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Where is the syllable priming effect in visual word recognition?☆

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Abstract

Recent studies using the masked priming paradigm have reported facilitating effects of syllable primes in French and English word naming (Ferrand, Segui, & Grainger, 1996; Ferrand, Segui, & Humphreys, 1997). However, other studies have not been able to replicate these effects in Dutch and English (Schiller, 1998, 1999, 2000). In Experiment 1, using the same stimuli and procedure as Ferrand et al. (1996), we did not replicate the syllable priming effect in French. In Experiments 2a and 2b, when prime duration was increased (from 30 to 45 and 60 ms), we did not obtain a syllable priming effect. In Experiment 3, with 60 participants and exactly the same procedure as Ferrand et al. (1996), we again failed to replicate the syllable priming effect. We conclude that the syllable priming effect is not a reliable effect and should be considered cautiously in the elaboration of models of word reading.

Keywords: Reading units; Syllable; Masked priming

During the last decade, several computational models have been developed to explain how readers retrieve phonology and access long-term memory representations from printed letter strings (Coltheart, Curtis, Atkins, & Haller, 1993; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Harm & Seidenberg, 1999; Jacobs, Rey, Ziegler, & Grainger, 1998; Plaut, McClelland, Seidenberg, & Patterson, 1996; Rastle & Coltheart, 1999; Seidenberg & McClelland, 1989; Zorzi, Houghton, & Butterwort, 1998). Compared to previous verbal models, a distinguishing feature of these computational models is their capacity to generate detailed quantitative predictions by running computer simulations (Jacobs & Grainger, 1994). However, although these models have a number of detailed predictions, most of them are restricted to a very specific micro-world, that of monosyllabic words. This heuristic was implicitly endorsed by psycholinguists as a first step in order to simplify the empirical and computational approaches. Indeed, polysyllabic words introduce additional questions related, for example, to stress assignment, vowel reduction, and syllabic parsing. Whereas such questions have been addressed in auditory word recognition and spoken word production (Norris, McQueen, & Cutler, 1995; Levelt & Wheeldon, 1994), very few works have been specifically dedicated to the study of polysyllabic words in visual word recognition. Obviously, given that polysyllabic words represent the largest pool of words in most languages, discovering the peculiarities of their processing seems to represent an important challenge for psycholinguistic research.

A central question in modeling visual word recognition is to determine the nature of the processing units. Although controversies exist, it has been suggested that for monosyllabic words, letters as well as graphemes and rimes would constitute relevant functional units (e.g., Bowey, 1990; Kay & Bishop, 1987; Peereman & Content, 1997; Rey, Ziegler, & Jacobs, 2000; Taft, 1991; Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). Once polysyllabic words are considered, a

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natural question is whether functional units corresponding to syllables underlie their processing. The answer to this question also has logical consequences for our understanding of the processing of monosyllabic words as the syllables composing polysyllables often correspond to single monosyllabic words. The present study was undertaken to assess the hypothesis that syllable units are involved when reading French words. A particular advantage of testing the syllable hypothesis in the French language is that, relative to other languages such as English, syllable boundaries in French are less ambiguous. For example, studies on auditory word recognition indicate that syllables might be less relevant in listening to English words than in French (Cutler, Melher, Norris, & Segui, 1986) because of the rhythmic and phonological differences between the two languages. Hence, if syllable units constitute relevant processing units in visual word recognition they should be more likely to be observed in performances in the reading of French words.

