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ABSTRACT

A study used a primed lexical decision task to explore readers' use of "onset" and "rime" units in processing words. Onset segments include the initial consonant or consonant cluster of a syllable, while rime segments consist of the pronounced vowel group and any final consonants. Subjects were 32 fifth graders and 27 college students. Words or word fragments having three relationships to the targets (matching the initial consonants and the vowels, matching the "rime," or unrelated) were used to prime word and nonword targets. Results indicated that: (1) in adults, fragments matching the "rime" facilitated processing while word primes that matched the target in any way interfered with processing; (2) fifth graders showed a similar pattern of facilitation for "rime" fragments but not for "rime" matching words; and (3) fifth graders showed facilitation for word fragments that matched the initial consonants and vowels. Findings suggest that for adults the "onset"/"rime" division is a natural one used in reading and that facilitation from "rime" fragment primes was not caused by a lexical analogy mechanism. Findings also suggest that fifth graders were using units smaller than the "onset" and "rime" or that they are inconsistent in their division of the syllable into subunits. (Three graphs of data are included and 14 references are attached.) (RS)

The Developing Use of Sublexical Units in Adult and Child Readers

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Abstract

A primed lexical decision task was used to explore reader's use of "onset and "rime" units in processing words. Subjects were 32 fifth graders and 27 college students. Words or word fragments having 3 relationships to the targets (1. matching the initial consonants and the vowels, 2. matching the "rime", or 3. unrelated) were used to prime word and nonword targets. In adults, fragments matching the "rime" facilitated processing while word primes that matched the target in any way interfered with processing. These data suggest the the "onset"/"rime" division is a natural one used in reading and that facilitation from "rime" fragment primes was not caused by a lexical analogy mechanism. Fifth graders showed a similar pattern of facilitation for "rime" fragments but not for " rime" matching words. They also showed facilitation for word fragments that matched the initial consonants and vowels. This suggests that they were using units smaller than the "onset" and the "rime" or that they are inconsistent in their division of the syllable into subunits.

One of the tasks in learning to read is to relate the visual symbols of written words to a spoken language that has been known and practiced for years. This can potentially be done using units at a number of different levels.

1) Lexical Analogy. It is possible to use the word level as the unit of analysis. One could simply memorize the visual appearance of each word and recognize the entire pattern. If whole words are the most commonly used recognition unit, then nonsense syllables and less familiar words may be pronounced by analogy to more familiar words (knowing how to pronounce "ack" because you know the word "back"). Glushko (1979) reported reaction time differences for reading words that are and are not compatible with an analogy strategy. Spelling patterns that have a single pronunciation are read more quickly than those with analogies presenting a number of possibilities. Thus, it should be more difficult to read words like "treat" which is visually similar to both "great" as well as "heat". Using analogies presents the opportunity for many lexical characteristics to influence word identification, because they influence access to the analogies.

There are also a number of sublexical units that provide possible correspondences between written and spoken language.

2) Phonemes. The traditional view is that the phonemes of the spoken word are associated with graphemes (letters or letter combinations) according to a complex set of phoneme-to-grapheme correspondence rules. The existence of such rules is suggested by the common finding that words which follow the rules are read more rapidly than words which violate the rules. Regularity effects of this type have been found by many researchers (e.g., Baron, & Strawson, 1976; Coltheart, Davelaar, Johasson, & Besner, 1977). Moreover, these rules are necessary to explain the skilled reader's ability to pronounce nonwords which do not have real word analogies, "joov" for instance (Humphreys & Evett, 1985).

3) Onset and Rime. Finally, the reader might use a unit in between the phoneme and the single syllable word in size. Treiman (1983) has proposed that spoken syllables can be divided into two segments. The first segment is the "onset" which includes the initial consonant or consonant cluster up to the pronounced vowel group of the syllable. The rest of the syllable, the pronounced vowel group and any final consonants, makes up the "rime".

Both children and adults appear to use the onset and rime as units in spoken language. For example, word games, like pig latin, that involve manipulating onset and rime units are much easier to learn than those that involve separating the final consonants of a syllable from the initial consonants and vowels (Treiman, 1983, 1985, 1986).

Treiman (1987) has also found evidence that the onset and rime are natural units in written language. Her subjects were faster and more accurate in solving anagram-like problems if the task required combining the onset unit with the rime, rather than if they had to

add the final consonants to the initial consonants and vowels (e.g., b/ook rather than boo/k). Similarly, Goswami (1986) found that beginning readers were better able to generalize to new words that shared the rime component with a known word than to new words that shared initial consonants and vowels. Goswami (1990) also found that presenting the rime alone was sufficient to improve performance on words containing the rime.

