.42$, $p < .05$]. Lower frequency words again produced more errors for both groups, and the difference between high- and low-frequency words was greater for poor readers. Post hoc tests indicated that poor readers showed both high- and low-frequency exception and strange effects. In contrast, the good readers showed only low-frequency exception and strange effects.

In the analysis of the latency data, there were significant main effects of group [$F(1,26) = 7.08$, $p < .05$], frequency [$F(1,26) = 15.00$, $p < .001$], and word class [$F(2,52) = 4.02$, $p < .05$], as well as significant interactions between frequency and group [$F(1,26) = 5.63$, $p < .05$], and word class and frequency [$F(2,52) = 4.02$, $p < .05$]. Analysis of the frequency x word class interaction indicated that there were exception and strange effects for low-frequency words only.

To summarize, good readers showed low-frequency exception and strange effects in terms of both reaction times and errors. Poor readers showed both high- and low-frequency exception and strange effects in terms of errors and low-frequency exception and strange effects

Table 1
Mean Pronunciation Latencies (MPL; in Milliseconds) and Percentage of Errors (PE), Experiment 1.

	Word Frequency			
	Low		High	
Word Class	MPL	PE	MPL	PE
	Poor Readers			
Regular	1556	25.0	1095	14.3
Exception	1547	48.2	1275	27.3
Strange	2475	51.3	1184	15.5
	Good Readers			
Regular	746	7.3	720	1.6
Exception	791	35.4	739	11.5
Strange	851	20.8	726	1.0

Table 2
Mean Lexical Decision Latencies (MLDL; in Milliseconds) and Percentage of Errors (PE), Experiment 1.

	Word Frequency			
	Low		High	
Word Class	MLDL	PE	MLDL	PE
	Poor Readers			
Regular	1719	20.8	1566	2.7
Exception	2038	25.7	1602	9.0
Strange	2238	49.3	1609	8.3
	Good Readers			
Regular	1050	1.6	1042	1.0
Exception	1140	15.6	1085	3.6
Strange	1197	10.4	969	2.1

in terms of reaction times. The data from the lexical decision task, then, show that good readers use spelling-sound information when making lexical decisions about low-frequency words but not high-frequency words. Poor readers use spelling-sound information when making lexical decisions about both high- and low-frequency words.

Sentence acceptability task. The latency and error data for the sentence acceptability task are presented in Table 3. An analysis of the error data revealed significant main effects of group [$F(1,28) = 15.68$, $p < .001$], frequency [$F(1,28) = 51.58$, $p < .001$], and word class [$F(2,56) = 17.92$, $p < .001$]. In addition, there were significant two-way interactions between group and frequency [$F(1,28) = 4.61$, $p < .05$] and frequency and word class [$F(2,56) = 8.92$, $p < .001$]; there was also a significant three-way interaction among group, frequency, and word class [$F(2,56) = 5.66$, $p < .01$]. Post hoc analyses showed that, whereas good readers showed a low-frequency exception effect and a high-frequency strange effect, poor readers showed both exception and strange effects for both high- and low-frequency words.

In the analysis of the latency data, there was a significant main effect for group [$F(1,28) = 13.32$, $p < .001$]. The only other significant effect was the interaction between frequency and word class [$F(2,56) = 5.05$, $p < .01$], which resulted from a low-frequency strange effect for both good and poor readers.

In summary, on the sentence task, poor readers showed both high- and low-frequency exception and strange effects in terms of errors and a low-frequency strange effect in reaction time. Good readers showed low-frequency exception and high-frequency strange effects in terms of errors and a low-frequency strange effect in reaction times.

Discussion

On all three tasks, there were main effects of group for both reaction time and error data, indicating that good readers recognized words more efficiently than poor readers, as expected. Across all tasks, high-frequency words were responded to more quickly and with fewer errors than low-frequency words; however, the difference between frequency classes was greater for poor readers.