Several empirical observations have been reported favoring the hypothesis that syllables correspond to processing units in visual word recognition (e.g., Carreiras, Alvarez, & De Vega, 1993; Ferrand, 2000; Perea & Carreiras, 1998; Prinzmetal, Treiman, & Rho, 1986; but see Jared & Seidenberg, 1990; Seidenberg, 1987). A stronger argument in favor of syllabic processing has been made by Ferrand et al. (1996) using the masked priming paradigm. In an experiment performed with French stimuli, they observed that words and pictures were named faster when they were preceded by a masked prime that corresponded to the first syllable of the target. For words starting with a CVC syllable (e.g., "BAL.CON"), naming latencies were shorter when the prime corresponded to the first syllable of the word (i.e., "bal%%%%") than when it was one letter shorter than the first syllable (i.e.,"ba%%%%"). Alternatively, for words starting with a CV syllable (e.g., "BA.LADE"), naming latencies were shorter when the prime corresponded to the first CV syllable of the word (i.e., "ba%%%%") than when it was one letter longer than the first syllable (i.e.,"bal%%%"). This interaction between the first syllable structure and the syllable prime seemed to provide an elegant and important demonstration favoring the view that syllable units are quickly activated during visual word recognition. Interestingly, the absence of any such syllabic priming effect in the lexical decision task also suggested that syllable unit activation is essentially related to phonological activation.

In a follow-up study, Ferrand et al. (1997) tried to replicate the syllable priming effect in English. What makes the English study particularly appealing is that English includes many words with ambisyllabic consonants, which are treated as part of the first as well as of the second syllable (Treiman & Danis, 1988). For instance, in the word BALANCE, the syllable boundary falls neither clearly before nor after the "L" because this intervocalic consonant can be legal in both word-initial and word-final positions. Hence, for such words, CVC and CV primes were expected to be equally effective. Ferrand et al. (1997) observed that words with a clear CVC first syllable structure (e.g., BALCONY) were named faster when preceded by a CVC prime (bal%%%%) than when preceded by a CV prime (ba%%%%%). However, for ambisyllabic words such as BALANCE, naming latencies were faster for both CV (ba%%%%%) and CVC (bal%%%%) primes compared to a neutral condition (%%%%%%%). These results obtained in English were thus also compatible with the syllable hypothesis.

However, three recent masked priming studies by Schiller (1998, 1999, 2000) failed to show the critical syllable priming effect in both Dutch and English. In particular, in Schiller's data, CVC primes always yielded shorter naming latencies than CV primes whatever the syllabic structure of the target word (an overlap effect). Consequently, the advantage of CV primes over CVC primes for words starting with a CV syllable was never obtained, even when using the original English stimulus material of Ferrand et al. (1997). These results led Schiller to conclude that the syllable priming effect observed by Ferrand et al. in the English language was probably due to methodological problems and/or strategic effects.

Given the controversy that exists concerning the syllable priming effect, we deemed it appropriate to reassess the syllable priming effect using French stimuli. Indeed, the absence of the syllable priming effect in Dutch and English in Schiller (1998, 1999, 2000) might be the result of differences in the rhythmicity of those languages when compared to French. As already mentioned, auditory experiments suggest that evidence for syllabic units in spoken word recognition is more easily obtained in syllable-timed language such as French than in stress-timed languages such as English or Dutch.

Experiment 1

Given the important results obtained with French stimuli by Ferrand et al. (1996, 1997) and the conflicting results in English and Dutch by Schiller (1998, 1999, 2000), Experiment 1 was designed to replicate the French study of Ferrand et al. (1996). In this experiment, we used exactly the same material and the same procedure as those used by Ferrand et al. (1996) in their first experiment. We expected to obtain, as in Ferrand et al. (1996), an interaction between the syllable structure of the target and of the syllable prime. Word targets starting with a CV syllable should be pronounced faster when preceded by a CV prime than when preceded by a CVC prime, whereas the opposite pattern should occur for targets starting with a CVC syllable.

Method

Participants

Thirty undergraduate students at the University of Bourgogne participated in Experiment 1 for course credits. All were native French speakers, with normal or corrected to normal vision.

