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Attentional Allocation within the Syllabic Structure of Spoken Words

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The role of the syllable during on-line speech perception was explored using a variant of the phoneme detection task developed by Pitt and Samuel (1990). In their task, listeners' attention to phonemes in different serial positions inside word or nonword stimuli was manipulated by varying the probability that a target phoneme occurred in the various positions. In our experiments, French and Spanish subjects had to detect targets that appeared either in the coda of the first syllable or in the onset of the second syllable of carrier words. Subjects' expectations about the structural position of the target were manipulated. In a series of five experiments (two using a decision paradigm and three using a detection paradigm), these expectations were shown to influence response latencies: that is, subjects who attended to the coda of the first syllable were faster when the target appeared in this position rather than in the onset of the second syllable; the reverse pattern was observed when subjects attended to the onset of the second syllable. This result held regardless of the serial position of the target. These results were equally valid for French and Spanish. Moreover, syllabification was present when Spanish pseudowords were used as carriers. The fact that subjects could focus their attention on a syllabically defined position, even when processing nonwords, suggests that syllabic information is specified at a prelexical level of representation. The phoneme detection task in which attention is manipulated provides us with an interesting new technique for exploring prelexical representations.

Most people have an intuitive notion of what syllables are. For example they can manipulate them in meta-linguistic word games (Treiman, 1983). Interestingly, they perform these games much more easily with syllables than with phonemes. This is especially true with preliterate children or illiterate adults (Liberman, Schankweiler, Fisher, & Carter, 1974; Morais, Cary, Alegria & Bertelson, 1979; Morais, Bertelson, Cary, & Alegria, 1986). The syllable also receives some support as a processing structure in studies on speech production. Indeed syllabic structure plays a role in the phonological encoding of the utterances (Levelt, 1989; Meyer, 1991). Further, modern phonology makes use of the syllable to express both phonotactic constraints and prosodic rules (Halle & Vergnaud, 1988).

However, the question remains as to whether the syllable plays a role in the on-

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line perception of speech. Two of the most frequently cited models of word recognition, namely the Cohort (Marlsen-Wilson, 1989) and TRACE (McClelland & Elman, 1986) models, make no use of syllables in the course of speech perception. However, Mehler, Dupoux, and Segui (1990) have argued that lexical acquisition in the child favors a bias toward the hypothesis that the prelexical level is structured in terms of a coarse-grained, syllable-like unit.

Early experimental support for the existence of the syllable during speech perception came from a study by Mehler, Dommergues, Frauenfelder and Segui (1981). They found that subjects detected a speech segment more quickly when it matched the first syllable of a word precisely: thus, reaction times to BAL were faster in BAL.CON than in BA.LANCE, and the reverse was true with the target BA. These results, first obtained with French, have since been replicated using the same task in other languages, e.g., Catalan (Sebastian-Gallès, Dupoux, Segui, & Mehler, 1992) and Dutch (Zwitserlood, Schiefers, Lahiri, & van Donselaar, 1990). Cutler, Mehler, Norris, and Segui (1986) and Bradley, Sánchez-Casas, and García-Albea (in press) report no syllabic effects for English, however. Interestingly, while English subjects do syllabify neither English nor French stimuli, French subjects do syllabify the very same material. Cutler et al. (1986) argued that the incidence of unclear syllable boundaries in English may induce listeners to ignore the syllabic structure when parsing the signal. In contrast, native speakers of a language with clear syllable boundaries, e.g., French, supposedly syllabify the signal consistently.

The above account was challenged when, under the same conditions as in the original French study, Sebastian-Gallès et al. (1992) failed to observe a syllabic effect in Spanish, a language whose syllabic boundaries are as clear as those in French. Data that weaken the original interpretation have also been obtained by Zwitserlood et al. (1990), who found syllabification for Dutch, a language with widespread ambisyllabicity. Other parameters than ambisyllabicity can be invoked to try and explain these observations. However, in this study, we have chosen to enrich the database by adding a new procedure to investigate speech perception.

In a recent study, Pitt and Samuel (1990) have proposed an interesting new method. In order to determine whether subjects can focus their attention on a precise phonemic location inside a word, they adapted the cue validity detection paradigm developed by Posner and Snyder (1975) to a generalized phoneme detection task (Frauenfelder & Segui, 1987; Marlsen-Wilson, 1984). They manipulated the probability of appearance of the targets at the different consonantal locations inside CVC#CVC words (# denotes a syllabic boundary). That is, for a first group of subjects, the targets appeared in the first consonant position on 75% of the trials, and on the 25% remaining trials, it occurred in any of the three other remaining consonant positions; a second group received most of its targets in the second consonant position, a third in the third position, and a fourth in the last position. This manipulation, the authors hoped, would lead the subjects to shift their attention toward the locus where the target was more likely to appear. Indeed, the results showed that subjects were both faster and more accurate at detecting targets at the expected location than at the unexpected ones. Moreover, facilitation was restricted to the precise serial position of the phoneme and did not extend to the other consonant of the same syllable. Pitt and Samuel (1990) argued that these results support the phoneme rather than the syllable as the primary perceptual unit.

Pitt and Samuel's rationale rests on the assumption that "if the syllable is a unit of analysis, all consonants within a syllable are equally available for inspection upon recognition of the syllable" (p. 613). However, this hypothesis seems less than compelling. Even if the syllable is first available as a whole, subjects engaged in a phoneme detection task may inspect it from left to right, phoneme by phoneme while attentional focus has highlighted one precise position in the syllable. The syllable could also be inspected in terms of its constituents: onset, nucleus, and coda. As a matter of fact, Pitt and Samuel (1990, experiments 1 and 2) used lists of word and nonword stimuli with an homogeneous syllabic structure CVC#CVC. Therefore the serial position the subjects were supposed to attend to was systematically confounded with a precise position in the syllabic structure of the stimuli. For example, subjects monitoring for the first consonant were also monitoring for the onset of the first syllable; whereas subjects monitoring for the second consonant were monitoring for the coda of the first syllable, and so on. Consequently, Pitt and Samuel used a design that does not allow us to know how the location of the attentional focus was specified. To assess whether subjects base their responses on a linear phonemic representation or a syllabically structured one, it is necessary to vary the target's position in the syllabic structure while keeping its serial position constant. That is what we have done in the experiments that we describe in this article.

