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Phonological Priming in the Lexical Decision Task: Regularity Effects Are Not Necessary Evidence for Assembly

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The contribution of assembled phonology in reading English was examined in the lexical decision task by comparing two markers: regularity effects and phonological priming. Strategic control was assessed by manipulating the phonological lexicality of the foils: Experiment 1 used legal nonwords, whereas Experiment 2 used pseudohomophones. Replicating existing findings, null regularity effects were obtained in the presence of legal nonwords. Modest regularity effects, in accuracy only, were observed with pseudohomophone foils. In contrast, phonological priming effects emerged in each of the experiments, regardless of the presence of regularity effects. Assembled phonology thus constrains reading under conditions that strongly discourage its use. However, regularity effects are not necessary evidence for its presence. The dissociation of regularity and phonological priming effects is discussed in terms of the two-cycles model.

Dual-route models of visual word recognition (e.g., Baron & Strawson, 1976; Coltheart, 1978; Coltheart, Curtis, Atkins, & Haller, 1993; Coltheart & Rastle, 1994; Paap & Noel, 1991) postulate two mechanisms for the identification of printed words. The direct route retrieves a stipulated whole-word representation from the mental lexicon based on graphemic information. In contrast, the assembly route is a phonological productive mechanism. It addresses the lexicon based on an intermediate phonological representation computed by mapping subword graphemic units onto phonemes. The role of assembled phonological representations in reading is one of the most controversial questions in psycholinguistics. According to the *slow phonology assumption,* phonology assembly is a slow process whose contribution is subject to strategic control. Reading, according to this view, is achieved mostly by direct access (e.g., Baron, 1973; Bower, 1970; Coltheart, 1978; Seidenberg, 1985; Seidenberg, Waters, Barnes, & Tanenhaus, 1984). Conversely, the *phonological hypothesis* portrays assembly as a fast process whose contribution is general and mandatory (e.g., Carello, Turvey, & Lukatela, 1992; Kawamoto, 1993; Lukatela & Turvey, 1993, 1994; Perfetti, Zhang, & Berent, 1992; Van Orden & Goldinger, 1994; Van Orden, Pennington, & Stone, 1990). Assembled phonology is considered the primary constraint on reading (Van Orden et al., 1990).

There is extensive empirical literature examining the role of assembly and its nature using a variety of marker effects. However, the existing evidence is highly contradictory (for a recent review, see Berent & Perfetti, 1995). Furthermore, Berent and Perfetti identified a systematic link between the marker effects used to detect assembly and the conclusions they support. An analysis of the properties of distinct markers of assembly and the inferences underlying their interpretation may help resolve the contradictions regarding the nature of assembly. The present research evaluates the role of assembly by reexamining one such marker: the *regularity effect.*

Regularity effects are the hallmark of a productive mechanism. They reflect the assembly of erroneous regularized forms for words whose pronunciation is unpredictable from their graphemic constituents. For instance, consider the word *come.* The pronunciation of *come* is unpredictable because its assembly is expected to yield an erroneous pronunciation rhyming with *home.* The correspondence between the graphemes and phonemes in *come* is thus irregular. Difficulties in the recognition of such irregular words (i.e., slower naming latency and regularization errors) are denoted regularity effects. Because these phonological effects can only result from the application of a productive mechanism, they constitute unequivocal evidence for the contribution of assembly. Regularity effects are thus clearly *sufficient* evidence for assembly.

Indeed, regularity effects are one of the most widely trusted markers of assembly. There are many reports of regularity effects in English word recognition. However, the conditions under which such effects emerge are quite limited. Regularity effects in the naming procedure are normally obtained only for low-frequency words (Andrews, 1982; Paap & Noel, 1991; Parkin & Underwood, 1983;

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Rosson, 1985; Seidenberg et al., 1984; Waters & Seidenberg, 1985) and are typically altogether absent in the lexical decision task, except in the presence of strange words (Parkin & Underwood, 1983; Seidenberg et al., 1984; Waters & Seidenberg, 1985). In both tasks, regularity effects are subject to strategic control (Bernstein & Carr, 1996; Monsell, Patterson, Graham, Hughes, & Milroy, 1992; Paap & Noel, 1991; Stanovich & Bauer, 1978; Waters & Seidenberg, 1985). Regularity effects are thus clearly limited in their scope. What do these limitations indicate regarding the role of assembled phonology in word recognition?

Several models have opted for rather transparent inferences in assessing the contribution of assembly in reading. Significant regularity effects are considered evidence for the presence of assembly. However, null regularity effects are taken as an indication for its absence. These limitations in the scope of regularity effects have been viewed as prima facie evidence supporting the slow phonology hypothesis. Specifically, the fact that regularity effects are obtained only for low-frequency words, for which the addressed mechanism is assumed to be slow, is interpreted as evidence for the slow nature of the assembly mechanism (e.g., Coltheart, 1978; Coltheart & Rastle, 1994; Paap & Noel, 1991; Paap, Noel, & Johansen, 1992; Seidenberg et al., 1984). According to this view, high-frequency words do not show regularity effects because they are identified by the fast direct route before the slow assembly mechanism affects the identification process. The finding that regularity effects are typically observed in a task that requires overt pronunciation (i.e., naming) but fail to emerge in a task that does not require articulation (e.g., lexical decision) has been used to support the idea that the assembly of phonology does not normally constrain silent skilled reading (e.g., Baron, 1973; Bower, 1970; Seidenberg, 1985; Seidenberg et al., 1984). Finally, the absence of regularity effects under conditions thought to discourage assembly is interpreted as evidence for the controlled nature of assembly as a whole (e.g., McQuade, 1981, 1983; Monsell et al., 1992; Paap & Noel, 1991; Pugh, Rexer, & Katz, 1994). Thus, inferences regarding the contribution of assembly to skilled reading based on regularity effects seem to rely on an assumption that is much stronger than the view of regularity effects as a marker of assembly. Regularity effects are considered not only sufficient but also *necessary* evidence for assembly.

There are several problems with this view of regularity effects as necessary evidence for assembly. One is a general logical problem. Hypotheses should not rely for their support on the interpretation of null effects, a problem that is extensively discussed by Van Orden et al. (1990). In the case of regularity effects, there is a specific reason to doubt the validity of such "null" inferences in view of the constituent structure of assembled phonology. Most of the irregularity in the mapping of graphemes to phonemes in English reflects difficulty in the assembly of vowels. Thus, null regularity effects are, in most cases, null evidence for the assembly of specific, well-defined phonological entities, namely, vowels. What does null evidence for this specific phonological entity tell us about assembly as a whole?

This question can only be answered with respect to specific assumptions about the structure of the assembled representation. If the assembled code consists of a linear, unidimensional string of phonemes, which makes no structural differentiation between consonants and vowels (e.g., Coltheart & Rastle, 1994), then null evidence for vowels amounts to null evidence for assembly.[1] However, if consonants and vowels are distinct constituents in the assembled representation, then vowel effects may not be a sine qua non for assembly. There is a wide body of psychological and linguistic evidence suggesting that consonants and vowels may be two distinct constituents in phonological representations (for a review, see Berent & Perfetti, 1995). If mental processes are sensitive to this structural distinction, then the assembly of consonants and vowels may be at least partially independent. Evidence for the absence of the vowel component should not preclude the assembly of consonants.

Indeed, several models of word recognition predict that vowel assembly in English is slow to emerge (Kawamoto, 1993; Kawamoto & Zemblidge, 1992; Plaut & McClelland, 1993; Van Orden & Goldinger, 1994). In a series of experiments using the masking and priming techniques, Berent and Perfetti (1995) demonstrated that vowel assembly is contingent on long exposure durations for the visual stimuli. Evidence for the assembly of vowels emerges primarily for low-frequency words, and it appears to be eliminated under load. It is important to note, however, that assembly can constrain the recognition process in the absence of vowels. Berent and Perfetti demonstrated that the masking or priming of a target by its consonants facilitates word recognition under brief durations, conditions that yield no evidence for the assembly of vowels. The contribution of consonant assembly was general and automatic: It appeared regardless of both the frequency of the word and its regularity, even in the presence of high memory load. To account for these findings, Berent and Perfetti proposed the two-cycles model. In this model, consonants and vowels are two distinct constituents in assembled representations. They are derived by distinct processes that differ in their speed and automaticity: Consonants are derived first by a fast and

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[1] The equation of null regularity effects with the absence of assembly is tacitly held by most existing research. In principle, however, given monosyllabic words, a linear, left-to-right model may still assume the assembly of the onset given null evidence for the vowel. Thus, the linear view maintains that null evidence for the vowel *must* indicate only the absence of the rhyme (i.e., the syllable nucleus and the coda). Conversely, the nonlinear view expressed by the two-cycles model assumes that all consonants, including the coda's consonants, may be present despite the absence of the vowel. Thus, these models specifically contrast with respect to the presence of coda consonants given null evidence for the vowel. The following experiments examined evidence for the presence of phonology given null evidence for vowel assembly (null regularity effects) using phonological priming. Any evidence for phonology assembly given null evidence for the vowel contradicts the implicit equation of null regularity effects and the absence of assembly as a whole. Because the difference between the graphemic and pseudohomophone primes in most words (60 out of 64) concerns, at least partly, the coda, these materials also permit addressing the conflicting predictions regarding the presence of the coda, specifically.

automatic process. Vowels are added to the representation only at a later stage by a slow and controlled process.