Stimuli

The same stimuli as in Ferrand et al. (1996) were used.[1] Targets consisted of 18 pairs of disyllabic French words sharing the same three initial letters (CVC). In each pair, one word had the syllable boundary after the second letter (CV target), as in "BA.LADE," and the other word had the syllable boundary after the third letter (CVC target), as in "BAL.CON." The average frequencies were 77 occurrences per million for CV words and 96 occurrences per million for CVC words (according to Trésor de la fangue française, 1971). Primes corresponded either to the two first letters of the target plus four additional "%" symbols (CV prime) or to the three first letters of the target plus three "%" symbols (CVC prime). For example, the CV target word BA.LADE was preceded either by the CV-prime "ba%%%%" or by the CVC-prime "bal%%%." Similarly, the CVC target word BAL.CON was preceded either by the CV-prime "ba%%%%" or by the CVC-prime "bal%%%." Type of prime (CV or CVC primes) and type of target (CV or CVC targets) were orthogonally manipulated. Each participant saw all targets in each of the two priming conditions.

Procedure

The stimuli were presented in the center of a computer screen using the Psyscope software (Cohen, MacWhinney, Flatt, & Provost, 1993). Items appeared as black characters on a white background and were displayed in Courier 24 font. The target word covered approximately 2.4° of visual angle from a viewing distance of 60 cm. Each trial consisted of a sequence of four visual events presented at exactly the same screen location. First, a forward mask (&&&&&&) was presented for 500 ms. It was immediately followed by the presentation of the prime for 30 ms, a backward mask (&&&&&&) for 15 ms, and finally, by the target word which remained on the screen until the participant's response. Primes were presented in lowercase letters, while targets were presented in uppercase letters. The participants were asked to concentrate on the middle of the forward mask. They were instructed to name the target words as rapidly and as accurately as possible. The presence of primes was not mentioned. Naming times were recorded from the target onset to the triggering of the voice key by the participant's response. Naming errors and voice key problems were noted by the experimenter. Stimulus presentation was randomized for each participant, with the restricting condition that one target could not appear twice within 10 trials. The experimental list was preceded by 10 practice trials.

Results and discussion

Error responses and voice-key problems (erroneous triggerings) were excluded from the analysis (2.3% and 0.5% of the data, respectively). Following Van Selst and Jolicoeur (1994) a two-step trimming procedure was applied to the latency data. The same procedure was also used in the subsequent experiments. In a first step, latencies longer than 1500 ms or shorter than 250 ms were excluded. In a second step, latencies higher or lower than 2.5 SD from the participants' means were also removed. This trimming procedure led to the exclusion of 1.5% of the latency data[2]. Mean naming latencies and error percentages in the four experimental conditions are provided in Table 1. ANOVAs were run on naming latencies with Type of Prime and Type of Target as main factors. *F*-Values are reported by participants (F_1) and by items (F_2). In Experiment 1, as well as in the subsequent experiments, participants made very few errors, and ANOVAs were therefore not performed on the error scores.

The main effect of Type of Prime was significant, $F_1(1,29) = 12.08$, $p < .01$; $F_2(1,34) = 6.18$, $p < .05$. Naming latencies were faster when the targets were preceded by a CV prime (533 ms, SD = 81) than when they were preceded by a CVC prime (542 ms, SD = 85). The main effect of Type of Target was also significant, $F_1(1,29) = 34.56$, $p < .001$, $F_2(1,34) = 4.35$, $p < .05$. Naming latencies were shorter for CVC targets (531 ms, SD = 81) than for CV targets (545 ms, SD = 86). The interaction between these two factors was not significant (all Fs < 1).

The purpose of Experiment 1 was to replicate the controversial syllable effect described by Ferrand et al. (1996) using the same French stimulus material. Surprisingly, we failed to obtain the same pattern of results. First, both the Target Type and the Prime Type effects which were not significant in their study were significant in Experiment 1. Second and more critically, the interaction between the two factors was significant in the Ferrand et al. (1996) study, but there was no hint of such

[1] We are indebted to Ludovic Ferrand for providing us with the stimulus list.

[2] An analysis of the data using the same trimming procedure as in Ferrand et al. (1996) (i.e., excluding naming latencies longer than 1000 ms) led to the same pattern of results as that presented in this study, for Experiments 1 and 2. A difference was observed only for Experiment 3. This difference is presented directly in the corresponding description of the results.

