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Syllabic Priming in Lexical Decision and Naming Tasks: The Syllable Congruency Effect Re-examined in French

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This study investigated the role of the syllable in visual recognition of French words. The syllable congruency procedure was combined with masked priming in the lexical-decision task (Experiments 1 and 3) and the naming task (Experiment 2). Target words were preceded by a nonword prime sharing the first three letters that either corresponded to the syllable (congruent condition), or not (incongruent condition). When primes were displayed for 67 ms, similar results were found in both the lexical decision and the naming tasks. Consonant-vowel targets such as *BA.LANCE* were recognised more rapidly in the congruent condition than in the incongruent and control conditions, while consonant-vowel-consonant targets such as *BAL.CON* were recognised more rapidly in the congruent and incongruent conditions than in the control condition. When a 43-ms SOA was used in the lexical-decision task, no significant priming effect was obtained. The results are discussed in an interactive-activation model incorporating syllable units.

Keywords: syllable congruency, lexical decision, naming, masked priming, CV versus CVC syllables

In recent decades, numerous studies have shown that phonological information is automatically activated during visual word recognition (see Frost, 1998, for a review). Masked priming (Forster & Davis, 1984) is a widely used paradigm to study phonological effects (e.g., Ferrand & Grainger, 1994; Frost, Ahissar, Gotesman, & Tayeb, 2003; Grainger, Diependaele, Spinelli, Ferrand, & Farioli, 2003; Lukatela, Frost, & Turvey, 1998; Pollatsek, Perea, & Carreiras, 2005; Rastle & Brysbaert, 2006; Shen & Forster, 1999). Besides avoiding strategic processes from participants (Forster, 1998), this paradigm has made it possible to demonstrate that phonological effects are not confounded with orthographic activation (e.g., Ferrand & Grainger, 1994; Frost et al., 2003; Lukatela et al., 1998). Moreover, phonological effects were obtained in tasks that did not involve postlexical phonological units, suggesting that these phonological effects arose from prelexical and lexical processes rather than articulatory processes (e.g., Lukatela et al., 1998).

To take into account robust phonological effects, models of visual word recognition have to include a phonological coding of visual inputs. This feature requires determining which phonological units are activated during silent reading. In languages with clear syllable boundaries like Spanish, data have shown that syllables are involved in the processing of polysyllabic words (e.g., Alvarez, Carreiras, & Perea, 2004; Carreiras, Alvarez, & de Vega, 1993; Carreiras & Perea, 2002; Perea & Carreiras, 1998). In French also, there is evidence for the activation of syllable units during lexical access (e.g., Carreiras, Ferrand, Grainger, & Perea, 2005; Doignon & Zagar, 2005; Mathey & Zagar, 2002; Mathey, Zagar, Doignon, & Seigneuric, 2006). However, the results are less consistent than in Spanish since some studies failed to obtain syllabic effects during the processing of French words (e.g., Brand, Rey, & Peereman, 2003; Rouibah & Taft, 2001). To account for syllable activation, a phonological prelexical level syllabically structured is assumed to be activated during visual word recognition. The syllable activation hypothesis has been developed in the interactive activation model with syllables (IAS model, Mathey et al., 2006). This model is an extended version of the interactive activation model of McClelland and Rumelhart (IA model, 1981) incorporating syllables (see also Carreiras et al., 1993), although it has not yet been implemented. Basically, the IAS model shares the main features with the IA model. When a word is displayed, letter units are activated and activate the word level by means of direct connexions. In turn, activated word units send activation to the letters they contain at a given position. At the word level, lexical representations compete with each other via lateral inhibition. Contrary to the IA model, adjacent letters are connected and syllable units (with frequency-based resting levels) are explicitly represented between letter and word units in the IAS model (see Figure 1). In addition to spreading directly to lexical representation by the orthographic route, activation at the letter level also spreads to the syllable level via direct connexions between connected letters and syllable units. Activation at the syllable level spreads to the lexical level by means of direct connexions between syllable and word units (phonological route). Furthermore, it is assumed that activation at the syllable level is a function of the amount of activation from both the letter level and the frequency-based syllable resting level. Thus, syllables, which are fundamentally phonological units, are activated at a phonological level, and this

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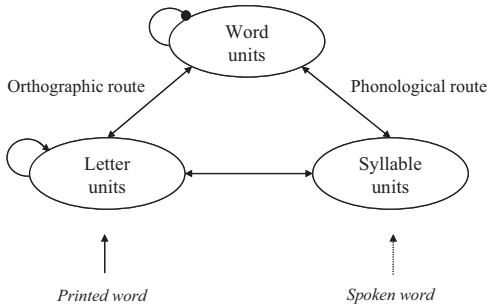

Figure 1. The interactive activation model with syllables. The arrows represent facilitatory connexions and the dot represents inhibitory connexions. Reprinted with permission from "The nature of syllabic neighbourhood in French," by S. Mathey, D. Zagar, N. Doignon, and A. Seigneuric, 2006, *Acta Psychologica*, 123, pp. 372–393. Copyright 2006 by Elsevier.

activation arises by means of orthographic units in case of written inputs. This framework takes into account various syllabic effects reported in the literature (see Mathey et al., 2006). However, as pointed out by Carreiras and Perea (2002), orthographic properties of syllables could account for syllabic effects. For example, the fact that the word *BONO* was processed faster when preceded by the pseudoword *bopa* rather than *caya* might not result from an increased activation due to the shared syllable between *bono* and *bopa* but from an increased activation due to the letter overlap between the two stimuli, this overlap coinciding with the syllable unit. As mentioned by Schiller (2000), some syllabic effects reported in the literature could be interpreted in terms of pure orthographic overlap. Thus, disentangling orthographic activation from phonological activation in syllabic effect appears to be a crucial issue for the syllabic activation hypothesis, as well as for models of visual word recognition. Indeed, a strict orthographic interpretation of syllabic effects would call into question the IAS model (Mathey et al., 2006). In the next sections, we report the effects observed with the syllable congruency procedure combined with priming, a paradigm which enables syllabic overlap to be disentangled from orthographic overlap. This is followed by the interpretations of these results. Then the issue of the present study is introduced.