The two-cycles model has some direct implications for the interpretation of regularity effects. In general, it predicts that the nature of assembly reflected by a given marker should depend on the contents tapped by this marker (the *what* question) and its time course (the *when* question). Regularity effects are limited insofar as they tap primarily into the late-vowel component. If the assembly of consonants constrains recognition even when vowel assembly is truncated, then null evidence for vowel assembly cannot constitute evidence for the absence of assembly as a whole. Thus, although regularity effects are a marker of assembly, they are not necessary evidence for its presence. Furthermore, the model makes a principled prediction regarding the constraints affecting the emergence of regularity effects: Because vowels are slow to emerge, the two-cycles model predicts that regularity effects require extensive processing for the visual stimulus. Long exposure durations for the visual display may be necessary to permit ample processing and to assure the assembly of vowels. However, it may not be sufficient: The lexical decision task typically yields null regularity effects despite clear viewing conditions. This null effect may be explained by assuming that participants may control the amount of processing applied over clearly visible targets. Van Orden and Goldinger (1994) proposed that participants may control the timing of the decision process depending on the type of foils used. Foils that have little resemblance to real words (e.g., WZOR) permit fast discrimination that terminates processing prior to the assembly of vowels. Conversely, the presence of strange words that resemble nonwords (e.g., YACHT) delays processing, thereby permitting the emergence of regularity effects. Hence, the emergence of regularity effects depends on the amount of processing, which may be controlled not only by the experimenter (by manipulating exposure duration) but also by the participant (by controlling the onset of the response).

Thus, the two-cycles model predicts that distinct markers of assembly may differ in their conclusions depending on the contents of the representation that they tap and their time course. Evidence for vowel assembly may be observed only given long exposure durations for the visual input. It is important to note, however, that methods of brief exposure durations designed to assess the consonant component should produce evidence for assembly under conditions that typically yield null regularity effects. To test this prediction, Berent and Perfetti (1995) compared the results of two markers of assembly: One was the regularity effect in target naming; the other was priming effects, examined by preceding each of the target words by a briefly presented nonword that primed either the target's vowel or its consonant. Long exposure durations for the orthographic input yielded evidence for vowel assembly in terms of both regularity and vowel-priming effects for low-frequency words. However, brief exposure durations, which normally yielded null regularity and vowel-priming effects, provided positive evidence for consonant assembly regardless of the frequency of the target or its regularity. These results reflect a dissociation between regularity effects and markers of consonant assembly in the naming task. They provide initial support for the claim that regularity effects are not necessary evidence for assembly.

In view of the repeated reports of null regularity effects using the lexical decision task (Andrews, 1982; Coltheart, Besner, Jonasson, & Davelaar, 1979; Seidenberg et al., 1984), it is important to examine whether evidence for assembly could be obtained in this task if markers of early stages of recognition are used. The following experiments were designed to extend the earlier finding (Berent & Perfetti, 1995) of a dissociation of regularity effects from markers of brief durations using the lexical decision task. These studies compared two markers of assembly in the lexical decision task: regularity effects and brief priming effects. Regularity effects are examined by comparing the identification of target words that contrast on their frequency and regularity. If vowel assembly constrains target identification, then regularity effects are expected, especially for low-frequency target words. The conclusions emerging from regularity effects are compared with those obtained from phonological priming effects. Toward this end, each of the target words presented in the study was preceded by one of three types of nonword primes. For instance, for the target word *lace,* the nonword primes were a pseudohomophone (LAIS), a graphemic control (LAFT), and a control prime (MUFT). The contribution of phonological information to the identification of the target was assessed by comparing the pseudohomophone (LAIS) and the graphemic prime (LAFT). These primes are equated in their graphemic similarity to the target but differ in their phonological resemblance. If phonological information mediates the recognition of the target, then the priming of its phonological representation by the pseudohomophone should facilitate lexical access compared with the graphemic control. Indeed, there are now ample demonstrations of phonological priming and masking effects that use briefly presented primes (Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994; Perfetti & Bell, 1991; Pollatsek, Lesch, Morris, & Rayner, 1992) and masks (Perfetti & Bell, 1991; Perfetti, Bell, & Delaney, 1988). For the sake of simplicity, the current design did not attempt to isolate the specific component of assembly (consonant vs. vowels) responsible for phonological priming. The relatively long exposure duration of the prime in these experiments (approximately 43 ms) may permit the assembly of both consonant and vowel information. However, because the advantage of the pseudohomophone prime over the graphemic control is expressed by the number of either consonant or vowel phonemes it shares with the target, phonological priming is expected even if the contents of assembly were reduced to consonant information alone.[2]

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[2] Note that the disadvantage of the graphemic prime relative to the pseudohomophone results both from its failure to introduce the target's correct phonemes as well as the introduction of incorrect phonemes. For instance, the pseudohomophone LAIS shares two correct consonants with the target *lace* and one correct vowel. In contrast, the graphemic control LAFT provides only one correct consonant phoneme. Conversely, LAFT introduces an incorrect vowel phoneme and two incorrect consonant phonemes. The

In summary, then, the design compared the results of two markers of assembly: regularity effects and phonological priming effects. These markers contrast on both the *contents* of assembly they are designed to reflect (the what question) and their *time course* (the when question). Regularity effects reflect vowel information exclusively, whereas priming effects may reflect both consonants and vowels. Phonological priming taps into early stages of identification. In contrast, the time course of regularity effects is flexible, depending on the ease of discrimination in the lexical decision task. Conditions permitting relatively easy discrimination of targets and foils, as in the presence of legal nonword foils, should encourage fast response, prior to the emergence of the slow-vowel component, resulting in null regularity effects (e.g., Coltheart et al., 1979; Seidenberg et al., 1984; Waters & Seidenberg, 1985; but see Stone, Vanhoy, & Van Orden, 1997). However, if regularity effects are not necessary evidence for assembly, then phonological priming may emerge in the face of null regularity effects.

Experiment 1

The goal of Experiment 1 was to compare two marker effects of assembly (regularity and phonological priming effects) in the lexical decision task using orthographically legal nonwords as foils. Such conditions normally result in null regularity effects. These null effects are often attributed to the absence of assembly in the lexical decision task. Experiment 1 was expected to replicate the finding of null regularity effects. The use of a second marker of assembly, phonological priming, may permit testing its interpretation. If null regularity effects reflect the absence of assembly, then this conclusion should not depend on the marker used: Null phonological effects are expected in both the regularity as well as in the phonological priming markers. Conversely, if null regularity effects reflect the absence of only a single phonological component—vowels—and if this component is not necessary for the computation of assembly as a whole, then markers of consonant phonology may detect evidence for assembly in the absence of regularity effects. Thus, phonological priming effects may be obtained despite null regularity effects.

Method

Participants

Twenty-four native English speakers at the University of Pittsburgh participated in the experiment in partial fulfillment of a course requirement.

Apparatus

The experiment was conducted on a Gateway 4DX2-66 computer with a Gateway 14 SVGA monitor using the Micro Experimental Lab software (Schneider, 1990). The precision in the brief display of the prime was achieved by locking the electron gun to the top of the screen at the beginning of each trial and the specification of the duration of the target and prime in terms of full refresh cycles.

Materials

Sixty-four monosyllabic words were selected as targets (see Appendix A). Half of these targets were regular words and half were exception words. To maximize the contrast between the two levels of target regularity, regular targets corresponded either to major patterns of primary vowels or to major vowel correspondences as defined in Venezky (1970). Irregular words were generally either exceptions to major patterns of primary vowels or members of minor vowel correspondences (Venezky, 1970). In addition to their contrast on the dimension of grapheme to phoneme correspondences, the two levels of regularity also differed in terms of the consistency of their bodies. As a group, regular words were more consistent than exception words.[3] Exception words were either inconsistent or hermits (i.e., words whose body was not shared by any other English word). Within each level of target regularity, half of the targets were high-frequency words and half were low-frequency words. The regular and exception targets were matched on their word frequency based on the estimate of Kucera and Francis (1967). The mean frequency of low-frequency words was 13 and 14 per million for regular and exception words, respectively. The mean frequency for high-frequency words was 324 and 330 per million for regular and exception words, respectively. The targets in the four categories of Frequency × Regularity were also matched for the number of letters. The mean number of letters was 4.5 letters per word.

For each target word, three types of primes were constructed: A pseudohomophone, a graphemic prime, and a control prime. The pseudohomophone was identical to the target in its phonology but not in its graphemic representation. The graphemic prime was matched to the pseudohomophone in the number of letters and letter positions shared with the target, but it differed from the target in its phonology. Finally, the control prime had no common letters or phonemes with the target. The nonword foils were 64 orthographically legal and pronounceable nonwords (see Appendix B). Thirty-eight of these foils were taken from the materials used in Stone and Van Orden's (1993) study. The foils were all primed by an identity prime (i.e., a prime identical to the target).

The warm-up materials consisted of 16 words and 17 nonwords. Targets were both regular and exception words. The foils were all legal, pronounceable nonwords. In the warm-up, the targets and foils were primed by control primes. Throughout the experiment, targets were presented in lowercase letters, whereas primes were presented in uppercase.

Identity priming of target words. One fourth of the target words were preceded by an identity prime that was identical to the

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disadvantage of LAFT relative to LAIS thus results from its failure to introduce some of the target's correct phonemes and the introduction of incorrect phonemes. Of importance is that this disadvantage is manifested in both consonant and vowel phonemes. Thus, even if the duration of the prime permitted the assembly of consonant information exclusively, the pseudohomophone should still have an advantage over the graphemic prime.