Table 1
Mean naming response times (RT in ms) and percentage of errors (% Err) in Experiment 1 (standard deviations in parentheses)

		CV targets	CVC targets
CV primes	RT	542 (84)	524 (80)
	% Err	2.04 (3)	2.78 (3.5)
CVC primes	RT	548 (89)	537 (83)
	% Err	1.85 (3.4)	2.24 (3.5)

an interaction in Experiment 1. Our results also depart from those reported by Schiller (1998, 1999, 2000). While a small superiority of CVC primes over CV primes was reported using Dutch and English stimuli, the opposite effect was observed with French material.

The main conclusion of Experiment 1 is that the empirical evidence that syllable units are involved in word recognition is far from clear, even in French. Given that we used exactly the same material as in the Ferrand et al. (1996) study, a clear interaction between Type of Prime and Type of Target was expected. However, a possible reason for our failure to replicate the syllable priming effect might relate to prime duration. Although prime durations were very similar in the two studies (29 ms in Ferrand et al.; 30 ms in Experiment 1) it seems reasonable to assume that other physical parameters (e.g., luminance, lighting in the room) are critical in masked priming. Thus, despite similar prime durations, the two experimental situations might cause different outcomes. In particular, the participants involved in Experiment 1 might have benefited less from the prime than the participants in Ferrand et al.'s study. Although the Prime Type effect observed in Experiment 1 suggests that the prime was processed, the duration of the prime might not have been sufficient in our experimental conditions to allow the phonological syllabic structure of the prime to influence target naming. Experiment 2 was therefore designed to examine whether Ferrand et al.'s results could be replicated using longer prime durations. Prime duration was 45 ms in Experiment 2A, and 60 ms in Experiment 2B.

Experiment 2

Method

Participants

The participants were 60 students recruited from the same population as in Experiment 1. Half of them participated in Experiment 2a (45 ms priming), and the other half in Experiment 2b (60 ms priming).

Stimuli and procedure

The targets and the primes were as in Experiment 1. The same procedure as in Experiment 1 was used, except that the prime duration was increased to 45 ms in Experiment 2a and to 60 ms in Experiment 2b. Because long prime durations could permit the participants to explicitly identify the prime, the visibility of the prime was assessed at the end of the experimental sessions. In the prime-visibility test, the participants had to identify the prime stimuli and to perform a forced-choice task. Prime duration was the same as in the naming task (45 ms in Experiment 2a; 60 ms in Experiment 2b). The same procedure as in the naming task was used, except that the presentation of the target word was replaced by the presentation of four different strings of letters. One of the four letter strings corresponded to the prime stimulus, and the others were foils. Each foil had the same length as the prime stimulus (2 or 3 letters), and differed from it by only one letter. For example, if the prime was "ba%%%%," the four choices were "BU", "BA", "CA", and "PA". Because the experimental trials always included the vowel "A," different vowel fillers were included in the list of trials. Participants had to decide which string corresponded to the fast display they had just seen before. The experimenter recorded the response and the participants pressed the space bar to start the next trial. In the prime-visibility test, all participants saw the 36 prime stimuli twice plus 36 additional filler trials.

Results

Mean naming latencies and percentages of errors appear in Table 2. Erroneous responses (1.7% and 2.1% in Experiments 2a and 2b, respectively) and voice-key problems (0.6% in both Experiments 2a and 2b) were excluded from the analyses. The trimming procedure led to the removal of 2.8% of the latency data in Experiment 2a, and 2.7% in Experiment 2b. ANOVAs were conducted separately for Experiments 2a and 2b with Type of Prime and Type of Target as main factors.

Experiment 2a. The effect of Type of Prime was not significant (both Fs < 1). The effect of Type of Target was significant by participants, $F_1(1, 29) = 18.5$, $p < .001$, and marginally significant by items, $F_2(1, 34) = 3.9$, $p = .056$. CVC targets (496 ms, SD = 57) yielded shorter naming latencies than CV targets (506 ms, SD = 56). The interaction between the two factors was not reliable (both Fs < 1).