The current experiment is designed to compare lexical analogy strategies, phoneme-to-grapheme translation strategies, and the use of onset and rime units in processing written information by readers at different levels of skill.

A primed lexical decision task was used to make the comparison. Normal fifth grade readers and college students represented the different skill levels. The target words used in the task differed in their consistency (i.e., whether the other words with the same spelled rime are pronounced in a rhyming manner) and in the size of their neighborhoods (i.e., the number of words sharing the same rime in both sound and spelling). These are both features of the lexicon rather than of the words themselves. The words were preceded with primes which differed in their relationship to the target (e.g., sharing the initial consonants and vowels, sharing the rime segment or unrelated) and in whether they were words or word fragments.

The three models predict radically different patterns of results from this combination of factors. It should be possible to clearly tell which approach can best account for the results.

Lexical Analogy. If subjects process words by analogy to other known words then they should show benefits in processing speed when the prime is a lexically represented word that shares sound and spelling patterns with the target word. It is possible that some facilitation might be expected when primes are related word fragments. However, it would be much smaller and would only occur if the fragments activated similar words in the lexicon which in turn facilitate processing of the target words. The model also predicts effects of consistency and neighborhood size. Consistent spelling patterns would provide a single pronunciation resulting in greater facilitation than inconsistent patterns which provide two possible pronunciations. Larger neighborhoods might result in greater facilitation as more potential analogies are available. No strong predictions can be made about the effects of beginning and ending similarity, though Kay and Bishop's (1987) idea of the "body" of the word world argue for greater facilitation with a rime match.

Grapheme-to-Phoneme Translation. This model predicts equal facilitation for word and nonword primes as long as they contain spelling and sound patterns that match the targets. The use of the rules should be the same in both cases. Similarly, this model predicts no effect of consistency or neighborhood size, as all the targets follow major sound-to-spelling correspondences. This model also predicts that greater facilitation would be found in the rime similarity conditions because the spelling pattern following a vowel constrains it's

pronunciation to a greater degree than the spelling pattern that precedes it.

Onset-Rime Units. The predictions of this model differ from the others in a number of ways. First, it predicts a greater facilitation for the related nonword primes than for related word primes. This facilitation would only be predicted for nonword primes that share the target's rime. These factors could also interact with consistency, as a reflection of the relative strength of consistent and inconsistent rime units. Finally, this model predicts that the lexical characteristic neighborhood size would not interact with the other factors.

Method

A primed lexical decision task was used in this experiment. The design crosses the following factors in a mixed factorial design:

Between Subjects factor:

Age of Subject (2 levels)

Within Subjects factors:

Word or Nonword Prime (2 levels)
Prime-Target Relationship (3 levels)
Word or Nonword Target (2 levels)
Number of Neighbors (2 levels)
Consistency (2 levels)

Subjects.

The child group consisted of 32 fifth graders, reading at or near grade level (within 1 year of grade level on the reading battery of the Comprehensive Test of Basic Skills). These children were recruited through the local school system and were tested individually during the school day. The subjects in the adult group were 27 native English speakers, recruited from introductory psychology classes. They received class credit in return for their participation. All subjects had normal or corrected to normal vision.

Priming Factors

Both word and nonword primes occurred in three types:

1. Primes that matched the targets in their initial consonants and vowels
   "desk"--"dent" or "de"--"dent"
2. Primes that matched the targets in their rimes
   "bent"--"dent" or "ent"--"dent"
3. Primes unrelated to the targets
   "pick"--"dent" or "pi"--"dent" or "ick"--"dent"

Target Factors

Both words and nonwords were used for targets, though only the word targets will be discussed.. The word targets were all regularly spelled according to Venesky's (1970) grapheme-to-phoneme translation rules, but differed in consistency and their number of neighbors.

Consistency. Half of the words used in the experiment were consistent. In a consistent word families all the words share the spelling pattern of the rime and are pronounced in a

rhyming manner (e.g., "cat", "rat", "pat", "hat" etc.). The other half of the words came from inconsistent word families, where the shared spelling pattern of the rime is pronounced in more than one way (e.g., "mint" and "hint", but also "pint").

Number of Neighbors. The word lists were also divided in half based on the number of other English words with the same spelling pattern and a rhyming pronunciation. For example, "cat" has many rhyming neighbors while "fix" has only a few.