[3] Only three of the regular words were inconsistent. All three words (*care, square,* and *case*) were high-frequency words. For two of these words (*care* and *square*) the enemy (*are*) is not a neighbor. Given their high frequency and the relatively high strength of their vowel correspondences, the inconsistency of these words should have little effect on the magnitude of the regularity effect for this set of materials.

target. These trials were included in the design but excluded from all analyses. The inclusion of the identity prime was intended to assess the contribution of graphemic information in reading. The assessment of graphemic contribution by using a real-word prime intentionally confounded the contribution of graphemic information with prime lexicality. Furthermore, because word primes were always followed by an identical target word, identity priming for word trials was also a perfect predictor of a "yes" response. Because the primary goal of the study was to demonstrate phonological effects in the lexical decision task, this design seemed to provide an appropriate bias toward the detection of graphemic effects and in favor of the slow phonology hypothesis. However, it appeared upon inspection of the data that this design could have operated against the graphemic priming effect rather than in its favor. Because all nonword foils were primed by an identity prime, it is conceivable that identity priming could have been perceived as a cue for a "no" response. The priming of the target by an identity prime could have thus encouraged an erroneous target rejection and masked the expected effect of identity priming. Further research is necessary to establish the effect of the materials' structure on the emergence of identity priming. Because the interpretation of identity priming in the materials used in this study is uncertain and because the primary goal of this research was to explore phonological priming, all word trials involving the identity prime were excluded from the analysis.

Design

The target properties (2 regularity–consistency × 2 frequency) and prime type (4: identity, pseudohomophone, graphemic, and control) were manipulated within subjects. The frequency and regularity–consistency variables were crossed. The resulting four combinations of Regularity–Consistency × Frequency were each counterbalanced with the prime type variable by using a Latin square, such that each participant saw four combinations of Prime × Frequency × Regularity; no target was seen more than once by any given participant; and each of the combinations of any target with its primes was presented to the same number of participants. Note that all target trials primed by the identity prime were excluded from the analyses. The order of trials in the experimental session was randomly determined for each participant.

Procedure

The visual stimuli were presented at the center of the screen at a distance of approximately 45 cm and at a visual angle of approximately 2° from the participant. To reduce the visual contrast, all visual stimuli were presented in a blue color on a black background.

At the beginning of each trial, a fixation point appeared at the center of the screen. A message presented below the fixation point indicated the trial number. Participants initiated the trial by pressing the space bar. The trial itself consisted of three events: a pattern mask followed by the prime and the target. The pattern mask consisted of a series of 8 Xs appearing at the center of the screen for 33 refresh cycles (approximately 470 ms). It was immediately (interstimulus interval = 0) replaced by a prime, presented for 3 refresh cycles (approximately 43 ms), and a target, presented for 10 refresh cycles (approximately 142 ms). Primes were presented in uppercase letters, whereas targets were presented in lowercase. To control for the visual salience of letters presented in external word positions, primes were presented with pound signs to their left and right. In this and all subsequent experiments, response latencies were measured and reported relative to the onset of the prime.

Participants indicated their response by using their preferred hand. Word responses were given by pressing the 1 key and nonword responses, by pressing the 2 key. Participants were instructed to make their response as quickly and as accurately as possible. Slow responses (slower than 1,500 ms) and inaccurate responses received negative feedback from the computer in the form of a tone and a computer message. The experiment initiated with a short warm-up followed by the experimental session.

Results

Participants' accuracy scores and correct response latencies were subjected to separate 3 (prime) × 2 (frequency) × 2 (regularity) analyses of variance (ANOVAs), by participants and items. Two of the low-frequency exception words (*sieve, sewn*) were excluded from both analyses because they tended to elicit extremely low accuracy performance (33% and 56%, respectively; for comparison, the mean response accuracy of the rest of the low-frequency exception words was 94%). The examination of these results focuses on the comparison of evidence for assembly emerging from two marker effects: regularity effects and phonological priming effects.

Phonological Priming

Latency data. Figure 1 plots the distribution of correct response latencies with the pseudohomophone against the graphemic prime. This distribution was created by randomly yoking each pseudohomophone prime trial to a trial in which the same word was preceded by a graphemic prime. The resulting distribution was bimodal. Specifically, a small cluster of responses at the upper tail of the distribution manifested a strong inhibitory trend of phonemic priming.

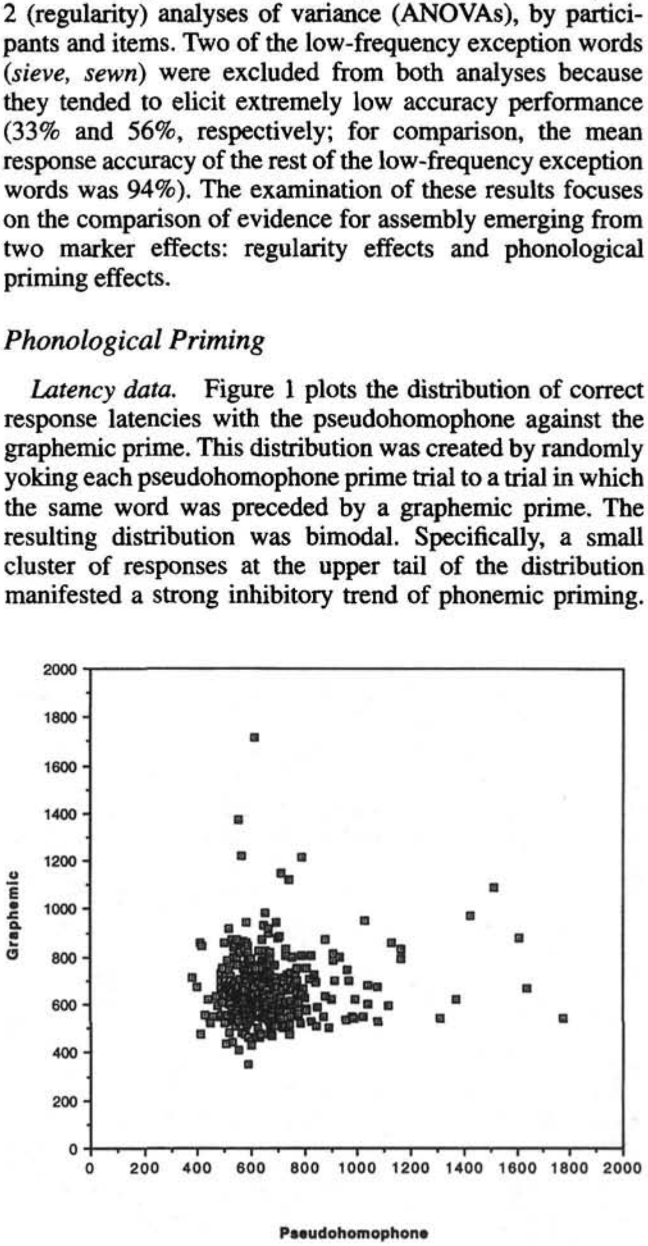

Figure 1. The distribution of correct response latency with the pseudohomophone and graphemic primes in Experiment 1.

To examine the effect of phonemic priming on the principal cluster of observations, a cutoff procedure that eliminated response latencies slower or faster than 2 *SD*s relative to the mean correct "yes" latency was applied. This procedure resulted in the elimination of 3.82% of the total correct responses.

Table 1 lists mean correct response latency and mean accuracy as a function of prime type. The contribution of phonological information was evaluated by a planned comparison in which recognition latency in the presence of the pseudohomophone relative to the graphemic prime was examined. The phonemic priming effect was highly significant: Priming the target by the pseudohomophone facilitated its identification compared with the graphemic prime ($\Delta = 20$ ms), $F_1(1, 46) = 10.42, p = .0023$, $F_2(1, 116) = 6.73, p = .0107$. The 2 (frequency) × 2 (regularity) × 3 (prime) omnibus ANOVAs revealed a main effect of prime type, significant by participants and items, $F_1(2, 46) = 5.77, p = .0058$, $F_2(2, 116) = 3.59, p = .0307$. None of the interactions involving the prime variable reached significance ($F < 1$).

Accuracy data. The contribution of assembly was assessed by planned comparisons of the pseudohomophone and graphemic prime. The phonemic effect was significant, $F_1(1, 46) = 4.10, p = .0487$, $F_2(1, 116) = 5.32, p = .0229$. In contrast to the latency data, the phonemic effect in accuracy was inhibitory in nature: Response accuracy dropped significantly in the presence of the pseudohomophone compared with the graphemic prime ($\Delta = 2.86\%$). The ANOVAs performed on participants' response accuracy revealed a main effect of prime type significant by items and marginally significant by participants, $F_1(2, 46) = 2.52, p = .0919$, $F_2(2, 116) = 3.16, p = .046$. None of the interactions with the prime-type variable approached significance.

Regularity Effects

As expected, the data provided little evidence for assembly in terms of regularity effects (see Table 2). The regularity effect was nonsignificant in the latency data ($F < 1$, by participants and items). In the accuracy data, the main effect of regularity was only marginally significant in the participant analysis and nonsignificant by items, $F_1(1, 23) = 3.69$, $p = .0672$, $F_2(1, 58) = 1.88, p = .1759$. Similarly, there was no hint of a Frequency × Regularity interaction in the accuracy or the latency data ($F < 1$). In contrast, the frequency effect was significant in the latency data $F_1(1, 23) = 38.90, p = .0000$, $F_2(1, 58) = 14.37, p = .0004$, and in the accuracy data, $F_1(1, 23) = 7.26, p = .0129$, $F_2(1, 58) = 4.21, p = .0448$.