All our experiments compare two groups of subjects. A first group receives most of the targets in the coda of the first syllable of CVC#CV... words (e.g., "paR#don", where the upper case letter is the target). A second group receives them most often in the onset of the second syllable in words of the form CV#CCV... (e.g., "ca#Price"). Moreover, for both groups of subjects, phoneme targets generally are in the third serial position. In addition, both lists share test words, where the following conditions apply: the target phoneme is either in the coda of the first syllable or in the onset of the second syllable and either in the third ("seG#ment", "di#Plôme") or in the fourth serial position ("traC#teur", "pro#Blème"). The behavior of the two groups of subjects is evaluated by comparing detection times on the four types of words. If subjects base their responses upon an unstructured sequence of phonemes, no difference is expected between the two groups. At best, one might predict that both groups would be slower when the target is in fourth position, if a phonemic serial induction, like that suggested by Pitt and Samuel, occurs. In contrast, if the representation upon which subjects effect their responses contains syllabic information, then one may expect them to be faster when the target appears in the syllabic structural position favored in their list: thus, subjects in the coda group would be faster at detecting /p/ in "cap#ture" than in "ca#price," and vice versa for the onset group. Moreover, if only the syllabic position of the target (and not the phonemic serial one) is relevant, there should be no difference between detecting the phoneme /k/ in "fac#ture" and in "frac#ture."

Two languages have been used in this study: French and Spanish. Given the sensitivity of French listeners to syllables (see Segui, Dupoux, & Mehler, 1990, for a review), it was interesting to explore this attentional paradigm with subjects who were more likely to yield syllabic effects. Spanish subjects can bypass the syllable in the segment monitoring task[1] (Sebastian-Gallès

[1] The task in which subjects have to monitor for a sequence of phonemes (e.g., BA) will be referred in this article as the "segment monitoring task" to distinguish it from the "phoneme monitoring task." We are aware of the confusion this appellation can create while the term "phoneme" is more and more often abandoned for the term "segment" in the phonological literature. Nevertheless, we avoid the term "syllable monitoring" that has sometimes been employed because it was an important point that the instructions given to subjects should never contain the word "syllable." This was necessary in order to require a positive answer from them in the mismatch case, e.g., BA in BALCON.

et al., 1992; Bradley et al., in press). Their behavior on this new task should help to clarify how the information processing necessary to perform a segment detection compares to that in this attentional paradigm.

EXPERIMENT 1

Material

Two sets of 58 French bisyllabic words were selected. In the coda set, the target phoneme was always the coda of the first syllable; in the onset set, it was always the onset of the second syllable. In addition, in both sets, the target was the third phoneme of the word.

Syllabification followed the "Maximal Onset" principle (see Goldsmith, 1990) and was in accordance with native French speakers' intuitions. Since any consonant can start a word in French, the Maximal Onset principle assigns an intervocalic consonant (VCV) to the onset of the following syllable (V#CV). Hence, a word-internal coda in French is necessarily part of a consonant cluster and therefore all the words in the coda set contained a medial consonant cluster. For symmetry's sake, all words in the onset set were chosen with a medial consonant cluster too. This was done so that the stimuli in the onset set could not be recognized as such only from the fact that they lacked an internal cluster. Thus, the words in the coda set all had a cvC#cv... syllabic structure (e.g., faC#teur; where the uppercase C points out the target), while those in the onset set all had a cv#Ccv... structure (e.g., di#Plôme).

Two experimental lists were constructed out of these two sets: the coda list included all words from the coda set, while the onset list included all those from the onset set. Sixteen items (eight from each set) were selected as "test" items and were included in the two lists. The remaining words were called "inductors" because their role was to induce subjects to attend to the target in a precise syllabic position.

Sixteen more test words containing the target phoneme in the fourth serial position were added to the two lists. Again, for half of these words, the target phoneme was in the coda of the first syllable (ccvC#cv type: e.g., cryP#ter) while for the eight others, it was in the onset of the second syllable (ccv#Ccv type: e.g., pro#Grès). Thus, there were four types of test items differing by the target syllabic position (coda vs onset) and its serial position (third vs forth).

Lists were constructed so that each test item was preceded by one or two inductors. In addition, the lists shared 32 distracting items that did not contain the target and had the same syllabic structure as the test words. Table 1 shows a few successive trials excerpted from the two lists and a detailed list of the material (test items and inductors) is given in Appendix 1.

Several kinds of phonemes (stops, liquids, and fricatives) were used as target phoneme for the inductor carriers. The targets in the test items, however, were always stops; their onset was defined at the release of the burst. French, unlike English, has stops with an explosion, in the coda position as well as in the onset position, so that defining the "burst" of stop consonant was quite straightforward.

To sum up, each of the two experimental lists was made up of 114 words: 50 inductor items with a monotonous syllabic structure (respectively cv#Cc... and cvC#c... for the onset and coda induction lists), 32 test

TABLE 1
A FEW SUCCESSIVE TRIALS EXCERPTED FROM THE TWO EXPERIMENTAL LISTS

Coda list	Onset list	Condition
—	—	
taCtile	taBleau	(Inductor)
flaGrant	flaGrant	(Test: onset/4)
costume	costume	(Distractor)
caPture	saFrant	(Inductor)
suRface	rePli	(Inductor)
seGment	seGment	(Test: coda/3)
—	—	

items (shared by both lists, see Appendix 1), and 32 distracting items. Thus, in each list the target phoneme appeared more often in one syllabic position (over 80% of the positive answers) than in the other. At the same time, in both lists, the third serial position was favored in 80% of the cases. The first experimental item appeared at the eighth trial.

The stimuli were recorded by a French female speaker at the regular rate of one word every 2 s. The speech stimuli were then digitised on a PDP 11–73 at 16 kHz and edited. A click was introduced to coincide with the burst of the stop consonant target of the 32 test items. The mean duration of the test items was 764 ms. The mean temporal position of the targets for the four different categories of test stimuli were 274 ms (SE = 17 ms), 289 ms (24 ms), 297 ms (12 ms), 277 ms (15 ms) cvc#c, cv#cc, ccvc#c, ccv#cc, respectively) and did not differ significantly. Two audio cassettes were prepared, one for each list, with the stimuli on the first channel and the (inaudible) click that triggered the timer of a PC on the second channel.

Procedure

The subjects were distributed in two equal groups, the Coda induction group and the Onset induction group, depending on the list presented.

Subjects were individually tested in a quiet room. They were seated in front of a PC computer linked to a TASCAM Porta One cassette recorder. They listened to the words binaurally through an AKG headphone at a level of about 70 dB. A trial began when a letter representing the target sound was printed in the center of the PC display. After a 1-s delay the letter was removed and 1s later, a word was heard through the headset. Subjects had 2 s after the offset of the word to respond by pressing one Morse key when the word contained the target and another key when it did not. Reaction times were measured from the onset of the target. The interval between the onset of two consecutive trials was about 5 s. The subjects were not informed that the target phoneme would occur more often at one precise position than another.

Note that we used about three times fewer trials than in the Pitt and Samuel study, which, if anything, should decrease the opportunity of observing induction. However, this allowed the whole experiment to last only about 10 min in comparison with the 45-min duration of Pitt and Samuel's experiment. Another difference between the two studies is that in our experimental design each group serves as a control for the other, while Pitt and Samuel's experimental groups were compared with a control group which received an unbiased training list.