When the task demanded overt pronunciation of a word, good readers showed low-frequency exception and strange effects and a high-frequency exception effect. The finding of both exception and strange effects for low-frequency words shows that good readers used spelling-sound information in reading these words. The finding of a high-frequency exception effect for Grade 3 good readers is consistent with findings by Backman et al. (in press) and Waters, Bruck, and Seidenberg (1983), who reported similar results for good readers of this age. However, this finding is in contrast with results reported by Seidenberg et al. (in press) and Waters and Seidenberg (1984) for adults, who did not show an exception effect for high-frequency words in pronunciation. This is consistent with the idea that older, more skilled readers are able to identify a larger pool of words without interference from irregular spelling-sound correspondences.

Given that the exception effect is attributed to the irregular spelling-sound correspondences of exception words, it is surprising that a similar effect was not seen for high-frequency strange words, which also have irregular spelling-sound correspondences. However, a similar result was found by Waters et al. (1983) for Grade 3 children who were both good readers and good spellers. These data suggest that common strange words are not as difficult to process as exception words. They may be easier to read because their atypical orthographic patterns make them easy to discriminate from other words. However, one piece of evidence against this hypothesis is the finding of a high-frequency strange effect on the sentence task for the good readers in the present study.

The failure to find a high-frequency exception effect for the good readers on either of the silent reading tasks, lexical decision or sentence judgment, shows that good readers were not affected by spelling-sound irregularity for high-frequency words when overt pronunciation was not required. The data from the lexical decision task show that, as with adults (Seidenberg et al., in press), children who are good readers recognize high-frequency words without phonological mediation. The finding of a low-frequency exception effect in lexical decision performance is consistent with Waters and Seidenberg's (1984) finding that skilled readers show such an effect when the stimuli include strange words.

Poor readers showed effects of spelling-sound irregularity for both high- and low-frequency words on all three tasks. Their ability to recognize high-frequency words on a visual basis is not as well-developed as that of good readers, who did not show an exception effect on either of the silent reading tasks, lexical decision and sentence acceptability. The special difficulty of low-frequency strange words for the poor readers is indicated

Table 3
Mean Reaction Times (MRT; in Milliseconds) and Percentage of Errors (PE) on the Sentence Acceptability Task, Experiment 1

	Word Frequency			
	Low		High	
Word Class	MRT	PE	MRT	PE
	Poor Readers			
Regular	1550	11.3	1405	5.9
Exception	1530	26.2	1536	10.1
Strange	1851	30.3	1473	13.1
	Good Readers			
Regular	1092	4.7	1018	2.1
Exception	1098	14.1	1159	2.6
Strange	1133	6.2	1018	7.8

by the fact that they were the only ones to show consistent effects in both reaction time and error data.

In summary, both the good and the poor readers' performance differed from that of skilled adult readers. Poor readers used spelling-sound information in processing high- and low-frequency words in all tasks. Good readers showed a more adult-like pattern of performance but, in contrast to adults, continued to use spelling-sound information when pronouncing high-frequency words.

The results from the sentence acceptability task were consistent with those for the other tasks, indicating that effects of spelling-sound irregularity occur even when subjects read words in context. In addition, this finding suggests that, at least for these children, the exception effect is not an artifact of having to pronounce a word aloud (as in pronunciation) or of making a conscious word-nonword judgment (as in lexical decision).

In Experiment 2, we examined the performance of older children, and in Experiment 3, of adults on these tasks. The primary goal was to determine whether more skilled readers would show effects of spelling-sound irregularity on the sentence task; pronunciation and lexical decision were included for comparison.

EXPERIMENT 2

Method

Subjects. Nineteen fifth-graders who were native speakers of English and whose reading scores on the comprehension subtest of the Gates-MacGintie reading test fell not more than 1 year below grade level participated in the experiment. Their scores ranged from the 4.0 to the 8.4 grade level, with a mean grade level of 5.7. On average, these children were reading two grade levels above the poor readers and one grade level above the good readers from Experiment 1.

