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Neighborhood effects in auditory word recognition: Phonological competition and orthographic facilitation

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Abstract

The present study investigated phonological and orthographic neighborhood effects in auditory word recognition in French. In an auditory lexical decision task, phonological neighborhood (PN) produced the standard inhibitory effect (words with many neighbors produced longer latencies and more errors than words with few neighbors). In contrast, orthographic neighborhood (ON) produced a facilitatory effect. In Experiment 2, the facilitatory ON effect was replicated while controlling for phonotactic probability, a variable that has previously been shown to produce facilitatory effects. In Experiment 3, the results were replicated in a shadowing task, ruling out the possibility that the ON effect results from a strategic and task-specific mechanism that might operate in the lexical decision task. It is argued that the PN effect reflects lexical competition between similar sounding words while the ON effect reflects the consistency of the sublexical mapping between phonology and orthography. The results join an accumulating number of studies suggesting that orthographic information influences auditory word recognition.

Keywords: Phonological neighborhood; Orthographic neighborhood; Auditory word recognition; Probabilistic phonotactics; Interactive Activation; Lexical access

When people perceive speech, word entries have to be contacted in the mental lexicon in order to gain access to meaning (Marslen-Wilson, 1989). However, imperfections of the speech signal and noise in the environment make it literally impossible for a *single* word entry to be activated with high precision (Luce & Pisoni, 1998). Instead, it is more likely that a stimulus activates a number of similar acoustic–phonetic representations in memory, among which the word recognition system must choose. In fact, many spoken word recognition models, such as TRACE (McClelland & Elman, 1986), SHORTLIST (Norris, 1994), MERGE (Norris, McQueen, & Cutler, 2000) or NAM (Luce & Pisoni, 1998), propose that word representations of similar sounding words, so-called *lexical neighbors*, are activated during word recognition, and that these word representations compete with one another.

The *lexical competition principle* embraced in these models predicts *inhibitory* neighborhood density effects. That is, people should find it harder to recognize words in dense neighborhoods than words in sparse neighborhoods. Neighborhood density is commonly defined as the number of words that sound similar to a target word. It is typically assessed by the single phoneme metric (e.g., Landauer & Streeter, 1973). In auditory word recognition, inhibitory neighborhood density effects have been reported in the majority of studies that manipulated this variable (e.g., Cluff & Luce, 1990; Goldinger, Luce, & Pisoni, 1989; Luce & Pisoni, 1998; Luce, Pisoni, & Goldinger, 1990; Vitevitch & Luce,

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1998, 1999). For example, in perceptual identification tasks, words with many neighbors are identified less accurately than words with few neighbors. In auditory naming and lexical decision tasks, words in large neighborhoods are responded to more slowly than words in small neighborhoods.

Interestingly, the lexical competition principle stimulated a large number of studies on the effects of neighborhood density in the visual domain as well. However, the effects in the visual domain turned out to be much less clear-cut than those in the auditory domain. Some studies did indeed find inhibitory effects mirroring those found in the auditory domain (Grainger, O'Regan, Jacobs, & Segui, 1989, 1992; Perea & Pollatsek, 1998; Pollatsek, Perea, & Binder, 1999). Others, however, reported null effects or even facilitatory neighborhood density effects (Andrews, 1989, 1992; Forster & Shen, 1996; Sears, Hino, & Lupker, 1995; for a review see Andrews, 1997).

One major key to understanding the conflicts in the visual domain was the insight that not all neighbors are equal (Peereman & Content, 1997; Ziegler & Perry, 1998). Peereman and Content (1997), for example, showed that only those orthographic neighbors that were also phonological neighbors (so-called *phonographic neighbors*) produced systematic facilitation in reading aloud. Similarly, Ziegler and Perry (1998) showed that only those orthographic neighbors that corresponded to a salient phonological unit (the rime) were able to facilitate visual word recognition in a lexical decision task. In other words, this research clearly suggested that the effects of orthographic neighbors are constrained by their phonological counterparts.

In the present research, we flip the coin and ask whether the effects of phonological neighbors in auditory word recognition are constrained by their orthographic counterparts. At first, this idea seems absurd. Why should orthographic neighbors play a role in auditory word recognition given that speech is primary and written language is only parasitic on spoken language? However, there is an accumulating number of studies showing orthographic effects on spoken word recognition in tasks such as rhyme judgment (Seidenberg & Tanenhaus, 1979), phonological priming (Jakimik, Cole, & Rudnicky, 1985), lexical decision (Ziegler & Ferrand, 1998), cross-modal priming (Borowsky, Owen, & Fonos, 1999), phoneme-monitoring (Dijkstra, Roelofs, & Fieuws, 1995; Hallé, Chereau, & Segui, 2000), syllable monitoring (Taft & Hambly, 1985), print-sound matching (Frost & Katz, 1989; Frost, Repp, & Katz, 1988), and blending tasks (Ventura, Kolinsky, Brito-Mendes, & Morais, 2001).

Orthographic effects in auditory word recognition are predicted by interactive models with bidirectional connections between phonology and orthography (Frost & Katz, 1989; Grainger & Ferrand, 1996; Grainger, Van Kang, & Segui, 2001; Stone, Vanhoy, & Van Orden, 1997; Van Orden & Goldinger, 1994; Ziegler & Ferrand, 1998). In the bimodal interactive activation model (Grainger & Ferrand, 1996), for instance, phonology and orthography are connected both at sublexical and lexical processing levels (for an illustration, see Fig. 1). The connections between processing levels are facilitatory, that is, units at one level (e.g., sublexical phonology) activate compatible units at another level (e.g., sublexical orthography). This way, the model allows for orthographic information to influence phonological processes. Within each processing level, similar units mutually inhibit each other. The lateral inhibition mechanism allows the bimodal interactive activation model to simulate inhibitory neighborhood density effects, as typically observed in spoken word recognition.

The goal of the present experiments was to test whether orthographic neighborhood had an effect on auditory word recognition, and if so, how it compared to the effects of phonological neighborhood. For this purpose, we manipulated orthographic neighborhood (ON) and phonological neighborhood (PN) in an orthogonal fashion. The prediction was that PN should produce the standard inhibitory competition effect: poorer performance for words with many phonological neighbors than for words with few neighbors (e.g., Cluff & Luce, 1990; Goldinger et al., 1989; Luce & Pisoni, 1998; Luce et al., 1990; Vitevitch & Luce, 1998, 1999). If orthographic information were automatically activated during auditory word recognition, as suggested by the bi-modal interactive activation model, and if lexical activation in the orthographic units were also subject to lateral inhibition, then we would expect ON effects to be inhibitory much like the PN effects. These predictions were tested in an auditory lexical decision experiment.

