Syllabic Priming Effects in Picture Naming in French

Lost in the Sea!

Cyril Perret, Patrick Bonin, and Alain Méot

LAPSCO/CNRS (UMR 6024), Université Blaise Pascal, Clermont-Ferrand, France

Abstract. Ferrand, Segui, and Grainger (1996) found robust syllable priming effects in picture naming latencies: Pictures primed with their initial syllable (e.g., *ba* for *baleine* [whale]) were processed faster than pictures primed with a string of letters shorter or longer than their initial syllable (e.g., *bal* for *baleine*). However, in several studies, these priming effects have not been replicated in word naming or in picture naming either in Dutch or in English (Schiller, 1998, 1999, 2000). The present study was aimed at replicating syllable priming effects in picture naming in French using a masked priming paradigm. The study employed a larger number of participants and items than were used in the Ferrand et al. (1996) study. The syllable priming effect in picture naming latencies was not replicated. Subsampling procedures were then used to examine the stability of the Ferrand et al. (1996) pattern of results in picture naming in greater detail. The syllabic priming effect in picture naming turned out to be an extremely rare event.

Keywords: syllable, wordform encoding, masked priming, picture naming

An important issue in spoken word production is to determine the types of units that are planned before articulation starts (Meyer, Roelofs, & Levelt, 2003). It is generally assumed that conceptually driven naming involves three main processing levels: conceptual, lexical, and articulatory (e.g., Caramazza, 1997; Humphreys, Riddoch, & Quinlan, 1988; Levelt, 1989; Levelt, Roelofs, & Meyer, 1999). The lexical level is assumed to involve the activation of a lexical entry that specifies the gender and the grammatical category (lemmas) and the retrieval of phonological codes (lexemes), which are the output of the articulatory level (Levelt, 1989; Levelt et al., 1999, but see Caramazza, 1997). A critical issue is whether syllables are *functional units* at the lexeme level. As discussed below, evidence from priming experiments supports the hypothesis that syllables are retrieved and used to build articulatory programs in speech production (Ferrand et al., 1996; Ferrand, Segui, & Humphreys, 1997; Ferrand & Segui, 1998), but such evidence is controversial.

Take the picture of a balcony to be named aloud as quickly as possible. If this picture is preceded by the brief masked visual presentation of its first syllable (e.g., *bal*), will it be named faster than when the same picture is preceded by a string of letters shorter (e.g., *ba*) or longer than its first syllable? Intuition certainly has led many authors to claim that the picture is indeed named faster in the former case. Ferrand et al. (1996) have shown large and reliable syllable priming effects on picture naming latencies in French. These effects have long been considered a well-established scientific empirical fact having major implications for the building of word production models. As explained in the Discussion section below, these effects are difficult to reconcile with Levelt et al.'s (1999) theory of word production.

Given that several studies have failed to replicate syllable priming effects in various lexical processing tasks (Brand, Rey, & Peereman, 2003; Schiller, 1998, 1999, 2000), the aim of the present study was to establish whether syllable priming effects in *picture naming in French*, as reported by Ferrand et al. (1996), should continue to be accorded scientific credence. Beyond the specific case of syllabic priming effects, our study also makes a methodological contribution with regard to discrepant results reported throughout psycholinguistic literature.

In a series of four experiments, Ferrand et al. (1996) provided one of the strongest pieces of evidence to date in favor of the hypothesis that the syllable plays a functional role in certain lexical processing tasks. In particular, they reported reliable syllabic priming effects in word and nonword reading and picture naming. Syllable priming effects were not observed in visual lexical decision. The paradigm used by Ferrand et al. (1996) is the masked form priming paradigm, a well-known and frequently used paradigm in psycholinguistics to study the nature of the representations involved in language processing as well as the time course of their activation (see Kinoshita & Lupker, 2003). In the variant used by Ferrand et al. (1996)—that is, the four field masked priming paradigm—a forward pattern mask is first presented and is followed by the brief presentation of a prime. Then, a backward pattern mask is presented and is followed by a target that requires a speeded response from the participant.

In the Ferrand et al. (1996) study, the forward pattern mask (a row of six or eight hashmarks "######" completely covering the prime) was presented for 500 ms, the visual prime corresponding to a string of letters was presented for 29 ms, and then the pattern mask ("######")

DOI 10.1027/1618-3169.53.2.95

was presented for 14 ms. The target item was then presented (a word, a nonword, or a picture) until the participant gave his or her response. Primes and targets were presented at the same location on the computer screen. The participants were not informed that the target would be preceded by a prime. To select the experimental stimuli, Ferrand et al. (1996) exploited the fact that in French, some words having the same initial phonemes may have different initial syllables. For example, the word *carotte* (carrot) in French has the same first three initial phonemes/letters as the word *cartable* (satchel). However, *car* which is the initial syllable of *car.table*, constitutes a string of letters that is longer than the first syllable for *ca.rotte*, whereas *ca* is the initial syllable for *ca.rotte* but is shorter as a letter string than the first syllable of the word *car.table* (we will adopt the notation of Ferrand et al. (1996) to indicate syllable boundaries—that is, a full stop between two adjacent letters that belong to two different syllables).

The *ca.rotte* type of words is referred to as CV words and the *car.table* type of words as CVC words. The primes corresponded either to initial syllable CV primes for CV words and CVC primes for CVC words, or to a unit different from the syllable—that is, CVC primes for CV words and CV primes for CVC words. Moreover, given that French has a regular syllable structure and that in general words have relatively clear syllable boundaries (Schiller, 1998, but see also Content, Kearns, & Frauenfelder, 2001), syllable priming effects were predicted to be especially robust compared to other languages in which the syllable boundaries are not so clear for certain words, as in English. According to the hypothesis that the phonological representations corresponding to words are syllabified or, stated differently, that the syllable is a unit that is planned at the phonological level, we should observe that visual primes corresponding to a syllable yield shorter response times than visual primes corresponding to a string of letters shorter or longer than the syllable.