Syllabic Priming Effects Using the Syllable Congruency Procedure

In a seminal study of auditory monitoring, Mehler, Dommergues, Frauenfelder, and Segui (1981) used pairs of words sharing the first three phonemes but not the syllable (e.g., *PA.LACE* and *PAL.MIER*) and segments corresponding to the first two or three phonemes of these words (*/pa/* and */pal/*). The data showed a syllable congruency effect. Participants were faster in detecting segments corresponding exactly to the first syllable of the word (*/pa/* in *PA.LACE* and */pal/* in *PAL.MIER*) rather than not (*/pal/* in *PA.LACE* and */pa/* in *PAL.MIER*). That is, performance were better when the segment was syllabically congruent with the word (e.g., */pa/-PA.LACE*) rather than syllabically incongruent (e.g., */pal/-PA.LACE*). Since that study, the syllable congruency effect has received much attention, and the design has been adapted to visual word recognition (Ferrand, Segui, & Grainger, 1996). The priming paradigm is the most widely used technique to investigate the syllable congruency effect in the processing of written words. The design is the same as in the monitoring task of Mehler et al. (1981), except that the segments serve as primes. In the congruent situation, primes share the first two/three letters and the first syllable with the target (e.g., *pa&&&&-PA.LACE*, *pal&&&&-PAL.MIER*), while in the incongruent situation they share the first two/three letters but not the syllable (e.g., *pal&&&-PA.LACE*, *pa&&&&&-PAL.MIER*). This procedure enables a phonological syllabic effect to be dissociated from a simple orthographic overlap. On the one hand, if syllables are functional prelexical units as assumed in the IAS model (Mathey et al., 2006), target words should be recognised faster in case of syllable congruency rather than not. Indeed, the prime should preactivate its corresponding syllable unit (i.e., *pa* would preactivate */pa/* and *pal* would preactivate */pal/*). Consequently, the target processing would be sped up in case of syllable congruency because of the residual activation of its first syllable by the prime. On the other hand, if syllable units play no role in lexical access or if the expected effects are confounded with orthographic properties of syllables, then the longer the prime, the stronger should be the priming effect, regardless of the syllable structure of the target (Schiller, 1998). In the latter prediction referred to as the segmental overlap hypothesis, the priming effect is assumed to depend on the longer of the shared segment between the prime and the target, and not on the structure of this segment.

Studies investigating the syllable congruency effect with the priming paradigm have led to inconsistent results according to the task and the language of the study. In word naming, Ferrand et al. (1996) showed a syllable congruency effect in French at a 43-ms stimulus onset asynchrony (SOA), but this effect was not replicated by Brand et al., (2003). Similarly, Ferrand, Segui, and Humphreys (1997) observed a syllable congruency effect in English when the SOA was 43 ms, but these data were not replicated subsequently (Schiller, 1999, 2000). Moreover, the syllable congruency effect was observed neither in Dutch (Schiller, 1998) nor in Spanish (Schiller, Costa, & Colomé, 2002). In the lexical-decision task, the syllable congruency effect was found in Spanish with SOAs higher than 60 ms when partial primes (Carreiras & Perea, 2002) and nonword primes (Alvarez et al., 2004; Dominguez, de Vega, & Cuetos, 1997) were used. However, the effect was observed neither in French (Ferrand et al., 1996) nor in English (Ferrand et al., 1997) at a 43-ms SOA.

Three main interpretations have been put forward to account for the data in syllable congruency experiments. First, several studies showing a syllable congruency effect suggest that syllables are units activated during the word recognition process (Alvarez et al., 2004; Carreiras & Perea, 2002; Ferrand et al., 1996; 1997). However, some authors assume that syllables might play a role at a postlexical level in French and English since syllabic priming effects were obtained in naming but not in a lexical-decision task (Ferrand et al., 1996; 1997). For others, syllables might play a role at a prelexical level, at least in Spanish, since a syllabic priming effect was found in a lexical-decision task, which does not involve postlexical phonological activation (Alvarez et al., 2004; Carreiras & Perea, 2002). However, there was no neutral control prime condition in any of these four studies, so it remained difficult to examine whether the syllabic priming effect was confounded with

any orthographic overlap (but see Alvarez et al., 2004). Second, some studies in English and Dutch using the syllable congruence design plus a control prime condition argue for the segmental overlap hypothesis and suggest that syllables play no role during the processing of written words (e.g., Schiller, 1998, 1999, 2000). Indeed, orthographic priming effects were observed instead of syllabic priming effects. That is, target words were processed more rapidly when the primes and targets shared the first three letters (e.g., *kon###-KO.NING*) rather than the first two (e.g., *ko####-KO.NING*) and more rapidly when they shared the first two rather than none (e.g., *%&$###-KO.NING*). This effect was observed regardless of the target syllable structure. Thus, it might be the length, and not the structure, of the segment which is responsible for the priming effect. Third, some studies in French call into question the syllable activation hypothesis but do not lend support to the segmental overlap hypothesis (Brand et al., 2003). Indeed, neither syllabic nor orthographic priming effects were obtained, and similar reaction times were found in all the experimental conditions. The authors concluded that further research is required to shed more light on these findings.

To sum up, inconsistent syllabic priming effects have been obtained with the syllable congruency procedure both across and within languages. While cross-linguistic differences might account in part for the inconsistencies between English and French (e.g., Alvarez, Carreiras, & de Vega, 2000; Schiller, 2000), this argument is not sufficient to explain discrepancies between French and Spanish. Indeed, syllabic effects were observed in French with other designs in the lexical-decision task (e.g., Carreiras et al., 2005; Mathey & Zagar, 2002; Mathey et al., 2006), thereby replicating Spanish data and arguing in favour of the syllable hypothesis. Therefore, it remains puzzling that the syllable congruency effect obtained in Spanish was not replicated in French in the lexical-decision task. Given the strong implications for the theoretical understanding of the basic processes involved in visual word recognition, these inconsistent results between the two languages merit further investigations. Overall, it appears that the main discrepancy between studies on syllable congruency concerns SOA duration, ranging from 43 ms to 250 ms. However, priming studies on the time course of sublexical activation demonstrated that the activation of phonological information, though rapid, intervenes later than the activation of orthographic information (around a 60-ms SOA; e.g., Ferrand & Grainger, 1994; Grainger & Ferrand, 1994; Pollatsek et al., 2005). It should be mentioned that phonological priming effects were previously reported with SOA close to 30 ms, but these effects arose when participants performed naming tasks (e.g., Ferrand, Grainger, & Segui, 1994; Lukatela & Turvey, 1994). On the contrary, when the task to be performed did not require any computation of output phonology such as the lexical-decision task, several studies showed that phonological priming effects failed to reach significance at short SOAs (e.g., Ferrand & Grainger, 1992, 1993; Grainger et al., 2003). Therefore, if Ferrand et al. (1996) did not obtain the syllable congruency effect in a lexical-decision task in French, it might not be because syllables are not functional units of lexical access but rather that the SOA was too short to enable significant activation of prelexical syllable units (Alvarez et al., 2004; Carreiras & Perea, 2002; Ferrand et al., 1996). To our knowledge, this explanation has never been tested empirically. Thus, the syllable congruency effect should be reinvestigated in a lexical-decision task using a longer SOA in French. In addition, the fact that the syllable congruency effect found in the naming task (Ferrand et al., 1996) was not replicated in subsequent studies (Brand et al., 2003; see also Schiller et al., 2002) needs further attention. Indeed, if syllables are lexical access units as assumed in the syllable activation hypothesis, the syllable congruence effect should be found in both lexical decision and naming tasks.