Subjects

Twenty volunteer subjects (aged between 20 and 24; 14 men and 6 women), students in various Paris Universities, participated in the experiment. They were all native speakers of French with no known auditory defect and were randomly assigned to each of the two groups.

Results and Discussion

Reaction times under 100 ms or above 1200 ms, as well as the misses (overall, 4% of the data), were replaced by the subject mean over the remaining items under the relevant condition. The overall rate of false alarms was 5.3%. Figure 1 displays the mean reaction times and error rates (misses + outliers) for the two groups of subjects and the four types of test words.

Errors and Latencies were submitted to different ANOVAs, first with subjects ($F1$) and then with words ($F2$) as the random factor. There was one between-subjects factor (Induction group) and two within-subjects factors (Syllabic and Serial position of the target). No significant effect nor interaction emerged in the error analysis. In the analyses of latencies, the interaction between Induction group and Syllabic posi-

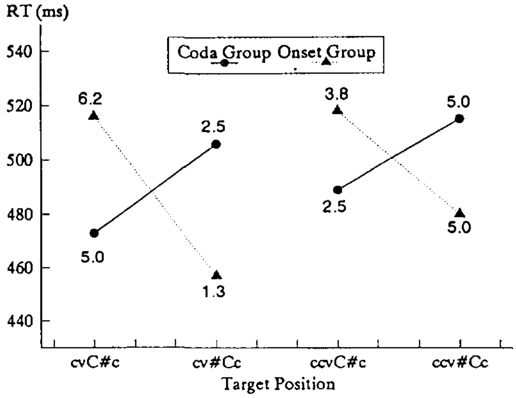

FIG. 1. Mean decision latencies and error rate (in percentage) of the Coda and Onset induction groups when the target appears at the four different positions. French subjects—decision task.

tion was the only significant effect in both subject and items analysis: $F1(1,18) = 6.8$, $p = .02$ ($MS_e = 4432$); $F2(1,28) = 11.4$, $p = .002$ ($MS_e = 2119$). No other effect reached significance: in particular the 14-ms advantage for targets in the third position against those in the fourth was not significant, $F1(1,18) = 1.47$, $p = .23$ ($MS_e = 1150$) and $F2(1,28) < 1$ ($MS_e = 6018$). Moreover, the triple interaction between Induction group, Syllable type, and Serial position was not significant (both $F1$ and $F2 < 1$). Subsequent analyses restricted to each induction group showed that the main effect of Syllabic position was significant for the Onset group: $t(9) = 2.8$, $p < .05$ by subjects and $t(30) = 2.2$, $p < .05$ by items, but not for the Coda group: $t(9) = 1.2$ by subjects and $t(30) = 1.3$ by items.

Results reported above suggest that subjects are influenced by the Syllabic position of the target. Indeed, the difference between the two groups of subjects was that the first one received most of the targets in the coda of the first syllable while the second one received most of them in the onset of the second syllable. Tested with the same words at both locations, each group was faster when the target appeared in the Syllabic position favored by its list. Had subjects used an unstructured linear representation in which words are considered as a string of phonemes, the results for the two groups should have been similar. The significant interaction between Induction group and Syllabic position is not consistent with the serial hypothesis. Rather, it is in line with the syllabic hypothesis. In this respect, these results are congruent with those obtained, in French, with the segment detection task.

Another point is worth mentioning: as stated under Material, there was no temporal difference between the targets in the different categories. Despite the fact that Pitt and Samuel do not report the temporal position of target phonemes, it seems reasonable to suppose that the Serial positions toward which subjects were induced to attend the target differed in temporal position. For that matter, Pitt and Samuel refer to "temporal selective attention" and do not raise the issue whether subjects habituate to a temporally or serially (phonemically) defined position. Our results suggest that the attention is defined by some structural property of the stimulus rather than by a temporal window.

EXPERIMENT 2

As mentioned in the introduction, the segment detection task has not always clearly supported the syllabic hypothesis. Spanish is a case where mixed results have been obtained. Several experiments (Bradley et al., in press; Sebastian-Gallès et al., 1992) have shown that the syllabic influence comes and goes depending on various factors such as, for example, the existence of catch trials or the speed of subjects. Sebastian-Gallès et al. (1992) accounted for this by proposing that although Spanish subjects compute a sublexical syllabic representation, they may rely on some subsyllabic information to perform the segment monitoring task (for a more detailed explanation, cf. Sebastian-Gallès et al., 1992).

However, the fact that clear syllabic effects in Spanish have only been obtained with rather slow responses could also mean that subjects have based their response on lexical information, i.e., after having recognized the words. Therefore, it is of interest to employ the attentional variant of the phoneme detection task with Spanish to evaluate these two different proposals.

Material and Procedure

This experiment is identical in most respects to the French experiment. Minor differences are highlighted below.

The lists were constructed in the same way as in the French experiment except that it was necessary to include trisyllabic as well as bisyllabic words in order to balance for stress location. Indeed, while bisyllabic items bore the stress on the first syllable, the trisyllabic ones were stressed on the second syllable. Also, as it was impossible to find enough words containing a stop consonant in the target position, we had to include four words with nasal targets as test items (see Appendix 2). The mean temporal positions of the target phoneme did not differ across the cvC#c, cv#Cc, ccvC#c, and ccv#Cc categories: they were 240 ms (SE = 20 ms), 230 ms (14.7), 268 ms (30), and 249 ms (14.1), respectively.

The procedure and the equipment were identical to those employed in the French experiment except that (a) lists were recorded by a native Spanish female professional speaker of Radio Nacional de España at Catalunya, (b) the stimuli were digitized and edited with an Olivetti 386 computer equipped with an OROS AU22 board and (c) subjects listened to the lists through Sennheiser Model HMD224 headphones.

Subjects

Fifty native Spanish speakers participated in this experiment. They were all undergraduate Psychology students at the University of Barcelona. They received extra-course credits for participating in the experiment. Subjects' ages ranged from 19 to 21 years. Twenty-five subjects were randomly assigned to each one of the two experimental groups. Each group received one list of words.