Stimuli. Stimuli for the pronunciation and lexical decision tasks were created by crossing two factors, frequency (high, low) and word type (regular, exception, strange). The same stimuli were used for the sentence acceptability task, but the strange words were deleted due to limitations on the amount of time the children were available. There were 15 monosyllabic words in each class (Appendix B). The words in each frequency group were matched as closely as possible for frequency and length. The median frequencies, based on the Carroll et al. (1971) word count, for the high-frequency words were: exception, 4,408; strange, 2,690; regular, 4,089. For the low-frequency stimuli, the median frequencies were: exception, 144; strange, 141; and regular, 117. For the lexical decision task, 60 pronounceable nonwords were included. They were constructed as in Experiment 1 and were interspersed randomly among the word trials. The stimuli for the sentence task were constructed in the same manner as in Experiment 1. The target words were the high- and low-frequency regular and exception words used in the pronunciation and lexical decision tasks. There were also 25 filler trials for which the target words formed nonsensical completions.

Procedure. The procedures for all three tasks were identical to those in Experiment 1, except that in the sentence acceptability task, the subjects read the sentences to themselves and then pressed a button, which resulted in the erasure of the sentence context from the screen and the presentation of the target word.

Results

Pronunciation task. The mean of the subjects' median naming latencies for correct responses in each of the six word classes and the percentages of errors are shown in Table 4. In the analysis of the error data, there were significant main effects of frequency [$F(1,18) = 40.12$, $p < .001$] and word class [$F(2,36) = 47.36$, $p < .001$]. In addition, there was a significant frequency x word class interaction [$F(2,36) = 12.05$, $p < .001$]. Post hoc analyses of the interaction showed that there were exception and strange effects for lower frequency words, but no differences among the higher frequency word classes.

In the analysis of the reaction time data, there was a significant main effect of frequency [$F(1,18) = 31.32$, $p < .001$], which resulted from longer pronunciation latencies for lower frequency words.

Lexical decision task. Table 5 shows the mean of the subjects' median reaction times and percentages of errors on this task. Analysis of the error data yielded main effects of frequency [$F(1,18) = 30.48$, $p < .001$] and word class [$F(2,36) = 10.15$, $p < .001$] and an interaction between frequency and word class [$F(2,36) = 4.04$, $p < .05$]. The results of post hoc tests indicated that children showed low- but not high-frequency exception and strange effects.

In the analysis of the reaction time data, there were significant main effects of frequency [$F(1,18) = 33.05$, $p < .001$] and word class [$F(2,36) = 6.17$, $p < .01$], and a marginal frequency x word class interaction [$F(2,36) = 2.95$, $p < .06$]. Post hoc analysis of the interaction showed that there was a low-frequency strange effect and a high-frequency exception effect.

Sentence acceptability task. Table 6 shows the subjects' median reaction times and percentages of errors on this task. In the analysis of the error data, there were a significant main effect of frequency [$F(1,18) = 5.28$, $p < .05$] and a frequency x word class interaction [$F(1,18) = 22.79$, $p < .001$]. Post hoc analysis of the in-

Table 4
Mean Pronunciation Latencies (MPL; in Milliseconds) and Percentage of Errors (PE), Experiment 2.

	Word Frequency			
	Low		High	
Word Class	MPL	PE	MPL	PE
Regular	704	1.8	628	1.1
Exception	701	16.9	660	2.5
Strange	728	8.8	656	1.1

Table 5
Mean Lexical Decision Latencies (MLDL; in Milliseconds) and Percentage of Errors (PE), Experiment 2.

	Word Frequency			
	Low		High	
Word Class	MLDL	PE	MLDL	PE
Regular	1013	6.3	819	1.8
Exception	1036	14.4	915	5.6
Strange	1105	15.4	876	1.8

Table 6
Mean Reaction Times (MRT; in Milliseconds) and Percentage of Errors (PE) on the Sentence Acceptability Task, Experiment 2

	Word Frequency			
	Low		High	
Word Class	MRT	PE	MRT	PE
Regular	1150	7.7	1173	8.4
Exception	1227	15.5	1124	6.3

teraction showed that there was a low-frequency exception effect.