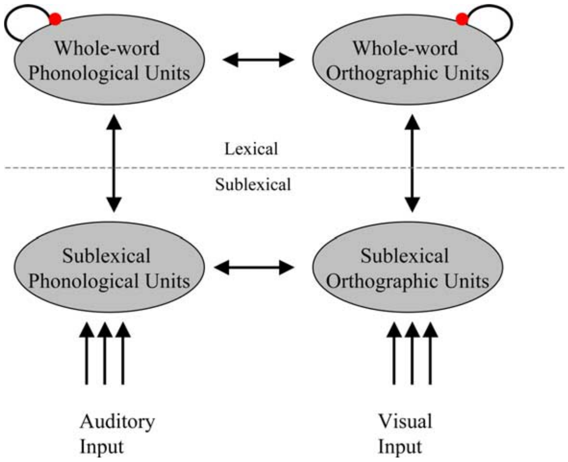

Fig. 1. Architecture of Grainger and Ferrand's (1996) bimodal interactive activation model.

Table 1
Characteristics of the words used in Experiment 1 (mean values)

Variables	PN−		PN+	
	ON−	ON+	ON−	ON+
Number of letters	4.65	4.65	4.75	4.75
Number of phonemes	3.35	3.35	3.2	3.2
Frequency (per million)	11.8	9.7	11.45	10.5
Number of PN-sub	5.3	6.25	13.25	13.65
Number of PN-all	13.5	17.4	28.2	28.8
Number of ON	1.3	4.95	1.00	5.35
Auditory length (ms)	650	676	649	699

Note. ON, orthographic neighborhood; PN, phonological neighborhood; PN-sub, substitution only; PN-all, substitution, addition, or deletion.

Experiment 1

Methods

Participants

Thirty-two undergraduate psychology students at the University of Provence participated in the study for course credit. All were native French speakers, with no reported history of speech or hearing disorders.

Stimuli and design

The experimental design resulted from an orthogonal manipulation of ON (small vs. large) and PN (small vs. large). PN is typically assessed by counting the number of words that can be obtained by changing, adding, or deleting a single phoneme (e.g., Luce & Pisoni, 1998). On the other hand, ON is assessed by counting the number of words that can be obtained by substituting a single letter at any position within the word (e.g., Coltheart, Davelaar, Jonasson, & Besner, 1977). To have an identical neighborhood definition for both the visual and the auditory domain, we adapted the Coltheart et al. (1977) metric for the auditory domain. That is, the number of phonological neighbors equals the number of words that can be obtained by substituting a single phoneme.[1] This information was taken from the lexical database (LEXOP) provided by Peereman and Content (1999).

Median values across all monosyllabic words in this database were used as cut-offs to divide words into sparse and dense neighborhood groups. Words in sparse orthographic neighborhoods (ON−) had less than three neighbors whereas words in dense orthographic neighborhoods (ON+) had more than three neighbors. Words in sparse phonological neighborhoods (PN−) had less than eight neighbors whereas words in dense phonological neighborhoods (PN+) had more than eight neighbors.

Eighty low-frequency monosyllabic words were selected that fell in one of the four groups (PN+ON+, PN+ON−, PN−ON+, PN−ON−) with 20 items per group. The four groups were matched in terms of orthographic length (number of letters), phonological length (number of phonemes), and word frequency according to French frequency counts (Imbs, 1971). Statistical tests showed that the four groups did not differ from one another on any of these dimensions (all F's < 1). Item characteristics are given in Table 1.

For the purpose of the lexical decision task, 80 nonwords were created that were identical in orthographic and phonological length to the words. To avoid excessive repetition of orthographic or phonological patterns, we did not attempt an orthogonal manipulation of ON and PN on the nonword trials. However, to exclude the possibility that people made their decisions on the basis of neighborhood density alone, we created nonwords that matched the real words with regard to ON and PN (i.e., 20 ON+, 20 ON−, 20 PN+, and 20 PN− nonwords). All items were digitally recorded by a female French native speaker in a soundproof room on a digital audio recorder. The recordings were normalized and edited using a digital waveform editor (Sound Edit).

Procedure

Participants were tested individually in a quiet room equipped with a computer terminal. They listened to the stimuli binaurally over headphones, at a comfortable listening level. The presentation of the stimuli was controlled using PsyScope (version 1.1b4; Cohen, MacWhinney, Flatt, & Provost, 1993). Participants were required to indicate as rapidly and accurately as possible if the auditorily presented stimulus was a real French word (standard auditory lexical decision). Participants gave their responses by pressing either the “yes” or the “no” button of the button box that was placed in front

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[1] A post hoc analysis showed that it does not really matter whether neighborhood is calculated by phoneme substitution only (e.g., Coltheart et al., 1977), or by phoneme substitution, addition, or deletion (e.g., Luce & Pisoni, 1998). Upon a reviewer's request, we provide values for both measures in Table 1 (for Experiment 1) and in Table 3 (for Experiment 2).

of them. The dominant hand was used for the "yes" responses. Response times were measured from the onset of the stimulus until the participant pressed the response key. Prior to the experiment, participants received eight practice trials to familiarize them with the task. After that, each participant received the 160 stimuli in random order.

Results

The results are presented in Table 2. Response latencies that were three standard deviations (SDs) beyond the participant's global mean were replaced by the 3-SD cut-off value (less than 0.39% of the data). Because of an error in stimulus recording, one item (*gang*) could not be taken into consideration. The remaining data were submitted to a two-way analysis of variance (ANOVA) resulting from the factorial combination of PN (PN+ vs. PN−) and ON (ON+ vs. ON−). Because the four experimental groups differed in auditory length of the stimulus recording despite being matched on number of phonemes (for the exact values, see Table 1), the item analysis (F_2) was designed to take differences in auditory length into account. This was done by performing an analysis of covariance (ANCOVA) on the item means using stimulus length of each item as a covariate. Both adjusted and non-adjusted means are provided in Table 2. However, adjusted means should be preferred for the interpretation of effect sizes because for them differences in auditory length have been factored out.

The latency analyses exhibited significant main effects of PN ($F_1(1,31) = 206.9$, $p < .0001$; $F_2(1,74) = 8.01$, $p < .01$) and ON ($F_1(1,31) = 10.18, p < .005; F_2(1,74) = 4.6$, $p < .01$). The interaction between the effects of ON and PN was significant by subjects but not by items ($F_1(1,31) = 4.12, p < .05; F_2(1,74) = 1.65, p > .20$). The main effect of PN was inhibitory, reflecting the fact that participants took longer to accept words from dense phonological neighborhoods (PN+) than words from sparse phonological neighborhoods (PN−). In contrast, the main effect of ON was facilitatory, reflecting the fact that ON+ words produced faster decision latencies than ON− words. The inhibitory PN effect was smaller for words from dense orthographic neighborhoods and the facilitatory ON effect was larger for words from dense phonological neighborhoods. However, this apparent interaction must be treated with caution because the interaction between ON and PN failed to reach significance in the item analysis.