Results and Discussion

Correct responses with latencies less than 100 ms or more than 1200 ms were considered as outliers and, like the misses, were replaced in the analysis (they accounted for 9.7% of the data). The false alarm rate was 7.3%. Errors (misses + outliers) and reaction times were submitted to a three-way analysis of variance with Induction group as a between-subjects factor and Syllabic and Serial positions as two within-subjects factors (Fig. 2). In the error analysis, the item analysis failed to display any significant effect; however, in the subject analysis, there were significantly more errors under the coda condition than under the onset condition ($F1(1,48) = 6.5$, $p = .01$) and also more errors in the fourth position than in the third position ($F1(1,48) = 9.9$, $p = .003$). No interaction came out significant. In the analysis of latencies, the interaction between Group and Syllabic type was significant in both the items and subjects analyses ($F1(1,48) = 25.49$, $p < .001$ ($MS_e = 8097$); $F2(1,28) = 25.90$, $p < .001$ ($MS_e = 3496$)). Targets in onsets were detected 51 ms faster than targets in coda ($F1(1,48) = 16.03$, $p < .001$ ($MS_3 = 8097$);

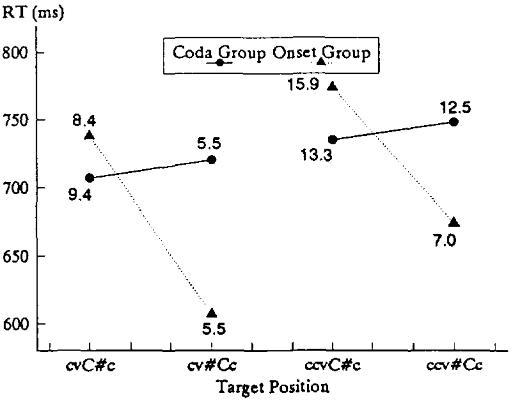

FIG. 2. Mean decision latencies and error rate (in percentage) of the Coda and Onset induction groups when the target appears at the four different positions. Spanish subjects—decision task.

$F2(1,28) = 4.2, p = .05$). Target phonemes were detected 40 ms faster when they were in third rather than in fourth position ($F1(1,48) = 18.85, p < .001$; but $F2(1,28) = 1.76, p = .2$). The t test comparisons of means showed that there was no difference between the two types of syllabic structures for the coda group ($t < 1$), while there were significant differences between the two syllabic structures for the Onset group (onsets faster than codas: $t(24) = 3.9, p < .001$ by subjects and $t(30) = 2.9, p < .01$ by items). Finally, a post hoc analysis showed that stress did not have any effect on response time.

The pattern of data in this experiment matches that of the French pattern. Indeed, the interaction of Induction group by Syllabic position is highly significant, showing that subjects can focus their attention on specific Syllabic structure positions, regardless of their Serial position in the word. Moreover, the Serial position effect was significant in the subject analysis, i.e., targets located in the third position were responded to faster than targets located in the fourth position, suggesting that a serial induction along the lines proposed by Pitt and Samuel (1990) is present. Another difference between the Spanish and the French results is the Syllabic position effect that arises only for Spanish: overall, Spanish subjects are faster and more accurate at detecting onsets than codas. Nevertheless, these two significant main effects are of relatively minor interest given the fact that the material was not counterbalanced across target position conditions.

General Discussion of Experiments 1 and 2

The main outcome from experiments 1 and 2 is the significant interaction between Group (onset versus coda induction) and Syllabic position of the target. This interaction was found for targets in both third and fourth Serial position: subjects responded faster to targets appearing in an expected Syllabic position rather than to targets located at unexpected positions (compared to subjects with a different expectation).

These experiments were set up to choose between two alternative hypotheses. The first hypothesis states that subjects rely on the Serial position of the phonemes to focus their attention and that the syllable plays no role. This hypothesis predicted that the only significant effect would be an advantage of the third over the fourth position. The second hypothesis suggests that subjects elaborate their responses taking into consideration the syllabic structure. This hypothesis predicts a significant interaction between Induction group and Syllabic position, a prediction that was supported by the data. A strong version of this hypothesis also predicts a generalization of the interaction between Induction group and Syllabic position from the third to the fourth Serial position. In other words, if subjects analyze the syllables in terms of onset, nucleus, and coda, the triple interaction of Group × Syllabic position × Serial position should not be significant. The lack of significance of the triple interaction, both in French and Spanish, supports our hypothesis.

A difference between the Spanish and the French results is the important advantage for targets in onset versus targets in coda for Spanish but not for French. This could reflect a difference in the processing of codas between the two languages, syllabic onsets being more salient than codas for Spanish listeners but not for French. One must be very cautious before accepting such an argument, however. The effect found in Spanish and the absence of effect found in French could be due to differences in the material which were not controlled across the different conditions. For example, the targets were not precisely the same in the four different test categories. The same remark applies to the Serial position effect found in Spanish where subjects were faster when the target was in the third rather than in the fourth position. Given that the target appeared more frequently in the third position, the subjects' behavior could reflect an attentional bias toward the third Serial position along the lines suggested by Pitt and Samuel. However, this effect might also be due to differences in the material pertaining to some uncontrolled variable.

In particular, lexical frequency of the carriers is a variable which might have had an impact on the reaction times. Indeed, using a generalized phoneme detection task, Frauenfelder and Segui (1989) reported semantic priming effects with stimuli and reaction times similar to ours, suggesting that our results might reflect less interesting late (lexical) processing rather then purely prelexical stages. If such is the case, one could expect lexical frequency to influence detection times.[2] Another indication that the prelexical origin of subject's responses is questionable and that we cannot rule out the possibility of lexical influences is that the reaction times, measured from word beginning, comes close to 800 ms, a delay comparable to the one needed to effect a lexical decision with this kind of material (e.g., Dupoux, 1989, experiment 6). Moreover, as stated previously, some experiments in Spanish using a segment monitoring task (Sebastian-Gallès et al., 1992) showed that the syllabic effect disappeared at fast latencies. To sustain our hypothesis that the syllabic effect emerges from a prelexical level of processing, it is important to replicate the preceding experiments with faster latencies.

[2] As the information was available for French (in *Trésor de la langue française*, 1971) we computed the mean lexical frequencies for test words with targets in the fourth and in the third position and found them to be significantly different (with cvC.. stimuli more frequent than ccvC.. stimuli). It is true that no differences were found between these two conditions in French. (However, the correlation between frequency and reaction times was nearly significant for the coda group, $r = .34$, $F(1,30) = 3.9$ (MSE = 3882), $p = 0.06$, but not for the onset group.)) This, however, does not dismiss the possibility that the faster reaction times obtained for targets in the third Serial position for Spanish might find their origin in a frequency difference. (There are much fewer ccv... words than cv... words in Spanish, thus it would not be surprising if the latter were also more frequent.)

Experiments 3 and 4

Experiments analogous to the previous ones with faster RT might clarify whether the observed pattern of results arises in the lexicon or if it reflects more primitive stages of processing. In order to get faster reaction times, it was decided to employ a go–no paradigm, i.e., a detection task rather than a decision. This task has been successfully used several times in previous studies to investigate different aspects of prelexical processing. For example, Cutler, Norris, and Williams (1987) argued that the lexically sensitive results obtained with segment detection by Taft and Hambly (1985) were due to their use of a decision rather than a detection task.

On the one hand, if the previous pattern of results reflects late stages of speech processing, it would be expected to obtain a decrement, or even a disappearance, of the syllabic effects, especially for Spanish. On the other hand, if the results are truly sublexical, the same pattern of results found in the previous two experiments should be replicated.