Clearly, the prediction from Ferrand et al.'s (1996) study is a crossover interaction between the type of words and type of primes factors. The authors obtained a pattern of results consistent with the syllable hypothesis in word/nonword reading and in picture naming. In visual lexical decision, syllable priming effects were not found. Because visual lexical decision does not require the production of an overt response, the findings were in accordance with the idea that syllabic priming effects are localized in an output stage common to both reading and picture naming and which is involved in the building of an articulatory program. Importantly, the Ferrand et al. (1996) findings have also been obtained in English, thus favoring the hypothesis that the syllable is a not a language-dependent unit. In effect, in the Ferrand, et al. (1997) study, strong syllable priming effects were found in English with words having clear syllable boundaries, and no reliable syllable priming effects were found with ambisyllabic words.

The findings from Ferrand et al.'s (1996, 1997) studies have strong theoretical implications: The syllable is a unit that is retrieved at the phonological level and used to plan an articulatory program in both word and nonword reading and conceptually driven speech production as operationalized in picture naming, the task on which we concentrate. Since the publication of the Ferrand et al. study in 1996, there have been several attempts to replicate Ferrand et al.'s (1996, 1997) findings, but only three of them have been in French (and only two of them have been published). One study attempted to replicate the syllabic priming effect in picture naming (Schiller, Costa, & Colomé, 2002) and another one in word reading (Brand et al., 2003; see also Evinck, 1997). However, the two studies did not succeed in replicating the specific syllabic priming effects identified by Ferrand et al. (1996). Given this fact, readers may be concerned about the aim of our study. However, below we make clear why we found it necessary to conduct a new study in French—and, more particularly, a picture naming study and, more generally, why we still consider the syllable priming issue important. We first briefly discuss the studies that failed to replicate the Ferrand et al. (1996, 1997) findings.

As stated above, since the publication of syllabic priming effects in French and in English in word and nonword reading and picture naming (Ferrand et al., 1996, 1997), several studies have attempted to replicate these effects. Schiller (1998, 1999, 2000) did not obtain syllabic priming effects in either Dutch or English. However, Schiller consistently found a segmental overlap effect in response times, with the result that longer primes yielded shorter latencies than shorter primes—for example, the *bal* type of primes yielded shorter latencies than the *ba* prime for both *ba.lloon* and *bal.cony* types of words. More recently, Brand et al. (2003) investigated the syllabic priming effect in French word reading latencies. In three word reading studies, they failed to replicate the syllable priming effect observed by Ferrand et al. (1996) even when using the very same procedure and items as used by Ferrand and colleagues. Brand et al. (2003) concluded that the syllabic priming effect is not a reliable one and should be considered cautiously when building models of phonological encoding. Thus, the situation seems clear as far as the Ferrand et al. syllable effects in word reading are concerned: They are not robust effects and should not be considered further for the building of models of word processing. Why, then, is it still important to investigate this issue? Several reasons are important to us and justify the current study.

First of all, unlike Brand et al. (2003), we concentrate on the picture naming task. In effect, in word reading, we cannot rule out the possibility that the findings concerning syllable priming effects are more difficult to interpret because of an orthographic influence (Levelt et al., 1999) such as partial visual similarity between prime and target (Schiller, 1998) and/or because words can be partly read via a nonlexical route (e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). Picture naming cannot be performed on the basis of a nonlexical route. Therefore, if syllable priming effects are real, they should be robust in this task. Also, as reported in Schiller et al. (2002), a picture naming study performed by Bonin, Peereman, and Schiller in French revealed a trend toward the pattern of results found by Ferrand et al. (1996). With a prime duration of 51 ms, instructions emphasizing speed, and a very intensive training session to enable the participants to learn the names of the pictures, there was an interaction between the type of words and the type of primes—that is, a pattern that looked like a syllabic priming effect.

However, there are certain important differences which, in our view, justify the goal of the present study. First of all, the syllable priming effect was obtained with a longer prime duration than the one used by Ferrand et al. (1996). It is not impossible that certain participants became aware of the relationship between the primes and the picture names and used it strategically. Second, the interaction was reliable by items, but it was marginally significant by participants and far smaller in size than the effect obtained by Ferrand et al. (1996). Indeed, Ferrand et al. obtained reliable effects on both participants and items and the effects were of 40 ms, whereas in Bonin, Peereman, and Schiller's study as reported by Schiller et al. (2002), the corresponding values were 9 ms for CV targets and 16 ms for CVC targets. Moreover, the planned comparisons corresponding to the interaction were not reported in the Schiller et al. study. Therefore, it cannot be conclusively stated that a genuine replication was obtained. Third, although Brand et al.'s (2003) distributional analyses are straightforward in terms of the conclusion that they allow us to reach—that is, the probability of observing the Ferrand et al. (1996) interaction in word reading latencies is zero—there are some limitations inherent to their analyses that require further investigation. In effect, Brand et al. (2003) used the mean word reading latency differences to evaluate the size of the interaction effect reported in the Ferrand et al. (1996) study. However, these authors did not use a standardized effect size that takes into account both the experimental and participant variability that may have been different in their study and in the Ferrand et al. study. Given this fact, their conclusion that the probability of obtaining the interaction effect size reported by Ferrand et al. (1996) is zero may be unwarranted. We will return to this issue in more detail in the Results section.