Table 1
Target Correct Recognition Latency and Mean Response Accuracy in Experiment 1 as a Function of Prime Type

Target type	Latency (RT in ms)	Accuracy (% correct)
Pseudohomophone	633	94.28
Graphemic	653	97.14
Control	637	96.89

Note. RT = response time.

Table 2
Target Correct Recognition Latency and Mean Response Accuracy in Experiment 1 as a Function of Target Frequency and Regularity

Target type	Latency (RT in ms)	Accuracy (% correct)
Low-frequency regular	661	95.49
Low-frequency exception	658	93.49
High-frequency regular	624	98.96
High-frequency exception	621	96.53

Note. RT = response time.

Discussion

Experiment 1 compared two markers of assembly: regularity effects and phonological priming. In accord with previous research (e.g., Andrews, 1982; Coltheart et al., 1979; Seidenberg et al., 1984), the results presented here provide no evidence for assembly in terms of regularity effects. Given this finding alone, one would be tempted to conclude that performance in the lexical decision task is unaffected by assembled phonology. The inclusion of a second marker of assembly, phonological priming, in this design, challenges this interpretation. Priming the target by phonological information clearly constrained its recognition. Strong effects of phonemic priming were obtained in both the latency and the accuracy data. Phonological priming was further general in its effect: Replicating the findings of other brief priming and masking studies (Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994; Perfetti & Bell, 1991), phonological effects were obtained regardless of word frequency.

Phonological priming, however, resulted in two competing effects: Priming the target by the pseudohomophone generally facilitated response latency but impaired response accuracy. A trace of this competition also emerged in the distribution of the response latency for the pseudohomophone and graphemic primes as an inhibitory trend at the upper tail of the response latency distribution (see Figure 1). The priming of the target by the pseudohomophone thus resulted in two simultaneous response patterns: a facilitation of a correct "yes" response, and a bias toward an erroneous "no" response. Such bistability is characteristic of the presence of competing perceptual categories (Tuller, Case, Ding, & Kelso, 1994). Indeed, within the lexical decision task, a pseudohomophone prime carries conflicting messages: It conveys the target's correct phonology at the price of incorrect lexical status and graphemic information. However, each of these response patterns must indicate the presence of assembled phonology: Both the facilitatory as well as the inhibitory effects are obtained relative to a graphemic prime, which matches the pseudohomophone in all aspects but its phonological similarity to the prime. These competing responses are thus directly attributable to the phonological identity between the pseudohomophone and the target. In fact, such a competition appears to emerge exclusively in the presence of phonological identity between the nonword prime and the target. A comparison of the graphemic and the control primes reveals that the presence of partial (phonological and graphemic) similarity to the target delays response latency (Δ = 16 ms), $F_1(1, 46) = 6.40$, $p = .0149$, $F_2(1, 116) = 3.52$, $p = .063$, without affecting response accuracy (Δ = 0.37%). Thus, the competing percepts associated with the pseudohomophone are not random, general fluctuations in participants' response strategies. Instead, they are a direct consequence of the phonological identity of a nonword prime, the pseudohomophone, and the target word.

The competing response patterns due to phonological priming are not unique to this experiment or to the lexical decision task. Their relative salience may be further manipulated empirically. In a recent study, Berent and Van Orden (1996) examined phonemic masking effects for homophone targets (e.g., *sine*) in the backward masking technique. An unequivocal identification of such targets requires processing their graphemic information. As in the present study, pairing the target with a pseudohomophone (e.g., SYNE) provided correct phonological information at the price of incorrect graphemic information. The salience of these two aspects of the pseudohomophone may be manipulated by varying the extent to which spelling is emphasized in this task. Following a study by Verstaen, Humphreys, Olson, and D'Ydewalle (1995) and using their homophone targets and masks, Berent and Van Orden manipulated reliance on spelling by reordering two lists consisting of homophonic and nonhomophonic targets. In the phonology-encouraging condition, homophone targets were introduced at the end of the experimental list. They were preceded by purely nonhomophonic targets, and participants were not informed of their presence. In contrast, in the spelling-encouraging condition, participants were explicitly warned about the presence of homophones and required to attend to spelling. The homophones were conspicuously presented at the beginning of the list and preceded by homophonic warm-up trials. Significant phonemic effects were obtained in each of these conditions. However, as in this study, their direction diverged: The phonology-encouraging condition resulted in a significant increase in reporting the target's homophone (e.g., *sign*) and a nonsignificant increase in target identification (this trend reached significance in Verstaen et al.'s [1995] study). Conversely, the spelling-encouraging condition resulted in the reversal of the direction of phonological effects: Target recognition accuracy decreased significantly with the pseudohomophone compared with the graphemic mask.

Berent and Van Orden's (1996) study demonstrated that the phonological identity of a nonword mask and the target may elicit competing response patterns. These data provide converging evidence of the conflicting consequences of phonological priming in the present study. Furthermore, these backward masking findings identify participants' reliance on spelling as a critical factor, the effect of which may be empirically manipulated to determine the direction of phonological effects. Extending this conclusion to the lexical decision task, the divergence between the speed and accuracy measures of phonological priming may reflect the role of phonological versus graphemic response strategies. Indeed, in the presence of legal nonword foils, both strategies could reliably discriminate targets and foils. Given reliance on phonology, the pseudohomophone may facilitate discrimination at no cost. Conversely, a strategy based on the conjunction of phonological and graphemic information may occasionally result in the misattribution of the pseudohomophone's incorrect orthography and lexical status to the following target, resulting in inhibition.

The findings of Experiment 1 carry two important implications. First, they demonstrate that, in contrast to the conclusions of most previous research on reading in English, assembled phonology strongly constrains performance in the lexical decision task. Previous findings of null regularity effects in the lexical decision task have typically been attributed to the absence of assembly in this task and its limited contribution to reading in general. The present results replicated this null effect but contrast it with a positive demonstration of a phonological priming effect. The dissociation between the results of the markers of regularity effects and phonological priming is a second important consequence of this study. This dissociation suggests that the assembly of phonology may proceed in the face of null regularity effects. Regularity effects may not be necessary evidence for its presence.

Experiment 2

Experiment 2 had two goals. One was to replicate the findings of phonological priming effects in the lexical decision task, which were observed in Experiment 1. A second goal was to evaluate the mandatory nature of phonology assembly. Experiment 1 yielded evidence for phonological priming in a task that did not require the assembly of phonology. However, phonology may nevertheless assist in the discrimination of targets and foils. Experiment 2 sought a stronger test for the phonological hypothesis. Following the work of Stone and Van Orden (1993), Experiment 2 assessed participants' control over the assembly of phonology by using an ideal strategy manipulation. This experiment used the very same set of experimental trials that had been used in Experiment 1. The control over assembly was investigated by strictly manipulating the context in which the experimental trials were presented (i.e., the type of foils used). The nonword foils in Experiment 2 all consisted of pseudohomophones that were matched in their graphemic similarity to the legal nonwords used in Experiment 1. Thus, these two types of foils differed only in their phonological similarity to real words. In the presence of pseudohomophone foils, the discrimination of targets and foils on the phonological dimension is practically impossible. The use of a phonological discrimination strategy should result in the misclassification of the foils as targets. Would participants assemble a phonological representation under circumstances in which the phonological dimension could actually impair discrimination?

According to the slow phonology hypothesis, the assembly of phonology may be inhibited if its computation is contrary to task demands. However, the existing literature provides only modest support for this claim. Consider first the findings obtained when the marker of consistency effects was used. A series of studies by Pugh et al. (1994) demonstrated the elimination of both consistency effects and the inhibition by an inconsistent prime (e.g. *couch–touch*) in the presence of pseudohomophone foils. However, Gibbs and Van Orden (in press) reported consistency effects in the lexical decision task despite the presence of pseudohomophones. Further evidence for the strategic control of assembly in the presence of pseudohomophone foils has been obtained by using additional, indirect measures of assembly. One such marker is the word length effect. If assembly is a resource-demanding process, operating on subword units, then the time required to assemble a phonological representation should increase with word length (Forster & Chambers, 1973; Fredriksen & Kroll, 1976). The finding that word length effects are eliminated in the presence of pseudohomophone foils is thus interpreted as evidence for the suppression of assembly (Pugh et al., 1994). Similarly, if assembly is used in recognition, then it should impair the rejection of pseudohomophone foils in the lexical decision task (Coltheart, Davelaar, Jonasson, & Besner, 1977; McCann, Besner, & Davelaar, 1988; Meyer & Ruddy, 1973; Rubinstein, Lewis, & Rubinstein, 1971; Seidenberg, Peterson, MacDonald, & Plaut, 1996). Conversely, if participants can adjust to the presence of pseudohomophones by eliminating assembly, then the difficulty in rejecting pseudohomophone foils should be reduced with practice (McQuade, 1983) and in the presence of a large proportion of pseudohomophones (Martin, 1982; McQuade, 1981). In fact, if assembly is a resource-demanding process, then its suppression in the presence of pseudohomophones may facilitate recognition. The findings regarding this question are inconsistent. Although Stone and Van Orden (1993) observed an inhibition in target identification even when all foils consisted of pseudohomophones, other studies (Andrews, 1982; Pugh et al., 1994) reported facilitation in target identification in the presence of pseudohomophone foils.