The Present Study

The aim of the study was to provide evidence for syllabic priming effects in French, these effects being assumed to ensue from the activation of prelexical syllabic units. Such results would have strong implications for models of visual word recognition and would argue in favour of a syllabically structured prelexical phonological level, as proposed in the IAS model (Mathey et al., 2006). The syllable congruency design combined with masked priming offers a suitable paradigm for investigating syllabic effects in visual word recognition. However, inconsistent results have been reported throughout the literature. In French, the use of short SOAs (43 ms) could be the cause of the null effects found in the lexical-decision task. Therefore, the present study used a longer SOA (67 ms) to enable the activation of syllabic units in a lexical-decision task (Experiment 1). In addition, a naming task was conducted to test whether the syllabic effect reported by Ferrand et al. (1996) could be replicated (Experiment 2). Finally, to ensure that the expected syllable congruency effect would occur owing to a long enough SOA, the effect was tested with a shorter SOA (43 ms) in the lexical-decision task (Experiment 3). Concerning the materials, a control prime condition was added in addition to the congruent and incongruent syllable prime conditions, in order to test whether the expected syllabic priming effect could be in part accounted for by any orthographic overlap (e.g., Schiller, 1998). Furthermore, the primes were nonwords systematically sharing the first three letters with the prime and not just a two- or three-letters segment (e.g., *ba.lieux-BA.LANCE, bal.veux-BA.LANCE, ba.lave-BAL.CON, bal.nat-BAL.CON*). Such primes would maximise the orthographic overlap for targets such as *BA.LANCE*, hence restricting the emergence of a syllabic effect if it results from orthographic overlap. If syllables are functional units of lexical access as assumed by the IAS model, a syllable congruency effect should be obtained, thus replicating Spanish data (e.g., Alvarez et al., 2004). That is, targets such as *BA.LANCE* should be recognised faster when preceded by *ba.lieux* than by *bal.veux*. On the contrary, targets such as *BAL.CON* should be recognised faster when preceded by *bal.nat* than by *ba.lave*. In addition, if the reaction times in the syllable incongruent prime condition are not different from those obtained in the control prime condition, this would strongly argue for the phonological nature of syllabic priming effects. Finally, if the expected effects take place at a prelexical level, they should be observed in both the lexical-decision task and the naming task.

Experiment 1

While syllabic priming effects were not found in the lexical-decision task with a 43-ms SOA (Ferrand et al., 1996), it has been suggested that phonological effects should emerge with longer prime durations (e.g., Ferrand & Grainger, 1994; Grainger &

Ferrand, 1994). Experiment 1 therefore investigated the syllable congruency effect in a primed lexical-decision task when the SOA was 67 ms.

Method

Participants. Forty-one volunteer students from the University of Bordeaux participated in this experiment. They were all native French speakers and reported having corrected-to-normal vision.

Materials. Sixty pairs of bisyllabic target words were selected in the Brulex French database (Content, Mousty, & Radeau, 1990). In each pair, words shared the same first three letters (e.g., *BALANCE* and *BALCON*), but one word had a CV structure—C refers to a consonant, V to a vowel—in the first syllable (referred to henceforth as CV targets) such as *BA.LANCE*, and the other word had a CVC structure in the first syllable (CVC targets) such as *BAL.CON*. The words were 5 to 8 letters long and had no higher frequency orthographic neighbours. The average frequencies were 51 occurrences per million for CV words and 41 occurrences per million for CVC words.[1] For each word, two types of related nonword primes were used, each prime sharing the three initial letters with the target. In one case, the primes had a CV structure in the first syllable (CV primes) such as *ba.lieux* for the target *BA.LANCE* and *ba.lave* for the target *BAL.CON*. In the other case, the primes had a CVC structure in the first syllable (CVC primes) such as *bal.veux* for the target *BA.LANCE* and *bal.nat* for the target *BAL.CON*.[2] In addition, there was a control prime consisting of a string of nonalphabetic symbols, the number of symbols corresponding to the number of letters of the target. One hundred and twenty orthographically legal and pronounceable nonwords were added for the requirements of the task. Three lists of stimuli were used so that, in each list, every stimulus appeared once in one of the three prime conditions.

Procedure. Participants performed a primed lexical-decision task individually. The items were presented using the DMDX software (Forster & Forster, 2003). For each trial, a forward mask consisting of a row of hash marks and matched for length with the prime was presented for 500 ms in the centre of the screen. Next, a centred lowercase prime was presented for 67 ms. The prime was immediately replaced by an uppercase target item. Primes were presented in lower-case letters and targets in upper-case letters to ensure that priming effects were not due to overlap of visual features (see Evett & Humphreys, 1981). The target remained on the screen until the participants responded or 2500 ms had elapsed. Participants had to decide as quickly and as accurately as possible whether the target was a French word or not by pressing one of two buttons on the keyboard. Visual feedback was provided when they failed to respond or when 2500 ms had elapsed. Reaction times were measured from target onset until the participant responded. All participants performed 18 practise trials before receiving the 240 trials in a different random order.

Results and Discussion

The mean correct reaction times and mean error rates averaged over participants for words are presented in Table 1. Reaction times shorter than 300 ms or longer than 1500 ms were removed (0.73% of the data). The word *tarir* was excluded from the analyses because of a high error rate and its associated word was also eliminated. The data were submitted to separate analyses of variance on the participant means ($F1$) and on the item means ($F2$) with Target Type (CV, CVC) and Prime Type (CV, CVC, control) as main factors.

