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Syllabic Segmentation and Literacy

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A total of 40 unschooled Portuguese adults, either illiterates or ex-illiterates, were presented auditorily with short sentences and asked to detect the occurrence of a word initiated by a specified syllable-sized target. The target was either CV or CVC, and the target-bearing word was initiated by either a CV or a CVC syllable. The dependent variable was the number of correct detections. Ex-illiterates performed better than illiterates. There was a significant interaction between target type and word structure: Detections were more numerous when the target coincided with the first syllable of the target-bearing word than when it did not. This effect is similar to the one obtained by Mehler, Dommergues, Frauenfelder, and Segui (1981) in a reaction-time study with French literate subjects, and shows evidence of a syllabification procedure. The fact that this syllable effect is obtained with illiterate subjects, regardless of their overall performance, suggests that the development of a syllabification procedure in speech processing depends primarily on informal experience with the language rather than on formal instruction.

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INTRODUCTION

Previous work on the mental representation of spoken language in illiterate adults has dealt with metalinguistic abilities more than with perceptual processing. However, the possibility of an influence of literacy on speech perception should not be neglected. Learning to read and write in an alphabetic system entails the ability to analyse speech intentionally into phonemic units (Morais, Cary, Alegria, & Bertelson, 1979; Morais, Bertelson, Cary, & Alegria, 1986; Read, Zhang, Nie, & Ding, 1986). Hence, it might also contribute to the elaboration of new processing strategies. The phonemic representation that is required in reading and writing might provide the basis for processes of spoken word recognition, consisting of finding the best match between a sequence of discrete segments and a lexical entry. Morais, Castro, Cabral, Kolinsky, & Content (1987) carried out an experiment on the recognition of words presented dichotically and found some evidence for an effect of literacy on listening strategies: The pattern of errors suggest that literate subjects tend to pay attention to individual phonemes, whereas illiterates seem to employ a more global strategy.

The present paper is concerned with the representation of syllables rather than that of phonemes. We will describe below an effect, formerly observed by Mehler, Dommergues, Frauenfelder, and Segui (1981), which suggests that the syllabic unit is used in speech processing, at least in some languages. Given that the intentional analysis of speech into syllabic units seems to be influenced by the acquisition of literacy, though to a lesser extent than the analysis of speech into phonemes, we thought it interesting to examine whether Mehler et al.'s (1981) effect, henceforth called the syllable effect, is affected by literacy.

To summarise briefly, the data obtained on the development of the intentional analysis of speech into syllables is as follows. Liberman, Shankweiler, Fischer, and Carter (1974) found a large increase in the number of children, from kindergarten to the first grade, who were able to meet specific performance criteria based on an experiment requiring them to count the number of syllables in a particular utterance. However, their results may simply be due to age or instruction in literacy. In an experiment which required illiterate adult Portuguese to reverse syllables in a particular utterance, Cary and Morais (1979) found that correct responses ranged from 13 to 93%. Testing a similar sample of illiterate adults, in an experiment based on the deletion of an initial syllabic vowel, Morais, Bertelson, Cary, and Alegria (1986) found that high performers (more than 75% correct) outnumbered low performers (less than 25% correct) by 4 to 1 (57 as compared to 14%). Among ex-illiterates, i.e. subjects from the same background who had learned to read and write by attending adult

literacy classes, 95% were shown to be high performers. The same pattern was also observed for a task on syllable detection. Thus it seems that the ability to analyse speech intentionally into syllables is achieved by some people before they become literate, but that literacy influences its development in others.

In Mehler et al.'s (1981) study of the syllable effect, the subjects (college students) responded to the target (either CV or CVC) faster when it corresponded to the initial syllable of the word than when it did not. For example, the target *pa-* was detected faster in *palace* than in *palmier*, whereas the target *pal-* was detected faster in *palmier* than in *palace*. This pattern of results, which suggests that a syllabic segmentation routine is used in speech processing, was obtained with highly literate French students, and has been replicated several times. However, these results were not replicated in a comparable sample of English-speaking subjects (Cutler, Mehler, Norris, & Segui, 1986); this was probably due to the fact that English, unlike French, has many examples of ambisyllabic consonants (e.g. the /l/ in "palace" belongs to two syllables). It may also have to do with the fact that English has a larger variety of syllabic structures compared to French. Moreover, the fact that the syllable effect appears in French speakers listening to English words but not in English speakers listening to French words, suggests that listeners tend to use the strategy that they have developed for the processing of their native language, regardless of what language they are listening to.