We hope we have now convinced readers that it is important to reexamine in greater depth the syllable priming effect in picture naming latencies in French, especially in the light of a trend in favor of the Ferrand et al. findings as reported by Schiller et al. (2002). Because these effects have major implications for the elaboration of word production models, one essential step is to assess whether syllabic priming effects are real. Consequently, the primary aim of our study is to increase the probability of replicating the syllable priming effect by using a large sample of participants and items, a procedure as close as possible to Ferrand et al.'s (1996), and by conducting detailed statistical analyses.

Experiment

Method

Participants

Sixty first-year psychology students (mean age: 19, range 17–21 years old) were recruited for this experiment. They were given course credits for their participation. All were native speakers of French, had normal or corrected to normal vision, and no known hearing deficit.

Stimuli

Forty-six bi- and trisyllabic French words corresponding to pictorial objects (see Appendix) were used. The items corresponded to pairs beginning with the same three phonemes but differing in syllable structure (CV or CVC). The items were matched for number of letters (mean = 7 letters), number of syllables (mean = 2.2 syllables), and log word frequency (mean = 2.60). The objects were presented as simple line drawings.

Procedure

The experiment started with a learning session. The participants were presented with each picture and its name. They were required to learn perfectly the name to use to name the picture. The presentation was controlled by PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) run on an Apple PowerMac computer. A picture was presented centered on the screen with the name presented both visually and auditorily. The next trial was initiated by the participant by pressing the space bar. The experimenter then checked whether the participant was able to provide without hesitation the name for each presented picture on a sheet of paper. For each failed picture, the participant had to relearn the name. The experiment proper did not start until the participant was able to name each picture correctly.

In the naming experiment, the presentation of the trials was also controlled by PsyScope. A microphone was used with the Button-Box to record latencies. Pictures were used as targets. A trial had the following structure: First a forward pattern mask was presented (a row of 11 ampersands ["&"]) for 500 ms, followed by the prime presented for 34 ms (i.e., two screen refresh cycles). Next, a backward pattern mask (a row of 11 ampersands) was presented for 17 ms (one screen refresh cycle). Finally, the target picture was presented centered on the screen and remained there until the participant responded. After the experiment, the participants had to indicate whether they were aware of the visual presentation of stimuli before each picture. We did not use the "#" hashmarks used by Ferrand et al. (1996) because a pilot experiment revealed that "&" signs were more effective masks than "#" hashmarks.

Results

General ANOVAs

Several analyses of variance (ANOVAs) were performed on the picture naming latencies: with the whole set of observations (i.e., there was no exclusion of naming latencies except those corresponding to erroneous responses), with the trimming procedure used by Ferrand et al. (1996) (i.e., latencies longer than 1,500 ms were excluded) with the data longer than two standard deviations from the participant and item means excluded (computed across the experimental conditions), with the data larger than two standard deviations from the participants and items means computed from the crossing of the experimental factors, and, finally, with the computation of harmonic means. ANOVAs were performed on both participants and items used as a random factor.

The error rate was 3.7%. There were no reliable effects on errors in either the participant or item analyses (all Fs < 1).

Table 1 summarizes the latency results of the ANOVAs performed on the participant and on the item means with the use of the different procedures chosen to eliminate the latency data. The first aspect worth noticing is that the interaction between type of words (CV words vs. CVC words) and type of primes (CV primes vs. CVC primes) was significant in none of the ANOVAs. Thus, the interaction effect found by Ferrand et al. (1996), which corresponded to a syllable priming effect, was not reliable in any of the analyses. The main effect of type of words was also not reliable. However, a reliable main effect of type of primes was found on both participants and items, with the exception of the analyses performed on the basis of the Ferrand et al. (1996) trimming procedure, in which the effect was only marginally significant on participants. As shown in Table 2, the main effect of type of primes took the form of a segmental overlap effect as reported by Schiller (2000), with the result that CVC primes yielded shorter latencies than CV primes.

As shown in Table 3, the effect sizes corresponding to the effect of type of primes (f, see Cohen, 1992) vary between .24 and .47, with a mean—computed over the different kinds of elimination criteria—of .36 on participants ($F1$) and .40 on items ($F2$). According to Cohen's (1992) terminology, these values correspond to large effect sizes. Given these high effect sizes, an issue is why a segmental overlap effect was not found in each study that used this paradigm. A reason could be the sample sizes used in these experiments. Indeed, a large effect size is not a sufficient condition to ensure that an experiment has a sufficient power; it is also necessary to use adequate sample sizes. Power analyses were performed with these effect size values taken as the true effect sizes and samples of 10 pairs of words and 18 participants. These sample characteristics correspond to those of Ferrand et al.'s (1996) picture naming experiment. The power of these analyses—for an alpha level of .05—varies between .15 and .47, with means of .29 on participants and .36 on items. The use of these samples sizes clearly leads to low powers, although the effect size is large. Moreover, if we chose these effect sizes using samples of 18 participants and 10 pairs of words, the effect of type of primes is never significant. The power becomes larger with 16 pairs of words (the sample size used by Schiller, 2000) and a significant effect of type of primes is observed at an alpha level of .05 in the by-item analysis and for most of the different types of data elimination.

Table 1. Results of the analyses for different data eliminations

	Participants (F1)						Items (F2)					
	Type of Words		Type of Primes		Words × Primes		Type of Words		Type of Primes		Words × Primes	
Source	$F1$	p	$F1$	p	$F1$	p	$F2$	p	$F2$	p	$F2$	p
All	.49	.48	5.40	.024	1.13	.29	.03	.87	4.21	.046	1.56	.22
Ferrand	.84	.36	3.25	.077	.25	.62	.03	.86	4.27	.045	.64	.43
2 sd	1.76	.19	12.97	.001	.02	.89	.06	.81	9.90	.003	.33	.57
Within 2 sd	.01	.94	6.83	.011	1.19	.28	.001	.98	8.22	.006	2.22	.14
HM	.30	.59	11.37	.001	1.83	.18	.01	.92	9.69	.003	3.19	.08

Note. All = no elimination of outliers, *Ferrand* = no latency above 1,500 ms, *2 sd* = elimination of latencies that were two standard deviations above the participant and item means, *Within 2 sd* = elimination of latencies that were two standard deviations above the participant and item means within each experimental condition, *HM* = use of harmonic means.