The analysis of the error data showed a significant main effect of PN ($F_1(1,31) = 19.39$, $p < .0001$; $F_2(1,75) = 4.33$, $p < .05$) but no significant main effect of ON. The interaction between the effects of ON and PN was significant by subjects but not by items ($F_1(1,31) = 11.82, p < .001, F_2(1,75) = 2.6, p > .10$). As in the RT analysis, the main effect of PN was inhibitory with a greater number of errors for words from dense regions than for words from sparse regions. The interaction between the effects of ON and PN went in the same direction as in the RT analysis, that is, reduced inhibitory PN effects in orthographically dense regions (ON+) and stronger facilitatory ON effects in phonologically dense regions (PN+).

Discussion

In the present experiment, we manipulated ON and PN in an orthogonal design in an auditory lexical decision task. Consistent with previous reports (e.g., Cluff & Luce, 1990; Goldinger et al., 1989; Luce & Pisoni, 1998; Luce et al., 1990; Vitevitch & Luce, 1998, 1999), we found inhibitory effects of PN. That is, words in dense phonological regions produced more errors and longer latencies than words in sparse regions.

More novel is the existence of an ON effect in an auditory task. In contrast to our expectation, however, the ON effect was facilitatory, not inhibitory; that is, words with many orthographic neighbors produced faster and more accurate response latencies than words

Table 2
Mean lexical decision latencies and error rates for words in Experiment 1

	Adjusted RTs (ms)[a]	Non-adjusted RTs (ms)	Error rates (%)
PN+			
ON−	1103 (19.5)	1084 (22.2)	11.6 (1.5)
ON+	1035 (19.6)	1052 (18.7)	7.0 (1.4)
PN−			
ON−	1022 (19.5)	1005 (20.3)	4.1 (.99)
ON+	1004 (19.9)	1003 (20.7)	6.1 (.91)
PN main effect	−56 ms	−64 ms	−4.23
ON main effect	+42 ms	+17 ms	+1.24

Note. ON, orthographic neighborhood; PN, phonological neighborhood.
Standard errors in parentheses.
[a] Adjusted for differences in auditory length between groups.

with few orthographic neighbors. Thus, orthographic and phonological neighborhood effects go in opposite directions with inhibition for PN and facilitation for ON. There was a statistically weak interaction between these effects suggesting that the ON effect tended to be larger within dense phonological neighborhoods and the inhibitory PN effect tended to be reduced when words had many orthographic neighbors.

How can the opposite effects of ON and PN be accounted for within the bi-modal interactive activation model? As argued above, inhibitory PN effects can be accounted for in terms of greater levels of on-line competition for words in dense neighborhoods (Luce & Pisoni, 1998; McClelland & Elman, 1986; Norris, 1994; Norris et al., 2000). On-line competition is implemented in the bi-modal interactive activation model through lateral inhibition of lexical neighbors. However, this mechanism would also predict inhibitory effects of ON. Therefore, in the context of this model, it is hard to see how facilitatory ON effects could emerge at a lexical level because the greater number of orthographic neighbors should always result in greater levels of lateral inhibition. This is illustrated in Fig. 2.

Fig. 2 contrasts the activation pattern for the words WIPE (Panel A) and TYPE (Panel B). WIPE is a word with many phonological and orthographic neighbors (PN+ON+), whereas TYPE is a word with many phonological but few orthographic neighbors. As can be seen in this figure, because WIPE has more orthographic neighbors than TYPE, it receives more lateral inhibition than TYPE in the orthographic lexicon. As a consequence, WIPE's lexical activation is reduced, which would result in longer decision latencies for WIPE than for TYPE (i.e., an inhibitory neighborhood density effect). Therefore, in the context of this model, activation at the lexical level alone cannot explain the facilitatory ON effect.

One could argue, however, that because the presentation is auditory there is no obvious way for orthographic neighbors to become activated in the first place. One way orthographic neighbors could become active is through their phonological counterparts. However, both PN+ON− and PN+ON+ words have a fairly similar number of phonological neighbors. As a consequence, the number of orthographic neighbors that are activated through lexical phonology should be fairly similar as well. Such a scenario would predict a null effect of ON; it does not predict facilitatory ON effects, however. Therefore, both explanations would run into trouble explaining how facilitatory ON effects could emerge at the lexical level.

At the sublexical level, however, WIPE has an advantage because it contains sublexical phonological patterns (e.g., /aIp/) that map strongly onto its sublexical orthographic patterns (e.g., −IPE). In comparison, this is much less the case for the PN+ON− word TYPE, because TYPE's sublexical phonological pattern (/aIp/) maps only very weakly onto its rare orthographic pattern (−YPE). In other words, in the case of TYPE, there is *inconsistency* between phonology and orthography (i.e., the dominant /aIp/ → IPE mapping clashes with the correct spelling for TYPE). Given that this kind of phonology–orthography (P–O) consistency can influence auditory word recognition (Ziegler & Ferrand, 1998), this would explain why the PN+ON+ words (e.g., WIPE) are processed faster than the PN+ON− words (e.g., TYPE). In other words, P–O consistency rather than the sheer number of orthographic neighbors might be at the origin of the facilitatory ON effect. It should be acknowledged that it is quite normal for a PN+ON− word to be P–O inconsistent because in order to have many phonological but only few orthographic neighbors a word must have a common phonology (shared by many other words) but a rare spelling (shared by only few words). A word with a common phonology but a rare spelling is necessarily P–O inconsistent.

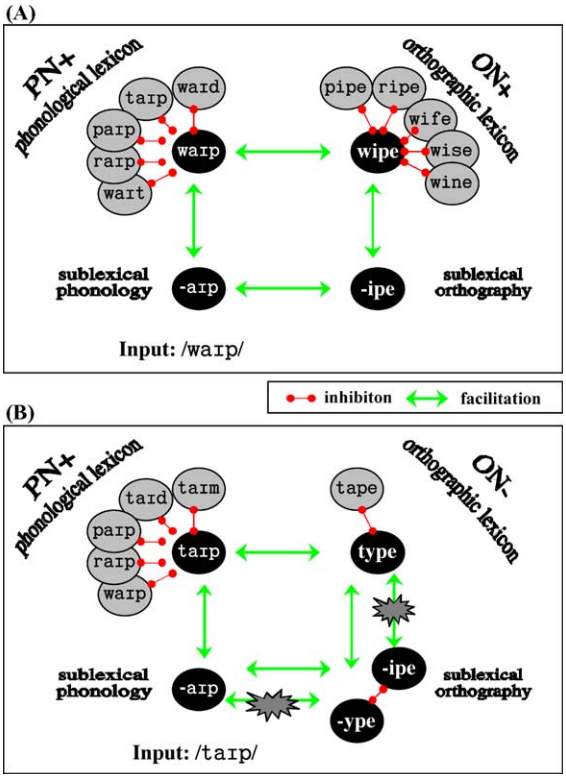

Fig. 2. Hypothetical patterns of activation for the PN+ON+ word WIPE (Panel A) and the PN+ON− word TYPE (Panel B) in the bimodal interactive activation model. For the sake of simplicity, sublexical activation is only illustrated for rime-size units. One can imagine similar activation patterns for smaller units, such as individual phonemes and graphemes.