For the prime-visibility test, participant's performance was tested against chance level which was 0.25 in the present case. The mean percentage of correct

Table 2
Mean naming response times (RT in ms) and percentage of errors (% Err) in Experiments 2a and 2b (standard deviations in parentheses)

		Experiment 2a		Experiment 2b	
		CV targets	CVC targets	CV targets	CVC targets
CV primes	RT	507 (57)	498 (56)	535 (60)	531 (62)
	% Err	1.11 (2.3)	1.67 (2.6)	1.30 (3.2)	2.78 (3.8)
CVC primes	RT	505 (60)	494 (55)	541 (75)	539 (60)
	% Err	1.48 (2.9)	2.41 (2.8)	2.04 (4.2)	2.22 (3.13)

responses was .35, and it was significantly different from chance ($t(29) = 3.22$, $p < .01$). This indicates that participants were able to capture some information about the prime stimuli, at least when instructed to identify the stimuli. However, a closer look at the participants' performance indicates that few of the participants were actually responding above chance level. *T* tests carried out separately for each participant showed that only 8 of the 30 participants were above chance level. For the 22 remaining participants, the mean percentage of correct responses did not significantly differ from chance level (.27; $t(21) = 0.83$, $p > .1$). Additional analyses were therefore conducted to assess whether a different pattern of results emerged in the naming task when only the RTs of these 22 participants were taken into account. The results were, however, very similar to those previously observed on the whole set of participants, revealing only a significant effect of Target Type ($F_1(1,21) = 31.3$, $p < .001$, $F_2(1,34) = 5.2$, $p < .05$).

Experiment 2b. The main effect of Type of Prime failed to reach significance in the by-participant analysis, $F_1(1,29) = 2.69$, $p = .11$, but it was reliable by items, $F_2(1,34) = 7.2$, $p < .05$. Naming latencies were shorter when targets were preceded by CV primes (533 ms, SD = 60) than when they were preceded by CVC primes (540 ms, SD = 70). The effect of Type of Target and the interaction with Prime Type were not reliable (all Fs < 1).

The mean percentage of correct responses in the prime-visibility test was .31, and it significantly differed from chance ($t(29) = 2.34$, $p < .05$). An examination of individual performance indicated that, as for Experiment 2a, only a few of the participants responded above chance level. *T* tests indicated that only 5 of the 30 participants were above chance. The mean percentage of correct responses for the 25 remaining participants was .24, and it did not differ from chance level ($t(24) = 0.70$, $p > .1$). As for Experiment 2a, additional ANOVAs were conducted on the naming latencies collected from the participants who did not differ from chance in the prime-visibility task. The results turned out to be similar to those observed in the initial analyses and revealed an effect of Type of Prime that became marginally significant by items ($F_1(1,24) = 1.8$, $p = .15$, $F_2(1,34) = 3.9$, $p = .056$).

Discussion

As Experiment 1 did not reveal the critical interaction between Target and Prime types, Experiments 2a and 2b were run using longer prime durations. We expected that such a lengthening of prime duration would increase reliance on phonological codes and thus increase the influence of the syllabic match between the prime and the target. Indeed, previous masked priming studies (e.g., Ferrand & Grainger, 1992) suggest that increasing prime duration leads to stronger phonological effects. However, as was the case in Experiment 1, no trace of a syllable priming effect emerged. To sum up, after three experiments using three different prime durations, and 90 participants tested, we consistently failed to replicate the critical interaction described by Ferrand et al. (1996) on a set of 20 participants. Both Experiments 1 and 2a showed a reliable effect of Target type, with CV targets giving rise to longer latencies than CVC targets. Such a difference might follow from small differences in word frequency. CVC targets were more frequent than CV targets (respectively 91.5 and 31.5 occurrences per million according to Lexique; New, Pallier, Ferrand, & Matos, 2001). Indeed, the Target Type effect failed to reach significance when frequency was included as a covariate in the by item analysis ($F_2(1,33) = 2.2$, $p = .08$). Also, both Experiments 1 and 2b suggested that CV primes might be slightly more beneficial than CVC primes, a result at variance with the CVC prime advantage described by Schiller (1998, 1999, 2000) for Dutch and English.