Table 2. Mean latencies using different procedures to eliminate the data for CV items, CVC items, all items as a function of type of primes (CV vs. CVC primes)

	CV Items			CVC Items			All Items		
	CV Primes	CVC Primes	Diff.	CV Primes	CVC Primes	Diff.	CV Primes	CVC Primes	Diff.
All	797	793	+4	808	792	+16	803	792	+11
Ferrand	774	769	+5	772	764	+8	773	767	+6
2 sd	760	750	+10	755	745	+10	757	747	+10
Within 2 sd	754	748	+6	758	745	+13	756	747	+9
HM	758	752	+6	760	746	+14	759	749	+10

Note. Diff. = difference between CVC primes and CV primes, *All* = no elimination of outliers, *Ferrand* = no latency above 1,500 ms, *2 sd* = elimination of latencies that were two standard deviations above the participant and item means, *Within 2 sd* = elimination of latencies that were two standard deviations above the participant and item means within each experimental condition, *HM* = use of harmonic means.

Table 3. Power (*pw/f*) and *p* value (*p/f*) of the prime effect test that would be obtained with the actual effect size (*f*) considered as the true effect size or the observed effect size in an experiment consisting of 18 participants and 10 (*F*) or 16 (*S*) pairs of items

	By Participants			By Items				
	f	*pw/f*	*p/f*	*f*	*F: pw/f*	*F: p/f*	*S: pw/f*	*S: p/f*
All	.30	.22	.23	.31	.24	.20	.38	.10
Ferrand	.23	.15	.36	.31	.24	.20	.38	.10
2 sd	.47	.45	.07	.47	.47	.06	.70	.02
Within 2 sd	.34	.26	.18	.43	.41	.08	.63	.03
HM	.44	.40	.09	.47	.47	.06	.70	.02
Mean	.36	.29	.16	.40	.36	.11	.56	.04

Note. All = no elimination of outliers, *Ferrand* = no latency above 1,500 ms, *2 sd* = elimination of latencies that were two standard deviations above the participant and item means, *Within 2 sd* = elimination of latencies that were two standard deviations above the participant and item means within each experimental condition, *HM* = use of harmonic means.

Subsampling Procedures

The analyses reported above strongly suggest that part of the discrepancy in the results obtained in different studies may be due to small sample sizes. However, these analyses cannot explain why the patterns of means were different in certain studies. In particular, they cannot explain why a syllabic priming effect was observed by Ferrand and colleagues and a segmental overlap effect was found in other studies.

To address this issue, Brand et al. (2003) used a subsampling procedure to evaluate the probability distribution of the interaction effect size reported by Ferrand et al. (1996) in word reading latencies. One drawback of this procedure was that the measure of the size of the interaction effect used by Brand et al. was not standardized. In effect, the amount of variability explained by the type of words × type of primes interaction is dependent on the random error and on the interaction between the subject factor and the two independent variables for *F*1 or the prime factor for *F*2. Using an unstandardized effect size is equivalent to omit that, for unknown reasons, the variances explained by these two aspects can differ largely from one experiment to another, thus resulting in very different unstandardized effect size measures. In the following subsampling procedures, we used the *p* values as a substitute for an effect size index. In effect, because the subsample sizes used here were the same as the ones used by Ferrand et al. (1996), these *p* values were directly comparable to those obtained by Ferrand et al. (1996).

One hundred thousand subsamples of 18 participants and 10 pairs of items were randomly selected from the observed data. We chose these numbers of participants and items because they were used in Ferrand et al.'s (1996) picture naming experiment. It should be remembered that Ferrand et al. found a reliable interaction effect on both participants ($F1 = 9.96$) and items ($F2 = 23.02$) and no reliable main effect of the type of words (both $F\text{s} < 1$) or of the type of primes (both $F\text{s} < 1$) factors.[1] The Ferrand et al. (1996) trimming procedure was used—that is, latencies longer than 1,500 ms were excluded from further analyses.[2] Various analyses were then performed on the basis of this random selection process, and these are described below.

The descriptive patterns are considered first. A syllable priming effect was defined as follows: a positive mean difference between CVC and CV primes for CV words and a negative mean difference for CVC words. A segmental overlap effect was defined as a positive mean difference between CV and CVC primes for both types of words (CV and CVC).

As can be seen from Table 4, the patterns of results were highly different. Furthermore, very few effects reached significance. At an alpha level of .05, only 1,293 (1.29%) subsamples showed a significant interaction corresponding to a syllable priming effect, and 4,443 (4.44%) subsamples a reliable main effect of type of primes showing a segmental overlap effect. Nevertheless, it should be stressed that overall the patterns were consistent with a segmental overlap effect.