Table 1
Mean Reaction Times (in ms) and Percentage of Errors (in Parentheses) on Target Words in the Lexical Decision Task With a 67-ms SOA (Experiment 1)

	Prime type		
Target type	CV	CVC	Control
CV	685 (7.6)	717 (7.5)	709 (6.8)
CVC	712 (4.1)	713 (5.5)	730 (6.6)

The analysis on reaction times showed a significant effect of prime type, $F1(2, 80) = 5.03$, $MSE = 1{,}888.68$, $p < .01$, $F2(2, 232) = 8.04$, $MSE = 2111.38$, $p < .001$. The main effect of target type was significant only in the participant analysis, $F1(1, 40) = 9.66$, $MSE = 1383.00$, $p < .01$, $F2 < 1$. More importantly, the interaction between prime type and target type was significant in both the participant and the item analyses, $F1(2, 80) = 5.73$, $MSE = 962.72$, $p < .01$, $F2(2, 232) = 3.20$, $MSE = 2111.38$, $p < .05$. Planned comparisons showed that CV targets were recognised more rapidly when they were preceded by a CV prime than by a CVC prime (+32 ms), $F1(1, 40) = 15.27$, $MSE = 1364.11$, $p < .001$, $F2(1, 116) = 16.24$, $MSE = 1825.70$, $p < .001$, or than by a control prime (+24 ms), $F1(1, 40) = 6.13$, $MSE = 1834.30$, $p < .05$, $F2(1, 116) = 10.37$, $MSE = 2174.67$, $p < .01$. There was no difference between the CVC and the control prime conditions for CV targets, Fs < 1. On the other hand, CVC targets were recognised more rapidly when they were preceded by a CV prime than by a control prime (+18 ms), $F1(1, 40) = 4.00$, $MSE = 1512.90$, $p = .05$, $F2(1, 116) = 4.75$, $MSE = 2174.67$, $p < .05$, and when preceded by a CVC prime than by a control prime (+17 ms), $F1(1, 40) = 5.90$, $MSE = 936.00$, $p < .05$, but $F2(1, 116) = 3.45$, $MSE = 2333.76$, $p = .07$. There was no difference between the CV and the CVC prime conditions for CVC targets, Fs <1.

The analysis on the error data showed a significant effect only of target type in the participant analysis, $F1(1, 40) = 6.65$, $MSE = 33.17$, $p < .05$, $F2(1, 116) = 1.64$, $MSE = 213.89$, $p > .10$.

The results showed a main effect of priming. More importantly, there was a reliable interaction between target type and prime type.

[1] The fact that the words had a rather low lexical printed frequency reflects the many constraints in the item selection process. Some studies reported syllable effects for both high- and low-frequency words (e.g., Carreiras et al., 1993), while others only for low-frequency words (e.g., Alvarez, Carreiras, & Taft, 2001). Thus, the issue of effect generalization to a wider range of frequency levels merits further investigation.

[2] To ensure that the participants used the intended syllable boundaries in the primes, a post test was conducted with 28 additional participants. They were presented with the 240 nonword primes written on a sheet in a random order and were told to make strokes to break down the syllables in the items. Results showed that they correctly created the intended syllable breaks for 98.8% of the items. More precisely, they correctly put a syllable break between the second and the third letter for 98.6% of CV primes, and between the third and fourth letter for 99.0% of CVC primes.

A clear syllable congruency effect was obtained for CV targets. They were processed more rapidly in the syllable congruent condition (CV prime) than in the syllable incongruent condition (CVC prime). These data do not support the segmental overlap hypothesis (e.g., Schiller, 1998) in French. On the contrary, it appears that when the prime duration was long enough to allow activation of phonological units (i.e., a SOA around 60 ms), a syllable congruency effect was found in a masked primed lexical-decision task, as previously observed in Spanish (e.g., Alvarez et al., 2004). This supports the syllable activation hypothesis. However, the results obtained for CVC targets were unexpected. A facilitatory priming effect was found for both the congruent and the incongruent prime conditions with respect to the control condition. Moreover, the priming effect for the congruent condition did not differ significantly from that of the incongruent condition. One could argue that the priming effects for CVC targets may not be strictly syllabic, but rather might ensue from the onset-nucleus compound of syllables (*ba* in the syllable *bal*). In that case, the coda (*l* in *bal*) would not be processed. This explanation is consistent with studies showing that coda units are difficult to process, at least in English (e.g., Treiman & Danis, 1988). However, if the priming effect we observed ensued from the onset-nucleus compound of syllables, an identical priming effect would have been obtained in the four priming conditions since for the pair of targets *BA.LANCE*/*BAL.CON* for example, each prime contained the same onset-nucleus group *ba* (*ba.lieux, ba.lave, bal.veux, bal.nat*). The pattern of results did not coincide with this prediction since no priming effect was obtained for CVC primes preceding CV targets (*bal.veux-BA.LANCE*). It remains possible that the special status of the onset-nucleus compound is restricted to the English language. In addition, the items were cautiously selected so there was no case of ambisyllabicity, that is the coda of the first syllable of the items could not be both the coda of the first syllable and part of the onset of the next syllable. This precaution made it possible to avoid multiple syllabification possibilities. A possible explanation for the priming effects in the CVC target condition in line with the syllable hypothesis is that CV syllables activate compatible CVC syllables. That is, a CV prime such as *ba.lave* might activate not only the CV syllable unit */ba/* but also the CVC syllable unit */bal/*. Therefore, when the target word *BAL.CON* is presented, its processing is speeded up compared to a control prime condition, because of the previous activation of its first syllable by the prime. We return to this issue in the General Discussion.

Experiment 2

A syllable congruency effect was obtained in Experiment 1 with the lexical-decision task. The aim of Experiment 2 was to examine whether this effect could be replicated in the naming task. According to the syllable activation hypothesis, similar results should be observed in both tasks. However, previous findings were discordant. For example, Ferrand et al. (1996) found the syllabic priming effect in the naming task while Brand et al. (2003) failed to replicate these data, calling into question the reliable role of syllables during lexical access. Hence, given the strong implications of these results, an additional experiment needed to be conducted in the naming task.

Method

Participants. Forty-seven volunteer students from the University of Bordeaux participated in this experiment. They were all native French speakers and reported having corrected-to-normal vision. None of them had participated in the previous experiment.

Materials. The stimuli were the same as those in Experiment 1, except that the nonword targets and the associated primes were not used.

Procedure. The same procedure as in Experiment 1 was used except that the task was a word-naming task. Participants were instructed to name as rapidly and accurately as possible the target words. The naming latencies were measured from target onset to the triggering of a voice key by the participant's response. The experimenter sat next to the participant to check his or her responses.

Results and Discussion

The mean correct reaction times and mean error rates averaged over participants for words are presented in Table 2. Incorrect voice key triggering (0.90% of the data), mispronunciation and hesitant responses (3.62%) and latencies shorter than 300 ms or longer than 1000 ms (0.59%) were removed from the data. Only mispronunciation and hesitant responses were considered as errors. The data were submitted to separate analyses of variance on the participant means ($F1$) and on the item means ($F2$) with Target Type (CV, CVC) and Prime Type (CV, CVC, control) as main factors.