The analysis of the reaction time data produced a significant frequency x word class interaction [$F(1,18) = 5.96$, $p < .05$]. Consistent with the error data, there was a low-frequency exception effect.

Discussion

The results for these older children on the naming task are very similar to those found by Seidenberg et al. (in press) and Waters and Seidenberg (1984) with adults, and contrast with those for the younger children in Experiment 1. For lower frequency words, more errors were made on both exception and strange words than on regular words, showing that spelling-sound regularity affected the pronunciation of these items. There were no statistically significant differences among the error rates on the higher frequency words, suggesting that by Grade 5 the pronunciations of high-frequency words are mainly accessed via a postlexical route that does not involve spelling-sound knowledge. A similar result was obtained by Backman et al. (in press) for fourth-grade children reading above grade level.

The results for the lexical decision task indicate that the Grade 5 children relied upon knowledge of spelling-sound correspondences when making lexical decisions about words. High-frequency exception words yielded longer reaction times than did regular words. Lower frequency exception and strange words also yielded more errors than regular words. The low-frequency exception effect is again consistent with Waters and Seidenberg's (1984) finding that skilled readers show this result when the stimuli include strange words. The finding of a high-frequency exception effect contrasts with the data for adults and for the good readers in Grade 3. However, given that these children did not show such an effect on any other task, and that Grade 3 good readers did not show such an effect, this result may reflect a Type I error and should be interpreted with caution.

The data from the sentence acceptability task suggest that children continue to use spelling-sound information in recognizing low-frequency words when the words occur in an appropriate sentence context, even when overt pronunciation of the sentence context or the target word is not required. The purpose of Experiment 3 was to determine whether adults would show a comparable effect on the sentence task; again, the pronunciation and lexical decision tasks were included for comparison

EXPERIMENT 3

Method

Subjects. Forty-five McGill University undergraduates participated in the experiment, 15 in each of the pronunciation, lexical decision, and sentence tasks. All subjects were native speakers of English and were paid for participating.

Stimuli. The target words for the pronunciation and lexical decision tasks consisted of high- and low-frequency regular, exception, and strange words. The same target words were used for the sentence task, except that the strange words were not included. There were 12 monosyllabic words in each class (Appendix C). The words in each frequency group were closely matched for frequency. Median word frequencies (Carroll et al., 1971) for the high-frequency exception, strange, and regular words were 623, 661, and 624, respectively; for the lower frequency exception, strange, and regular words, they were 29, 17, and 21, respectively. In addition to the target trials, there were 36 nonword filler trials in the lexical decision task and 26 filler trials in the sentence task in which the target words formed nonsensical completions.

Procedure. The procedure was identical to that in the previous experiment.

Results and Discussion

Analyses of variance were computed on the subjects' median reaction times and on the square root of the number of errors, with the factors being word frequency (high or low) and word class (regular, strange, or exception for the pronunciation and lexical decision tasks, and regular or exception for the sentence task).

Pronunciation task. The mean of the subjects' median pronunciation latencies for correct responses in each of the six word classes and the percentages of errors in each class are shown in Table 7. In the analysis of the error data, there were significant main effects of frequency [$F(1,14) = 110.43$, $p < .001$] and word class [$F(2,28) = 4.03$, $p < .05$], and a frequency x word class interaction [$F(2,28) = 7.55$, $p < .01$]. Post hoc tests indicated that the interaction was due to a low-frequency strange effect.

In the analysis of the reaction time data, there were significant main effects of frequency [$F(1,14) = 32.52$, $p < .001$] and word class [$F(2,28) = 24.16$, $p < .001$], and a frequency x word class interaction [$F(2,28) = 38.65$, $p < .001$]. The interaction resulted from longer

Table 7
Mean Pronunciation Latencies (MPL; in Milliseconds) and Percentage of Errors (PE), Experiment 3.

