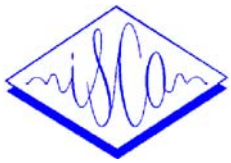

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THE LOCUS OF THE SYLLABLE EFFECT: PRELEXICAL OR LEXICAL?

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ABSTRACT

The claim that the syllable constitutes a basic perceptual unit in French is commonly accepted. It is based in part on the syllable effect [1] obtained with words. The present study extends these syllable detection experiments to pseudowords. Four experiments failed to replicate the syllable effect observed on words. Detection responses in pseudowords are made as soon as sufficient information becomes available in the signal. The different pattern of results obtained with words and pseudowords suggests that the syllable effect is post-lexical rather than pre-lexical.

1. INTRODUCTION

One important issue in the study of spoken word recognition involves determining how acoustic-phonetic information is mapped onto lexical representations. It is generally assumed that this mapping is mediated by one or several levels of sublexical representations, and various kinds of linguistic units, from phonetic features to syllables, have been suggested as intermediate codes. One influential source of evidence favouring the hypothesis that syllabic units are instrumental in speech processing comes from studies using the sequence monitoring task [2].

In the original study [1], French subjects detected consonant-vowel (CV) or consonant-vowel-consonant (CVC) targets in spoken carrier words which varied in syllabic structure (CV.CV- "pa.lace" vs CVC.CV- "pal.mier"). Detection latencies showed a cross-over interaction between target type and carrier syllabic structure, such that responses were faster when the target corresponded to the initial syllable of the carrier. Surprisingly, despite a number of replications of the syllable effect [3], no published study has examined the existence of this effect for French pseudoword carriers. Indeed, such an experimental demonstration would help to confirm the prelexical locus of the syllable effect. Moreover, the generality of the original findings is further limited by the fact that published studies in French used only liquids as pivotal consonants. We thus conducted experiments aimed at examining the syllable effect with pseudoword carriers, in which we varied the nature of the pivotal consonant and the preceding vowel. We introduced pivotal consonants (fricatives) for which syllable effects are less likely given the more limited allophonic variation of these consonants. These manipulations should permit us to assess to what extent the syllable effect is dependent on specific acoustic or phonetic characteristics of the pivotal consonant.

2. LINGUISTIC MATERIALS

Thirty-two pairs of pseudowords were constructed such that in each pair, the CV carrier and the CVC carrier started with the same CVC sequence. For example:

PA.LOUNE / **PAL.**NUFFE

Four different vowels were used: /a/, /i/, /u/, /y/. Three classes of consonants were used as pivotal consonant:

- liquids /r/ and /l/
- stops: /p/ and /k/
- fricatives: /f/, /S/ and /s/. In one half of the pairs, the CVC carrier contained a consonant cluster that cannot be tautosyllabic, so that the syllable boundary is placed after the fricative, as in

BA.CHELLE - **BACH.**MI

whereas in the other half, the syllable boundary was located before the fricative as in

CA.FERE - **CA.F**LI

In addition, 128 target-absent filler trials (e.g., target TOU, carrier PALON) and 128 foil trials were constructed. The foils were devised to ensure that subjects could not respond on the basis of a partial match on the initial segments (e.g., target GU, carrier GALOR; target GUL, carrier GURIP).

In each experiment, the experimental trials thus constituted one third of all trials.

The carriers were read by a French native speaker (male, Belgian accent). A French native speaker (female, French accent) pronounced 64 targets (32 CV and 32 CVC). Each target corresponds to the initial sequence of one carrier pair.

A classical syllable monitoring procedure was used. Each trial consisted of a warning signal, followed by the presentation of the target and the carrier. Subjects were required to press a key as rapidly as possible if the target was present at the beginning of the carrier. Each subject received all carriers twice, once with the CV target and once with the CVC target. Order of targets was counterbalanced across subjects.

3. EXPERIMENTS

Four experiments were conducted with the same test items and with the same task.