In summary, the examination of evidence for assembly by means of the consistency effect and a series of indirect markers provides some support for the claim that the computation of assembly may be eliminated in the presence of pseudohomophones. However, the existing data are inconsistent. Furthermore, the evidence suggesting the suppression of assembly in the presence of pseudohomophones all rely on null effects associated with an unreliable attention-demanding component of assembly. These findings could be attributed to the assembly of vowels (Berent & Perfetti, 1995). The elimination of evidence for vowel assembly may be the result either of participants' ability to suppress vowel assembly (Berent & Perfetti, 1995) or of their ability to control the timing of discrimination decisions, resulting in an early examination of the assembled code, prior to vowel assembly (Van Orden & Goldinger, 1994). However, the elimination of evidence for the vowel component does not necessarily indicate the elimination of assembly as a whole. As in Experiment 1, the present study examined evidence for assembly using two markers: regularity effects and the phonological priming effects. The slow phonology hypothesis predicts null evidence for assembly under conditions discouraging its use. Conversely, the phonological hypothesis predicts that evidence for assembly should emerge even when the discrimination of targets and foils on the phonological dimension is practically impossible.

Method

Participants

Twenty-four native English speakers at the University of Pittsburgh participated in the experiment in partial fulfillment of a course requirement.

Materials

The targets were the same 64 words used in Experiment 1. The foils were 64 pseudohomophones (see Appendix C). These pseudohomophones were matched in their graphemic similarity to their respective words to the legal nonwords used as foils in Experiment 1. Thus, the two types of foils in Experiments 1 and 2 were equivalent in their graphemic similarity to real English words. The only difference between these two types of foils was strictly in terms of the phonological resemblance of the foils to English words.

Prior to the experimental session, participants were presented with 32 warm-up trials. The targets in the warm-up were the same 12 regular and exception words used in Experiment 1. However, the legal nonword foils used in the warm-up of Experiment 1 were replaced by pseudohomophones, matched for their graphemic similarity to their respective targets.

Procedure

The procedure was similar to that of Experiment 1. Participants were informed that the foils presented in this experiment consisted of "nonwords which sound like English words, but are not spelled like real words." To discourage the reliance on a phonological strategy, participants were explicitly told that the reliance on phonological information in this task would be misleading. They were asked to make their lexical decision according to the spelling of the stimuli and to ignore their sound.

The design, apparatus, and procedure were identical to those of Experiment 1.

Results

The following analyses examined two questions. First, does phonology constrain recognition in the presence of pseudohomophone foils? This question was addressed by comparing the effects of the two markers—phonological priming and regularity effects—in the data of Experiment 2. To interpret the effect of the pseudohomophone foils on the manifestation of phonological effects, however, it is important to find out whether the strategy manipulation was effective. Are there changes in performance that can be directly attributed to the phonological similarity of the foils to real words? To aid in evaluating the effectiveness of the strategy manipulation, a meta-analysis comparing the results of Experiments 1 and 2 follows.

Phonological Effects in the Presence of Pseudohomophone Foils: Experiment 2

Participants' accuracy scores and correct response latencies were subjected to separate 3 (prime) × 2 (frequency) × 2 (regularity) ANOVAs, by participants and items. Two of the low-frequency exception words (*sieve, sewn*) were excluded from both analyses because they tended to elicit extremely low accuracy performance (11% and 39%, respectively; for comparison, the mean accuracy for the rest of the low-frequency exception words was 90%). Figure 2 plots the distribution of correct response latencies with the pseudohomophone against the graphemic prime. As in Experiment 1, this distribution reflected bimodality. In contrast to Experiment 1, however, the cluster of outliers primarily reflected longer response latency with the graphemic prime compared with the pseudohomophone at the upper tail of the latency distribution. To eliminate the effect of outliers, responses slower than 2.5 *SD*s from the mean were excluded. This procedure resulted in the elimination of 2.71% of the total correct responses. Additional analyses performed on the untrimmed data indicated that the trimming procedure did not alter the overall pattern of results.[4] The following analyses thus report the results of the trimmed data only.

Phonological priming. The analyses of response accuracy did not reveal a main effect of prime type or any interactions involving the prime-type variable ($F < 1$). Response accuracy with the pseudohomophone and graphemic prime was literally identical (92.45%). In contrast, the phonemic priming effect was highly significant in the latency data (see Table 3). Priming the target by the pseudohomophone facilitated its recognition compared with the graphemic prime ($\Delta = 25$ ms), $F_1(1, 46) = 6.10$, $p = .0173$, $F_2(1, 116) = 4.29$, $p = .0405$. The main effect of prime type was marginally significant in the omnibus ANOVA, $F_1(2, 46) = 3.05$, $p = .0572$; $F_2(2, 116) = 2.40$, $p = .0956$, and it did not interact with any of the other variables.

Table 3
Target Correct Recognition Latency and Mean Response Accuracy in Experiment 2 as a Function of Prime Type

Target type	Latency (RT in ms)	Accuracy (% correct)
Pseudohomophone	679	92.45
Graphemic	704	92.45
Control	692	92.19

Note. RT = response time.

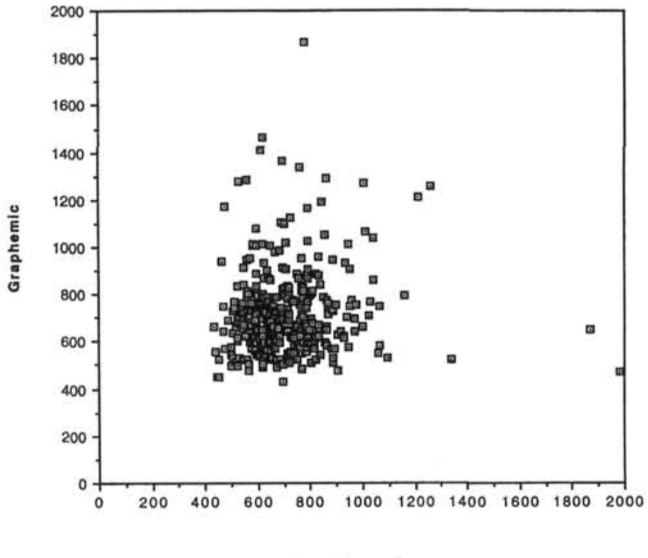

Figure 2. The distribution of correct response latency with the pseudohomophone and graphemic primes in Experiment 2.

Regularity effects. The ANOVA performed on participants' response latency revealed no evidence of a regularity effect ($F < 1$, by participants and items). However, the accuracy data reflected a main effect of regularity, significant by participants, $F_1(1, 23) = 9.64$, $p = .005$, and marginally significant by items, $F_2(1, 58) = 3.38$, $p = .0713$. Response accuracy for regular words was higher than for exception words ($\Delta = 4.86\%$; see Table 4). The Frequency × Regularity interaction did not approach significance in the latency, $F_1(1, 23) = 1.65$, $p = .2122$ ($F_2 < 1$), or accuracy, $F_1(1, 23) = 2.08$, $p = .1628$ ($F_2 < 1$), data. The latency data also revealed a main effect of frequency, significant by participants and items, $F_1(1, 23) = 33.00$, $p = .0001$, $F_2(1, 58) = 8.30$, $p = .0056$.

Effect of Foils' Phonological Lexicality: Comparison of Experiments 1 and 2

Foil identification. To evaluate the effect of the phonological similarity of the pseudohomophone foils to real words, rejection accuracy and correct rejection latency for the pseudohomophone foils in Experiment 2 were compared with those of the legal nonwords in Experiment 1. The phonological resemblance of the foils to real words impaired recognition latency by items ($\Delta = 37$ ms), $F(1, 126) = 5.34$,

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[4] Specifically, the untrimmed data reflected a highly significant effect of phonemic priming. Response latencies to the pseudohomophone were significantly faster compared with the graphemic control ($\Delta = 29$ ms), $F_1(1, 46) = 5.44$, $p = .0241$, $F_2(1, 116) = 4.24$, $p = .0418$. The main effect of prime type was marginally significant, $F_1(2, 46) = 2.83$, $p = .0692$, $F_2(2, 116) = 3.06$, $p = .0508$. In contrast, neither the regularity effect, $F_1(1, 23) = 1.27$, $F_2(1, 58) < 1$, nor the interaction of Frequency × Regularity ($F < 1$) approached significance. The only finding diverging from the results of the trimmed analyses was the emergence of the three-way interaction of Prime × Regularity × Frequency, $F_1(2, 46) = 3.31$, $p = .0455$, and a Prime × Regularity interaction, $F_1(2, 46) = 3.80$, $p = .0297$, in the participant analysis only. Because these interactions did not approach significance by items (all Fs < 1.50), they were likely due to the effect of a small number of outlier responses to a few of the items. Such outliers are evident in Figure 2. Indeed, the cutoff procedure resulted in the elimination of these spurious interactions but did not alter the principal finding of phonemic priming.

Table 4
Target Correct Recognition Latency and Mean Response Accuracy in Experiment 2 as a Function of Target Frequency and Regularity

Target type	Latency (RT in ms)	Accuracy (% correct)
Low-frequency regular	713	92.36
Low-frequency exception	723	89.93
High-frequency regular	669	97.22
High-frequency exception	663	89.93

Note. RT = response time.

$p < .05$, but not by participants, $F(1, 46) = 1.08, p < .4$ (*ns*). Accuracy performance for the pseudohomophone foils did not differ significantly from the legal nonwords foils ($\Delta = 2.16\%$), $F(1, 46) = 0.80$, $F(1, 126) = 1.10$, $p < .3$ (*ns*), by participants and items.

Target identification. The effect of the strategy manipulation on target identification latency and accuracy was examined by separate 2 (foil) × 2 (frequency) × 2 (regularity) × 3 (prime) ANOVAs. For the sake of simplicity, the following report describes only the main effects and interactions involving the foil-type variable.