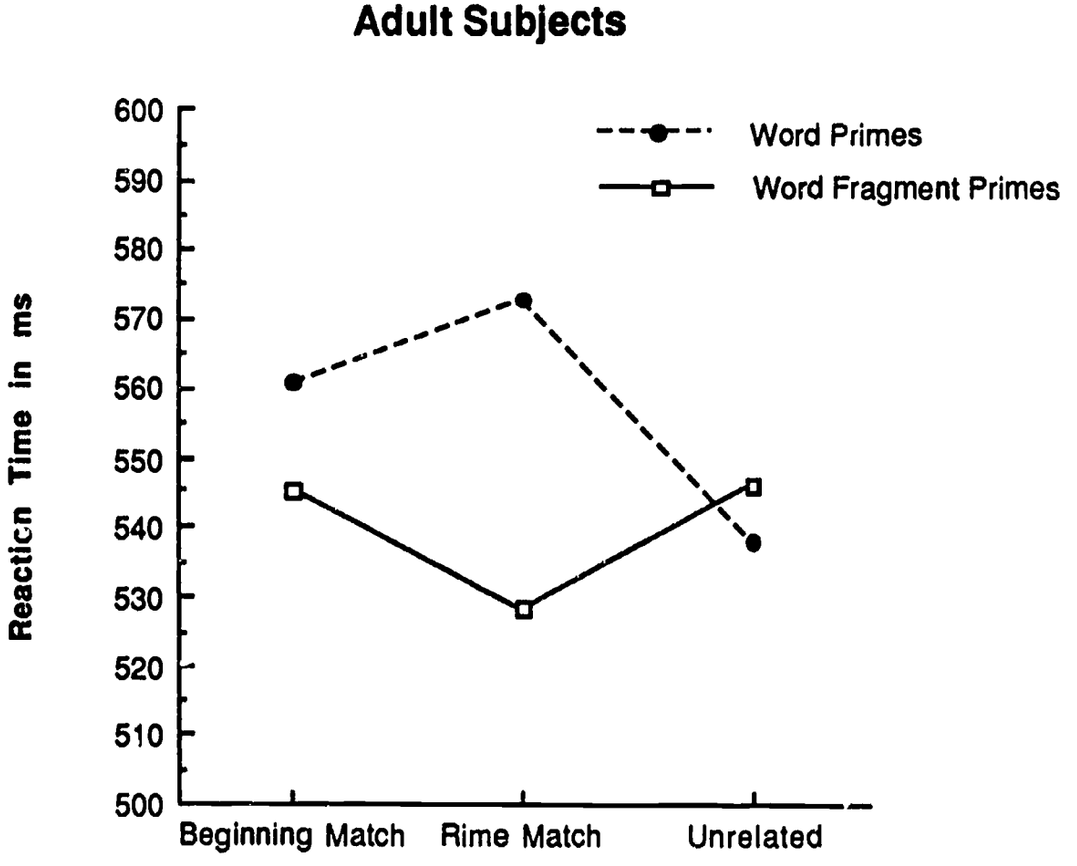
All 4 lists were equated for word frequency, as word frequency effects lexical decision reaction times. The words and their primes were divided into 3 lists so that each subject saw each target word twice, once with a word prime and once with a nonword prime. Each target word appeared in each of the six priming conditions across subjects.

Procedure. The subjects were tested individually in a quiet room (at the school for the children and at the university for the adults). The stimuli were presented on a computer screen. Each trial began with a warning signal in the center of the screen. 250 ms later the prime appeared either directly above the warning signal or directly below it. Varying the location of the prime prevents subjects from filtering it out, ensuring that it is processed. The target appeared in place of the warning signal 350 ms later. Both the prime and the target remained on the screen until the subject pressed one of two response keys, indicating whether the target was a word or not. Subjects completed two 48 trial practice blocks, followed by 4 blocks of test trials, each 48 trials long. Subjects were given a 5 minute break after the second block of test trials and received feedback about their accuracy and speed at the end of each block.