3.1. Experiment 1 and 2

E1 and E2 examined whether and how the presence of foils (carriers pseudowords that contain the first phoneme(s) of the target, but that should not elicit a detection response) modulated the pattern of detection latencies.
In Experiment 1, the 128 foils were replaced by target-absent trials (128 other fillers). 36 subjects were tested in E1 and 29 subjects in E2.

3.2. Experiment 3 and 4

In the original experiments, all targets were made up of the vowel /a/ and a liquid pivotal consonant. We hypothesized that the homogeneity of the targets might have helped subjects to extract syllabic cues. E3 and E4 examined whether blocking of carriers by vowel (E3) and pivotal consonant (E4) influenced the results.
28 subjects were tested for E3 and 44 subjects for E4.

3.3. Results

Overall , we failed to replicate the syllable effect: in each experiment, CV targets were detected faster than CVC targets, with no hint of a crossover interaction.

Subjects were faster in Experiment 1, in which foils were replaced by target-absent fillers, but the pattern was otherwise similar in the four studies.
Statistical analyses of the response times showed

- A Target Length Effect : the detection of CVC targets requires more time than the detection of CV targets ($p < .0001$ for the four experiments) (Fig 1, 2, 3, 4).
- A Carrier Type Effect: the detection times to CVC carriers are faster than to CV carriers ($p < .0001$ for E2, E3, E4 and $p = .0002$ for E1).
- A significant interaction was observed in E2, E3 and E4. However, it is due to a reduction of the target length effect with CVC carriers, rather than to the expected cross-over interaction.

Blocking the carrier items did not produce any particular effect. In E3 (blocking by vowels), no syllabic effect appeared, even for the vowel group including /a/. In E4 (blocking by pivotal consonant), we observed a Carrier by Targets interaction for liquids. However, this interaction does not demonstrate an influence of syllabic units, because for CVC carriers, CV targets are always detected faster than CVC targets.
The error analyses did not show any particular effect except for E2 (with foils) for which there is a carrier type effect (more errors for CVC carriers, $p = .0011$). But this effect is due to an increase in errors for detecting CVC targets in CVC carriers.

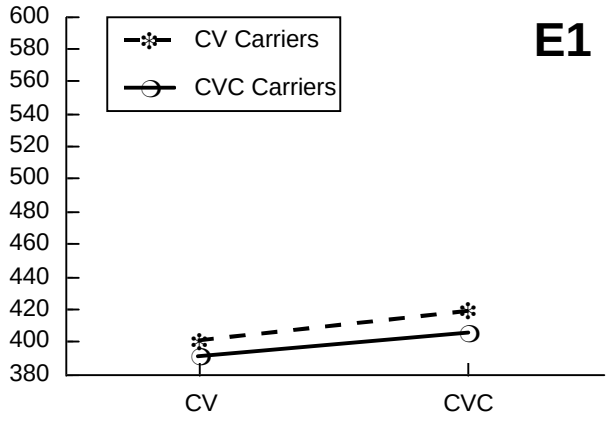

Figure 1: Detection latencies (in milliseconds) in E1.

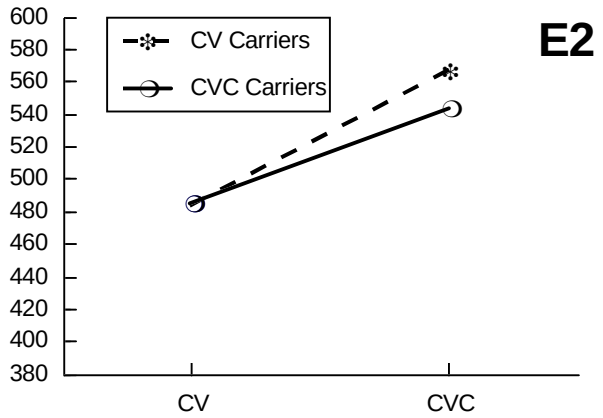

Figure 2: Detection latencies (in milliseconds) in E2.