Given that both English and French are written alphabetically, the absence of the syllable effect in English speakers makes it unlikely that the effect obtained with French speakers reflects a procedure which would have developed after instruction in literacy. However, the development of this procedure might require *both* a language with clear syllable boundaries and/or relatively few syllable structures, *and* the acquisition of literacy.

Because of the unavailability of French illiterate adults, a sample of Portuguese subjects was tested instead. A syllable effect might be expected with literate Portuguese subjects, because Portuguese does not suffer from ambisyllabicity. However, this observation could not be taken for granted because, at the level of surface phonology, Portuguese (at least as it is spoken in Portugal) presents many examples of vocalic reduction, which render syllabification more complex and ambiguous than in French.

To examine literacy effects, illiterate and ex-illiterate subjects were compared. Ex-illiterates, who are relatively good at analysing speech intentionally into syllables, were expected to display the syllable effect. This prediction was based, of course, on the assumption that Portuguese is as apt as French for eliciting the syllabification procedure. The most interesting question concerns the behaviour of the illiterates. If the development of the syllabification procedure depends only on the charac-

teristics of the language, then illiterates should display the syllable effect as much as ex-illiterates, regardless of level of performance. But if it depends not only on the characteristics of the language but also on the degree of ability attained at segmenting speech intentionally into syllables, then illiterates as a group, and among them the poorest performers, might display a reduced syllable effect.

Because the task was expected to be difficult, leading to a non-negligible number of errors (cf. Morais et al., 1986; Cary and Morais, 1979), especially in the illiterate subjects, this investigation was concerned with response accuracy. Response times were not recorded because the testing conditions in the field were not such as to encourage stable reaction time performance, and because running the experiment in the laboratory would have led to considerable difficulties in recruitment.

METHOD

Subjects

The experiment was carried out in an agricultural area of southern Portugal and in the shantytowns of Lisbon. The sample comprised 20 illiterate and 20 ex-illiterate subjects, each of whom was paid for their participation in the experiment.

The illiterates comprised 18 females and 2 males, aged 19–67 years, all of whom had never attended a school. Of these, 12 were agricultural workers, 6 were servants and 2 were masons. The ex-illiterates comprised 17 females and 3 males, aged 19–64 years, all of whom had never attended a school during their childhood but who were all attending adult literacy classes. Of these, 15 were servants and 5 were masons.

Materials and Procedure

A total of 12 pairs of common words sharing the same three initial phonemes (CVC) were selected (see Appendix). In each pair, one had a syllable boundary after the initial CV, whereas the other had a syllable boundary immediately after the second C. Each word was included in a sentence four to eight words long. The sentences were appropriately neutral, and the position of the target-bearing word was varied [e.g. "O homem fechou a garagem", *The man closed the garage* (targets /gʌ/ or /gʌr/); "Os larapios roubaram o carro", *The burglars stole the car* (targets /lʌ/ or /lʌr/)]. There were also 24 distractor sentences, thus making a total of 48 trials. These were recorded at a slow–normal rate and presented to the subjects in blocks of eight trials. Each block was defined by a particular target: /pa/, /pal/, /gʌ/, /gʌr/, /lʌ/, and /lʌr/. Four trials in a block

contained the target, and four did not. Among the former, the target was a syllable in two trials and less than or more than a syllable in the other two. For example, the target /gʌ/ was a syllable in *garagem* but not in *garganta*, and the target /gʌr/ was a syllable in *gargalo* but not in *garoto*.

A potentially interesting variable is the percentage of phonemes shared by the target and the target-bearing word. On average, this percentage was highest for CVC target/CV word trials (49%), followed by CVC target/CVC word trials (44%), and lowest for CV target/CV word and CV target/CVC word trials (32 and 30%, respectively). Performance therefore depends on whether concordance of the target with the target-bearing word or the percentage of common phonemes is the relevant variable.

The blocks were presented randomly, except for the proviso that the two blocks containing a target with the same initial CV were presented in succession. For one of these blocks, 10 subjects in each group were to detect the target CV and 10 were to detect the corresponding CVC target. Thus, for each subject asked to detect /gʌ/ in *garagem* and *garganta*, and /gʌr/ in *gargalo* and *garoto*, there was another who was asked to do the reverse. In addition, for each subject with a CV-CVC target order, there was another with a CVC-CV target order.

The target was presented orally to the subjects before each block. Their task was to tap on the table whenever they heard the target and to pronounce the word containing it.