In the following analyses, the definitions of a syllable priming effect and a segmental overlap effect were more highly constrained. We considered that a syllabic priming effect occurred when the following criteria were fulfilled: (1) The mean difference between CVC and CV primes was positive for CV words and negative for CVC words. (2) The interaction effect was significant at least at an alpha level of .05. (3) The main effect of type of primes was not reliable (.10). (4) The planned comparisons between the means of CVC and CV primes at each level of the type of

1 For the by-items analysis, a close examination of the reported *F* and degrees of freedom (*df*) indicates that the *df* were not correctly reported given the design used in this experiment. In effect, the by-items analysis used a mixed subjects design with two factors: a between-subjects factor type of targets (CV vs. CVC) with 10 words by level and a within-subjects factor type of primes (CV vs. CVC). The *df* for the test of the interaction between the two factors is $(2 - 1) \times (2 - 1) = 1$ for the interaction mean square and $2 \times (2 - 1) \times (10 - 1) = 18$ for the MSE (which is the within-factor X subject factor interaction pooled over the between-factor level). Ferrand et al. (1996) reported an *F* with 1 and 9 *df*. One explanation could be that they used a complete within-subjects design to analyze their data, because, in this case, the second *df* would be $(2 - 1) \times (2 - 1) \times (10 - 1) = 9$.

2 Ferrand et al. (1996) did not explain the reason why they chose the specific value of 1,500 ms to trim the latency data.

Table 4. P values obtained from 100,000 subsamples of 18 participants and 10 pairs of items for tests of the interaction effects and main effect of type of primes for observed means showing a syllabic effect or a segmental overlap effect

Syllabic Effect: Interaction Effect Tests

*p*_F1*p*_F2	> .10	].05; .10]	].01; .05]	].001; .01]	< .001	Total
> .1	15,665	1,272	581	29	2	17,549
].05; .10]	1,325	723	612	79	5	2,744
].01; .05]	726	739	865	192	21	2,543
].001; .01]	60	119	313	147	7	646
< .001	4	6	27	36	1	74
Total	17,780	2,859	2,398	483	36	23,556

Segmental Overlap Effect: Main Effect Tests

*p*_F1*p*_F2	> .10	].05; .1]	].01; .05]	].001; .01]	< .001	Total
> .1	25,266	3,149	1,787	191	6	30,399
].05; .10]	1,888	1,534	1,547	285	22	5,276
].01; .05]	960	1,229	2,236	778	63	5,266
].001; .01]	68	193	697	413	71	1,442
< .001	4	11	69	86	20	190
Total	28,186	6,116	6,336	1,753	182	42,573

words factor were significant at least at an alpha level of .10. A segmental overlap effect occurred when (1) the mean difference between CV and CVC primes was positive and significant at least at an alpha level of .10 for both CV and CVC words; (2) there was no interaction effect at an alpha level of .10; and (3) the main effect of type of primes was significant at an alpha level of .05. With these criteria, only 73 (0.07%) and 475 (0.47%) of subsamples exhibited a syllable priming effect and a segmental overlap effect, respectively.

To analyze the syllable priming and segmental overlap pattern in greater detail, we computed the frequency with which each participant and each pair of items was included in the subsamples that give rise to these effects. Then, the 10 pairs of items and the 18 participants that were most frequently involved in the emergence of one of the two patterns were retained to create two new types of subsamples: a syllable type subsample and a segmental type subsample. (We chose these numbers of participants and pairs of items because they correspond to the sample sizes used by Ferrand et al., 1996. However, the contribution of the participants [of the items] to the emergence of the two patterns is thought to be continuous.)

An example illustrates the type of analyses performed. For the syllable priming pattern, a subsample of 10 pairs of items and a subsample of 18 participants were defined. These two subsamples contained the 10 pairs of items and the 18 participants that were most frequently found in the syllable priming pattern. Thus, these corresponded to the 10 (18) pairs of items (participants) most representative of the syllable priming pattern. The same procedure was used to establish the two subsamples for the segmental overlap pattern.

To perform the analyses, we considered three sets of items: the overall items (the 23 pairs), the syllable subsample of items, and the segmental subsample of items as defined above. For each of the three sets of items (overall, syllable, segmental), three kinds of analyses were performed: (1) one using the latencies of all the participants; (2) another using the RTs of the 18 subjects who were most representative of the syllable priming pattern, and (3) a final one using the RTs of the 18 subjects who were most representative of the segmental overlap pattern. In each, we computed ANOVAs on both participants and items (see Table 5).

Most striking is the high level of sensitivity of the results to the types of subsamples. The patterns vary in a specific way depending on the items and/or the participants included in the sample. Also, it appears that, although not many subsamples exhibited a syllable priming effect, they could nevertheless be found. Finally, one rather bizarre result is that the level of sensitivity appears to be more dependent on the participants than on the items. Indeed, while an items-type pattern can be reversed by the use of the complementary participants-type pattern, the reverse is not true. This observation cannot be due to the elimination procedure used in these analyses because exactly the same pattern of results was found when the data were analyzed with the harmonic means. We cannot further analyze the reasons underlying this pattern of findings. However, it is not attributable to differences in the overall speed of responding or in the number of missing values or errors. It also cannot be due to differences between the participants' conscious perception of the primes because only one participant mentioned that he perceived the primes in the sample in question (overall, 7 participants out of 60 mentioned that they had consciously perceived the primes).

Discussion

The aim of this study was to determine whether syllable priming effects in picture naming latencies in French can be replicated. We considered it worthwhile to examine this issue again since these effects were obtained by Ferrand et

Table 5. Results of the analyses using subsamples with a pattern corresponding to a syllable priming (*Syll*) or to a segmental overlap (*Segm*) effect

		Means (by Participant)							
		CV Word		CVC Word					
Items	Participants	CV Prime	CVC Prime	CV Prime	CVC Prime	*F*1ab	*F*2ab	*F*1b	*F*2b
All	All	774	769	772	764†	.25	.64	3.25†	4.27*
	18 Syll	754	792***	785	767†	27.75***	17.03***	2.60	1.64
	18 Segm	808	762***	792	760***	1.88	.92	198.09***	38.93***
10 Syll	All	753	766	760	734**	16.51***	13.10**	1.05	2.14
	18 Syll	729	790***	768	738*	34.70***	21.90	2.81	2.11
	18 Segm	785	763†	780	728***	4.80*	3.57†	13.72**	25.01***
10 Segm	All	790	771*	781	758*	.1	.23	8.76**	10.10**
	18 Syll	761	800**	797	765	20.93***	9.06***	.06	.09
	18 Segm	834	761***	811	745***	.09	.2	78.77***	47.04***