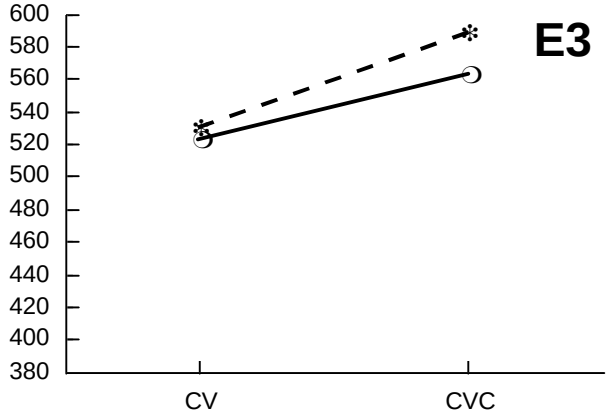

Figure 3: Detection latencies (in milliseconds) in E3.

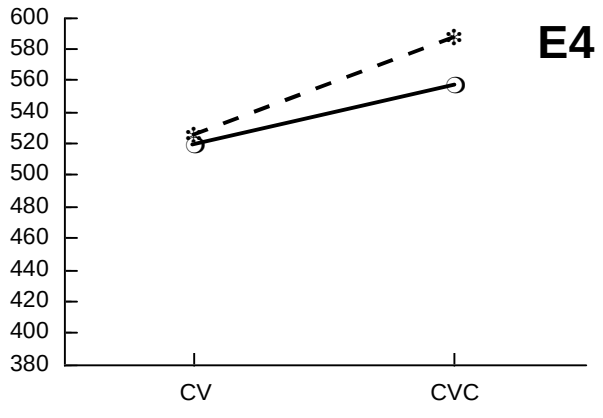

Figure 4: Detection latencies (in milliseconds) in E4.

Taken together, the results appear consistent with a phonemic processing hypothesis: the target is detected as soon as all of its phonemes are identified in the signal. Thus, subjects are generally faster at detecting shorter targets. This suggests that detection responses are made as soon as sufficient information becomes available in the signal.

4. ACOUSTIC AND PERCEPTUAL MEASUREMENTS

To test this hypothesis further, the detection latencies were correlated with phonetic measurements of the vowel onset and of the pivotal consonant onset on the carriers, as well as with perceptual estimates, obtained in a phoneme gating experiment.

4.1. Acoustic measurements

The temporal location of Vowel Onset (VO_1) and Pivotal Consonant Onset (PCO_1) was measured by a trained expert phonetician (C.M.) for each carrier.

4.2. Perceptual measurements

Twenty-one subjects heard increasing portions of signal (by increments of 15 ms) and had to write down what they heard as precisely as they could. From the protocols, we estimated onset of vowel and pivotal consonant as the duration until first correct report. Individual data were averaged over subjects to obtain VO_2 and PCO_2 estimates, for each carrier item.

4.3. Regression analyses

We examined separately for CV and CVC targets and for each experiment what proportion of the variance (across items) is accounted for by

- Step 1 (Forced predictor) : the temporal position of VO (VO_1 or VO_2).
- Step 2 : the delay between PCO and VO (ΔPC_1 or ΔPC_2).

As shown in figures 5 and 6, the outcomes based on acoustic and perceptual measurements were highly consistent.

The location of the vowel onset accounts for a large part of the item variance (50 to 80%), and more so for the detection of CVC targets than CV targets. Total variance explained is between 50 and 90%, except for E1 (without foils). Furthermore, and more interestingly, the temporal position of the pivotal consonant accounts for 20-25% of the remaining variance, but only for CVC targets.
It confirms that detection is determined primarily by phonemic throughput.

5. CONCLUSIONS

Our results provide no evidence for the existence of a syllable effect in French with pseudowords in a variety of experimental conditions. The presence or absence of foils and the use of different blocking conditions (by vowel and by pivotal consonant) did not allow us to replicate the syllable effect obtained previously for words. This finding is quite surprising since the experimental conditions used here were selected to maximize the likelihood of obtaining a syllabic effect.
For all the experiments with foils (E2,E3,E4), detection latencies are accounted for well by the phonetic properties of the carriers. Subjects' detection responses are made as soon as sufficient acoustic information becomes available in the signal to identify the final segment of the target (V and C, respectively). In contrast, the generally faster RTs obtained in E1 (without foils) and the weaker correlations indicate that subjects here respond even earlier, perhaps once the initial matching segment has been identified.