The ANOVAs on the correct response latency data revealed a significant main effect of foil type, $F_1(1, 46) = 8.02, p = .0069, F_2(1, 58) = 76.73, p = .0001$. Similarly, the main effect of foil type was highly significant in the accuracy analyses, $F(1, 46) = 9.06, p = .0042$, $F(1, 58) = 9.75, p = .0028$. Target recognition was significantly slower ($\Delta = 51$ ms) and less accurate ($\Delta = 3.74\%$) in the presence of pseudohomophones compared with legal nonwords. None of the interactions involving the foil-type variable reached significance.

Discussion

Experiment 2 examined evidence for assembly in a situation in which its computation clearly impairs the discrimination of targets and foils. According to the slow phonology hypothesis, these conditions should discourage reliance on phonology. However, the results provide strong evidence for assembly. Replicating the findings of Experiment 1, the priming of the target by phonological information facilitated its recognition latency. As in Experiment 1, phonological priming was not modulated by word frequency, indicating that the contribution of assembly is general. Together, these findings strongly suggest that the assembly of phonology constrains performance in the lexical decision task even when the computation of phonology is not only unnecessary but, in fact, contrary to task demands. Please note that the convergence between the results of Experiments 1 and 2 cannot be attributed to the weakness of the strategy manipulation. The comparison of Experiments 1 and 2 reveals a strong effect of foil type on target identification latency and accuracy. These results, which replicated the findings of Stone and Van Orden (1993), demonstrate that participants' performance in the lexical decision task is impaired by the presence of pseudohomophone foils. Because the legal nonwords and the pseudohomophone foils were matched in their graphemic similarity to the target, this finding indicates that the increased difficulty in word identification in the presence of the pseudohomophones is specifically due to their *phonological* similarity to real words. This result demonstrates the effectiveness of the strategy manipulation and provides converging evidence for phonological effects in the lexical decision task.

The separate analyses of Experiment 2 also indicate some divergence between its results and the findings of Experiment 1. In the presence of pseudohomophone foils, there was no indication of inhibitory effects of phonemic priming. Further research is required in order to establish whether this finding may be reliably attributed to the presence of pseudohomophone foils. One may speculate that the presence of pseudohomophone foils elicited cautious, slower performance, which might have spared participants from the adversary effect of the pseudohomophone prime. Such a slower performance perhaps permitted the accumulation of stronger evidence supporting the target's correct spelling, thereby reducing the salience of the incorrect graphemic and lexical information carried by the pseudohomophone prime.

A second difference between the findings of Experiments 1 and 2 concerns the regularity effect. Experiment 1 revealed no evidence for regularity effects. In contrast, a regularity effect did emerge in the accuracy data of Experiment 2. Because the manifestation of this effect was absent in the latency data and the relevant interaction did not emerge in the meta-analyses of Experiments 1 and 2, the interpretation of this result requires some caution. This finding, however, agrees with the results of Gibbs and Van Orden (in press) demonstrating that the presence of a pseudohomophone in the lexical decision task results in the emergence of a regularity effect. It may be explained by the delay in identification in the presence of the pseudohomophone foils. Because vowel assembly, the component responsible for regularity effects, is a slow process, its effect is more likely to emerge under conditions demanding slow, careful performance.[5] Indeed, the delay in performance that is due to the presence of strange words results in a significant regularity effect in the lexical decision task (Parkin & Underwood, 1983; Waters & Seidenberg, 1985). Conversely, the encouragement of fast response by a tight response deadline results in the elimination of regularity effects (Waters & Seidenberg, 1985). The contingency of regularity effects on response timing may further explain the failure to observe regularity effects among fast readers (Seidenberg, 1985). In the present experiment, the inclusion of pseudohomophone foils clearly delayed discrimination. This delay could have

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[5] The emergence of regularity effects in the presence of pseudohomophone foils appears incompatible with Pugh et al.'s (1994) report of the elimination of consistency effects in the presence of pseudohomophone foils. However, the introduction of pseudohomophones foils in Pugh et al.'s experiment resulted in a significant facilitation in response latency (perhaps because of the orthographic illegality of some of these items; see Gibbs & Van Orden, in press). The truncation of evidence for vowels under conditions eliciting fast response is fully compatible with my proposal.

increased the chances of the tapping of the slow-vowel component by the marker of the regularity effect.

In summary, these findings reflect strong evidence for assembly under conditions designed to discourage its use, that is, in the presence of pseudohomophones. Contrary to the predictions of the slow phonology hypothesis, the pseudohomophone foils did not cancel the contribution of phonological information. In fact, these conditions actually strengthened the evidence for assembly, which was detected by each of the two markers of assembly: the regularity and phonological priming effects. These results suggest that assembly is a strong, perhaps mandatory, constraint in reading.

General Discussion

Regularity effects are one of the most trusted markers of assembly. Their scope, however, is limited. Regularity effects are typically absent for high-frequency words. The lexical decision task normally yields null regularity effects even for low-frequency words in the presence of legal nonwords. These findings are often attributed to the absence of assembly. The lexical decision task is thus viewed as a "nonphonological task," unaffected by the assembly mechanism. Consequently, assembly is believed to be disabled or ignored under conditions that do not require, or actively discourage, its use. In general, null regularity effects support the view of phonology as a slow, weak constraint on reading. The present research attempted to evaluate this interpretation. Two general questions guided this investigation: (a) Are regularity effects necessary evidence for assembly, that is, can evidence for assembly be obtained despite null regularity effects? (b) Does assembly constrain reading under conditions that do not require, or actively discourage, its use?

Two experiments examined evidence for assembly in the lexical decision task by comparing two markers: regularity effects and phonological priming effects. Experiment 1 examined evidence for assembly in the presence of legal nonwords, conditions that do not require the assembly of phonology. Experiment 2 attempted to actively discourage assembly by using pseudohomophone foils. As expected, the marker of regularity effects yielded null evidence for assembly in the presence of legal nonword foils and a modest effect, in accuracy only, in the presence of pseudohomophone foils. In contrast, strong evidence for assembly emerged in each of the experiments by the marker of phonological priming. Significant facilitatory effects of phonological priming were obtained despite the use of pseudohomophone foils. In the presence of legal nonword foils, phonological priming resulted in competing responses: a facilitation in the latency data coupled with an inhibition in the accuracy data. This competition is attributed to the "conflicting messages" carried by the pseudohomophone prime, that is, correct phonology at the price of incorrect lexical and graphemic information. The finding of phonological priming effects is a conceptual replication of numerous demonstrations of phonological effects by briefly presented primes in English (Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994; Perfetti & Bell, 1991; Pollatsek et al., 1992), French (e.g., Ferrand & Grainger, 1992, 1993, 1994, 1996), and Serbo Croatian (Lukatela & Turvey, 1990). These results suggest that, in contrast to the slow phonology hypothesis, assembled phonology constrains performance in the lexical decision task despite conditions discouraging its use. Regularity effects are thus not necessary evidence for its presence.

These strong conclusions, however, suffer from two potential caveats. The demonstration of phonological effects in the lexical decision task, even in the presence of pseudohomophones, obviously does not preclude the possibility that stronger manipulations may yet fail to yield such effects. This pursuit of null phonology effects would seem to carry the burden of proof. Proponents of the slow phonology hypothesis may proceed to question the contribution of assembly even in the current setting. This investigation attempted to show that regularity effects suffer from some principled limitations that systematically reduce their sensitivity. This claim was supported by the demonstration of phonological priming in the absence of regularity effects. Rather than accepting the limitations of regularity effects, one may wish to question the evidence of phonological priming.

Priming effects are thought to reflect the presence of shared or linked representations. The pseudohomophone, by definition, shares with the target an identical phonological representation. Because the pseudohomophone is a nonword, its phonology must be obtained by means of assembly. The simplest explanation for phonological priming by the pseudohomophone assumes that phonological priming reflects the sharing of assembled phonology by the prime and target. By this account, the assembly of the pseudohomophone prime's phonology preactivates the target's assembled phonology and thus facilitates lexical access relative to the graphemic control. Conversely, an alternative explanation attributes priming effects to a shared representation of addressed, rather than assembled, phonology. By that account, the activation of the pseudohomophone's assembled phonology addresses the lexicon, and it is that addressed representation that preactivates the target's addressed representation and facilitates lexical access. Phonological priming, from this perspective, does not necessarily indicate the contribution of assembled phonology to the target.

The lexical mediation account for phonological priming is clearly less parsimonious than the view of priming effects as prelexical (i.e., as resulting from the preactivation of a shared assembled phonology). Furthermore, its predictions are unclear and, hence, unfalsifiable. A seemingly natural prediction associated with lexical priming is that phonological priming effects should be modulated by word frequency. The predicted direction of the frequency effect, however, is uncertain. From one perspective, high-frequency words, associated with strongly activated lexical information, should manifest stronger priming effects compared with low-frequency words. Conversely, one may argue that if the recognition of high-frequency words is already at ceiling, then low-frequency words should be the ones to show greater priming effects. The present data do not support either view, as priming effects were unaffected by word frequency. Note, however, that such a null interaction with frequency does not necessarily contradict the lexical account. An interaction of prime and word frequency does not follow from all models of lexical access. For instance, verification models assume that word frequency effects are confined to verification, a stage that is normally truncated under masking (e.g., Paap & Johansen, 1994). Null frequency effects under masking could also be explained by activation and search models (for a discussion, see Forster & Davis, 1984). Thus, although the lexical account cannot be ruled out, its greater complexity seems unmotivated. The additional processing assumptions of the lexical account do not make any clear predictions, nor do they provide a better explanation for the existing data.