To address the possibility that P–O consistency might be at the origin of the facilitatory ON effect, we performed post hoc analyses on the item means, in which P–O consistency was factored out using covariance analyses. If P–O consistency was responsible for the facilitatory ON effect, then the ON effect should disappear in the covariance analyses. On the other hand, if orthographic neighbors have an independent effect on auditory word recognition, then ON effects should persist even when P–O consistency was factored out. For these post hoc analyses, we calculated a combined consistency ratio that takes into account the consistency of the initial consonant cluster (C1), the vowel, and the final consonant cluster (C2). The consistency ratio varies between 0 and 1 and is calculated by dividing the number (or frequency) of P–O *friends* at each position by the number (or frequency) of P–O *friends* and *enemies* at the same position. *Friends* are words, in which a given segment is pronounced and spelled the same way. *Enemies* are words, in which that segment is pronounced the same way but is spelled differently. Both type and token measures were calculated. The computations were performed on the LEXOP database, which contains entries for all monosyllabic French words.

The results of the covariance analyses showed that the ON effect disappeared when type or token consistency was factored out (token: $F(1,73) = .97$, $p > .30$; type: $F(1,73) = 1.5$, $p > .20$). In contrast, the PN effect remained significant in the covariance analysis (token: $F(1,73) = .5.31$, $p < .05$; type: $F(1,73) = 4.35$, $p < .05$). The interaction between the effects of PN and ON was not significant in the covariance analysis either (all F's < 1.2). Thus, this analysis suggests that P–O consistency rather than the sheer number of orthographic neighbors caused the facilitatory ON effect. This is entirely consistent with the bi-modal interactive activation model because in the model facilitatory effects must arise at a sublexical level (see Fig. 2).

Before accepting this account, however, there are two other possible explanations for the existence of facilitatory ON effects that should be considered. First, ON effects could be due other phonological variables that are confounded with ON. For example, a number of authors have shown that *phonotactic probability* (i.e., the frequency with which particular segments co-occur together) has a facilitatory effect on word recognition (Jusczyk, Friederici, Wessels, Svenkerud, & Jusczyk, 1993; Jusczyk, Luce, & Charles-Luce, 1994; Storkel, 2001; Vitevitch & Luce, 1998, 1999). If ON were correlated with this kind of sublexical information (i.e., words with many orthographic neighbors might contain frequently occurring phonological sequences), this would explain the facilitatory nature of the ON effect.

The other possibility is that facilitatory ON effects might be *task-specific* reflecting sophisticated read-out procedures that operate in the lexical decision task. The following experiments attempt to tease apart these theoretical interpretations. Experiment 2 rules out the possibility that ON effects are due to a facilitatory influence of phonotactic probability. Experiment 3 rules out the possibility that ON effects are task-specific and strategic.

Experiment 2

The finding that structural density can produce both facilitation and inhibition has been reported previously (e.g., Metsala, 1997; Pitt & Samuel, 1995; Storkel & Morisette, 2002). Most prominently, Vitevitch and Luce (1998, 1999) observed that neighborhood density had a facilitatory effect on nonword processing but an inhibitory effect on word processing. They explained this duality with the fact that neighborhood density is highly correlated with phonotactic probability, a sublexical variable known to produce facilitatory effects on word recognition (Jusczyk et al., 1993, 1994; Storkel, 2001). Because the effects of neighborhood density and phonotactic probability go in opposite directions, they can only be detected if either lexical or sublexical processes are emphasized. For example, Vitevitch and Luce (1998, 1999) have shown that if sublexical processing is encouraged by asking participants to process nonwords, the facilitatory effects of phonotactics outweigh the inhibitory effects of lexical competition.

Because phonotactic probability was not controlled for in Experiment 1, the goal of Experiment 2 was to replicate the facilitatory ON effect while controlling for this variable. A replication of the ON effect under these conditions would rule out the possibility that the ON effect was simply due to the facilitatory influence of sublexical phonological processes. Of course, there might be sublexical variables other than phonotactic probability, but, to our knowledge, these variables are either not correlated with neighborhood density or they have not been shown to have facilitatory effects on word recognition.

Because in the previous experiment most of the action took place in phonologically dense regions, in Experiment 2, we investigated the ON effect in phonologically dense regions only. Using a simpler design also allowed us to double the number of items in the critical ON+/ON- comparison. This reduces the possibility that the effect was caused by a small number of "weird" items.

Method

Participants

Twenty-nine undergraduate psychology students at the University of Provence participated in the study for course credit. All were native French speakers, with no reported history of speech or hearing disorders.

Stimuli and design

Eighty monosyllabic low frequency words were selected from the LEXOP database (Peereman & Content, 1999). They belonged to fairly dense regions of phonological space with an average of 12 phonological neighbors, and they varied with regard to ON. Words with few orthographic neighbors (ON−) had less than four neighbors, whereas words with many orthographic neighbors (ON+) had four or more than four neighbors. Mean values are presented in Table 3.

The two groups were matched with regard to word frequency, orthographic and phonological length (number of letters and phonemes), and uniqueness points. Statistical tests confirmed that the two groups did not statistically differ on any of these measures (all F's < 1). Most importantly, the groups were matched for phonotactic probability. As a measure for phonotactic probability, we calculated both positional segment frequency (i.e., how often a particular segment occurs in a given position in a word) and positional biphone frequency (i.e., segment-to-segment co-occurrence probability). The metrics were based on log-frequency weighted counts of words in the LEXOP database. The computations were identical to those described in Vitevitch and Luce (1998, 1999). The values can be found in Table 3. Statistical tests showed that there was no significant difference between the two groups on either measure (both F's < 1).