Note. *F1ab*, *F2ab* = *F* values in the tests of the type of words × type of primes interaction effect; *F1b*, *F2b* = *F* values in the tests of the main effect of type of primes. For each type of word, the results of the planned comparison between CV and CVC primes is shown after the mean for the CVC prime, *All* = all items or participants; *18 Syll* (*Segm*) = 18 participants most frequently involved in the subsamples showing a *Syll* (*Segm*) effect; *10 Syll* (*Segm*) = 10 pairs of items most frequently involved in the subsamples showing a *Syll* (*Segm*) effect.
†: ≤ .10. * $p < .05$. ** $p \leq .01$. *** $p \leq .001$.

al. (1996) in French, a language with a regular syllabic structure and clear syllabic boundaries, and in picture naming, a task in which such effects can be unambiguously interpreted. In effect, picture naming cannot be performed on the basis of a nonlexical procedure contrary to reading aloud. Also, as reported by Schiller et al. (2002), there have been some indications that syllabic priming effects can be obtained under certain conditions in picture naming latencies in French. It should be remembered that Bonin, Peereman, and Schiller (as reported in Schiller et al., 2002) found a syllabic priming effect in picture naming with the use of a 51 ms prime duration, an intensive learning session before the experiment proper, and instructions emphasizing speed. Therefore, given the significant consequences that syllable priming effects may have for models of word production (as discussed below), we thought it appropriate to give syllable priming effects proper consideration. We also had several other reasons for reopening the syllable issue in word processing and we discuss these below.

A large-scale experiment was performed (60 participants and 23 pairs of items) and several analyses were run. It should be remembered that Ferrand et al. (1996) used only 18 participants and 10 pairs of items. First, several ANOVAs were performed with different procedures to analyze the data. The ANOVAs were performed with participants and items used as random factors (Clark, 1973). It must be stressed that we selected virtually all pairs of items that satisfied the selection criteria used by Ferrand et al. (1996)—that is, pairs of items that were pictoriable, bisyllabic, and had the same three initial phonemes. We conducted ANOVAs on the raw data; on the data using the same trimming procedure as employed by Ferrand et al. (1996)—that is, observations longer than 1,500 ms were excluded; on the latencies with those longer than two standard deviations from the overall participant and item means excluded; on data with latencies longer than two standard deviations above the participants and items means computed from the crossing of experimental factors excluded; and, finally, on the harmonic means.

The results were clear-cut: There was no hint of syllabic priming effects in the picture naming latencies. Overall, the pattern of results was consistent with the segmental overlap hypothesis advocated by Schiller (1998, 1999, 2000), which corresponds to the observation that longer primes (CVC primes) yield shorter latencies than shorter primes (CV primes). Because the observed standardized effect sizes (*f*, see Cohen, 1992) corresponding to the effect of type of primes were large, we ran power analyses using the sample sizes used by Ferrand et al. (1996) and Schiller (2000). These analyses suggested that a reason why a segmental overlap effect was not found in most of the studies could partly be due to the fact that the sample sizes were too small.

Given major discrepancies between the mean patterns observed in several studies, different analyses were performed on the basis of a random selection of 100,000 subsamples of 10 pairs of items and 18 participants, the sample characteristics with which Ferrand et al. (1996) obtained a large and reliable syllable priming effect in picture naming latencies. Brand et al. (2003) performed similar analyses of word reading latencies to investigate the distribution of the size of the syllabic priming effect. However, as already explained, their approach was limited by the fact that they did not take into account the variability among participants that was certainly different between their study and Ferrand et al.'s (1996). In our analyses, we first determined the number of times a syllable priming effect and a segmental overlap effect was observed in the 100,000 subsamples drawn randomly from the original data. We then added additional constraints to define the occurrence of these two patterns. The findings were again clear-cut. The syllable priming effect was extremely difficult to observe even descriptively, and if we concentrate on the specific syllabic effect found in Ferrand et al. (1996)—a crossover interaction reliable on both participants and items—the number of subsamples exhibiting this interaction was extremely low, although not equal to zero, contrary to what Brand et al. (2003) found in word reading.

The overall pattern of findings clearly points toward a segmental overlap effect as found in both English and Dutch by Schiller (1998, 1999, 2000) and also by Brand et al. (2003) in word reading in the fastest participants from their Experiment 3. Overall, these analyses lead to the conclusion that the syllabic priming effect in picture naming latencies as found by Ferrand et al. (1996) is a very rare event.[3] The instability of the findings does not seem to be due to our sample of participants and items and/or to the task used here, because in the Brand et al. (2003) word reading study, the pattern of results also varied from experiment to experiment. It is only in Experiment 3 that the segmental overlap effect was found in the fastest participants.