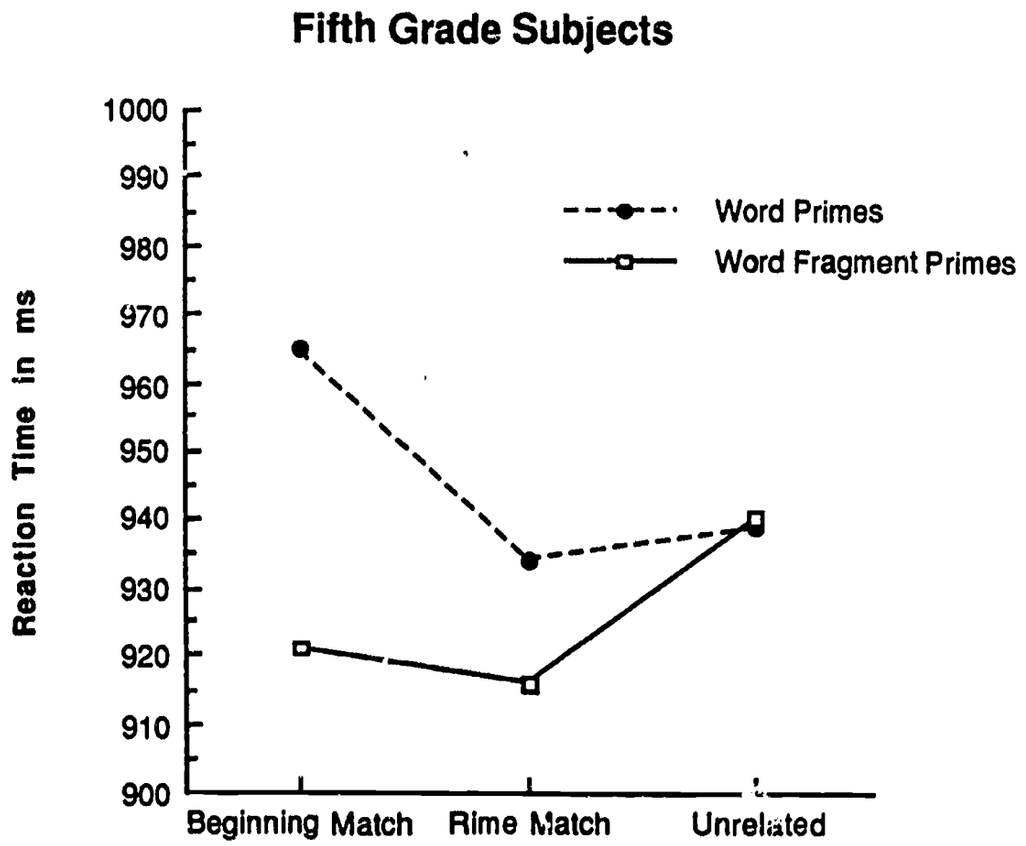
Results

Priming effects

The overall age X word vs fragment prime X prime similarity interaction was significant ($F(2,114)=3.65$, $p<.05$), indicating that the adults and children responded differently to the priming conditions. In a simple effects analysis, both groups show significant word vs. fragment X prime similarity interactions. However, the patterns of these interactions are different.



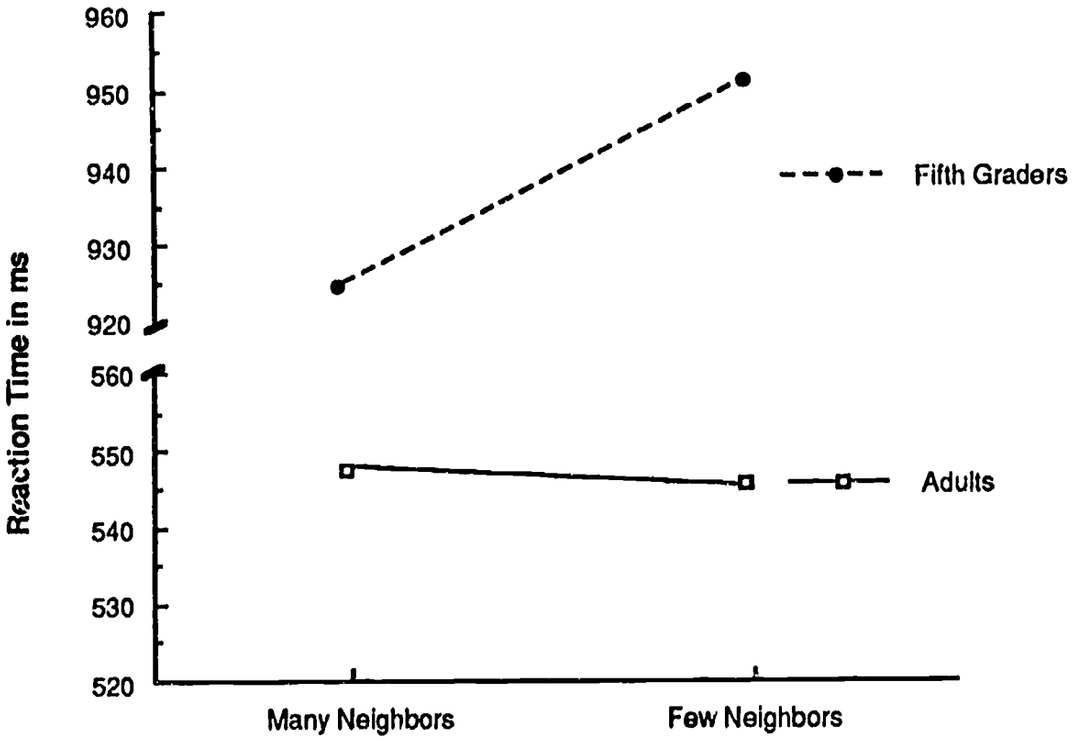
For adults, fragment primes that matched the targets in their rimes facilitated (speeded up) processing, while all other types of similarity resulted in interference. This simple interaction is significant ($F(2,52)=14.72$, $p<.001$). This pattern held for all of the stimulus lists, regardless of the target characteristics.