RESULTS

On average, the illiterate subjects detected 55.7% of the targets, with individual performances ranging from 8.4 to 91.7%; ex-illiterates detected 84%, with a range of 41.7–100%. False detections were extremely rare: 1% when the target was a CVC and 2.5% when it was a CV, with no difference between the groups.

The analysis of variance on the correct detections showed a highly significant effect of literacy both across subjects [$F1(1,38) = 18.28$, $P < 0.0005$] and across items [$F2(1,22) = 84.79$, $P < 0.0005$]. There was also a highly significant interaction between word structure and target type [$F1(1,38) = 24.64$, $P < 0.0005$; $F2(1,22) = 30.04$, $P < 0.0005$]. This interaction was significant both in the illiterate subjects [$F1(1,19) = 14.74$, $P < 0.005$) and in the ex-illiterates [$F1(1,19) = 9.91$, $P < 0.01$], and it did not depend on group ($F1<1$) (see Fig. 1). CV targets were detected more accurately when they corresponded to the initial syllable of the word than when they were part of an initial CVC-syllable [$F1(1,38) = 21.87$, $P < 0.0005$; $F2(1,22) = 22.25$, $P < 0.0005$]. The reverse was observed for CVC targets, this effect being significant in the analysis of subjects [$F1(1,38) = 4.81$, $P < 0.05$] but failing to reach significance in the analysis of items

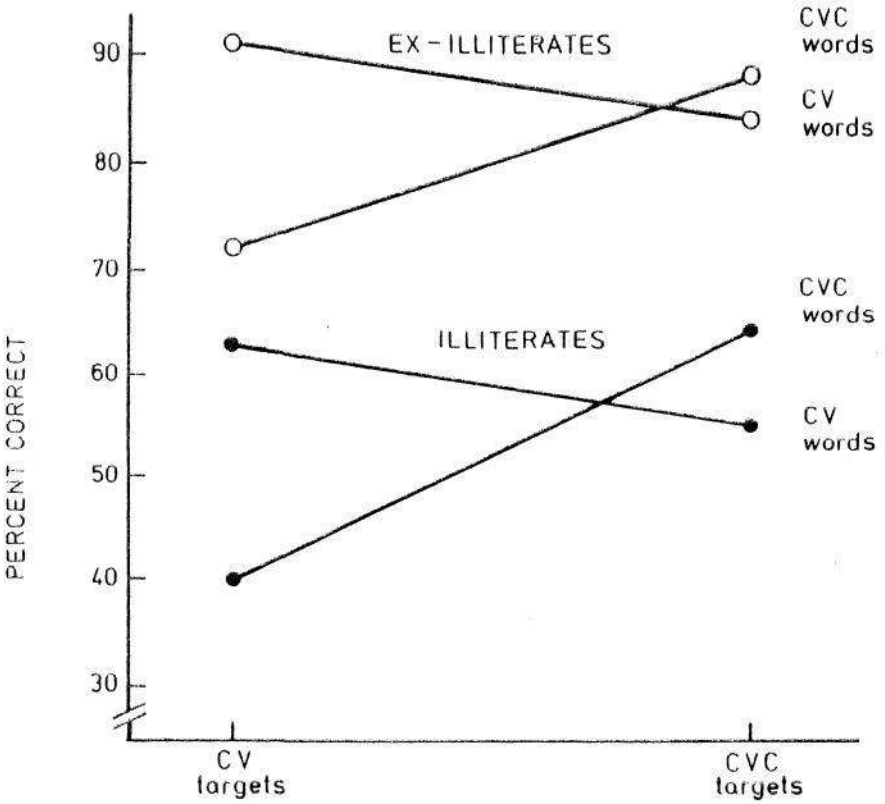

Fig. 1 Mean percentage of correct detections for illiterates and ex-illiterates, as a function of target type and word structure.

[$F2(1,22) = 2.89$, $P = 0.05$]. A direct comparison, for illiterates and ex-illiterates taken together, of the effect observed for each type of target showed a much greater difference for the CV targets than for the CVC targets [$t(39) = 3.09$, $P < 0.005$].

Word structure was significant [$F1(1,38) = 7.96$, $P < 0.01$; $F2(1,22) = 6.83$, $P < 0.025$], reflecting better average scores when the initial syllable was CV. Target type fell short of significance in the analysis of subjects [$F(1,38) = 4.38$, $0.10 > P > 0.05$] and was significant in the analysis of items [$F2(1,22) = 6.83$, $P < 0.025$], reflecting better average scores for a CVC target. These two effects stem from the fact that detection of CVC in a word initiated by a CV syllable was better than detection of CV in a word initiated by a CVC syllable.

