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Orthographic and Semantic Similarity in Auditory Rhyme Decisions

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Abstract¹

Seidenberg and Tanenhaus (1979) demonstrated that orthographic information is obligatorily activated during auditory word recognition by showing that rhyme decisions to orthographically similar rhymes *pie-tie* were quicker than rhyme decisions to orthographically dissimilar rhymes *rye-tie*. This effect could be due to the fact that orthographic and phonological codes are closely inter-related in lexical memory and the two dimensions are highly correlated. However, it could also be an example of a more general similarity bias in making rhyme decisions, in which subjects cannot ignore irrelevant information from other dimensions. We explored this later possibility by having subjects make rhyme decisions to words that vary in orthographic similarity and also to words that vary in semantic similarity (*good-kind, cruel-kind*). This possibility is ruled out in two experiments in which we fail to find an interfer-

ence effect with semantically related trials, while replicating the basic orthographic interference and facilitation results.

Introduction

There have been a number of studies demonstrating that orthographic information is activated during auditory word recognition. One of the clearest demonstrations was originally reported by Seidenberg and Tanenhaus (1979). They found that rhyme decisions were faster to orthographically similar rhymes such as *pie-tie* than to orthographically dissimilar rhymes such as *rye-tie*. One explanation for these results is that orthographic and phonological codes become closely inter-related in the process of learning to read when the mapping of orthographic to phonological codes occurs. As a consequence of this learning, both phonological and orthographic information are activated during auditory word recognition. During the rhyme decision, the orthographic information causes a Stroop-like effect in the decision process. Subjects seem unable to use

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an optimal strategy that would rely solely on the phonological codes that are required for the rhyme decision.

There is an alternative explanation which does not assume any special correspondence between these two lexical codes. Kahnemann (personal communication, 1985) suggested that these orthographic effects are an example of a more general phenomenon that he refers to as cognitive Stroop effects. These effects arise when subjects cannot ignore information from an irrelevant dimension. On this view, when multiple aspects of a representation are activated, it becomes difficult to ignore irrelevant information. As a result, the orthographic interference obtained with auditory rhyme decisions is not a product of the linkage between phonological and orthographic codes, but would be due to a general similarity bias with *Yes* decisions to words being facilitated when they are similar along any dimension. As a result, rhyme decisions would be quicker to *pie-tie* than to *rye-tie* since *pie-tie* are similar along more dimensions than are *rye-tie*. Seidenberg and Tanenhaus (1979) also showed that rhyme decisions to orthographically similar non-rhymes like *touch-couch* were slower than to orthographically dissimilar non-rhymes like *dutch-couch*. Since a *No* response is required for a non-rhyme, the orthographic similarity results in a slower *No* decision. Thus, the general similarity bias explanation can neatly account for the orthographic effect in rhyming without positing any special linkage between phonology and orthography.

The proposal that a general similarity bias might produce an artifactual pattern of results corresponding to orthographic in-

terference is important to consider given that there have been a number of task differences in the lexical-semantic priming literature that have been attributed to post-lexical bias. For example, when subjects read a sentence and then have to name a target that is highly related to the sentence, responses to targets are facilitated. However, if the subject response is a lexical decision, responses to the targets are inhibited (Fischler & Bloom, 1979; Stanovich & West, 1983). Presumably, the facilitation reflects a passive automatic spread of activation between highly related or predictable concepts and naming is sensitive to this effect. Likewise, responses made by lexical decision include this automatic component but also include a more strategic aspect. Seidenberg (1985) suggests that the lexical decision creates a situation similar to that of a Stroop task. The target words are highly related to the sentential context. When the expectation or bias for a particular concept is violated, the lexical decision proves to be sensitive to this relatedness aspect of the task and the incongruity inhibits the lexical decision response. In a similar fashion, when there is incongruent orthography between the stimuli that do rhyme, the *overall* similarity between the rhyming stimuli decreases. Thus, in experiments such as these, the phonological similarity crucial to the rhyme decision and the orthographic incongruity could result in an inhibitory component in the decision task. If the similarity bias hypothesis alone is sufficient to account for the effects of orthography on rhyming, it should also be difficult to make a *No* response with a rhyme decision to semantically related non-rhymes such as *good-kind*.

In experiment 1, we sought to replicate the Seidenberg and Tanenhaus (1979) re-

sult and also to include a condition to test the similarity bias hypothesis. We tested the similarity bias hypothesis by including synonyms and antonyms. If a similarity strategy is used by subjects, we would expect longer *No* response times for the synonyms compared to the antonyms.

Experiment 1

Stimuli

Monosyllabic stimuli consisted of primes that varied in their phonological and orthographic similarity to the target. In the rhyme condition, targets were preceded by an orthographically similar or dissimilar prime, for example, *plate-gate* or *freight-gate*. In the non-rhyme condition, targets were preceded by an orthographically similar or dissimilar prime like *touch-couch* or *dutch-couch*. The additional non-rhyme condition involved the use of synonyms like *kind-good* and antonyms like *kind-cruel*. There were twelve of each of these kinds of trials in each of two lists. Twelve orthographically similar and twelve orthographically dissimilar rhymes were included as filler trials.