Given the unexpected failure to replicate the syllable priming effect, more attention was paid to methodological differences between our experimental setup and that used by Ferrand et al. (1996). Two main differences were identified. First, the masking stimuli in the present study consisted in a row of six "&" characters, while hash marks ("#") were used in the seminal study. Second, the PC computer used by Ferrand et al. displayed the stimuli as white characters on a black screen, while the Macintosh computer used in the present study displayed stimuli as black characters on a white screen. In a final attempt to capture the syllable priming effect, we therefore decided to follow their procedure even more closely, using exactly the same masks as well as the same characters and background colors. In addition, we increased the number of participants tested. Prime duration was set to 29 ms, as in Ferrand et al. (1996).

Experiment 3

Method

Participants

Sixty undergraduate students recruited from the same population as in the previous experiments. None of them had participated in the previous experiments.

Stimuli and procedure

The targets and the primes were as in the previous experiments. Stimulus presentation and timing were controlled by a PC computer using the Mel software. Items appeared on the screen as white characters on a black background and were displayed in Courier 24 font. Each character covered approximately 0.38° of visual angle from a viewing distance of 60 cm, so that the target words covered about 2.28° of visual angle. The procedure was as in Experiment 1 except the prime was displayed for 29 ms and that the forward and backward masks consisted of a row of six hash marks ("######").

Results

Mean naming latencies and percentages of errors are given in Table 3. Latency data corresponding to errors or erroneous triggering of the voice-key were excluded from the analyses (0.32% and 0.2%, respectively). The same trimming procedure as in previous experiments led to the removal of 0.5% of the data.

The main effect of Type of Prime was not significant, both Fs < 1. The effect of Type of Target was significant by participants, $F_1(1,59) = 24.11$, $p < .001$, and marginally significant by items, $F_2(1,34) = 2.76$, $p = .10$. Naming latencies were shorter for CVC Targets (514 ms, SD = 82) than for CV Targets (524 ms, SD = 86). The interaction between the two factors was not significant by participants, $F_1(1,59) = 2.16$, $p = .15$, but marginally significant by items $F_2(1,34) = 3.98$, $p = .054$ (in the analysis conducted on these data after the same trimming procedure as in Ferrand et al. (1996), the effect was no longer significant by items, $F_2(1,34) = 2.3$, $p = .14$). However, as Table 3 indicates, the interaction between Prime and Target types was not in the expected direction. While CVC primes tended to facilitate CV targets more than CV primes, CV primes tended to facilitate CVC targets more than CVC primes. Note, however, that none of the planned comparisons on these differences were significant.

Discussion

Contrary to Experiments 1 and 2, in which small procedural differences were identified when compared to Ferrand et al.'s study, Experiment 3 was as close as possible to the seminal study. However, despite our effort in trying to replicate the syllable priming effect, no such effect emerged. One final possibility that we envisaged is that our participants might have been less engaged in syllabic parsing when processing the target word than the participants in the Ferrand et al. study. Indeed, in auditory experiments, it has been suggested that evidence for syllabic coding might be more easily observed on slow than on fast participants (Dupoux, 1993). Given that the mean response times in Ferrand et al.'s study were slower than in the present study, an additional ANOVA was performed using the 30 slowest participants from Experiment 3. Mean naming latencies and percentages of errors as a function of participants speed are given in Table 4.

On average, mean naming latencies for the slowest participants in Experiment 3 were similar to those observed by Ferrand et al. (577 and 578 ms, respectively). The main effect of Type of Prime was not significant, both Fs < 1. The effect of Type of Target was reliable, $F_1(1,29) = 16.33$, $p < .001$, $F_2(1,34) = 4.02$, $p < .05$. Naming latencies were shorter for CVC Targets (571 ms, SD = 78) than for CV Targets (583 ms, SD = 80). However, the critical interaction between Type of Prime and Type of Target was not significant, $F_1(1,29) = 1.48$, $p = .23$, $F_2 < 1$. It thus appears that our failure to replicate the syllable priming effect is not related to the overall speed of the participants who were engaged in the present study.