Differences in auditory duration between the groups were balanced by stretching or compressing the recording of particularly short or long words using the "cadence" function of the waveform editor (Sound Edit 16). This function does not alter the pitch of the sound file. This procedure affected about 20% of the items in each group. Before the application of this procedure, the durations were 635 and 702 ms for ON− and ON+ words, respectively. After the modifications, a closer match for these two groups was obtained (665 vs. 673 ms, respectively). The nonwords were identical to those used in Experiment 1.

Table 3
Characteristics of the words used in Experiment 2 (mean values)

	ON−	ON+
Number of letters	4.63	4.63
Number of phonemes	3.1	3.15
Word frequency	8.53	8.13
Number of PN-sub	12.00	12.10
Number of PN-all	25.8	25.5
Number of ON	1.70	5.83
Auditory length (ms)	665	673
Positional segment probability	.0672	.0653
Positional biphone probability	.00840	.00765
Uniqueness point	3.95	4.00

Note. ON, orthographic neighborhood; PN, phonological neighborhood; PN-sub, substitution only; PN-all, substitution, addition, or deletion.

Procedure

The procedure was identical to Experiment 1.

Results

Mean response latencies and error rates for ON+ and ON− words are presented in Table 4. Three items from each group were excluded because of high error rates. Statistical tests showed that after the exclusion of these high-error items the two groups were still balanced with regard to word frequency, orthographic and phonological length, uniqueness point, auditory duration, and phonotactic probability (all F's < 1). For the remaining trials, data trimming was identical to Experiment 1 and affected 0.18% of the data. As in Experiment 1, in the F_2-analysis, differences in auditory length were factored out using an ANCOVA. Both adjusted and non-adjusted means are provided.

As can be seen in Table 4, a facilitatory ON effect was obtained. That is, words with many orthographic neighbors were identified about 40 ms faster than words with few orthographic neighbors. This effect was significant by subjects and items ($F_1(1,28) = 41.80$, $p < .0001$; $F_2(1,71) = 4.31$, $p < .05$). The error data mirrored the latency data. That is, participants committed fewer errors on words with many orthographic neighbors than on words with few orthographic neighbors. This effect was significant in both analyses ($F_1(1,28) = 40.87$, $p < .0001$; $F_2(1,71) = 8.44$, $p < .01$).

As in Experiment 1, we wanted to know whether the facilitatory ON effect was due to the number of orthographic neighbors or the consistency in the mapping between phonology and orthography. Thus, we performed a covariance analyses on the RT item means with P–O consistency as a covariate. P–O consistency was calculated as described before. The results showed that the ON effect disappeared when P–O consistency was factored out (type: $F(1,70) = .31$, $p > .50$; token: $F(1,70) = 1.48$, $p > .20$).

Discussion

In this experiment, the existence of a facilitatory ON effect in auditory lexical decision was replicated using a larger set of items and controlling for phonotactic probability, a variable that has been shown to produce facilitatory effects in previous studies (Jusczyk et al., 1993, 1994; Storkel, 2001; Vitevitch & Luce, 1998, 1999). Thus, it seems unlikely that the facilitatory ON effect can be explained in terms of sublexical phonological processes that exploit statistical regularities of the phonological input.

Table 4
Mean lexical decision latencies and error rates for words in Experiment 2. Standard errors in parentheses

	Adjusted RTs (ms)[a]	Non-adjusted RTs (ms)	Error rates (%)
ON−	1107 (14.8)	1099 (15.6)	18.1 (1.9)
ON+	1063 (14.8)	1057 (16.4)	9.7 (1.6)
ON main effect	+ 44 ms	+ 42 ms	+ 8.4

Note: ON, orthographic neighborhood.
Standard errors in parentheses.
[a] Adjusted for differences in auditory length between groups.

However, as in Experiment 1, a post hoc covariance analysis suggested that the ON effect is not caused by the sheer number of orthographic neighbors. Instead, it seems that the greater P–O consistency of words with many orthographic neighbors is responsible for the ON effect. Taken together with the results of Experiment 1, three preliminary conclusions about the locus of the ON effect can be made. (1) The ON effect is truly "orthographic" in the sense that it is not due to a confound with a sublexical phonological variable (i.e., phonotactic probability). (2) The ON effect is not purely "orthographic" in the sense that it results from the consistency of the mapping between phonology and orthography rather than the activation of orthography alone. (3) The ON effect seems to occur at a sublexical rather than a lexical level.

There is one other possibility to save the idea that the ON effect does occur at the lexical level. This possibility is based on the idea that when people make lexical decisions, they might do so on the basis of global activation within the lexicon. According to this idea, the more global activation there is, the more likely people are to say "yes" to a given stimulus, Such an account would predict that responses to large-N words should be faster, because these words produce high levels of global activation.

In the visual domain, such a task-specific read-out mechanism has been implemented in the context of the interactive-activation model (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Grainger & Jacobs, 1996; Jacobs, Rey, Ziegler, & Grainger, 1998; Ziegler, Jacobs, & Klüppel, 2001). In order to perform visual lexical decisions, the read-out mechanism of the model monitors the rising activation of single word units and the global activation within the orthographic lexicon. A "yes" decision is made if either a single word unit or the global activation passes critical activation thresholds within the orthographic lexicon. This model would predict facilitatory ON effects in auditory lexical decision, if one were to postulate that the orthographic read-out mechanism was also active in the auditory lexical decision task. If so, it would happen occasionally that for words with many orthographic neighbors global activity in the orthographic lexicon reaches a critical activation threshold before unit activity in the phonological lexicon. On these trials, words with many orthographic neighbors would produce a latency advantage compared to words with few orthographic neighbors.

Of course, such a strategic read-out mechanism is very special to the lexical decision task, because in other tasks responses cannot be made on the basis of global activation. If the facilitatory ON effect was due to such a task-specific read-out mechanism (i.e., the monitoring of global activation in the orthographic lexicon), then it should disappear in a task that does not require making lexical decisions. This prediction was tested in Experiment 3.

Experiments 3A and 3B

The aim of the present experiment was to find out whether the ON effect would persist in a task, in which a read-out mechanism based on global orthographic activation was unlikely to operate. Thus, we replicated Experiments 1 and 2 using a shadowing task. In a shadowing task, participants are simply asked to name aloud a previously presented target word. Finding an ON effect in the shadowing task would not only put the task-specific strategy explanation to rest but it would also support the claim that the ON effect occurs at a sublexical level (i.e., mapping between phonological and orthographic patterns). This is the case because shadowing only requires a precise analysis of the phonetic properties of the stimulus but does not necessarily require lexical access. Having said this, it should be pointed out that lexical effects are still found in shadowing (e.g., Radeau & Morais, 1990; Vitevitch, 2002), but they are typically smaller in size than those found in lexical decision.