The present findings do not definitively rule out the possibility that syllables play a role in word production. Various observations obtained with different paradigms suggest that the syllable may play a role in lexical processing. It is possible that the priming paradigm is not the most appropriate one for investigating the role of syllables in lexical processing (Cholin, Schiller, & Levelt, 2004). For instance, Ferrand and New (2003) found a syllabic length effect in lexical decision and word naming on low-frequency words, thus suggesting that syllables play a role in word recognition. Moreover, Cholin et al. (2004) used a variant of the implicit paradigm to investigate the role of syllables in speech production. In this technique, participants learn sets of prompt-response pairs and the responses may or may not be related. Cholin et al. provided evidence that syllables are functional units in speech production. According to these authors, the success of the implicit paradigm, compared to the priming paradigm, in demonstrating syllable effects is attributable to the fact that it requires an overarticulation of each word. It is important to state that we are not suggesting that the priming paradigm is a technique that yields inconsistent results. Take, for instance, the identical priming effect that corresponds to the observation that the processing of an item is facilitated when it has been immediately preceded by itself rather than by another item. This effect is one of the most robust effects reported in visual word recognition (Forster & Davis, 1984, 1991; Lukatela, Frost & Turvey, 1999; Lukatela, Savic, Urosevic, & Turvey, 1997; Segui & Grainger, 1990), and it has been reported in speech production many times (Ferrand, Grainger, & Segui, 1994; Ferrand, Humphreys, & Segui, 1998; Ferrand, Segui, & Grainger, 1995; La Heij, Puerta-Melguizo, van Oostrum, & Starreveld, 1999). As far as French is concerned, we were able to replicate Ferrand and colleagues' (Ferrand et al., 1994; Ferrand et al.,1998) finding that, in picture naming, word frequency and identical priming combine additively (Bonin & Méot, 2002).

The current findings make it clear that the syllabic priming effect in picture naming as found by Ferrand et al. (1996) should not be discussed any further in relation to word production models. In effect, it had been claimed that the syllable effects were difficult to reconcile with the Levelt et al. (1999) model of word production (one of the most prominent models in the word production literature), because, in this model, the phonological representations corresponding to words give access to individual phonemes and not to syllables (the lexeme level). In effect, a core assumption of Levelt et al.'s (1999) theory is that there are no syllable representations in the word form lexicon. The syllabification process is a major process of phonological encoding, but syllables are created on the fly on the basis of syllabification rules. Moreover, the syllabification process is context dependent. Syllables are never retrieved during phonological encoding. In their model, a prime activates segments and not syllables. A CV prime activates the corresponding segments, and it does not matter that it corresponds to a syllable. Therefore, this model predicts a segmental overlap priming effect: a CVC prime is more effective than a CV prime in speech production.

One possibility put forward by Levelt et al. (1999) to explain the Ferrand et al. (1996) syllable priming effects (see also Schiller, 1998) is as follows. If it is assumed that French segments are marked for syllable position (onset, nucleus, coda) in the input lexicon, the syllable priming effect could be due to the fact that active phonological segments in the perceptual network *directly* activate corresponding phonological segments in the production lexicon. However, this proposal is unable to explain why a syllable priming effect was not found in visual lexical decision latencies in the Ferrand et al. (1996) study (Levelt et al., 1999). The current findings help to clarify the matter. The Ferrand et al. (1996) syllable priming effects are not at all robust even in a language with relatively clear syllable boundaries (i.e., French).

It could be argued that our failure to replicate the Ferrand et al. (1996) results was because we did not use *exactly* the same items, the same software, the same type of computer or screen, or the same masks. But Brand et al. (2003) were also unable to replicate the Ferrand et al. (1996) syllabic priming effect in word reading even when using *exactly* the same items, type of masks, and procedure. Even if we were to accept the idea that our failure to replicate is due to these small changes in stimuli and procedures, what would be the meaning and the implication of an effect that can be replicated only with the same items and/or software and/or masks used in a seminal study? The implication is clear. It would tell us that the effect is not a robust one and that we should be extremely cautious when constraining models from it. And this is precisely what our study signals: The syllabic priming effect in picture naming is not robust at all.

It should be noted that a number of effects in the psy-

3 It could be argued that the overall length effect prevented the occurrence of a crossover interaction, as suggested by the descriptive patterns that indicated that CVC primes were more effective than CV primes for CVC items (see Table 2). However, the general ANOVAs did not reveal a significant interaction. It is therefore difficult to infer that the difference between CV and CVC primes was different for CV and CVC targets. Furthermore, subsampling procedures indicated that at an alpha level of .05, only 290 (0.29%) of the subsamples showed a significant interaction in support of this hypothesis.

cholinguistic literature have been obtained with different software programs, languages, technologies, items, and participants. Take, for example, age-of-acquisition effects in picture naming latencies, which correspond to the observation that latencies are longer (and errors more numerous) on late-acquired than on early-acquired words (e.g., Barry, Hirsh, Johnston, & Williams, 2001; Bonin, Fayol, & Chalard, 2001). In every study in which pictures having early-acquired names have been compared to pictures having late-acquired names, it has been found that the former are processed faster than the latter (Johnston & Barry, 2005).

It should be remembered that we indeed found that it is possible to find subsamples that give rise to syllabic priming effects in picture naming latencies. However, it is an extremely rare event (less than 0.05% of the subsamples exhibited the effect). Moreover, when such an effect is observed, our analyses suggest that its outcome depends more on the characteristics of certain participants than on particular items. Unfortunately, we were unable to determine what these characteristics are, although we established that the effect was not due to the speed and accuracy of responding or the ability to consciously perceive the primes. Therefore, these analyses strongly suggest that the huge discrepancy between our findings and those of Ferrand et al. (1996) is due to differences between participants. However, this aspect should not distract us from the fact that the syllabic priming effect in picture naming is extremely difficult to obtain and therefore is not a robust effect.

The methodological implication of our study is that in cases of effects that prove to be difficult to replicate and for which meta-analyses cannot be performed, the approach we have adopted could be used. First, we think it is appropriate to replicate an effect having major implications for the building of models or theories. Second, when an effect turns out to be difficult to replicate, we submit that large-scale experiments could be run and subsampling procedures could be used. To conclude, we think that the body of evidence concerning the syllabic priming effects in word reading and in picture naming is now clear enough. Ironically, we may say that these effects are lost in the sea.