In addition to changing the task in order to obtain fast reaction times, instructions put special emphasis on speed, and subjects were explicitly told not to wait until the end of the words to answer.

Experiment 3

Material and Procedure

The same material and procedure as in the first experiment were used. The equipment was slightly different: the stimuli were stored at a sampling rate of 16 kHz and were presented directly through an OROS AU22 16-bit D/A board at 64 kHz (four times oversampled), followed with lowpass filtering at 20 kHz. Subjects were instructed to press a single Morse key as soon they heard the target in the incoming word.

They were asked not to wait for the end of the word and were informed that their reaction times were measured.

Subjects

Forty volunteer subjects aged between 20 and 27 (26 men and 14 women), students in various Parisian universities, participated in the experiment. None of them had taken part in the first experiment. All of them were native speakers of French.

Results and Discussion

Reactions times under 100 ms or above 1200 ms as well as the misses (overall, 3.4% of the data) were replaced by the mean subject latency over the items belonging to the relevant condition. The overall rate of false alarms was 6.3%. Figure 3 displays the mean reaction times and error rate for the two groups of subjects at the four locations.

Four ANOVAs were performed on the error data and on the mean latencies, first with the subjects and then with the items as the random variable. Three two-level factors were declared: Induction group (between subjects), Syllabic position and Serial position (within subjects). The error analyses failed to reveal any main effect or interaction. In the analyses of latencies, the interaction between Induction group and Syllabic position was significant: $F1(1,38) = 4.96, p = .03$ ($MS_e = 3947$) and $F2(1,28) = 4.59, p = .04$ ($MS_e = 1705$). No other effect reached significance. Restricted analysis showed that the syllabic effect was only marginal for both groups: $t(19) = 1.9$ (by subjects), $p = .07$ for the onset group and $t(19) = 1.4, p = 19$ (by subjects) for the coda group ($t < 1.5$ for both groups in the item comparison).

Changes in the instructions and in the task have had the desired effect of speeding responses: subjects are about 150 ms faster in this experiment than in experiment 1. Despite the improvement in speed performance, false alarms rate and misses did not increase. The qualitative results of the first experiment are replicated. Once again, subjects have utilized the global bias of their list toward a syllabic structure to optimize their behavior: they were faster when the target appeared at the most probable Syllabic position, regardless of its Serial position.

We now turn to the Spanish case. This case is critical given that, with the segment monitoring task, Sebastian-Gallès et al. (1992) showed that Spanish subjects seem to be insensitive to the syllabic structure of the stimuli at fast latencies.

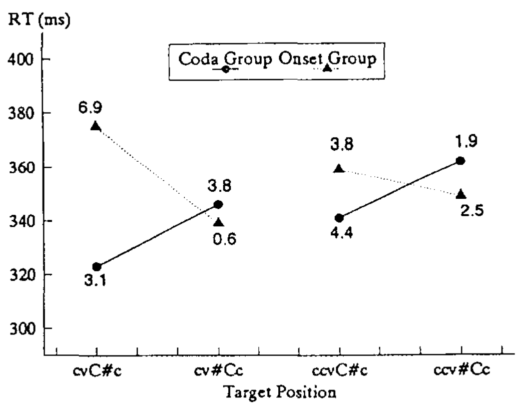

FIG. 3. Mean detection latencies and error rate (in percentage) of the Coda and Onset induction groups when the target appears at the four different positions. French subjects—detection task.

EXPERIMENT 4

Method

Thirty-six Spanish subjects participated in this experiment, 18 under each of the two induction conditions. Subjects were selected from the same population as that in experiment 2.

The material and procedure employed were exactly the same as those employed in experiment 2, except that subjects now had to respond only when the target phoneme was in the carrier word. We also enhanced the importance of the speed of response in the instructions (as in the French detection experiment).

Results and Discussion

Misses and reaction times longer than 1200 ms or shorter than 100 ms were replaced by the same procedure as above. They represented 4.8% of the data. The rate of false alarm was 9.8%. Three-way ANOVAs were performed on the error and latency data are displayed in Fig. 4. The error analyses revealed that subjects in the Onset group made significantly more errors than those in the Coda group ($F1(1,34) = 8.7$ ($MS_e = .372$), $p < .01$ and $F2(1,28) = 3.2$ ($MS_e = 1.594$), $p < .05$), and that the errors were especially increased when the target appeared in the unexpected Syllabic position: the interaction Syllable by Group was significant, ($F1(1,34) = 13.1$ ($MS_e = .271$), $p = .001$ and $F2(1,28) = 3.9$, $p = .06$). The ANOVAs on latencies showed that the interaction between induction group and Syllable type was significant in the subjects analysis and in the items analysis ($F1(1,34) = 14.36$, $p < .001$ ($MS_e = 8097$); $F2(1,28) = 8.90$, $p < .006$ ($MS_e = 1746$)). The syllabic position main effect was significant ($F1(1,34) = 12.46$, $p < .001$ ($MS_e = 3525$); $F2(1,28) = 4.2$, $p < .05$ ($MS_e = 3755$)). No other effect reached significance levels. Post hoc analysis showed that subjects in the Onset group responded

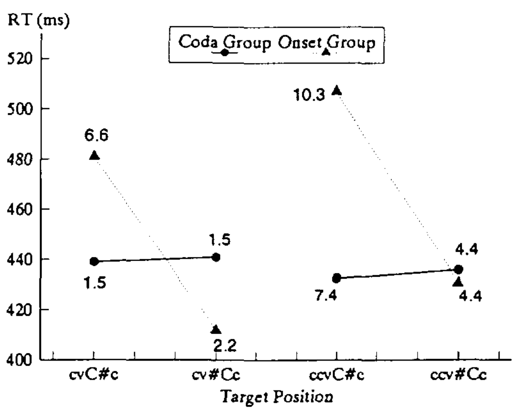

FIG. 4. Mean detection latencies and error rate (in percentage) of the Coda and Onset induction groups when the target appears at the four different positions. Spanish subjects—detection task.

significantly faster for onsets than for codas: $t(17) = 4.4$, $p < .001$ by subjects and $t(30) = 2.0$, $p < .06$ by item; no main effect of syllabic position was revealed for the Coda group ($t < 1$).

GENERAL DISCUSSION OF EXPERIMENTS 3 AND 4

The interaction between Induction group and Syllabic position is again significant in both French and Spanish. These results strengthen those obtained with the decision task and fit well with the view that the syllable is intervening at a prelexical level. By manipulating the task and subjects instructions, we managed to speed their responses and, therefore, to reduce the opportunity of their using lexical information.