The two experiments were run with the same participants as a single experiment. The results are nevertheless presented separately for both the orthogonal manipulation of PN and ON (previously Experiment 1, now Experiment 3A) and the simple manipulation of ON (previously Experiment 2, now Experiment 3B). A *delayed shadowing task* was also added for half of the participants.[2] In the delayed shadowing task, participants were asked to delay their response until a response signal occurred shortly after the offset of the target. At the occurrence of the signal, participants named aloud the target word as quickly as possible.

In reading aloud, the delayed naming procedure is often used to control for articulatory differences in the stimulus material (e.g., Balota & Chumbley, 1985; Forster & Chambers, 1973; McRae, Jared, & Seidenberg, 1990). The idea of delayed naming is that, by the time the response signal occurs, the processes of interest (encoding, lexical access, lexical selection) are well completed. What is left and thus being measured is related to more peripheral factors of response execution and articulation. Whenever onsets are not matched across experimental conditions in a naming experiment, a delayed naming control is crucial because voice keys trigger differently depending on the nature of the onset (e.g., much later for words with initial fricatives than for words with initial plosives, see Rastle & Davis, 2002). Because articulatory differences would affect delayed naming as much as immediate naming, delayed naming latencies can be used to factor out potential articulatory differences when the stimulus material is not matched for initial onsets. This was the purpose of the delayed naming condition in the present experiment.

Method

Participants

Forty-six undergraduate psychology students at the University of Provence participated in the experiment for course credit. Twenty of them also participated in the delayed shadowing task. All were native French speakers, with no reported history of speech or hearing disorders.

Stimuli

The word stimuli were identical to those used in Experiments 1 and 2. The six items that were excluded from Experiment 2 due to high error rates were also not used in Experiment 3, leaving a total of 80 words from Experiment 1 and 74 words from Experiment 2. The two stimulus sets were collapsed into a single list. Because the task was shadowing, no nonwords were needed in the present experiment.

Procedure

All participants were presented with a single list containing the words of Experiments 1 and 2. The list was randomized for each participant. Words that previously occurred in both experiments (23 out of 160 items) were presented only once in this experiment but their RTs and error rates were used in both analyses (i.e., Experiments 3A and 3B).

As in the previous experiments, the stimuli were presented binaurally via headphones. Participants were instructed to listen carefully to each word and to name it aloud as quickly and accurately as possible (standard shadowing task). Responses were recorded via a microphone connected to a PsyScope button box (Cohen et al., 1993). Latencies were measured from the onset of the stimulus recording until the participant's response triggered the voice key. Sensitivity of the voice key was determined for each participant before the experiment.

Twenty of the students also participated in a delayed shadowing task that was designed in the following way. On each trial, after the normal shadowing response had been given, participants were asked to name aloud the same item again. However, they were also asked to delay their response until a response signal occurred (400 Hz beep). To avoid anticipations, the interval between the offset of the target and the onset of the beep was variable (1400, 1600, 1800, or 2000 ms). Participants were told to "keep the word on the tip of their tongue" during that interval, ready to name it as quickly as possible as soon as the response signal occurs. Response latencies in the delayed naming trials were measured from the onset of the beep until the participant's response triggered the voice key. Apart from these changes, the procedure was identical to that of Experiments 1 and 2.

Results

Experiment 3A

The results of the factorial manipulation of PN and ON are presented in Table 5 for both shadowing and delayed shadowing. Latencies that were below 250 ms and above 2500 ms were considered as voice key errors and discarded from further analyses (1.90% of the data). The subject data were submitted to a two-way ANOVA with PN and ON as within-participant factors. The item data was analyzed in a two-way ANCOVA with PN and ON as between-item factors and both auditory length and delayed naming latency as covariates for each item.

The shadowing results clearly show a similar pattern to that of the lexical decision task with inhibitory effects of PN and facilitatory effects of ON. However, the inhibitory effect of PN was somewhat weaker in this experiment than in the previous experiment, as suggested by a main effect that was only marginally significant by items ($F_1(1,45) = 35.1$, $p < .0001$; $F_2(1,74) = 2.89$, $p < .10$). The effect of ON was significant by subjects

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[2] The delayed naming task was added half way through the experiment, because preliminary analyses showed somewhat weak ON effects in Experiment 3B, which suggested that they might have been cancelled out by articulatory differences between the two stimulus groups.

Table 5
Mean shadowing latencies and error rates in Experiment 3A

	Adjusted RTs (ms)[a]	Non-adjusted RTs (ms)	Delayed naming RTs	Error rates (%)
PN+				
ON−	1047 (15.6)	1050 (16.2)	609 (7.9)	2.1 (.59)
ON+	1005 (15.7)	998 (17.4)	605 (8.6)	2.1 (.45)
PN−				
ON−	1017 (15.7)	1025 (15.0)	610 (9.7)	1.4 (.37)
ON+	982 (15.7)	973 (16.2)	597 (9.3)	2.9 (.74)
PN main effect	−27 ms	−25 ms	−3 ms	+0.1
ON main effect	+39 ms	+53 ms	+8 ms	−0.76

Standard errors in parentheses.

[a] Adjusted for differences in auditory length and delayed naming between groups.

and items ($F_1(1,45) = 167.3$, $p < .0001$; $F_2(1,74) = 6.1$, $p < .05$). The interaction between the effects of PN and ON was not significant (both F's < 1).

The delayed shadowing task showed that a small portion of the facilitatory ON effect was also present in delayed naming (+8 ms). This small effect might be due to articulatory differences between the groups, which resulted in an overestimation of the size of the ON effect in the non-adjusted means. Note, however, that the ON effect remains highly significant in the above F_2-analysis, in which differences in delayed shadowing latencies were factored out. Even on the adjusted means, the facilitatory ON effect was larger than the inhibitory PN effect. This pattern is different from Experiment 1, where PN effects were somewhat larger than ON effects.

The overall error rate was much lower in this experiment than in Experiment 1 (around 2%), which is due to the fact that shadowing is a much easier task than lexical decision. None of the main effects or interactions reached significance in the error analysis.

Experiment 3B

The results of the ON manipulation, which employed the item set of Experiment 2, are presented in Table 6 for both shadowing and delayed shadowing. Latencies that were below 250 and above 2500 ms were considered as voice key errors and discarded from further analyses (1.97% of the data). Both adjusted and non-adjusted means are provided. The F_2-analysis includes delayed naming latencies and auditory length for each item as covariates.