One interesting result emerged in the data for the 30 fastest participants. The analyses revealed that, as was the case in Schiller's (1998, 1999, 2000) experiments, CVC primes (458 ms, SD = 33) produced faster

Table 3
Mean naming response times (RT in ms) and percentage of errors (% Err) in Experiment 3 (standard deviations in parentheses)

		CV targets	CVC targets
CV primes	RT	516 (79)	502 (76)
	% Err	0.37 (1.73)	0.28 (1.22)
CVC primes	RT	510 (76)	508 (81)
	% Err	0.28 (1.22)	0.37 (1.39)

Table 4
Mean naming response times (RT in ms) and percentage of errors (% Err) in Experiment 3 as a function of participants' speed (standard deviations in parentheses)

		Slow participants		Fast participants	
		CV targets	CVC targets	CV targets	CVC targets
CV primes	RT	584 (81)	567 (82)	467 (29)	460 (36)
	% Err	0.37 (1.41)	0.19 (1.01)	0.37 (2.06)	0.37 (1.41)
CVC primes	RT	583 (80)	575 (75)	460 (31)	455 (31)
	% Err	0.37 (1.41)	0.37 (1.41)	0.19 (1.04)	0.37 (1.41)

responses than CV primes (463 ms, SD = 30), $F_1(1,29) = 9.9$, $p < .005$, $F_2(1,34) = 5.42$, $p < .05$. Interestingly, an examination of the mean naming latencies described in Schiller's experiments reveals that the Dutch and English participants were, on average, as fast as our fast participants. Our fast participants also showed a significant effect of Type of Target on participants, $F_1(1,29) = 5.6$, $p < .05$, an effect that was marginally significant by items, $F_2(1,34) = 3.2$, $p = .08$. Naming latencies were shorter for CVC Targets (457 ms, SD = 31) than for CV Targets (464 ms, SD = 32). Finally, the interaction effect was not significant for the fast participants (both Fs < 1).

Distributional analyses of the size of the syllabic priming effect

The strong discrepancy between the present results and those reported by Ferrand et al. is quite impressive given the procedural similarity between the two studies. Although the critical interaction was not obtained, we can examine how far the present data were from obtaining the expected syllable priming effect. To this end, one thousand groups of 20 participants were selected randomly from the 60 students having taken part in Experiment 3. For each group, the size of the interaction was computed as follows. First, the mean latency differences between CVC and CV primes were computed separately for CV and CVC targets. If there is a syllable priming effect, the differences should be positive for CV targets (i.e., latencies shorter for CV than for CVC primes) while the difference should be negative for CVC targets (i.e., latencies longer for CV than for CVC primes). Next, the difference score for CVC targets was subtracted from the difference score for CV targets. The resulting value corresponds to the *size of the interaction effect* and should be highly positive when CV primes facilitate CV targets and when CVC primes facilitate CVC targets. In the Ferrand et al.'s study, the interaction size was 65 ms (a 32-ms advantage for CV primes over CVC primes for CV targets, a −33-ms disadvantage for CV primes over CVC primes for CVC targets). In the present study, the size of the interaction effect in Experiment 1 was −7 ms ((548 − 542) − (537 − 524); see Table 1). Using this procedure, a sample of 1000 values was obtained, with each value representing the size of the interaction effect for a random group of 20 participants.