It is worth noting that the interaction between word structure and target type is observed even at low levels of performance. Among the eight

illiterates with a mean performance below 50%, seven displayed the interaction. An analysis of variance on the correct detections of illiterates only, including both low (<50%) and high (>50%) performers, showed that the interaction between target and word structure does not depend on group ($F1 < 1$). Consistent with this analysis, the correlation between the size of the syllable effect and overall performance was low and non-significant ($r = 0.15$) in the illiterate group.

Finally, it is also worth noting that performance in the two conditions in which the target and the initial syllable of the word coincided, was positively correlated with performance in the two conditions in which there was no such coincidence ($r = 0.79$, $P < 0.001$, in the illiterate group, and $r = 0.60$, $P < 0.01$, in the ex-illiterate group). It thus seems that performance was dictated to a large extent by a component that is common to both kinds of conditions.

DISCUSSION

The present experiment confirms previous results (Morais et al., 1986) on the ability of illiterate and ex-illiterate subjects to detect the occurrence of syllable targets. In the previous study (Morais et al., 1986), the mean number of correct detections for illiterates was 52%, and in this study it was 64% for the two conditions tested when the target coincided with the initial syllable of the critical word. Ex-illiterates, however, obtained much higher scores: 83 and 90%, respectively. As far as we are able to assume that illiterates and ex-illiterates are comparable in terms of both general cognitive capacity and attitudes towards testing, it can be concluded that alphabetic literacy helps people to focus on the internal structure of utterances in order to detect syllable targets.

The present experiment shows that detection performance is significantly lower for targets that do not coincide with the first syllable of the target-bearing word than for those that do. These results are similar to those obtained on reaction times with French literate subjects (see Mehler et al., 1981). They suggest that Portuguese-speaking subjects tend to represent spoken words as a sequence of syllabic units.

As far as literacy effects are concerned, the main contribution of the present study is that the relative advantage, for monitoring purposes, of a syllabification procedure over other—either more analytical or more global—procedures does not depend on the acquisition of literacy. As a matter of fact, the pattern of errors displayed by the illiterates is identical to that of the ex-illiterates as regards the syllable effect. Moreover, even the poorest illiterate subjects displayed the effect. The syllabification procedure, of which the syllable effect gives evidence, thus appears to depend primarily on informal experience with the language rather than on

formal instruction. Illiterate subjects with very low metaphonological ability have certainly not developed a syllabification procedure for coping with highly artificial monitoring tasks. Thus, it is fair to assume that the syllable effect reflects a syllabic representation of speech at some perceptual level.

However, one still has to explain the poor performance displayed by some subjects, even when the target corresponded to the initial syllable of the word stimulus. It can probably be accounted for by the metaphonological components of the detection task: accessing the syllabically organised perceptual representation; isolating a particular syllable from the others; and operating a match between the isolated syllable and their representation of the target. That the present task involves at least two components, of which one is presumably of a metaphonological nature and the other is responsible for the syllable effect, is also suggested by the fact that the illiterates showed a high positive correlation between the situations in which the target and the initial syllable of the word coincided and those in which they did not, but no correlation between the syllable effect and overall performance.

If the monitoring performance was affected only by the fact that the target matches or does not match the initial syllable of the target-bearing word, and not at all by the phonological complexity of either the target or the target-bearing word, then the interaction obtained should have been perfectly symmetrical. However, this was not the case. In addition to the syllable effect, the present experiment shows effects of target type and word structure. CVC targets were more frequently detected than CV targets. This result is inconsistent with a hypothesis that could *a priori* be taken as reasonable and, according to which, facility of detection is an inverse function of the phonological complexity of the target. It would be consistent, however, with the uncertainty hypothesis (Foss & Swinney, 1973; Swinney & Prather, 1980). One potential explanation for the present target effect is that CVC targets are more frequently detected than CV targets, because in the first case more cues are available and so subjects' uncertainty diminishes. In other words, the facility of detection would depend on the proportion of phonological information that is shared by the target and by the target-bearing word. This hypothesis implies, of course, that the representations involved in the target–word matching operation may have not only a syllabic format but also a more global one.

In the interpretation of the present results, the notion of a strategy based on the amount of non-syllabic cues can be reconciled with the idea of resort to a syllabification procedure if one admits that this procedure is more efficient for some types of trial but not for others. It should be noted that the interaction observed between target type and word structure shows an advantage for CVC targets as well as for words initiated by a CV syllable.