	Word Frequency			
	Low		High	
Word Class	MPL	PE	MPL	PE
Regular	503	6.7	522	1.1
Exception	549	9.4	508	.5
Strange	604	17.8	508	

Table 8
Mean Lexical Decision Latencies (MLDL; in Milliseconds) and Percentage of Errors (PE), Experiment 3.

	Word Frequency			
	Low		High	
Word Class	MLDL	PE	MLDL	PE
Regular	616	5.0	561	1.7
Exception	651	11.1	567	.5
Strange	700	16.7	587	1.7

Table 9
Mean Reaction Times (MRT; in Milliseconds) and Percentage of Errors (PE) on the Sentence Acceptability Task, Experiment 3

	Word Frequency			
	Low		High	
Word Class	MRT	PE	MRT	PE
Regular	770	3.8	794	4.4
Exception	855	17.7	767	10.0

pronunciation latencies for low-frequency exception and strange words than for low-frequency regular words.

Lexical decision task. Table 8 shows the mean of the subjects' median reaction times and percentages of errors on this task. Analysis of the error data yielded main effects of frequency [$F(1,14) = 33.20$, $p < .001$] and word class [$F(2,28) = 6.47$, $p < .01$], and a frequency x word class interaction [$F(2,28) = 5.95$, $p < .01$]. The interaction resulted from more errors on low-frequency exception and strange words than on low-frequency regular words but no differences across word classes for the high-frequency items.

In the analysis of the reaction time data, there were significant main effects of frequency [$F(1,14) = 77.42$, $p < .001$] and word class [$F(2,28) = 10.03$, $p < .01$], but no interaction. The frequency effect was due to longer reaction times for low-frequency words than for high-frequency words, and the word-class effect resulted from longer reaction times for strange words than for regular words.

Sentence acceptability task. In the analysis of the error data (see Table 9), the effect of word class [$F(1,14) = 5.10$, $p < .05$] and the interaction between word class and frequency [$F(1,14) = 19.64$, $p < .01$] were significant. The frequency x word class interaction indicated that the subjects showed a low- but not a high-frequency exception effect. In the analysis of the reaction time data, there was a significant frequency x word class interaction [$F(1,14) = 5.05$, $p < .05$]. Post hoc tests showed that there was an exception effect for low- but not for high-frequency words. These results demonstrate that there is an exception effect in the sentence acceptability task, even for skilled readers.

GENERAL DISCUSSION

The results of these studies suggest that the extent to which irregular spelling or spelling-sound correspondences influence word recognition depends on the skill and age of the reader, the familiarity of the words, and the type of reading task. Comparisons between good and poor third-grade readers, and between fifth-grade children and adults, indicated that younger, less skilled readers showed greater effects than older, more skilled readers.

The performance of the skilled adult readers on the pronunciation and lexical decision tasks indicates that the effects of irregular spelling and spelling-sound correspondences are limited to lower frequency words. It is clear that skilled readers are able to recognize and pronounce a large pool of common words without interference from irregularities in spelling or pronunciation. The highly skewed frequency distribution for words in English–specifically, the fact that a relatively small pool of items accounts for a very large proportion of the tokens actually used (McCusker, Hillinger, & Bias, 1981)–suggests that these irregularities have little effect on skilled reading (Seidenberg, in press).

The data from the pronunciation task replicate our previous findings with adults (Seidenberg et al., in press; Waters & Seidenberg, 1984) showing that both irregular spelling and irregular pronunciation influence the naming of lower frequency words. The data from the lexical decision task, indicating an exception effect for lower frequency words, contrast with those of Seidenberg et al. (in press), but are consistent with those of Waters and Seidenberg (1984). The latter study provides the explanation for the inconsistent results of these and other studies (e.g., Coltheart et al., 1979; Parkin, 1982). The occurrence of an exception effect in lexical decision depends upon the composition of the stimuli. When the stimuli include only words with regular orthographic patterns (i.e., regular and exception words), no effect of spelling-sound regularity is found (as in Seidenberg et al.'s, in press, Experiment 3). When the stimulus set is a heterogeneous mix including words with both regular and irregular orthographic patterns (i.e., regular, exception, and strange words), the effect is obtained. Thus, the presence or absence of strange words controls the occurrence of the exception effect for lower frequency words in lexical decision. Waters and Seidenberg (1984) suggested that the composition of the stimuli affects the criteria subjects establish for making word/nonword decisions. Whether or not an effect of irregular pronunciation occurs in this task depends upon how these criteria are set relative to the time course of phonological code activation. If the visual analysis provides enough information for lexical decisions to be made before phonological information has been accessed, no effect of spelling-sound regularity is seen. If the decision process is slowed by the inclusion of orthographically irregular words, effects of spelling-sound regularity begin to emerge.