Procedure

Thirty-two native English speaking students participated. Primes and targets were presented on one channel of a two-headed stereo tape recorder (Sony TC-270). A brief 1000 Hz trigger tone was placed on the other channel, precisely at the onset of the second word. The trigger tone, which was inaudible to the subject, was connected to a silent solid-state voice relay. An Apple IIe equipped with a Digity CTS system was used to time the duration from the onset of the second item to

the subject's response. Subjects listened to the prime words binaurally through stereo headphones.

Subjects received 10 practice trials and 94 experimental trials. Subjects were instructed to attend to the two words presented over the headphones, and quickly decide if the items rhymed or not, and press either the YES or NO button.

Results

There was an interaction between rhyme decision (yes-no) and orthographic match (match or no-match), $F(1, 30) = 11.82, p < .001$. Subjects were slower by 42 msec to make rhyme decisions to orthographically dissimilar rhymes (741 msec) than to orthographically similar rhymes (699 msec), $F(1, 30) = 7.47, p < .02$. However, decisions to orthographically similar non-rhymes (861 msec) were slower by 57 msec than the orthographically dissimilar non-rhymes (804 msec), $F(1, 30) = 9.21, p < .005$. There was no difference in rhyme decision latencies between the synonym (727 msec) and antonym (746 msec) word pairs, $F(1, 30) = 1.45, p = .238$. A parallel effect was obtained in the error analysis.

Discussion

The orthographic interference which was obtained for non-rhymes with a rhyme-decision task replicated Seidenberg and Tanenhaus (1979). Even in an auditory task, orthographic differences affected rhyme decisions. If a similarity strategy had been used by subjects we would have expected longer *No* response times for the synonyms compared to the antonyms, however, this did not occur.

Experiment 2

It may be that comparing synonyms and antonyms was not a strong enough test of the similarity hypothesis. It is possible that semantic similarity along any dimension² (i.e., synonyms or antonyms) produces interference in a rhyme decision.

In experiment 2, we manipulated semantic similarity for non-rhymes by using synonym and antonym pairs, but we rotated these trials such that a semantically unrelated control condition was included. For example, *good-kind* and *cruel-kind* can now be compared to the completely unrelated *fast-kind*. This should provide a better baseline for an interference effect rather than comparing two differently related conditions.

We manipulated orthographic similarity for non-rhymes (like in experiment 1) and also rotated these items to provide for a completely unrelated condition as well. In this case, *touch-couch* and *dutch-couch* can be compared to *leaf-couch*. If a similarity strategy is being used in the rhyme decision, we would not expect an interaction between the three levels of the semantic condition and the three levels of the orthography condition, since semantically related trials would show interference when compared to the semantically unrelated trials. Filler trials were included, resulting in an equal number of rhyme and nonrhyme decisions. Forty-eight native English speaking students participated. The procedure and

²We want to acknowledge that there are other stimulus dimensions in which one could use to manipulate similarity bias. However, the nature of the 'yes/no' rhyme decision task and the similarity/dissimilarity of the synonyms and antonyms led us to believe that this particular semantic manipulation would be particularly sensitive to a possible response bias.

task was identical to experiment 1.

Results

An interaction obtained with semantic nonrhymes and orthographic nonrhymes, $F(2, 94) = 20.34$, $p < .001$. There was no difference in reaction time between the three levels of the semantic condition (synonyms, 698 msec; antonyms, 701 msec; unrelated, 703 msec), $F(2, 94) < 1$. However, orthographically similar nonrhymes (848 msec) were responded to more slowly than the dissimilar nonrhymes (765 msec) which were, in turn, responded to even more slowly than their unrelated control (723 msec), $F(2, 94) = 36.58$, $p < .001$. A parallel effect was obtained in the error analysis.

Discussion

The results of this experiment are consistent with those of experiment 1, which did not use the completely unrelated control condition. The interaction between the semantic condition and the orthographic condition suggests that the subjects utilize the orthographic information in making rhyme decisions and do not allow some more abstract similarity metric to influence the decision.

Conclusions

We have replicated the finding that orthographically similar words that rhyme can be detected more quickly than orthographically dissimilar rhymes. These results are consistent with a model in which multiple codes become activated in parallel, even if initially such activation is not useful for the task. Such activation would

seem to be an automatic effect since subjects did not adopt a strategy where they used only the phonological information in the rhyme decision. Had a subject been selectively able to use phonological information, no interference would have been obtained with the orthographically dissimilar trials, and there should also have been no difference between the orthographically similar and dissimilar non-rhyme conditions.

This effect appears to be specific to the orthographic code, in that we can rule out a general similarity strategy or response bias, since we failed to find semantic interference with the rhyme decision in both experiments. While there are clearly a number of cognitive Stroop phenomena that can be explained with a similarity heuristic, the orthographic interference obtained with auditory rhyme decisions appears to be a product of the linkage between phonological and orthographic lexical codes, and is not due to a general similarity bias with *Yes* decisions to words being facilitated when they are similar along any dimension.

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