Let us first take the situation in which the target corresponds to the initial syllable of the word. There were as many correct detections for CVC targets in words initiated by a CVC syllable as for CV targets in words initiated by a CV syllable. This is the result that would be expected if the input is identified syllable-by-syllable. By contrast, if the input were identified on the basis of non-syllabic cues, there could have been more correct detections in CVC target/CVC word trials. This is because the percentage of phonological information shared by the target and by the target-bearing word is greater for CVC target/CVC word trials (44% of phonemes) than for CV target/CV word trials (32%) (we assume, indeed, that the proportion of phonemes and the proportion of unsegmented phonological information are highly correlated).

Let us now take the situation in which the target does *not* correspond to the initial syllable of the word. Here the syllabification procedure is insufficient, and the fact that CVC target/CV word trials yielded more correct detections than CV target/CVC word trials is probably linked to the greater number of phonological cues available in the former (49 and 30% of phonemes, respectively). Thus, the present results support a model of the detection of syllable-sized units by Portuguese listeners according to which a syllabification procedure is used and, if unsuccessful, is followed or is at least supplemented by, some kind of non-syllabic, presumably more global matching between the target and the word stimulus.

A possible alternative to this global matching could in principle be that matching in the non-coincident situation depends on an intentional phonemic analysis of the relevant syllables of the word stimulus. There are at least two empirical arguments, one provided by the present study and the other arising from a comparison between the present and previous studies, against this hypothesis. Let us take the situation where a CVC target has to be found in a word initiated by a CV syllable. The hypothesis implies that the subject has both to disregard for a while the last consonant of the target (in order to match the target with the initial CV) and to isolate the consonant that initiates the second syllable of the word (in order to match it with the second consonant of the target). Phonemic segmentation demands would thus be greater in this situation than in the opposite situation which consists of detecting a CV target in a CVC syllable-initiated word. Here, the subject is only required to disregard the last consonant of the initial syllable of the word stimulus. However, the less demanding of these two situations, in terms of phonemic segmentation operations, is the one that yielded the lowest performance. Futhermore, previous studies with illiterates have shown that, almost without exception, these subjects are very poor on phonemic segmentation tasks. By contrast, in the present study, 3 illiterate subjects out of 20 had perfect detection scores, and 13 others scored at least 50% correct in the more difficult of the two situations

mentioned. It thus seems that the hypothesis of resort to an intentional phonemic analysis in the present detection task may be discarded.

The phonological information used in the detection task may in principle be of high or low level of abstraction. Abstraction is low if articulatory features that are not relevant for meaning distinctions are represented. Such articulatory differences are present in this experiment between both target and word types. For *pa(l)*, the CV target/CVC word trials present an allophonic variation on the vowel, whereas the CVC target/CV word trials present two allophonic variations: on the vowel but also on the /l/, because the articulatory origin of the /l/ is more posterior at the end than at the beginning of the syllable. As far as /g Λ r/ and /l Λ r/ targets are concerned, it must be noted that the /r/ in the intervocalic position (i.e. in CV words) is articulatorily different from the /r/ at the end of a syllable (i.e. in CVC words). If target monitoring were sensitive to some extent to such articulatory differences, then CVC target/CV word trials could yield less detections than CV target/CVC word trials. The results do not support this prediction. Given that allophonic variation does not seem to result in a deteriorated performance, detection of targets which do not match the initial syllable of the word is likely to be based, not on a representation of the item phonetic realisation, but on a more abstract phonological representation.

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Appendix

Target-bearing words initiated by the syllable

/pa/: /pal∧/, /palju/, /palətɔ/, /palid∧/.
/pal/: /palm∧jr∧ʃ/, /palrar/, /palm∧ʃ/, /palku/.
/g∧/: /g∧rop∧/, /g∧rotuʃ/, /g∧r∧tuʒ∧ʃ/, /g∧mɛl∧/.
/g∧r/: /g∧rgalu/, /g∧rfad∧/, /g∧rbozu/, /g∧rg$\tilde{\wedge}$t∧/.
/l∧/: /l∧rik∧/, /l∧rapjuʃ/, /l∧r∧jr∧/, /l∧r$\tilde{\wedge}$ʒ∧ʃ/.
/l∧r/: /l∧rgadu/, /l∧rgiɲu/, /l∧rdjadu/, /l∧rgez∧/.