The results show again a facilitatory effect of ON that was significant by subjects and items ($F_1(1,45) = 8.8$, $p < .005; F_2(1,70) = 4.1$, $p < .05$). The delayed shadowing task produced a small inhibitory effect of ON that was marginally significant ($F_2(1,70) = 2.7$, $p < .10$). Because this difference goes in the opposite direction to that of the facilitatory ON effect, it effectively reduces the size of the ON effect in the non-adjusted means. However, when these differences in delayed naming and auditory length were factored out in the F_2-analysis, the ON effect was significant by subjects and items (see above). Thus, Experiment 3B replicates the existence of a facilitatory ON effect in the shadowing task using an item set that was controlled for phonotactic probability.

Discussion

Experiments 3A and 3B clearly showed that the facilitatory ON effect is not restricted to the lexical decision task but persists in a shadowing task. Because responses in the shadowing task cannot be based on global activation, we can rule out the strategy explanation according to which the facilitatory ON effect results from a strategic read-out mechanism that operates in the lexical decision task (Grainger & Jacobs, 1996).

As in Experiment 1, the PN effect was again inhibitory. Interestingly, the size of this inhibitory PN effect was smaller in shadowing than in lexical decision (−56 ms in Exp. 1 as opposed to −27 ms in Exp. 3A). This is consistent with the claim that lexical effects are generally smaller in shadowing than in lexical decision. In contrast, the size of

Table 6
Mean shadowing latencies and error rates in Experiment 3B

	Adjusted RTs (ms)[a]	Non-adjusted RTs (ms)	Delayed naming RTs	Error rates (%)
ON−	1042 (16.4)	1028 (16.4)	601 (6.5)	1.6 (.53)
ON+	1005 (16.4)	1015 (16.4)	615 (6.5)	2.2 (.51)
ON main effect	+37 ms	+13 ms	−14 ms	−0.60

Note. ON, orthographic neighborhood: PN, phonological neighborhood.

Standard errors in parentheses.

[a] Adjusted for differences in auditory length and delayed naming between groups.

the ON effect remained relatively constant across experiments (+42 ms in Exp. 1 as opposed to +39 ms in Exp. 3A). This could be expected because shadowing and lexical decision might differ in terms of lexical processing but not so much in terms of sublexical processing. Thus, our finding that the ON effect is of similar size in both shadowing and lexical decision is consistent with our claim that the ON effect occurs at a sublexical level.

General discussion

In the present article, we investigated the role of orthographic and phonological neighbors in auditory lexical decision and shadowing tasks. The lexical decision results of Experiment 1 show inhibition of PN and facilitation of ON. That is, phonological neighbors hurt whereas orthographic neighbors help spoken word recognition. Because previous experiments found facilitatory effects in auditory word recognition due to sublexical facilitation coming from phonotactic constraints (Jusczyk et al., 1993, 1994; Luce & Large, 2001; Storkel, 2001; Vitevitch & Luce, 1998, 1999), an additional experiment controlled for phonotactic probability and still found a facilitatory ON effect in the lexical decision task.

The possibility that the facilitatory ON effect might be due to a task-specific response mechanism that operates in the lexical decision task was tested in Experiment 3. In particular, it has been suggested that responses in visual lexical decision can be based on the monitoring of global activation in the orthographic lexicon (Grainger & Jacobs, 1996). This response mechanism would produce a facilitatory ON effect, because the more neighbors there are, the greater the global activation, and hence the faster the responses. By replicating our effects in the shadowing task, a task where responses cannot be based on global activation, we were able to reject the strategic response mechanism hypothesis.

Taken together, the present results join an accumulating number of studies suggesting that orthographic information does indeed influence auditory word recognition (Borowsky et al., 1999; Dijkstra et al., 1995; Frost & Katz, 1989; Hallé et al., 2000; Jakimik et al., 1985; Seidenberg & Tanenhaus, 1979; Taft & Hambly, 1985; Ventura et al., 2001; Ziegler & Ferrand, 1998). Given the variety of tasks employed in these studies (phoneme and syllable monitoring, shadowing, lexical decision, rhyme judgment, print-sound matching, priming, blending, phoneme counting, etc.), it seems highly unlikely that all of these effects could be discarded as being artifactual or strategic.

Locus of PN and ON effects

All of the current word recognition models assume that inhibitory PN effects emerge at the lexical level where they result from competition between similar sounding words (Luce & Pisoni, 1998; McClelland & Elman, 1986; Norris, 1994; Norris et al., 2000). This is also the case in the bimodal interactive activation model (Grainger & Ferrand, 1996), in which words with many neighbors receive more lateral inhibition than words with few neighbors (see Fig. 2). The claim that the inhibitory PN effect emerges at a lexical level is also supported in our finding that the PN effect is smaller in shadowing than in lexical decision. This would be expected given that shadowing generally produces smaller lexical effects than lexical decision.

It is unlikely that the locus of the ON effect is also at the lexical level, because, if so, it should have been inhibitory much like the PN effect. Given its facilitatory nature, we suggested that the ON effect must arise at a sublexical level. Because ON is not confounded with sublexical information at a purely phonological level (e.g., probabilistic phonotactics, see Exp. 2), it was hypothesized that the ON effect actually comes from the sublexical mapping between phonology and orthography. The idea was that words with many orthographic neighbors should have more consistent P–O mappings than words with few orthographic neighbors. This makes perfect sense because a word with many phonological and many orthographic neighbors (PN+ON+) has a common phonology and a common orthography. Thus, it contains by definition more consistent P–O relations than a word with a common phonology but a rare orthography (PN+ON−). Consistent with the hypothesis that the ON effect reflects the consistency of the P–O mapping rather than the sheer number of orthographic neighbors, we showed in various covariance analyses that the facilitatory ON effect disappeared when P–O consistency was factored out. The second hint that the ON effect occurs at a sublexical level comes from the finding that the facilitatory ON effect was still present and of similar size even when the task emphasized sublexical processes (i.e., shadowing, see Exp. 3).

Together then, we suggest that the facilitatory ON effect is caused by the consistency of P–O relations at the sublexical level. This interpretation is consistent with our previous finding that inconsistency in the P–O-mapping can impede auditory lexical decisions (Ziegler & Ferrand, 1998). Such an interpretation is also consistent with the seminal finding of Seidenberg and Tanenhaus (1979) that auditory rhyme decisions were faster when cue-target pairs were orthographically similar (e.g., *pie-lie*) than when they were orthographically dissimilar (e.g., *rye-lie*). It is quite clear from this example that orthographically dissimilar items like *rye* must contain inconsistent P–O-relations.

On-line feedback or off-line learning?

Thus far, we have interpreted our ON and PN effects in the context of interactive models with bidirectional connections between phonology and orthography (Frost & Katz, 1989; Grainger & Ferrand, 1996; Stone et al., 1997; Van Orden & Goldinger, 1994; Ziegler & Ferrand, 1998; Ziegler, Montant, & Jacobs, 1997). In such models, the ON effect comes about because orthography is automatically activated and feeds back information to the phonological system. Even if ON and PN effects have their locus at different levels (i.e., lexical vs. sublexical), both are *on-line* effects, at least in the context of the models mentioned above.