Conversely, the attribution of priming effects to shared assembled phonology fits well with the generality of priming effects. The generality of the contribution of assembly in the present experiments is striking. The activation of assembly was detected despite conditions believed to discourage its use and in the face of null regularity effects. Given that assembly was launched for the prime in each trial, there is no reason to suspect that assembly could have been inhibited for the target. The only possible justification to the claim that phonological priming does not reflect target assembly requires the assumption that assembly was launched for the target but did not affect its recognition because of the availability of direct access. However, the generality of phonological priming and masking effects with respect to word frequency, in this and in other studies in the literature (e.g., Berent & Perfetti, 1995; Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994; Perfetti & Bell, 1991), strongly suggests that the contribution of phonology is sufficiently fast to constrain reading even when the direct route is readily available as a means for word identification (i.e., for real words that are highly familiar). At the very least, the detection of phonological priming by a nonword must indicate the assembly of the prime's phonology. This finding demonstrates that assembly is maintained in the lexical decision task. Thus, regularity effects are certainly not a necessary marker of assembly. It is highly plausible that phonological priming is not a necessary marker of target assembly either. The simplest, most parsimonious explanation for the effects of phonological priming observed in these studies is that they are due to assembled phonology, shared between the target and the prime. Phonological priming thus appears to be marker of target assembly. Contrary to the conclusions obtained by regularity effects, the marker of phonological priming suggests that the contribution of assembly is fast and mandatory. Regularity effects, then, may not be a necessary marker of target assembly.

Assuming phonological priming effects reflect target assembly, and given that regularity effects often fail to detect such effects, the present findings reflect a dissociation of the two markers of target assembly. Why do the two markers of assembly contrast in their conclusions? What are the implications of this dissociation with respect to the nature of assembly?

According to the two-cycles model, the assembly of consonants and vowels is accomplished by two distinct stages. Thus, the two-cycles model predicts that conclusions regarding the nature of assembly should depend on the contents of assembly tapped and the time course at which assembly is examined. The markers of phonological priming and regularity effects contrast on each of these dimensions. The regularity effect is primarily a marker of the slow-vowel component, whereas in these experiments, phonological priming is designed to assess both consonants and vowels. With respect to time course, phonological priming permits tapping into early stages of the assembly process, whereas the time course of regularity effects is determined by participants' strategies. The relatively easy discrimination between targets and legal nonword foils in Experiment 1 permitted a fast decision, resulting in an early truncation of target processing prior to the computation of the slow vowel component. Because the regularity effect is limited to the detection of primarily vowel assembly, this marker yielded null evidence for assembly, whereas the marker of phonological priming nevertheless reflected the assembly process. The substitution of the foils with pseudohomophones in Experiment 2 increased the discrimination difficulty, resulting in a delay in the recognition process. This delay apparently permitted the assembly of the slow-vowel component, resulting in the emergence of evidence for assembly by each of the two markers.

Conclusions regarding the nature of assembly thus seem to vary dramatically depending on the contents of assembly assessed and the timing of the assessment. This finding has two interrelated implications. The dissociation between the two markers of assembly is compatible with the idea that consonants and vowels have distinct time courses. Although the distinct time course of consonants and vowels does not require any explicit assumptions regarding the structure of assembly, it is clearly compatible—indeed, predicted—by the claim of the two-cycles model that consonants and vowels are distinct structural entities. The dissociation of regularity and phonological priming effects also has an important methodological implication. The conclusions of a marker with respect to the nature of assembly are determined by the contents of assembly it taps and the time course at which the representation is tapped into. This claim calls for a reevaluation of conclusions regarding the nature of assembly with reference to the structural and temporal properties of the markers in question.

Of particular importance is the examination of the marker of regularity effects. Regularity effects are one of the most widely used markers of assembly. However, the interpretation of regularity effects, and primarily of null regularity effects, normally fails to consider that, in most cases, regularity effects in English specifically indicate vowel assembly. Indeed, the identification of a particular component responsible for phonological effects is of little importance for linear models of assembled phonology. If the assembly process is blind to the internal constituent structure of phonological representations, then null evidence for one of its constituents (i.e., vowels) amounts to the absence of all subsequent phonemes. Following this rationale, most existing research has attributed the absence of vowels to the absence of assembly as a whole. The finding of a dissociation of regularity effects and phonological priming demonstrates that this logic is flawed. Null evidence for vowel assembly cannot constitute null evidence for phonology. Regularity effects are thus not a necessary indication of assembly. More generally, this conclusion reaffirms the link between structural and processing accounts of assembled phonology (for a discussion, see Berent & Perfetti, 1995). An accurate evaluation of the contribution of assembled phonology to word recognition requires explicit consideration of the structure of the assembled representation as a linguistic entity.

References

Andrews, S. (1982). Phonological recoding: Is the regularity effect consistent? *Memory & Cognition, 10,* 565–575.

Baron, J. (1973). Phonemic stage not necessary for reading. *Quarterly Journal of Experimental Psychology, 25,* 241–246.

Baron, J., & Strawson, C. (1976). Use of orthographic and word-specific knowledge in reading words aloud. *Journal of Experimental Psychology: Human Perception and Performance, 2,* 386–393.

Berent, I., & Perfetti, C. A. (1995). A rose is a REEZ: The two-cycles model of phonology assembly in reading English. *Psychological Review, 102,* 146–184.

Berent, I., & Van Orden, G. (1996). Can we unmask the phonemic masking effect? The problem of methodological divergence. In G. Cottrell (Ed.), *Proceedings of the 18th annual conference of the Cognitive Science Society* (pp. 494–500). Mahwah, NJ: Erlbaum.

Bernstein, S. E., & Carr, T. H. (1996). Dual-route theories of pronouncing printed words: What can be learned from concurrent task performance? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 86–116.

Bower, T. G. (1970). Reading by eye. Phonology and reading. In H. Levin & J. O. Williams (Eds.), *Basic studies in reading* (pp. 134–146). New York: Basic Books.

Carello, C., Turvey, M. T., & Lukatela, G. (1992). Can theories of word recognition remain stubbornly nonphonological? In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 211–226). Amsterdam: North-Holland.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of information processing* (pp. 151–216). London: Academic Press.

Coltheart, M., Besner, D., Jonasson, T., & Davelaar, E. (1979). Phonological encoding in the lexical decision task. *Quarterly Journal of Experimental Psychology, 31,* 489–507.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual route and parallel distributed processing approaches. *Psychological Review, 100,* 589–608.

Coltheart, M., Davelaar, E., Jonasson, T. V., & Besner, D. (1977). Access to the internal lexicon. In D. Stanislav (Ed.), *Attention and performance VI* (pp. 532–555). Hillsdale, NJ: Erlbaum.

Coltheart, M., & Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual-route models of reading. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 1197–1211.

Ferrand, L., & Grainger, J. (1992). Phonology and orthography in visual word recognition: Evidence from masked nonword priming. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 45A,* 353–372.

Ferrand, L., & Grainger, J. (1993). The time course of orthographic and phonological code activation in the early phases of visual word recognition. *Bulletin of the Psychonomic Society, 31,* 119–122.

Ferrand, L., & Grainger, J. (1994). Effects of orthography are independent of phonology in masked form priming. *Quarterly Journal of Experimental Psychology, 47A,* 365–382.

Ferrand, L., & Grainger, J. (1996). List context effects on masked phonological priming in the lexical decision task. *Psychonomic Bulletin and Review, 3,* 515–519.

Forster, K. I., & Chambers, S. M. (1973). Lexical access and naming time. *Journal of Verbal Learning and Verbal Behavior, 12,* 627–635.

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 680–698.

Fredriksen, J. F., & Kroll, J. F. (1976). Spelling and sound: Approaches to the internal lexicon. *Journal of Experimental Psychology: Human Perception and Performance, 2,* 361–379.

Gibbs, P., & Van Orden, G. C. (in press). Pathway selection's utility for strategic control of word recognition. *Journal of Experimental Psychology: Human Perception and Performance.*

Kawamoto, A. (1993). Nonlinear dynamics in the resolution of lexical ambiguity: A parallel distributed processing account. *Journal of Memory and Language, 32,* 474–516.

Kawamoto, A., & Zemblidge, J. (1992). Pronunciation of homographs. *Journal of Memory and Language, 31,* 349–374.

Kucera, H., & Francis, W. (1967). *Computational analysis of present-day American English.* Providence, RI: Brown University Press.

Lesch, M., & Pollatsek, A. (1993). Automatic access of semantic information by phonological codes in visual word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 285–294.

Lukatela, G., & Turvey, M. T. (1990). Phonemic similarity effects and prelexical phonology. *Memory & Cognition, 18,* 128–152.

Lukatela, G., & Turvey, M. T. (1993). Similar attentional, frequency, and associative effects for pseudohomophones and words. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 166–178.

Lukatela, G., & Turvey, M. T. (1994). Visual lexical access is initially phonological: 1. Evidence from associate priming by words, homophones, and pseudohomophones. *Journal of Experimental Psychology: General, 123,* 107–128.

Martin, R. C. (1982). The pseudohomophone effect: The role of visual similarity in non-word decisions. *Quarterly Journal of Experimental Psychology, 34A,* 395–409.

McCann, R. S., Besner, D., & Davelaar, E. (1988). Word recognition and identification: Do word-frequency effects reflect lexical access? *Journal of Experimental Psychology: Human Perception and Performance, 14,* 693–706.