The analysis on reaction times showed a similar pattern of results as in the lexical-decision task. There was a significant effect of prime type, $F1(2, 92) = 12.24$, $MSE = 319.79$, $p < .001$, $F2(2, 236) = 5.22$, $MSE = 946.05$, $p < .01$. The main effect of target type was not significant, Fs <1. The interaction between prime type and target type was significant in both the participant and the item analyses, $F1(2, 92) = 6.02$, $MSE = 368.53$, $p < .01$, $F2(2, 236) = 3.59$, $MSE = 946.05$, $p < .05$. Planned comparisons showed that CV targets were recognised more rapidly when they were preceded by a CV prime than by a CVC prime (+17 ms), $F1(1, 46) = 17.92$, $MSE = 375.78$, $p < .001$, $F2(1, 118) = 12.22$, $MSE = 906.63$, $p < .001$, or than by a control prime (+13 ms), $F1(1, 46) = 8.40$, $MSE = 440.23$, $p < .01$, $F2(1, 118) = 6.96$, $MSE = 786.85$, $p < .01$. There was no significant difference between the CVC and the control prime conditions for CV targets, $F1(1, 46) = 1.26$, $MSE = 357.61$, $p > .10$, $F2 < 1$. In addition, CVC targets were recognised more rapidly when they were preceded by a CV prime than by a control prime (+13 ms), $F1(1,$

Table 2
Mean Reaction Times (in ms) and Percentage of Errors (in Parentheses) on Target Words in the Naming Task With a 67-ms SOA (Experiment 2)

	Prime type		
Target type	CV	CVC	Control
CV	554 (3.1)	571 (6.1)	567 (3.4)
CVC	560 (3.7)	560 (2.1)	573 (3.3)

46) = 10.94, *MSE* = 348.66, $p < .01$, *F*2(1, 118) = 4.59, *MSE* = 786.85, $p < .05$, and when preceded by a CVC prime than by a control prime (+13 ms), *F*1(1, 46) = 12.81, *MSE* = 288.50, $p < .001$, but *F*2(1, 118) = 3.36, *MSE* = 1,144.67, $p = .07$. There was no difference between the CV and the CVC prime conditions for CVC targets, *F*s <1.

The analysis on the error data showed an effect of target type that was significant only in the participant analysis, *F*1(1, 46) = 5.62, *MSE* = 16.14, $p < .05$, *F*2(1, 118) = 1.88, *MSE* = 61.73, $p > .10$. There was no effect of prime target, *F*s <1. A significant effect of interaction between prime type and target type was obtained, *F*1(2, 92) = 8.23, *MSE* = 17.21, $p < .001$, *F*2(2, 236) = 7.15, *MSE* = 26.17, $p < .001$. This interaction indicated that CV targets produced more errors when preceded by a CVC prime than by a CV prime (+3.0), *F*1(1, 46) = 9.92, *MSE* = 21.01, $p < .01$, *F*2(1, 118) = 9.10, *MSE* = 30.92, $p < .01$, or than by a control prime (+2.7), *F*1(1, 46) = 6.67, *MSE* = 24.92, $p < .05$, *F*2(1, 118) = 9.93, *MSE* = 23.08, $p < .01$. The other planned comparisons were not significant.

The pattern of results found in this experiment was similar to that obtained in Experiment 1. A syllable congruency effect was found in the CV target condition. For CVC targets, both CV and CVC primes yielded a facilitatory priming effect, and the facilitation was not stronger for CVC primes than for CV primes. These results do not support the segmental overlap hypothesis, in agreement with those obtained in the lexical-decision task. On the contrary, the data provide evidence in favour of the syllable activation hypothesis, at least for CV words. Contrary to studies yielding an onset priming effect (e.g., Forster & Davis, 1991; Grainger & Ferrand, 1996), no priming effect was found for CV targets preceded by CVC primes, while CVC primes shared the initial phonemic onset with the targets. Interestingly, several studies on syllabic priming failed to observe onset priming, just as in our experiment (e.g., Ferrand et al., 1997, Experiment 5; Schiller, 2000, Experiment 2). An explanation for this discrepancy could be that most studies reporting onset priming effects used monosyllabic items. According to Colé, Magnan, and Grainger (1999), displaying monosyllabic words might induce participants to use intrasyllabic units such as onset and rhyme during word processing. On the contrary, when polysyllabic words are displayed, syllable units might dominate word processing.

Experiment 3

In Experiment 1, a syllable congruency effect was obtained in the primed lexical-decision task with a SOA of 67 ms, while Ferrand et al. (1996) did not find this effect with a SOA of 43 ms. The absence of syllable congruency at a 43-ms SOA has been accounted for by the prime duration which was not long enough to allow syllables to be activated (Alvarez et al., 2004; Carreiras & Perea, 2002; Ferrand et al., 1996). To support this interpretation, we conducted a third experiment to check that no syllable priming effect would be obtained when the same materials and procedure as in Experiment 1 were used, except that the SOA was shorter (43 ms instead of 67 ms). No syllable priming effect should be obtained, as observed by Ferrand et al. (1996), that is neither the priming effect nor the interaction effect should reach significance.

Method

Participants. Thirty-nine volunteer students from the University of Bordeaux participated in this experiment. They were all native French speakers and reported having corrected-to-normal vision. None of them had participated in the previous experiments.

Materials. The stimuli were the same as those in Experiment 1.

Procedure. The same procedure as in Experiment 1 was used except that the SOA was set to 43 ms.

Results and Discussion

The mean correct reaction times and mean error rates averaged over participants for words are presented in Table 3. Reaction times shorter than 300 ms or longer than 1500 ms were removed (0.48% of the data). Three words were excluded from the analyses because of a high error rate and their associated words were also eliminated. The data were submitted to separate analyses of variance on the participant means (*F*1) and on the item means (*F*2) with Target Type (CV, CVC) and Prime Type (CV, CVC, control) as main factors.

The analysis on reaction times showed that the effect of prime type was not significant, *F*1(2, 76) = 1.24, *MSE* = 1,649.91, $p > .10$, *F*2(2, 228) = 1.73, *MSE* = 2,165.35, $p > .10$. The main effect of target type was significant in the participant analysis only, *F*1(1, 38) = 21.50, *MSE* = 1,676.82, $p < .001$, *F*2 < 1. The interaction between prime type and target type was not significant, *F*1 < 1 and *F*2 < 1.

In the analysis on the error data, only the target type effect was significant, though only in the participant analysis, *F*1(1, 38) = 9.82, *MSE* = 16.51, $p < .01$, *F*2(1, 114) = 1.79, *MSE* = 129.90, $p > .10$.