Although the finding of an exception effect for low-frequency words on the pronunciation and lexical decision tasks replicates our previous work, it has not been clear how performance on these tasks relates to reading under more natural conditions. These tasks involve task-specific demands that may not be implicated in normal silent reading. To examine this possibility, the present studies included a sentence meaningfulness judgment task, which avoided the requirement that subjects name words aloud or perform word/nonword discriminations. Adults' performance on this task was very similar to that on the pronunciation and lexical decision tasks, in that they showed effects of spelling-sound regularity for low- but not high-frequency words. This finding is important because it demonstrates that the effects of irregular pronunciation are not merely a consequence of having to say words aloud or to make a lexical decision. Furthermore, irregular spelling-sound correspondences affected responses on the sentence task even though the stimulus set did not contain orthographically irregular words. As in naming, but in contrast to lexical decision, the exception effect in the sentence task is not dependent upon the inclusion of strange words. This result provides clear evidence that irregular spelling-sound correspondences influence the recognition of lower frequency words among skilled adult readers.

Treiman, Freyd, and Baron (1984) also investigated skilled adult readers' ability to read sentences containing regular and exception words. In their study, target regular and exception words were embedded in sentence contexts. The regular and exception words were matched pairs (e.g., "great, greet") chosen such that if the exception word were pronounced according to the major spelling-sound correspondences of English, it would sound like the regular word. Subjects were required to judge whether the sentences were meaningful or not. Subjects made more errors on sentences containing target exception words than on sentences containing target regular words, suggesting that phonological codes were derived by the use of spelling-sound rules. Treiman et al. concluded that spelling-sound rule use continues to be important even for skilled readers.

In the Treiman et al. (1984) study, the stimuli consisted of a mix of high- and low-frequency words. As we have now demonstrated in several studies, the effects of spelling-sound irregularity for skilled readers are limited to lower frequency words. Although Treiman et al. did not evaluate the effects of frequency, the exception effect was significant in their study when the data were analyzed on a by-subject basis, but not by-items, suggesting that their effect might also have been carried by the lower frequency words. A second difference between the studies is that in the Treiman et al. experiment the stimuli consisted of pairs of words containing very similar spelling patterns. Seidenberg et al. (in press) have found that the repetition of similar spelling patterns with different pronunciations within an experiment produces priming effects that result in larger effects of spelling-sound irregularity than when spelling patterns are not repeated. The subject's first encounter of a spelling pattern (e.g., "have") biases the encoding of a subsequent word with the same spelling pattern, but a different pronunciation (e.g., "gave"). A similar effect may have occurred in the Treiman et al. study, in which regular and exception words with very similar spelling patterns (e.g., "size" and "seize") were presented within subjects.

While the effects of irregular spelling and irregular spelling-sound correspondences were specific to lower frequency words for adults, these effects were also seen with high-frequency words for less skilled readers. Poor readers in Grade 3 showed effects of irregular spelling and irregular spelling-sound correspondences for both high- and low-frequency words on all three tasks. Grade 3 good readers showed effects of irregular pronunciation for high-frequency words on the overt pronunciation tasks but not on the silent reading tasks. By the fifth grade, the children showed a pattern of performance very similar to that of adult skilled readers.