References

Barry, C., Hirsh, K. W., Johnston, R. A., & Williams, C. L. (2001). Age of acquisition, word frequency, and the locus of repetition priming of picture naming. *Journal of Memory and Language, 44,* 350–375.

Bonin, P., Fayol, M., & Chalard, M. (2001). Age of acquisition and word frequency in written picture naming. *Quarterly Journal of Experimental Psychology, 54A,* 469–489.

Bonin, P. & Méot, A. (2002). Do identical priming and word frequency truly interact in picture naming when a neutral baseline is used? *Current Psychology Letters: Brain, Behavior & Cognition, 7,* 51–70.

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.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14,* 177–208.

Cholin, J., Schiller, N. O., & Levelt, W.J.M. (2004). The preparation of syllables in speech production. *Journal of Memory and Language, 50,* 47–61.

Clark, H. H. (1973). The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. *Journal of Verbal Learning and Verbal Behavior, 12,* 335–359.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155–159.

Cohen, J., McWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: An interactive graphic system for designing and controlling experiments in the psychology laboratory using Macintosh computers. *Behavior Research Methods, Instruments, & Computers, 25,* 257–271.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. C. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108,* 204–256.

Content, A., Kearns, R. K., & Frauenfelder, U. H. (2001). Boundaries versus onsets in syllabic segmentation. *Journal of Memory and Language, 45,* 177–199.

Evinck, S. (1997). *Production de la parole en français: Investigation des unités impliquées dans l'encodage phonologique des mots* [Speech production in French: Investigation of the units implied during the phonological encoding of words]. *Unpublished Ph.D. dissertation, Bruxelles University*.

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., Humphreys, G. W., & Segui, J. (1998). Masked repetition and phonological priming in picture naming. *Perception & Psychophysics, 60,* 263–274.

Ferrand, L. & New, B. (2003). Syllabic length effects in visual word recognition and naming. *Acta Psychologica, 113,* 167–183.

Ferrand, L. & Segui, J. (1998). The syllable's role in speech production: Are syllables chunks, schemas, or both? *Psychonomic Bulletin & Review, 5,* 253–258.

Ferrand, L., Segui, J., & Grainger, J. (1995). Amorçage phonologique masqué et dénomination. *L'Année Psychologique, 95,* 645–659.

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. (1997). The syllable's role in word naming. *Memory & Cognition, 25,* 458–470.

Forster, K. I. & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, & 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 & Language, 30,* 1–25.

Humphreys, G. W., Riddoch, M. J., & Quinlan, P. T. (1988). Cascade processes in picture identification. *Cognitive Neuropsychology, 5,* 67–103.

Johnston, R. A. & Barry, C. (2005). Age of acquisition effects in the semantic processing of pictures. *Memory & Cognition*, 33, 905–912.

Kinoshita, S. & Lupker, S. (Eds.). (2003). *Masked priming: The state of the art*. New York: Psychology Press.

La Heij, W., Puerta-Melguizo, C., van Oostrum, M., & Starreveld, P. A. (1999). Picture naming: Identical priming and word frequency interact. *Acta Psychologica, 102,* 77–95.

Levelt, W.J.M. (1989). *Speaking: From intention to articulation*. Cambridge, MA: MIT Press.

Levelt, W.J.M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1–75.

Lukatela, G., Frost, S. J., & Turvey, M. T. (1999). Identity priming in English is compromised by phonological ambiguity. *Journal of Experimental Psychology: Human Perception and Performance, 25,* 775–790.

Lukatela, G., Savic, M., Urosevic, Z., & Turvey, M. T. (1997). Phonological ambiguity impairs identity priming in naming and lexical decision. *Journal of Memory and Language, 36,* 360–381.

Meyer, A. S., Roelofs, A., & Levelt, W.J.M. (2003). Word length effects on object naming: The role of a response criterion. *Journal of Memory and Language, 48,* 131–147.

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). Berlin: Mouton de Gruyter.

Segui, J. & Grainger, J. (1990). Masquage et effet de répétition du mot: Sa nature et sa localisation fonctionnelle [Masked priming and the word repetition effect]. *L'Année Psychologique, 90,* 345–357.

Appendix

Picture names used in the experiment. An approximate translation is given in parentheses.

CV words	CVC words
Baril (keg)	Barbelé (barbed wire)
Bison (bison)	Biscuit (cracker)
Cacahuète (peanut)	Cactus (cactus)
Calumet (calumet)	Calmar (squid)
Capuche (capuchin)	Capsule (seal)
Carabine (carbine)	Cartable (satchel)
Carafe (carafe)	Carnet (notebook)
Carotte (carrot)	Carpette (rug)
Caravane (caravan)	Cartouche (cartridge)
Carillon (carillon)	Carquois (quiver)
Casier (drawer)	Castor (beaver)
Cerise (cherry)	Cerveau (brain)
Filet (net)	Filtre (filter)
Garage (garage)	Garçon (boy)
Haricot (bean)	Harpon (harpoon)
Marin (sailor)	Marmite (pot)
Maracas (maracas)	Marcassin (young wild boar)
Marionnette (puppet)	Marguerite (daisy)
Palace (palace)	Palmier (palm tree)
Piscine (swimming pool)	Pistolet (pistol)
Seringue (syringe)	Serpent (snake)
Soleil (sun)	Soldat (soldier)
Volant (steering wheel)	Volcan (volcano)

Patrick Bonin

Laboratoire de Psychologie Sociale et Cognitive (LAPSCO)
Université Blaise Pascal
34 avenue Carnot
63037 Clermont-Ferrand
France
E-mail Patrick.Bonin@srvpsy.univ-bpclermont.fr