As expected, the priming and the interaction effects obtained in Experiment 1 were not found in Experiment 3. Given that the two experiments differed in SOA duration (67 vs. 43 ms), this suggests that a 43-ms SOA was not long enough to allow for the syllable activation to arise in the lexical-decision task. This finding is consistent with the study of Ferrand et al. (1996). With short SOAs (around 40 ms), syllable units would not have time to significantly influence visual word processing, while using longer SOAs (around 60 ms) allows phonological priming effect to occur.

General Discussion

The aim of the study was to test the syllable prelexical activation hypothesis in the visual recognition of French words, as assumed in the IAS model (Mathey et al., 2006). To do so, the syllable congruency procedure combined with masked priming was used in

Table 3
Mean Reaction Times (in ms) and Percentage of Errors (in Parentheses) on Target Words in the Lexical Decision Task With a 43-ms SOA (Experiment 3)

	Prime type		
Target type	CV	CVC	Control
CV	695 (7.0)	705 (5.8)	692 (5.8)
CVC	724 (3.8)	725 (5.5)	718 (4.3)

both the lexical-decision task and the naming task. When a 67-ms SOA was used (Experiments 1 and 2), the outcomes were highly similar in both tasks. On the one hand, CV targets (e.g., *BA.LANCE*) were responded to more rapidly when they were preceded by a CV prime (*ba.lieux*) than by a CVC prime (*bal.veux*). This facilitatory priming effect can be termed a syllable congruency effect since the primes yielded faster responses if, and only if, they shared the first syllable with the prime. In addition, the reaction times in the CVC prime condition did not differ significantly from those in the control prime condition. On the other hand, CVC targets (e.g., *BAL.CON*) were responded to more rapidly when preceded by both a CVC prime (*bal.nat*) and a CV prime (*ba.lave*). That is, regardless of their first syllable structure, the primes facilitated the processing of the targets with respect to a control prime condition. Moreover, there was no significant difference between the reaction times in the CV and in the CVC prime conditions. Finally, neither a significant priming effect nor an interaction effect was found when the SOA was set to 43 ms in the lexical-decision task (Experiment 3).

Theoretical Implications of the Syllable Congruency Effect

The present results provide evidence for the activation of syllable units during lexical access. Indeed, for CV targets, although CV and CVC primes shared the first three letters with the target, a facilitatory priming effect was obtained for CV primes only—that is, in the event of syllable congruency. Such findings are in contradiction with the segmental overlap hypothesis (Schiller, 1998) according to which a prime sharing a large segment with the target preactivates more orthographic units than a smaller segment, and consequently strongly facilitates target processing. According to this pure orthographic hypothesis, a priming effect should have been found in the CVC prime condition compared to the control prime condition. However, this was not the case. The fact that there was no priming effect for CVC primes strongly suggests that a partial orthographic overlap was not sufficient to facilitate the target processing. What is important is the syllable overlap between the prime and the target—that is, a pure phonological overlap.

In the present study, the syllable congruency effect was found in both the lexical-decision task and the naming task. Although our results do not allow us to refute the output influence of syllable units in the naming task (Ferrand et al., 1996; 1997), such an interpretation does not account for the data as a whole since the lexical-decision task does not involve any articulatory response. Thus, the present findings provide evidence for an activation of syllable units in the early stages of visual word recognition. Moreover, the syllable congruency effect was obtained in the lexical-decision task when a 67-ms SOA was used compared to a 43-ms. This replicates the data of Ferrand et al. (1996) and strongly suggests that a relatively long SOA (around of 60 ms) is required for the emergence of syllabic effects in the lexical-decision task. This is consistent with previous studies on the time course of phonological activation (see Ferrand & Grainger, 1994; Grainger & Ferrand, 1994).

The IAS model (Mathey et al., 2006) predicted the facilitatory syllable congruency effect reported in the present study. In this framework, when a nonword prime is presented, activation is sent from the letter level to the corresponding syllable unit at the phonological level (e.g., the prime *ba.lieux* activates the syllable */ba/*). Then, when the target is displayed, activation is sent from the letter level to both the lexical and syllable levels. In case of congruency, the syllable unit activated by the prime and by the target is similar. Thus, in the congruent condition, strong activation is sent from the syllable level to the lexical level, compared to the incongruent or control conditions. The processing of the target is therefore facilitated in the syllable congruent condition compared to the other prime conditions.

The present findings replicate the data of Ferrand et al. (1996) in a naming task in French with a 67-ms SOA (but see Brand et al., 2003) and extend the findings to the lexical-decision task. Moreover, they confirm studies conducted in Spanish reporting syllable congruency effects (Alvarez et al., 2004; Carreiras & Perea, 2002; Dominguez et al., 1997; but see Schiller et al., 2002). The similarity of syllabic effects between French and Spanish can be explained by the comparable linguistic characteristics of the two languages, such as clear syllable boundaries and transparent orthographies. These characteristics make salient syllables in words, so the phonological units turn into relevant units of word processing. Finally, our data are not consistent with studies supporting the segmental overlap hypothesis in English (e.g., Schiller, 1999, 2000). A possible explanation is that syllables are not reliable units of word processing in English, given the depth of the writing system and the numerous cases of ambisyllabicity (e.g., Alvarez et al., 2000).

Processing of CV Versus CVC Syllables

A theoretical interpretation of the present pattern of results in terms of syllable activation could be weakened by the data obtained in the CVC target condition (see also Alvarez et al., 2004). In both nonword prime conditions, primes and targets shared the first three letters. Nevertheless, the results of Experiments 1 and 2 showed that for CV targets, CV primes yielded to a priming effect unlike CVC primes. That is, although the orthographic overlap was similar in both prime conditions, only syllabically congruent primes produced an advantage on response latencies. This result argues in favour of the syllabic activation hypothesis, while the segmental overlap hypothesis can be ruled out since a similar priming effect was expected for both CV and CVC primes. On the contrary, data for CVC targets showed that both CV and CVC primes yielded to facilitatory priming effects. This would be evidence in favour of the segmental hypothesis. At this point, it seems necessary to examine whether the segmental overlap hypothesis can reliably account for the priming effects found for the CVC targets. First, in three central studies in Dutch and English supporting the segmental overlap hypothesis (Schiller, 1998, 1999, 2000), an orthographic segment priming effect was systematically reported for both CV and CVC targets.[3] Therefore, in the view of the segmental overlap hypothesis, a dissociation of orthographic priming effects according to the syllabic structure of targets has

[3] Out of 12 experiments to date, the only one not in agreement with the others is the first experiment reported by Schiller (2000), since no priming effect was obtained either for CV primes or for CVC primes. This experiment was conducted with the materials of Ferrand et al. (1997).