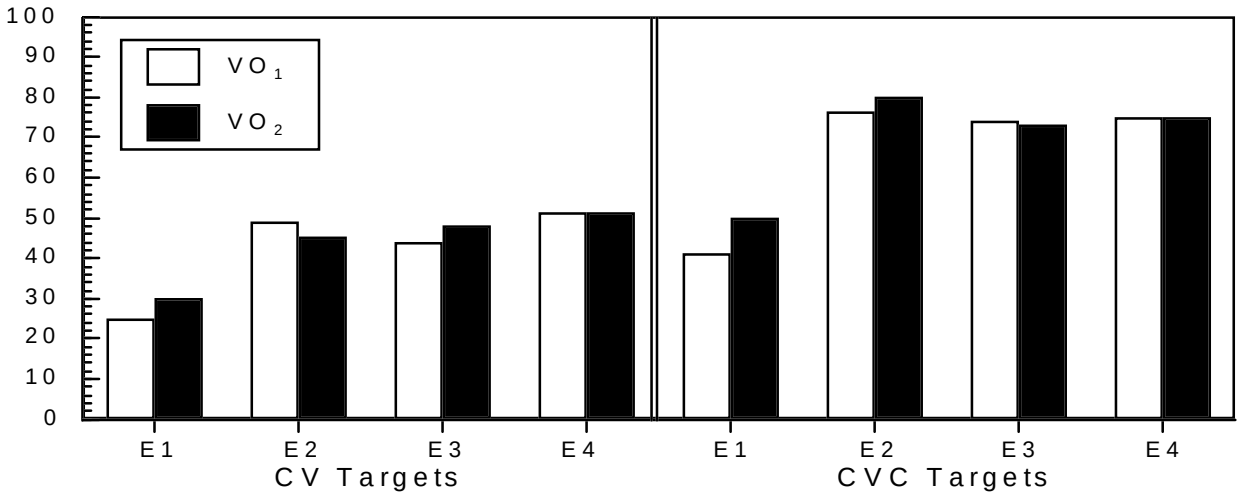

Fig 5: Proportion of variance explained by Vowel Onset location

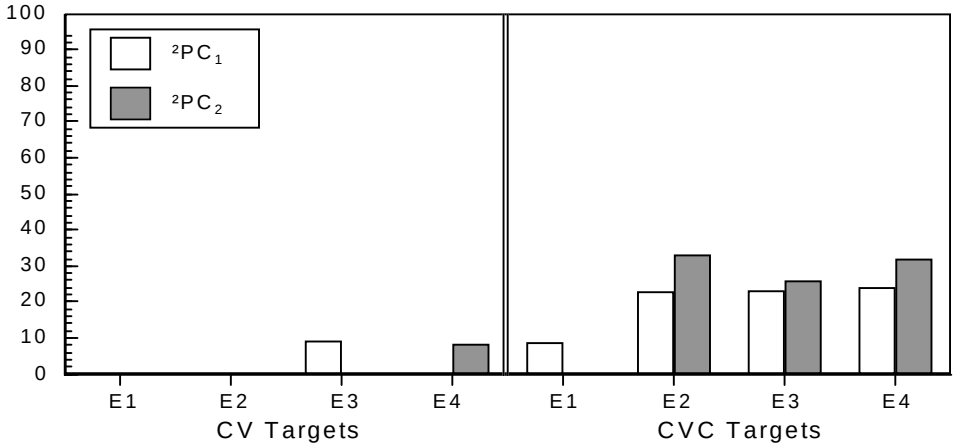

Fig 6: Proportion of residual variance explained by Pivotal Consonant Onset location (relative to Vowel Onset)

The fact that the syllable effect has been obtained for words in the original experiments but not for pseudowords in the present study suggests that the locus of this effect is at the post-lexical rather than at the pre-lexical level. To test this hypothesis, we are now conducting two experiments with matched materials and conditions, one with words and the other with pseudowords. The comparison of the results from these experiments should allow us to answer to this question.

6. REFERENCES

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