The effect of Serial position, found in Spanish with the decision task, is not replicated. At the end of the discussion of experiments 1 and 2 we suggested that this effect could have been induced by a confounding of frequency and Serial position in our material. If the phonemic position effect was really a masked frequency effect, then it might be expected to reduce in a task that minimizes the involvement of the mental lexicon. In contrast, if the effect is a true Serial position effect, then it should be found regardless of the nature of the task. Our current results clearly support the first explanation.

However, even though we have tried to decrease lexical involvement in experiments 3 and 4, a stronger test of the sublexical nature of the syllabic effect could be achieved by using pseudowords instead of words.

EXPERIMENT 5

It is commonly accepted that the use of pseudoword stimuli reduces the likelihood of getting lexical effects. Pitt and Samuel tested subjects with both word and pseudoword stimuli and failed to observe any substantial difference between the two conditions. Nevertheless, running a pseudoword experiment in Spanish was commended for two reasons. First, as we have already argued above, the results of Sebastian-Gallès et al. (1992) could be interpreted by a lexical account. Second, testing subjects with new material can determine whether the important main effect of syllabic type (onsets faster to detect than codas) found in the Spanish experiment replicates.

Subjects

Twenty-six Spanish subjects from the same population as in experiments 2 and 4 participated in this experiment. None of them had participated in the previous experiments.

Materials and Procedure

Trisyllabic pseudowords (164) were created. All of them conformed to Spanish phonotactic constraints. Half of the stimuli were stressed on the last syllable and the other half were stressed on the penultimate syllable. All stimuli were constructed in such a way that they became nonwords at the fourth phoneme (one exception, see Appendix 3). The other specifications about materials and procedure were exactly the same as those in the detection experiments.

The mean temporal positions of the target phoneme across the cvC#c, cv#Cc, ccvC#c, and ccv#Cc categories were 200 ms (SE = 29.1 ms), 177 ms (13.7), 211 ms (12.3), and 247 ms (30.4), respectively. Two categories differed significantly: the cv#Cc and the ccv#Cc.

Results and Discussion

Mean reaction times and errors are displayed in Fig. 5. Cutoff points were established at 100 and 1200 ms. Misses and outliers accounted for 9.6% of the data. The false alarm rate was 8.2%. Analyses of variance were performed on mean latencies and error data for subjects and items. As far as the errors are concerned, there was a significant effect of serial position ($F1(1,24)$ = 6.8, p = .01 (MS_e = .569), but $F2 < 1$), and a marginal effect of syllabic structure ($F1(1,24)$ = 3.8 (MS_e = 1.0), p = .06 and $F2 < 1$). In the analysis of latencies, the interaction between Induction group and Syllabic position was the only reliable effect in both the subjects and items analyses ($F1(1,24)$ = 22.80, $p < .001$ (MS_e = 4746); $F2(1,28)$ = 21.70, $p < .001$ (MS_e = 3224)). The only other significant effect came from Induction group in the items analysis but not in the subjects analysis ($F1(1,24)$ = 1.7, $p > .2$; $F2(1,28)$ = 21.60, $p < .0001$ (MS_e = 3224)). That is, subjects of the Coda group responded faster than subjects of the Onset group. No other main effect or interaction reached the .05 significance level. Mean comparisons restricted to both groups showed that the Onset group detected onsets significantly faster than codas ($t(12)$ = 3.2, p = .01 by subjects and $t(30)$ = 3.4, p < .01 by items), while the advantage for codas vs onsets was only marginally significant for the coda group ($t(12)$ = 1.9, p = .07 and $t(30)$ = −1.8, p = .07).

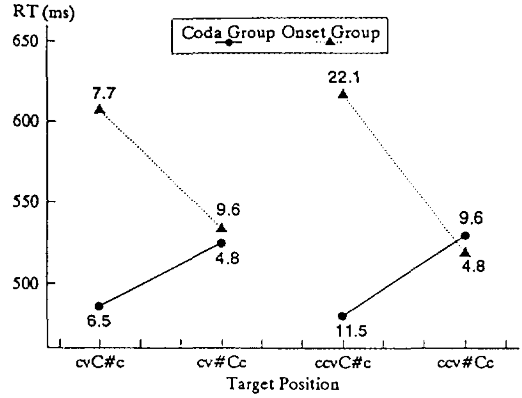

FIG. 5. Mean decision latencies and error rate (in percentage) of the Coda and Onset induction groups when the target appears at the four different positions. Spanish subjects—pseudoword stimuli—detection task.

These results parallel and extend the results obtained in the previous decision and detection experiments. That is, subjects employed a syllabic strategy which is very unlikely to have a lexical status. The present results confirm that the main effects, either of Serial position (experiment 2) or of Syllabic position (experiments 2 and 4), were not robust effects and could have originated from any peculiar properties of the material.

General Discussion

In the five experiments reported above, we found clear evidence that French and Spanish subjects who engage in a phoneme detection task are affected by the syllabic structure of target bearing words. Indeed, regardless of their maternal language, subjects detected targets in an expected syllabic position faster than in an unexpected position. For example, when most of the targets occurred in the coda of the first syllable, subjects responded faster when targets appeared in this position rather than in the onset of the second syllable. However, subjects were unaffected by the Serial position of the target. Even though the target appeared four of five times as the third phoneme, latencies remained unchanged when the target was in fourth position. It should be noted that the influence of the syllable was observed with a task and instructions that were not especially propitious to a syllabic outlook. Moreover, when informally interviewed at the end of the experiments, subjects did not mention having noticed the regularity of the target position.

The detection of a constituent, either a phoneme or a larger segment such as a CV or a CVC, is one of the most popular methods used to study speech comprehension. Pitt and Samuel (1990) added the attentional phoneme monitoring technique which we have refined in this study. Indeed, we compared results obtained when subjects had to make either a yes–no decision as in the Pitt and Samuel studies (our experiment 1 and 2) or a simple detection (our experiments 3 and 4). Our aim was to reduce the putative strategic effects which may arise with the decision task. However, these two variants produced much the same pattern of results, allowing us to talk about a generic attentional phoneme detection paradigm. We will argue that while the segment detection task used in previous studies of the on-line role of the syllable is more sensitive to the acoustic–phonetic details of the signal, while the Pitt and Samuel paradigm reflects the representation that subjects use to encode the speech signal. To this end, it is useful to compare the results observed in French and those in Spanish.

Studies in French usually give rise to syllabic effects. In segment monitoring studies (Cutler et al., 1986; Mehler et al., 1981) French subjects responded faster when the target coincided with the first syllable of the target bearing item compared to either smaller or larger targets. Syllabic effects in French were also observed in experiments 1 and 3 described above. Thus, both methods provide a similar picture of the processing routines in which subjects engage. The outcome of these studies is consistent with the ability of French speakers to syllabify French utterances.