never been reported to our knowledge. Indeed, since syllables are assumed not to play any role in lexical access, it remains difficult to explain why, when two primes share exactly the same orthographic segment with a target, one would produce a reliable priming effect and the other a null effect for CV targets, whilst both primes would produce a reliable priming effect for CVC targets. Second, according to studies on the time course of sublexical unit activation, orthographic priming effects are the strongest at SOAs of 30 to 50 ms, while phonological priming effects arise more favourably with SOAs around of 60 ms (e.g., Ferrand & Grainger, 1993, 1994; Grainger & Ferrand, 1994; Pollatsek et al., 2005). Thus, if the priming effect found for CVC targets in Experiments 1 and 2 with a SOA of 67 ms was orthographic in nature, similar or stronger priming effects should have been obtained with a SOA of 43 ms in Experiment 3 (see Schiller, 2000). However, planned comparisons for CVC targets showed that there was significant priming effect neither in the CV prime condition nor in the CVC prime condition (all Fs < 1). Therefore, this suggests that the priming effects found in Experiments 1 and 2 are phonological in nature.

It remains to explain the asymmetrical data for CV and CVC targets obtained in Experiments 1 and 2. Such results are consistent with studies in Romance languages which have reported robust syllabic effects and provided signs of divergence between CV and CVC word processing. More precisely, several previous studies failed to observe any syllable congruency effect specifically for CVC targets (e.g., Alvarez et al., 2004; Colé et al., 1999; Marin & Carreiras, 2002; Tabossi, Collina, Mazzetti, & Zoppello, 2000). For example, Alvarez et al. (2004) observed that "lexical decision responses to CVC words [. . .] were not modulated by the presence of nonword primes that shared the first initial syllable with the target item" (p. 144). According to Colé et al. (1999), the syllable congruency effect is more likely to occur for CV words because the CV structure is much more frequent than the CVC structure, at least in French and Spanish, so CV syllables would be more easily activated. In the present study, the use of a control condition in addition to the two usual nonword conditions further extends this observation. This was not an absence of priming effect which was reported for CVC targets, but an identical priming effect with CV and CVC primes. A possible explanation in line with the syllable activation hypothesis is that CV syllables might activate consistent CVC syllables, that is CVC syllables that embed the CV syllable. Such an assumption fits in with the hypothesis of Marin and Carreiras (2002) according to which CV and CVC syllables "collaborate" in word processing (see also Alvarez et al., 2004). The IAS model (Mathey et al., 2006) can account for a specific CV to CVC syllable collaboration provided direct connexions between embedded syllables are added at the syllable level. In such a framework, the presentation of a prime like *ba.lieux* or *ba.lave* would preactivate the syllable /ba/, explaining the facilitatory priming effect for the CV target, and the syllable /ba/ would also preactivate the compatible syllable /bal/. When the CVC word is displayed, therefore, its first syllable has already been activated by the prime, involving faster word recognition. A post hoc analysis was carried out on CVC target latencies in Experiments 1 and 2 to provide additional evidence for this assumption. In this pool of target words, we distinguished between words with a nasal consonant in the third position (e.g., MAN.TEAU, NO*M*.BRIL) and words with a liquid or stop consonant at this position (e.g., BAL.CON, CA*R*.NET, CA*P*.TIF). Thus, the first syllable of CV primes (e.g., syllable /ma/ in *ma.nance*) was not embedded into the first syllable of CVC targets with a nasal consonant, (e.g., syllable /mã/ in *MAN.TEAU*). On the contrary, the first syllable of CV primes (e.g., syllable /ba/ in *ba.lave*) was embedded in the first syllable of CVC targets with a liquid or stop consonant (e.g., syllable /bal/ in *BAL.CON*). The analysis showed that the priming effect for CVC targets preceded by CV primes was significant for CVC targets with a liquid or stop consonant (+22 ms, $F(1, 116) = 13.17$, $MSE = 1{,}440.30$, $p < .001$), but not for CVC targets with a nasal consonant (+1 ms, $F < 1$). This suggests that only syllabically consistent CV primes facilitate CVC target processing, that is CV primes for which the first CV syllable is embedded in the first CVC syllable of targets. These data are consistent with previous studies (e.g., Marin & Carreiras, 2002) and show the mode of collaboration between CV and CVC syllables.

To conclude, the present findings support the view that syllables are functional units of lexical access in French (see also Carreiras et al., 2005; Doignon & Zagar, 2005; Mathey & Zagar, 2002; Mathey et al., 2006). Future experiments should be conducted in order to investigate the difference between CV and CVC syllable processing and the organisation of syllabic units at the sublexical level.

Résumé

Cette étude a examiné le rôle de la syllabe dans la reconnaissance visuelle de mots français. La procédure de congruence de la syllabe a été combinée à l'indiçage masqué dans la tâche de décision lexicale (Expériences 1 et 3) et la tâche de dénomination (Expérience 2). Les mots cibles étaient précédés par un indice non-mot partageant les trois premières lettres qui correspondaient à la syllabe (condition congruent) ou non (condition non congruent). Quand les indices étaient présentés pendant 67 ms, des résultats similaires ont été obtenus dans les tâches de décision lexicale et de dénomination. Les cibles consonne-voyelle comme *BA.LANCE* étaient reconnues plus rapidement dans la condition congruent que dans les conditions non congruent et contrôle, alors que les cibles consonne-voyelle-consonne comme *BAL.CON* étaient reconnues plus rapidement dans les conditions congruent et non congruent que dans la condition contrôle. Quand un SOA de 43 ms était utilisé dans la tâche de décision lexicale, aucun effet significatif de l'indiçage n' a été obtenu. Les résultats sont interprétés à l'intérieur d'un modèle d'activation interactive incorporant les unités de la syllabe.

Mots-clés : congruence de la syllabe, décision lexicale, dénomination, indiçage masqué, syllabes CV contre CVC

References

Alvarez, C. J., Carreiras, M., & de Vega, M. (2000). Syllable-frequency effect in visual word recognition: Evidence of sequential-type processing. *Psicológica, 21,* 341–374.

Alvarez, C. J., Carreiras, M., & Perea, M. (2004). Are syllables phonological units in visual word recognition? *Language and Cognitive Processes, 19,* 427–452.

Alvarez, C. J., Carreiras, M., & Taft, M. (2001). Syllables and morphemes: Contrasting frequency effects in Spanish. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27,* 545–555.

Brand, M., Rey, A., & Peereman, R. (2003). Where is the syllable priming effect in visual word recognition? *Journal of Memory and Language, 48,* 435–443.