The data from all three reading tasks point to greater involvement of phonological information in word recognition in the early stages of learning to read than in skilled reading. It has long been argued that the use of phonological information may be more important for beginning readers than for skilled readers. Edfeldt (1959), for example, suggested that children use phonological information when reading all words initially but that as words become more familiar they are identified on a visual basis. However, studies by Barron and Baron (1977), Condry, McMahon-Rideout, and Levy (1979), and Rader (1975) failed to support this view because they provided evidence that even very young children were using visual, as opposed to phonological, codes in accessing meaning.

Several researchers have attempted to reconcile these views by suggesting that whether children recognize words on a direct visual basis or through the use of phonological mediation depends on their strategy for performing the task (McCusker et al., 1981; Jorm & Share, 1983). According to this view, phonological mediation and direct visual access represent alternative routes to word recognition; readers are thought to be flexible in using these alternatives, with the use of a particular route dependent on such factors as word frequency, length, difficulty of the text, and reading skill. This leads to a view of reading education in which the goal is to develop flexibility in decoding processes (Jorm & Share, 1983). Coltheart et al. (1979) suggested that these alternatives are also available to skilled readers. On this view, then, access of phonological information is a strategic option under the subject's control; phonology is more likely to be used when words are unfamiliar or difficult to decode. Because recognition via the phonological route is thought to be slower than direct visual access, greater reliance on phonology has been associated with less skillful reading (Doctor & Coltheart, 1980).

An alternative view, however, is that, except perhaps among very young readers whose decoding processes are not automatized, access of phonological information in immediate decoding is not a strategy under subject control. Rather, it depends upon the time course of the recognition process (Seidenberg et al., in press; Waters & Seidenberg, 1984). On this view, both orthographic and phonological information automatically become available as a word is being processed; access of phonological information is not under strategic control, but, rather, depends upon how long this information has to accrue. Visual information is extracted over time, and as common orthographic units are identified, their phonological representations are activated. Access of phonological information lags somewhat behind the visual analysis because it is parasitic upon prior visual processing. Therefore, the effects of spelling-sound regularity depend upon how long the recognition process takes. When the visual analysis allows recognition to be achieved before the phonological process has been initiated, no effect of spelling-sound regularity will be seen. If the recognition process is slowed (e.g., because the reader's visual decoding skills are poor, the word is unfamiliar, or the subject establishes a conservative response criterion in the lexical decision task), effects of spelling-sound regularity begin to emerge.[1] According to this hypothesis, younger and poorer readers show greater effects of spelling-sound irregularity because of the relative inefficiency of their visual recognition processes. These readers are unable to recognize even high-frequency words prior to the activation of phonological information. As children become more skilled readers, however, they become able to recognize a larger pool of words strictly on the basis of visual information, obviating effects of irregular spelling or spelling-sound correspondences.

Within this model of the recognition process, the factor that determines whether phonological effects occur is simply decoding speed. For skilled readers, lower frequency words are likely to produce such effects because frequency is inversely related to recognition time. However, recognition speed varies across subjects. Some very skilled readers are able to recognize even lower frequency words rapidly enough to obviate phonological effects. Thus, in a study by Seidenberg (in press), the exception effect for lower frequency words was specific to subjects whose naming latencies were slow. In the Waters and Seidenberg (1984) study, the exception effect was also entirely due to subjects whose lexical decision latencies were slow. In effect, fast decoders treat a larger class of items as "high-frequency" items. Conversely, for younger readers the pool of "high-frequency" words recognized on a visual basis is much smaller.

In sum, skilled readers acquire the ability to rapidly recognize common words without interference from irregular spelling or spelling-sound correspondences. Poorer and younger readers are more affected by these characteristics of words. However, these factors continue to influence the decoding of lower frequency words by skilled adults, even when they are read silently in context. Among skilled readers, then, phonological information may become available either during the initial decoding of a word (prelexically) or as a consequence of recognition (postlexically), depending on the speed of the recognition process. In either case, the result is rapid access of phonological information. Although this information appears to have a limited role in recognizing words among skilled readers, it may serve to facilitate the retention in working memory of a sequence of syllables (in a multisyllabic word) or a sequence of words (in a phrase or sentence) prior to recoding into a higher level, meaning-based representation.