However, there is another possibility for how orthographic information can influence auditory word processing without assuming that there is on-line feedback from orthography. This possibility is based on the idea that learning about orthography can permanently alter the way people perceive spoken language. Recently, this point was made by Frith (1998) who compared the acquisition of an alphabetic code to a virus: "This virus infects all speech processing, as now whole word sounds are automatically broken up into sound constituents. Language is never the same again" (p. 1051).

The logic for the emergence of orthographic effects on speech processing could be described in the context of the lexical restructuring model (Metsala & Walley, 1998). According to this model, early in language development, the child needs to discriminate relatively few unique words, and so quite holistic representations of phonological forms will suffice (e.g., Ferguson, 1986; Jusczyk, 1993). However, as more and more words are acquired, children are thought to begin to represent smaller segments in words, that is, segmental phonology is represented at an increasingly fine-grained level during the course of development (Garlock, Walley, & Metsala, 2001; Metsala & Walley, 1998; Storkel, 2002). According to Metsala (1997), segmental restructuring does not occur in an all-or-none, system-wide fashion but rather on an item-by-item basis. That is, the degree of segmentation for a given lexical item depends amongst other things on the crowdedness of the phonological space, i.e., the number of phonological neighbors. Thus, words in dense neighborhoods are more likely to undergo lexical restructuring than words in sparse neighborhoods (see also Storkel, 2002).

Although orthographic neighborhood density was not explicitly mentioned in the original lexical restructuring model (Metsala & Walley, 1998; Storkel, 2002), it seems quite plausible that during the process of reading and spelling instruction, similarity relations within the orthographic system are also used to restructure, specify and organize lexical representations. This would mean that not only words with similar acoustic and articulatory patterns begin to cluster (Nittrouer, Studdert-Kennedy, & McGowan, 1989), but also words with similar orthographic patterns. In other words, orthographic similarity would contribute to the process of lexical restructuring. This idea is supported by the observation that explicit awareness of sounds at the phoneme level does not develop automatically as children get older but seems to depend largely on direct instruction in reading and spelling (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974). This can be nicely seen in adult illiterates who generally lack the phonemic awareness skills displayed by young literate children (e.g., Morais, Cary, Alegria, & Bertelson, 1979). Similarly, the work by Ehri and others has shown that orthography influences people's conception of sounds in words (Ehri, 1984; Ehri & Wilce, 1980; Landerl, Frith, & Wimmer, 1996), an amalgamation process that Ehri described as "visual phonology."

If we accept the idea that learning about orthography provides an additional constraint in driving segmental restructuring and organization of phonological word representations (see also Goswami, 2000), then we would predict that lexical similarity *within the orthographic system* has its role to play in auditory word recognition, not so much during an on-line activation phase of word recognition but rather during an off-line process of structuring and specifying lexical representations. Metsala (1997) made a similar argument with regard to the dual role of phonological neighbors (see also Vitevitch & Luce, 1998, 1999). According to Metsala (1997), phonological neighbors produce both an *on-line competition effect* due to the fact that a single item has to be selected amongst similar sounding competitors and a *structural–residual effect* that arises from structural properties of lexical representations and results from the developmental phase. Interestingly, these two effects go in opposite directions. On-line effects will impede word recognition with increasing neighborhood density because of competition between similar sounding words. Structural–residual effects, on the other hand, will facilitate recognition with increasing neighborhood density because there will be pressure on holistic representations to undergo segmental restructuring and because sublexical patterns of activation will be more often instantiated for words with many similar sounding neighbors (Vitevitch & Luce, 1998, 1999).

Thus, to the extent that orthographic similarity might have a structural–residual effect on the specification of phonological representations, facilitatory ON effects could be accounted for without assuming on-line feedback. According to this idea, orthographic neighbors would be beneficial because they allow the system to develop better (i.e., more specified, more detailed, more segmental, more invariant) phonological representations. In a sense, this would be both a lexical and a sublexical effect. It would be lexical because it affects the structure of lexical representations. It would be sublexical because it allows the representation of increasingly fine-grained subsyllabic units, which could then be activated during the on-line phase of word recognition.

If we assume that orthographic neighborhood had its effect during an off-line developmental phase, this would also answer the question raised earlier about how orthographic neighbors would become active to begin with. That is, orthographic neighbors would not have to be active during on-line processing at all. They could have done their job well before during off-line restructuring of phonological representations.

At present, it is extremely difficult to test the restructuring account against an interactive framework that assumes on-line feedback. In an attempt to do so, we have used tasks that focus to a greater extent on the structure of lexical representations rather than the processes that operate upon them (e.g., neighborhood generation, Luce & Large, 2001). However, because all psycholinguistic measurements are based on tasks in which processes operate on representations, we have not yet been able to decide between these theoretical alternatives. Clearly, more work is needed to decide whether orthography is always co-activated in an on-line fashion during auditory word recognition or whether orthography has a more developmental effect during the restructuring of phonological representations.

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Appendix A. Word stimuli used in Experiments 1 and 3A

P–O–	P–O+	P+O–	P+O+
âpre	cube	baffe	bêche
bombe	dune	bourg	biche
brun	fauve	châle	brise
cible	frite	chic	cache
crêpe	gang	crête	coupe
dinde	gomme	flair	faune
fève	loupe	frais	flan
flou	meule	frein	grève
fugue	morne	gamme	laine
grade	muse	grue	motte
guêpe	paume	phare	niche
guide	pince	phase	pitre
meute	plage	puce	râle
ongle	prose	quête	rime
pompe	ronce	râpe	ruche
stade	sonde	sève	sèche
taupe	tige	seize	sauce
tube	troc	trêve	site
veuf	vogue	tripe	soupe
zèle	vrac	voûte	vase

Appendix B. Word stimuli used in Experiments 2 and 3B

O–	O+
nappe	brève
chic	brise
biffe	bûche
gaffe	bulle
beige	cime
cône	code
bouc	cure
baffe	dette
lobe	fade
gîte	faune
jute	flan
pêche	fonte
noce	fosse
phase	four
râpe	fric
frein	frise
lance	gaine
gamme	grès
châle	grève
tempe	lande
vigne	lave
brou	ligue
grue	lime
rance	mèche
frais	mage
voûte	moche
cran	mule
craie	natte
puce	niche
plot	panne
plomb	rave
seize	rêche
sève	ride
dard	sèche
flair	sauge
blair	soude
pagne	soupe
grêle	trac
quête	vente
tripe	poupe

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