McQuade, D. V. (1981). Variable reliance on phonological information in visual word recognition. *Language and Speech, 24,* 99–109.

McQuade, D. V. (1983). Pre-lexical phonological recoding becomes automatic with stimulus repetitions. *Language and Speech, 26,* 393–405.

Meyer, D. E., & Ruddy, M. G. (1973, November). *Lexical-memory retrieval based on graphemic and phonemic representations of printed words.* Paper presented at the meeting of the Psychonomic Society, St. Louis, MO.

Monsell, S., Patterson, K., Graham, A., Hughes, C. H., & Milroy,

R. (1992). Lexical and sublexical translation of spelling to sound: Strategic anticipation of lexical status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 451–467.

Paap, K. R., & Johansen, L. S. (1994). The case of vanishing frequency effect: A retest of the verification model. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 1129–1157.

Paap, K. R., & Noel, R. W. (1991). Dual-route models of print to sound: Still a good horse race. *Psychological Research, 53,* 13–24.

Paap, K. R., Noel, R. W., & Johansen, L. S. (1992). Dual-route models of print to sound: Red herrings and real horses. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 293–318). Amsterdam: North Holland.

Parkin, A. J., & Underwood, G. (1983). Orthographic vs. phonological irregularity in lexical decision. *Memory & Cognition, 11,* 351–355.

Perfetti, C. A., & Bell, L. (1991). Phonemic activation during the first 40 ms of word identification: Evidence from backward masking and priming. *Journal of Memory and Language, 30,* 473–485.

Perfetti, C. A., Bell, L. C., & Delaney, S. M. (1988). Automatic (pre-lexical) phonetic activation in silent reading: Evidence from backward masking. *Journal of Memory and Language, 32,* 57–68.

Perfetti, C. A., Zhang, S., & Berent, I. (1992). Reading in English and Chinese: Evidence for a "universal" phonological principle. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 227–248). Amsterdam: North-Holland.

Plaut, D., & McClelland, J. (1993). Generalization with componential attractors: Word and nonword reading in an attractor network. In *Proceedings of the 15th annual conference of the Cognitive Science Society* (pp. 824–829). Hillsdale, NJ: Erlbaum.

Pollatsek, A., Lesch, M., Morris, R. K., & Rayner, K. (1992). Phonological codes are used in integrating information across saccades in word identification and reading. *Journal of Experimental Psychology: Human Perception and Performance, 18,* 148–162.

Pugh, K. R., Rexer, K., & Katz, L. (1994). Evidence of flexible coding in visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 807–825.

Rosson, M. B. (1985). The interaction of pronunciation rules and lexical representations in reading aloud. *Memory & Cognition, 13,* 90–99.

Rubinstein, H., Lewis, S. S., & Rubinstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. *Journal of Verbal Learning and Verbal Behavior, 10,* 645–657.

Schneider, W. (1990). *MEL user's guide: Computer techniques for real time experimentation.* Pittsburgh, PA: Psychology Software Tools.

Seidenberg, M. S. (1985). The time course of phonological code activation in two writing systems. *Cognition, 19,* 1–30.

Seidenberg, M., Peterson, A., MacDonald, M., & Plaut, D. (1996). Pseudohomophone effects and models of word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 48–62.

Seidenberg, M. S., Waters, G. S., Barnes, M. A., & Tanenhaus, M. K. (1984). When does irregular spelling or pronunciation influence word recognition? *Journal of Verbal Learning and Verbal Behavior, 23,* 383–404.

Stanovich, K. E., & Bauer, D. W. (1978). Experiments on the spelling-to-sound regularity effect in word recognition. *Memory & Cognition, 6,* 410–415.

Stone, G. O., Vanhoy, M., & Van Orden, G. C. (1997). Perception is a two-way street: Feedforward and feedback phonology in visual word recognition. *Journal of Memory and Language, 36,* 337–359.

Stone, G. O., & Van Orden, G. C. (1993). Strategic control of processing in word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 744–774.

Tuller, B., Case, P., Ding, M., & Kelso, J. A. S. (1994). The nonlinear dynamics of speech categorization. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 3–16.

Van Orden, G. C., & Goldinger, S. D. (1994). Interdependence of form and function in cognitive systems explains perception of printed words. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 1269–1291.

Van Orden, G. C., Pennington, B. F., & Stone, G. O. (1990). Word identification in reading and the promise of subsymbolic psycholinguistics. *Psychological Review, 97,* 488–522.

Venezky, R. L. (1970). *The structure of English orthography.* The Hague, The Netherlands: Mouton.

Verstaen, A., Humphreys, G., Olson, A., & D'Ydewalle, G. (1995). Are phonemic effects in backward masking evidence for automatic prelexical phonemic activation in visual word recognition? *Journal of Memory and Language, 34,* 335–356.

Waters, G. S., & Seidenberg, M. S. (1985). Spelling-sound effects in reading: Time-course and decision criteria. *Memory & Cognition, 13,* 557–572.

Appendix A

Targets and Primes Used in Experiments 1 and 2

Target	Pseudo-homophone	Graphemic	Control	Target	Pseudo-homophone	Graphemic	Control
	Low-frequency regular words				High-frequency regular targets		
scoop	SKUPE	STIPH	WHURF	*soon*	SUNE	SANP	BARP
boom	BUME	BEMP	TERV	*fight*	PHITE	STRIF	CRAMB
tune	TOON	TRIN	PORD	*care*	KAIR	MARF	SONF
quote	KWOAT	PROCT	BARSH	*quite*	KWYTE	SNATE	VOORM
quake	KWAIK	PLASK	STREF	*case*	KAIS	FAMS	GOPH
cape	KAIP	MARP	BORD	*deep*	DEPE	DEMP	MAIG
glaze	GLAIZ	GLANZ	PROFF	*stage*	STAIGE	STAUGH	BLURND
spike	SPYKE	SPAME	CRORT	*while*	WILE#	WHID#	JOONG
globe	GLOAB	GLOOK	TRAIZ	*side*	SYDE	SADZ	GLIR
lace	LAIS	LAFT	MUFT	*fine*	PHYNE	CRENT	SKOPS
skate	SCAIT	SPART	PLOUM	*square*	SKWAIR	SPRAUT	COONCH
pale	PAYL	PARL	DRIS	*clay*	KLAE	PLAD	DRIG
flame	PHLAIM	CREELM	SPRINS	*make*	MAICK	MAUSK	NOOPT
rake	RAICK	RAUSK	MILTH	*name*	NAIM	NARM	TIRS
squeeze	SKWEASE	STRENVE	CLANGOO	*state*	STAIT	STAFT	CRIRG
flock	PHLOC	CLOOP	PRESF	*fact*	PHAKT	CRABE	TIRNSH
	Low-frequency exception words				High-frequency exception words		
glove	GLUV#	GLOEP	PIRCH	*both*	BOETH	BOMTH	GERPP
gauge	GAIDGE	GEARGH	POORDS	*door*	DORE	DOOV	MILP
lure	LOOR	LABE	KAID	*come*	KUMM	BIMF	PRIZ
sieze	CEEZ#	MERZ#	BRAUG	*gone*	GAWN	GRUN	STUM
sieve	CIV##	BIE##	BAV##	*does*	DUZ#	DOUP	CRIT
prove	PROKE	TLIMT		*done*	DUNN	DEND	KISP
ghost	GOAST	GLIST	RUEMP	*dead*	DEDD	DRAD	LOMB
deaf	DEPH	DEEK	KIB#	*floor*	PHLORE	CHOORP	EKAUPH
sewn	SONE	SNEP	CANP	*give*	GHIV	GREV	NOBS
cough	KAWFF	BRIST	NEALT	*knew*	NUE#	CREN	RAUP
tomb	TUME	THEB	BLAG	*lose*	LOOZ	LOAK	CRAV
wolf	WULPH	WALCH	GAHN#	*move*	MOOV	MOCE	GRAG
doll	DAHL	BREL	BUBE	*none*	NUNN	NENS	GUEL
gross	GROCE	GROOK	BIBTH	*work*	WERCK	WARS K	FENFT
shove	SHUV#	SHEME	MANCK	*whom*	HOOMC	HOM	NERK
steak	STAICK	STRAKS	DRIPHS	*whose*	HOOZ#	PLOCH	MAIFS

Appendix B

Legal Nonword Foils Used in Experiment 1

cirn
hest
proge
speet
tice
belf
snerk
trest
borch
falpe
jelp
nent
rofe
solp
whert
birsh

flar
jeck
nerpe
sperk
whees
fiart
leath
scire
slear
crean
dilt
frim
lealt
serke
swarl
libe

shest
gheen
lipe
phize
slirt
thaif
merte
moish
thubb
tenge
tast
hauct
hote
fesst
bhaid
schap

slar
braet
strog
rete
glam
blim
soln
tarv
snaert
tark
gropp
lavve
healtt
darp
precs
ramb

(*Appendixes continue*)

Appendix C

Pseudohomophone Foils Used in Experiment 2

korn
heet
proze
sleat
tyme
beaf
sneek
treet
berch
falce
jeap
neet
roze
soop
wheet
buth
feer
jirk
nurve
speek
wheal
furst
leesh
skore
speer
cleen
durt
frum
leest
surve
swerl
lyne
sheat
grean
lyke
phaze
shurt
theef
murge
moyst
thumm
tence
takt
hawnt
hoze
feest
brayd
skrap
skar
braiv
skroo
rute
gloo
kloo
koan
kaiv
knawwt
tawk
groop
leeve
hellth
darc
prehs
rume

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