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NOTE

1. It should be noted that comparisons of absolute reaction times across tasks and across subject groups can only be made with caution because reaction times on each of the tasks reflect not only time to recognize the word but other processing as well. Reaction times on the pronunciation task also reflect time to access and produce the motor program for a given word, on the lexical decision task time to make the word/nonword decision, and on the sentence task time to make the acceptability judgment. For example, for the adults in Experiment 3, reaction times for the high-frequency words on the sentence task are actually longer than those for even the low-frequency words on the lexical decision task, and yet effects of spelling-sound regularity are seen in the latter but not in the former case. However, the longer reaction times on the sentence task than on the lexical decision task likely reflect processing that is subsequent to recognition of the word (the greater difficulty of deciding that a whole sentence is acceptable compared to deciding that a letter string is or is not a word). In a similar vein, lexical decision latencies for high-frequency words for the Grade 5 children in Experiment 2 are actually shorter than those for the good Grade 3 readers in Experiment 1, and yet in the former case an effect of spelling-sound regularity is seen, whereas in the latter case it is not. However, a larger proportion of the reaction time likely reflects recognition time for the Grade 5 children than for the Grade 3 children because making the word/nonword decision may be easier for older children.

Appendix A
Stimuli Used in Experiment 1

Regular	Strange	Exception
	High Frequency	
best	school	both
green	once	great
day	friend	done
bring	eye	heard
heat	earth	does
door	two	some
stick	piece	says
strong	sign	shall
still	key	foot
free	young	give
got	world	put
part	front	break
	Low Frequency	
beach	yolk	sew
dime	sword	bush
stuck	guard	deaf
gate	axe	steak
pest	ache	gross
dust	busy	pint
burst	sleigh	doll
turn	climb	bowl
beef	tongue	touch
wake	laugh	broad
luck	weird	wool
sock	view	lose

Appendix B
Stimuli Used in Experiment 2

Regular	Strange	Exception
	High Frequency	
part	friend	done
time	front	give
not	earth	both
still	once	some
life	two	have
held	his	shall
stop	school	says
each	their	put
just	who	does
take	piece	said
name	young	great
help	group	were
with	from	are
or	world	do
page	she	what
	Low Frequency	
plump	laugh	gross
carve	bulb	steak
yell	juice	deaf
rink	guy	spook
cub	tongue	pint
hunt	debt	wool
gate	worse	broad
tent	earn	lose
pest	comb	choose
oak	view	sew
stuff	yolk	doll
sock	sleigh	worm
truck	seize	touch
soap	ghost	shoe
smile	choir	wash

Appendix C
Stimuli Used in Experiment 3

Regular	Strange	Exception
	High Frequency	
thin	earth	watch
least	piece	choose
nine	sign	touch
race	view	break
these	knife	some
face	eye	says
beach	friend	wool
shell	once	lose
wake	ghost	wash
still	two	doll
feel	climb	give
corn	tongue	heard
	Low Frequency	
mode	gauge	deaf
fern	sword	tomb
pest	seize	steak
math	chute	soot
hike	heir	worm
chore	aisle	sew
greed	brooch	phase
grill	tsar	gross
dock	corps	plaid
bakes	sieve	wan
tile	choir	caste
rust	weird	wand

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NOTICES

Search for Editor of *Memory & Cognition*

The new editor is expected to begin handling submissions about January 1, 1985, or shortly thereafter. Nominations of qualified individuals should be sent to Robert G. Crowder, Department of Psychology, Yale University, Box 11A Yale Station, New Haven, CT 06520, by August 1, 1984.

25th Annual Meeting of The Psychonomic Society, Inc.—Change of Dates for Meeting

The dates for the 25th annual meeting of The Psychonomic Society, Inc., have been changed:

From—November 1-3, 1984

To—November 8-10, 1984

The meeting still will be held at the Hilton Palacio Del Rio, San Antonio, Texas.