The simple word vs nonword prime X prime target relationship interaction was also significant for the children ($F(2,62)=3.31$, $p<.05$). The fifth graders showed a pattern of facilitation for fragments that matched the target's rime but not for words that matched the target's rime. Words matching the beginning of the target resulted in interference, as they did for the adults. The children differ from the adults in showing facilitation for fragments that matched the beginnings of the targets. This facilitation is smaller than for rime match fragments but is significant. It suggests that the children may either be using smaller spelling to sound units some of the time or that they are inconsistent in their subdivision of the onset and the rime. Finally, the children were similar to the adults in that neither consistency nor neighborhood size interacted with the priming effects.

Target Effects

The other interaction to reach significance in the combined analysis was that of age by neighborhood size ($F(1,57)=7.02, p<.01$).



The neighborhood size effect occurred only for the children. This suggests that the children's word processing is being influenced by their lexical knowledge. This finding is somewhat difficult to explain. One possibility is that the children were using lexical analogies to identify the target words. However, the use of analogies is incompatible with the prior findings for 2 reasons. The children showed no evidence of facilitation with related word primes, so it seems implausible that they would fail to use analogies when an analogous word was suggested but use analogies on the other trials. Also, if analogies were mediating the word fragment priming effect, neighborhood size should interact with the priming variables. A simpler and more compatible possibility is that the children were more familiar with the words with many neighbors.

Conclusions

The pattern of results is very different from that predicted by the phoneme-to-grapheme translation model. While this model did predict greater facilitation for rime matches, it incorrectly forecast facilitation for rime matches in word primes.

The analogy model also is not able to account for the results. For both adults and children related word primes resulted in interference rather than the facilitation that the model predicts, while rime fragments resulted in facilitation. In addition, the model predicts that the target characteristics, consistency and number of neighbors should interact with the priming effect. These interactions were not found in either age group. While the neighborhood size effect found in the children's performance could suggest that lexical analogies were used, familiarity with the particular words in the many neighbor list provides a simpler and more compatible account of the data.

Only the onset-rime model can explain the current set of results. This model proposes that words can be recognized by identifying their component parts, the onset and the rime. Thus, the model can explain the facilitation for targets primed by their rimes. The word fragments matching the targets in their initial consonants and vowels fail to produce facilitation in the adults because these primes did not match the access units used by these subjects. The children may be less consistent in their subdivision of the words resulting in a small degree of facilitation for fragments that matched the beginning of the targets. An alternative explanation for this result is that the children in the study came from a school that had placed a strong emphasis on the importance of phonetic skills in early grades. Therefore, the children may have been employing smaller units of sound-to-spelling correspondence on some occasions.

Word primes did not facilitate processing of their related targets and actually interfered with their processing. The model might have predicted a slight facilitation if word primes sharing their rime with the target activated the rime unit, and thus indirectly facilitated processing. There is clearly no evidence of such an indirect priming effect in this data. The interference caused by word primes could be explained by the activation of competing representations at a pre-response decision stage.

Finally, the lack of higher order interactions between the prime factors on the one hand and consistency and neighborhood size on the other hand is also compatible with the onset/rime model. Because the processing in this model is prelexical there is little reason to expect interactions of the priming factors with lexical characteristics.

These results strongly suggest that both moderately and highly skilled readers can use sublexical units like the onset and the rime to identify words, at least under the current conditions. This conclusion is highly compatible with the results reported by Kirkley, Bryant,

MacLean, and Bradley (1989), Wise, Olson, and Treiman (1990) and Goswami ((1990), demonstrating the use of onset and rime units in both intuitions about the sound components of words and in actual reading performance in beginning readers. The results also suggest that the fluid use of these subsyllabic units develops with increased experience in reading. Further study of the role of these subsyllabic units in both beginning and skilled reading should contribute to our understanding of sound-to-symbol correspondences in reading and has important implications for reading instruction.

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