Spanish speakers, like the French, know how to syllabify the speech stream without any trouble. Yet, Sebastian-Gallès et al. (1992) found that Spanish subjects do not show signs of syllabification in a segment monitoring paradigm. Indeed, they found that subjects detect CV targets faster than CVC targets both in CV and CVC words. How are we to account for the difference in the behavior of Spanish and French subjects? Sebastian-Gallès et al. (1992) invoke the notion of acoustic transparency. By acoustic–phonetic transparency they refer to the ease with which a segment can be identified as distinct from other competing candidates in the language. They notice that while French has about 16 vowels, Spanish has only 5 vowels. It is plausible to suppose that the syllabic space is more crowded in French than in Spanish. For instance, the two French CVs, /Re/ ("D note") and /Rɛ/ ("ray") are closer to each other than any two items existing in Spanish. Thus, Sebastian et al. speculated that in a standard (no foils) segment detection task, Spanish subjects can recognize a CV or a CVC from the initial portions of the carrier words. Indeed, the absence of foils allows subjects to accept both targets just from the onset of the carrier. This is possible because acoustic transparency allows the onset and nucleus to be obtained before they are influenced by the opened or closed nature of the first syllable. In a follow-up experiment, these authors showed that when subjects are slowed, syllabification emerges (see also Bradley et al., in press). This observation is congruent with the view that acoustic transparency makes it possible to bypass stable representations in some versions of the segment detection task.

What about the attentional task used in the experiments reported here? One would not expect acoustic transparency, which supposedly helps early identification of vowels, to play any role in this paradigm. Hence, we predicted no difference between French and Spanish subjects. Indeed, subjects remain sensitive to syllabic structure regardless of their native language, suggesting that the attentional paradigm provides a more reliable estimate of the subjects' knowledge and representations than the segment detection task. However, the segment detection task is an excellent indicator of some of the acoustic–phonetic properties of the language that play a part in the uptake of information. As we stated before, the number of vowels in a language may explain why French subjects cannot bypass the syllabic structure of the carrier word while Spanish subjects can occasionally do so.

Is it necessary to admit that syllabic effects arise at times prelexically and at others lexically, or alternatively, could it be argued that syllables arise exclusively from lexical representations? The results observed with the segment detection might be interpreted as showing that syllabification arises in Spanish speakers only after lexical access has taken place. If this interpretation is correct we would be obliged to argue that the Spanish use syllables to represent lexical items exclusively but not to recognize speech. However, experiment 5 counters such an interpretation since syllabic effects also emerge with pseudowords.

TABLE 2
RT ADVANTAGES (IN ms) FOR THE MOST AND LEAST FREQUENT CLUSTERS

	French		Spanish	
	Coda	Onset	Coda	Onset
Most	/KT/	/TR/	/KT/	/BR/
frequent	16	40	54	58
Least	/GM/	/CL/	/NS/	/PL/
frequent	78	132	17	27

There are several alternative accounts which could be invoked to explain our findings. One account can be couched in terms of the types of word internal clusters that the Ss identify from the induction lists. Of course, the kinds of clusters one encounters afford a cue to syllabic boundary. For example, the most frequent cluster in the French onset induction list was TR. One might expect that test words with TR internal cluster will be responded to faster than words with clusters that occurred less frequently in the induction list. Post-hoc analysis of the French and Spanish data do not support this hypothesis (Table 2)[3]. However, there is another, more abstract, cluster-based hypothesis that could fare better. Namely, subjects might get accustomed to

[3] We compared the RT advantages (difference between the group that did not expect the target and the group that expected the target at the right position) for test words that contained the cluster that occurred most frequently in the induction list and for test words that contained the least frequent cluster. The hypothesis of habituation to certain clusters predicts a larger advantage for words with more frequent clusters. Table 2 shows the clusters and the figures (in ms) for experiments 1 and 2.

Without capitalizing too much on such post-hoc analysis, we must stress that the French data goes against the prediction of the cluster hypothesis although that of Spanish subjects displays the predicted trend. However, even the less frequent Spanish clusters, with only one or two inductors, show advantages (27 and 17 ms) consistent with the induction.

processing certain types of clusters. For example, subjects in the Onset group might discover that most of the internal clusters belong to the "stop-liquid" kind. Note, however, that there is much less regularity in the coda induction lists (see Appendices). Thus, the "type of cluster" hypothesis biases to predict that the Onset group should be relatively more advantaged by induction than the Coda group. In contrast, if only the syllabic status of the target is relevant, no difference is expected between the Coda and the Onset group: both should be equally facilitated when the target appears at the expected location. In fact, when we contrasted each group with a control group of subjects who received no induction, we found the advantages of coda and onset induction to be fairly similar in size.[4] These results render less plausible the cluster account.

There are other reasons to prefer the strict syllabic formulation over cluster accounts. Namely, the former is linguistically motivated and has a firm rooting in psycholinguistics of speech. It also explains our results and makes the right predictions about the results reported by Pitt and Samuel. Subjects draw inferences about positions in a syllabic grid. In contrast, the cluster hypothesis which might provide an alternative account of our results seems to explain the observations reported by Pitt and Samuel in a less direct fashion. Indeed, although Ss in all groups received exactly the same stimuli, ergo, the same clusters, the effects are very different for the Ss induced to respond to the third or the fourth position. Of course, some ad hoc modifications might explain these results. However, the syllabic account appears to be more straightforward. The only problematic aspect of the syllabic account is that, in general, it was thought not to apply to English (see Cutler et al., 1986).

Hopefully, an induced phoneme detection design such as the one used here will be tried with English. Indeed, previous studies using segment detection, see Cutler et al. (1986, 1987), have claimed that the syllable is an adequate unit for French but not for English. With straight segment detection in Spanish, Sebastian-Gallès et al. failed to find syllabification. However, in this report, Spanish yields an effect compatible with a syllabic hypothesis. In Sebastian-Gallès et al. (1992), it was argued that Spanish is a syllable-based language while English, although still a controversial case, was described as nonsyllabic. It would thus be important to evaluate English with this new task. Metrical phonology, in order to account for stress phenomena (among others), suggests that English speakers, like French and Spanish, have syllabic representations. Moreover, Treiman (1986; Treiman and Danish, 1988) have argued that native speakers of English know about the syllable and its components. These considerations would lead us to predict that English speakers, tested with the attentional paradigm in the same way as French and Spanish subjects, should syllabify. Of

[4] Control groups were ran in French (20 subjects) and in Spanish (28 subjects) with the go–no go paradigm. Control subjects were tested with the same 16 test words (as in experiments 3 and 4), but they received an unbiased induction list: this list was created by intermixing the coda and onset induction lists so that half the phoneme targets were codas and the other half, onsets. Thus, subjects were not let to attend to a precise syllabic position. The experimental procedure was as in experiments 3 and 4. For French control subjects, the mean reaction times to codas and to onsets, regardless of Serial position (3 and 4), were 321 ms (SD = 70) and 325 ms (SD = 77), respectively. This allows computation of the benefit figures for the Coda and the Onset groups of experiment 3 by subtracting the differences between the RT of the experimental and the control groups at the unexpected and at the expected location of the target. The statistics were 15 and 30 ms for the Coda and the Onset groups, respectively. These are ordered as predicted by the cluster hypothesis (larger advantage for the Onset than for the Coda group) but do not significantly differ. The Spanish control subjects performed at 513 ms (SD = 127) on codas and 482 ms (SD = 123) on onsets. This gave benefit figures of 47 ms for the coda induction and 53 ms for the onset induction. Here, both advantages were substantial and, moreover, no group seemed to benefit more than the other. This goes contrary to the cluster account prediction.

course, another outcome is conceivable since the reasons we have just invoked for postulating syllables in English are not based on on-line measures of speech processing.