The distribution of the interaction effect is presented in Fig. 1. The size of the interaction effect is distributed around a mean of −6.2 ms, with a standard deviation of 5.9 ms, and with minimum and maximum values of −14.9 and 23.8 ms, respectively. As can clearly be seen from Fig. 1, the 63-ms interaction effect obtained by Ferrand et al., 1996 does not fit within the distribution;

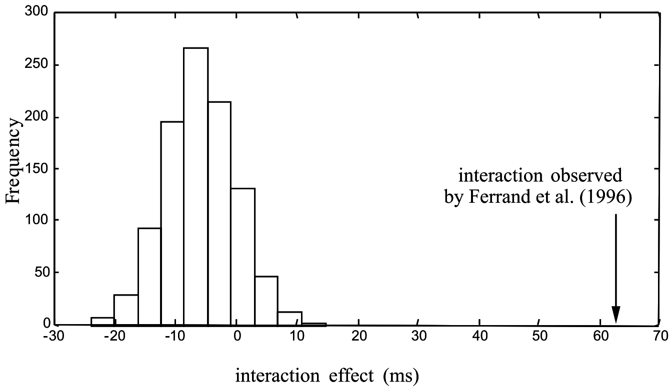

Fig. 1. Results of the simulations performed with participants from Experiment 3: distribution of the interaction effect between prime and target.

the probability of an event being in the interval [60; 65] is $p = 0$. The probability of an event being in the interval [−5; 0], as in Experiment 3 (effect size = 0 ms), is $p > .20$. The probability of an event being in the interval [−10; −5], as in Experiment 1 (effect size = −7 ms), is $p > .49$. Finally, the probability of an event being the intervals [0; 5] and [−5; 0] as in Experiments 2a and 2b, respectively (effect size: 2 and −2 ms) was $p > .11$ and $p > .20$, respectively.

The main result of the analysis is that Ferrand et al.'s (1996) interaction is located 10 standard deviations away from the mean of the distribution of our interaction effect. The distribution is even centered around an interaction value (−6.2 ms) that is opposite in sign to the one observed in their experiment. This analysis therefore clearly indicates that we do not replicate the syllable priming effect. It also demonstrates that even with a large chance value, we could not obtain a result similar to that reported by Ferrand et al. (1996).

General discussion

The present study was designed to replicate the important finding reported in Ferrand et al.'s study (1996). The motivation for conducting this set of replication studies was that Schiller (1998, 1999, 2000) consistently failed to obtained the syllable priming effect in both Dutch and English. Schiller only obtain a segmental overlap effect, i.e., faster response times for longer primes. Due to the discrepancy between these studies, we decided to assess the reliability of the syllable priming effect in French in order to determine whether this effect should be taken into account in the elaboration of models for polysyllabic word reading.

In none of the four experiments did we obtain a syllable priming effect. With exactly the same stimulus material as in Ferrand et al. (1996), and using exactly the same experimental procedure and material (at least in Experiment 3), we consistently failed to replicate the interaction effect reported in their study. Our final distributional analysis even demonstrates that the probability of obtaining this result is close to zero. We can therefore confidently conclude that the syllable priming effect was not replicable. Together with Schiller's studies, our results indicate that the syllable priming effect is not a reliable effect and that it should not be taken into account in modeling visual word recognition.

Why both Schiller and we were unable to observe a syllable priming effect while Ferrand et al. did so in English and French is still unclear. Perhaps some methodological aspects not mentioned in the Ferrand et al. reports are responsible for such a major discrepancy. A careful examination of their procedure did not reveal potentially important differences, apart, of course, from the fact that the subjects were different. However, the French students tested in the present study were not characterized by particular dialectal variations when compared to the Parisian students tested by Ferrand et al. The way syllabification is performed in spoken language also does not seem to differ between the two populations. It is also possible that the participants differed in their reading level. As we have mentioned above, naming latencies in Ferrand et al.'s study were longer than in the present experiments. However, even the slow participants in Experiment 3 did not show the expected interaction between prime and target type.

Although our failure to replicate does not rule out the syllable hypothesis in visual word recognition, it provides a strong argument for conducting replication studies. As in the present case, the implication of experimental results might be so critical for constructing models and theories that if there are any doubts about the reliability of any reported effect then the conduct of replication studies is a necessity in order to clearly determine whether an effect is or is not reliable or, alternatively, under what conditions the effect can or cannot be observed. In conclusion, we argue in the present study that the syllable priming effect is not a reliable empirical effect and that the hypothesis that syllables constitute relevant processing units in visual word recognition should be motivated by other empirical demonstrations.

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