Carreiras, M., Alvarez, C. J., & de Vega, M. (1993). Syllable frequency and visual word recognition in Spanish. *Journal of Memory and Language, 32,* 766–780.

Carreiras, M., Ferrand, L., Grainger, J., & Perea, M. (2005). Sequential effects of phonological priming in visual word recognition. *Psychological Science, 16,* 585–589.

Carreiras, M., & Perea, M. (2002). Masked priming effects with syllabic neighbors in a lexical decision task. *Journal of Experimental Psychology: Human Perception and Performance, 28,* 1228–1242.

Colé, P., Magnan, A., & Grainger, J. (1999). Syllable-sized units in visual word recognition: Evidence from skilled and beginning readers of French. *Applied Psycholinguistics, 20,* 507–532.

Content, A., Mousty, P., & Radeau, M. (1990). BRULEX: Une base de données lexicale informatisée pour le français écrit et parlé. *L'Année Psychologique, 90,* 551–566.

Doignon, N., & Zagar, D. (2005). Illusory conjunctions in French: The nature of sublexical units in visual word recognition. *Language and Cognitive Processes, 20,* 443–464.

Dominguez, A., de Vega, M., & Cuetos, F. (1997). Lexical inhibition from syllabic units in Spanish visual word recognition. *Language and Cognitive Processes, 12,* 401–422.

Evett, L. J., & Humphreys, G. W. (1981). The use of abstract graphemic information in lexical access. *The Quarterly Journal of Experimental Psychology, 33A,* 325–350.

Ferrand, L., & Grainger, J. (1992). Phonology and orthography in visual word recognition: Evidence from masked non-word priming. *The Quarterly Journal of Experimental Psychology, 45,* 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. *The Quarterly Journal of Experimental Psychology, 47,* 365–382.

Ferrand, L., Grainger, J., & Segui, J. (1994). A study of masked form priming in picture and word naming. *Memory & Cognition, 22,* 431–441.

Ferrand, L., Segui, J., & Grainger, J. (1996). Masked priming of word and picture naming: The role of syllabic units. *Journal of Memory and Language, 35,* 708–723.

Ferrand, L., Segui, J., & Humphreys, G. W. (1997). The syllable's role in word naming. *Memory & Cognition, 25,* 458–470.

Forster, K. I. (1998). The pros and the cons of masked priming. *Journal of Psycholinguistic Research, 27,* 203–233.

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 680–698.

Forster, K. I., & Davis, C. (1991). The density constraint on form-priming in the naming task: Interference effects from a masked prime. *Journal of Memory and Language, 30,* 1–25.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35,* 116–1124.

Frost, R. (1998). Toward a strong phonological theory of visual word recognition: True issues and false trails. *Psychological Bulletin, 123,* 71–99.

Frost, R., Ahissar, M., Gotesman, R., & Tayeb, S. (2003). Are phonological effects fragile? The effects of luminance and exposure duration on form priming and phonological priming. *Journal of Memory and Language, 48,* 346–378.

Grainger, J., Diependaele, K., Spinelli, E., Ferrand, L., & Farioli, F. (2003). Masked repetition and phonological priming within and across modalities. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29,* 1256–1269.

Grainger, J., & Ferrand, L. (1994). Phonology and orthography in visual word recognition: Effects of masked homophone primes. *Journal of Memory and Language, 33,* 218–233.

Grainger, J., & Ferrand, L. (1996). Masked orthographic and phonological priming in visual word recognition and naming: Cross-task comparisons. *Journal of Memory and Language, 35,* 623–647.

Lukaleta, G., & Turvey, M. T. (1994). Visual lexical access is initially phonological: 2. Evidence from phonological priming by homophone, and pseudohomophones. *Journal of Experimental Psychology: General, 123,* 331–353.

Lukatela, G., Frost, S. J., & Turvey, M. T. (1998). Phonological priming by masked nonwords primes in the lexical decision task. *Journal of Memory and Language, 39,* 666–683.

Marin, J., & Carreiras, M. (2002). *Syllable processing upon illusory conjunctions paradigm.* Paper presented at the 8th Annual Conference on Architectures and Mechanisms for Language Processing. September, 19–21. Tenerife, Spain.

Mathey, S., & Zagar, D. (2002). Lexical similarity in visual word recognition: The effect of syllabic neighbourhood in French. *Current Psychology Letter: Behaviour, Brain, & Cognition, 8,* 107–121.

Mathey, S., Zagar, D., Doignon, N., & Seigneuric, A. (2006). The nature of syllabic neighbourhood in French. *Acta Psychologica, 123,* 372–393.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Pt. 1. An account of basic findings. *Psychological Review, 88,* 375–407.

Mehler, J., Dommergues, J., Frauenfelder, U., & Segui, J. (1981). The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior, 20,* 298–305.

Perea, M., & Carreiras, M. (1998). Effects of syllable frequency and syllable neighbourhood frequency in visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 24,* 134–144.

Pollatsek, A., Perea, M., & Carreiras, M. (2005). Does *conal* prime CANAL more than *cinal*? Masked phonological priming effects in Spanish with the lexical decision task. *Memory & Cognition, 33,* 557–565.

Rastle, K., & Brysbaert, M. (2006). Masked phonological priming effects in English: Are they real? Do they matter? *Cognitive Psychology, 53,* 97–145.

Rouibah, A., & Taft, M. (2001). The role of syllabic structure in French word recognition. *Memory & Cognition, 29,* 373–381.

Schiller, N. O. (1998). The effect of visually masked syllable primes on the naming latencies of words and pictures. *Journal of Memory and Language, 39,* 484–507.

Schiller, N. O. (1999). Masked syllable priming of English nouns. *Brain and Language, 68,* 300–305.

Schiller, N. O. (2000). Single word production in English: The role of subsyllabic units during phonological encoding. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 512–528.

Schiller, N. O., Costa, A., & Colomé, A. (2002). Phonological encoding of single words: In search of the lost syllable. In C. Gussenhoven, & N. Warner (Eds.), *Laboratory Phonology* 7 (pp. 35–59). Berlon: Mouton de Gruyter.

Shen, D., & Forster, K. I. (1999). Masked phonological priming in reading Chinese words depends on the task. *Language and Cognitive Processes, 14,* 429–459.

Tabossi, P., Collina, S., Mazzetti, M., & Zoppello, M. (2000). Syllables in the processing of spoken Italian. *Journal of Experimental Psychology: Human Perception and Performance, 26,* 758–775.

Treiman, R., & Danis, C. (1988). Syllabification of intervocalic consonants. *Journal of Memory and Language, 27,* 87–104.

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