APPENDIX 1: FRENCH MATERIAL (EXPERIMENTS 1 AND 3)

Onset List

Test items. cyClone, caPrice, noBlesse, diPlôme, miGraine, suBlime, nomBreux, paTrie. prêTresse, triPler, criBler, flaGrant, proBlème, plaTrer, tremBler, proGrès.

Inductors. naVrée, seVrée, ciTron, naCrée, reCrue, déClin, réClame, cyCliste, miCrobe, saCrée, suCrée, seCret, déBris, puBlic, faiBlesse, taBleau, douBlure, faBrique, féBrile, liBraire, viBrant, souPlesse, suPplice, déPrime, rePli, déPlaire, cyPrès, caPsule, suPrême, gouDron, suFfrage, reFlux, nauFrage, saFran, reFrain, coFfrage, réFlexe, siFfler, néVrose, paTron, reTraite, péTrole, viTrine, moTrice, maîTrise, myStère, reGret, maiGrir, tiGresse, deGré.

Coda List

Test items. caPtif, doCteur, seGment, symPtôme, faCteur, suBtil, rePtile, leCture. staGner, fluCtue, fraGment, stiGmate, traCteur, cryPter, planCton, fraCture.

Inductors. paRdon, veRtige, paRquet, seRpent, veRbal, moRtel, peRsonne, caRton, gaRder, suRface, paRcours, noRmal, maRquer, tuRban, suRtout, souRdine, maRteau, paRfum, veRdure, ceRtaine, fuRtive, viRgule, maRtyr, faCture, paCtole, teChnique, seCteur, taCtile, viCtime, neCtar, laCté, faCtice, sePtembre, caPture, scePtique, piGmé, maGma, maGnum, piGment, suBmerge, suBsiste, suBjugue, maLsain, vuLgaire, voLcan, voLtige, fiLmer, caLmant, cuLture, suLtan.

Note. French, unlike English or Spanish, possesses nasal vowels. For example, the phonetic transcriptions of "plancton" is "plãctõ." Thus, the test words "symPtôme" and "planCton" belong to the C(C)VC#C groups, while "nomBreux" and "tremBler" belong to the C(C)V#C groups. For all Appendices, the target phoneme is capitalized.

APPENDIX 2: SPANISH TEST WORDS (EXPERIMENTS 2 AND 4)

Onset List

Test items. saGrado, soBrina, coPla, caPricho, miCrobio, liBro, meTralla, rePrimir. preClaro, flaGrante, triPlicar, proClive, triPle, proGre, proBlema, proGrama.

Inductors. ciClo, faBrica, ceTrino, deGradar, siGlo, liBreta, buCle, feBrero, meDrar, saCristan, coBre, rePlica, moFlete, soPrano, feBril, loBrego, ciPres, tiGre, seGlar, loGrar, ciClico, reProche, viTrina, reFrescar, soFrito, rePlegar, laDrar, reBrotar, laGrima, ciFra, caBle, viBrar, caBra, ceDro, queBrantar, maDrugar, deCreto, suBlime, dePresion, maDrigal, paDrino, paTron, siDra, seCreto, miGra, laBrador, biBlico, fiBra, meTrico.

Coda List

Test items. caNsado, seGmento, ruPtura, liNce, neCtar, rePtil, doGma, reCtitud. fluCtua, bloNda, fraGmento, traCto, glaNdula, fraCtura, criPta, traCtor.

Inductors. piGmeo, gaMba, faCtor, sePtimo, caPtar, laPso, caMpestre, fuRtivo, maGno, baCteria, caPturar, maRtir, viCtima, laStima, doCtor, seNsacion, maGnitud, seCtor, caDmio, suBlingual, raPtado, cuLtivo, maGnesio, reCtor, maGma, maSticar, caPsula, suBsuelo, caNdor, teCnico, laCteo, raPtar, piGmento, leCtura, veCtor, faCturar, taCtil, suBcostal, viCtoria, doCtrina, cuLpa, suBsanar, duCtil, suBsistir, jaCtarse, diGno, siGma, suBvencion, seCta.

APPENDIX 3: SPANISH TEST PSEUDOWORDS (EXPERIMENT 5)

Onset List

Test items. coFlinciar, piDriente, teGleral, piTronal, toClanto, ciBreda, maPlecho, muTrisar. froBlante, cleProna, traPleno, driClivo, gloPluron, treBlinar, ploGlifar, ploGlidal.

Inductors. taClefon, chaBreto, caDrafa, ruGlutel, taPresior, siProche, fiDrante, siBrenor, piCraton, coDrinar, peGraspar, coTruico, ciBronal, diGropar, piBrerol, taPladar, chuBrigo, poClino, maFreto, chuFruisa, tuPligo, teGrina, soDruogal, joDrastor, fiCrontEn, piBrante, doClidion, puGlarda, tuFra, soBlentia, coTracha, piCrismon, diGruaval, teBrentol, queDrieson, toPral, seBrltua, seBrador, caFlegil, siGrear, chiBruito, soBlefar, puGlosia, niBreras, seTriza, siBreto, baTronciar, tiPresil, faBlico, seBra.

Coda List

Test items. ceMboilga, dePtonia, soBdula, reLvinuar, tuNtoba, cuNcero, duNsielar, cePtoril. ploNdinar, cloPtuicon, pleStomia, pruCtosa, truPtano, dreCtural, droCtivar, bliPtonsar.

Inductors. dePtorial, paGmorsia, muNsaza, doPterdo, reDmida, deMpostro, siPturdor, fiStucar, puGmesol, deCtreba, raNdina, dePtordil, poCtora, roCtona, seGniral, poCtular, ciRtoval, tiGmiense, biRdiela, puSgotriel, doLties, soMbionar, coLpino, moCturon, vaCmaler, buCtoria, saGmelar, cuPsorte, reLpordar, saPtencar, roPtacor, raLparron, miRtila, geMbora, foCtaso, muRlido, riGnedio, cuNtida, paGnodiur, muCtilda, siPtala, maPsola, piNdiural, deCtueso, tiStomal, chaPtemon, soBledir, rePsulon, paGnida, daGtordil.

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