

Rhythmic patterns and lexical parsing in French

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ABSTRACT

Two experiments examined the effects of usual and reverse rhythmic patterns on two-syllable sequence segmentation. The usual short-long pattern impeded parsing of monosyllabic words embedded in disyllabic words. In Experiment 2, focusing subjects' attention on the timing structure strengthened this effect. Implications for speech recognition models are discussed.

INTRODUCTION

In a language with fixed stress placement, as French, in which stress usually falls on the last syllable in polysyllabic words and is therefore predictable, stress pattern may be used for lexical parsing more readily than in a language with variable stress placement as English: Indeed, prosodic patterning of an utterance could facilitate speech segmentation into lexical units. A non-emphatic rhythmic group in French is best characterized by a sizeable lengthening of its final syllable as compared with non-final syllables. Although there exists a tendency to stress word-initial syllable in certain speaking styles (e.g., radio broadcasts), short-long (iambic) structure appears reliably as the basic rhythmic structure in French (Fletcher 1991, Vaisière 1991). The role of this pattern in speech perception could be tested by examining whether inversion of usual disyllabic word stress information affects or not lexical parsing.

Previous research has shown that, in French, the syllable is the basic unit of segmentation and is used in early lexical processing (Cutler, Mehler, Norris and Segui 1987). In this line of research, structural parameters, as the number of syllables, appear to affect lexical access more than durational parameters, which permit contrasting stressed and unstressed syllable (Dupoux and Mehler 1990). In this view, stress pattern, either normal or reverse, should have no effect on lexical parsing: Rhythm should be processed post-lexically.

Nevertheless, in English, strong syllables trigger segmentation and initiate lexical access, even when in non-initial position (Cutler and Norris 1988). Rhythm may be used to improve perceptual processing (Pitt and Samuel 1990). These results suggest that syllabic-timing differences that characterize a rhythmic group at the word level could play a role in French. Since French is a trailer-timed language (Wenk and Wioland 1982), final lengthening in a two-syllable sequence should induce listeners to merge the first short syllable with the second long syllable and derive a coherent lexical unit. The aim of the present study is to test whether rhythmic expectancies play a role in segmenting two-syllable sequences into one or two words depending on their stress pattern.

If such is the case, the prosodic pattern is an important cue to word identity: A short-long (iambic) pattern would facilitate one-word perception, a long-short (trochaic) pattern would facilitate two-word perception. It may be the case, however, that syllable lengthening *per se* facilitates speech processing: According to this view, longer syllables might help access in monosyllabic words, whatever their within-word position. On the other hand, a "structural" model, according to which prosodic information is processed post-lexically, would predict that monosyllabic words are accessed faster than disyllabic words and all the faster as they are more frequent, whatever their rhythmic or durational patterning.

EXPERIMENT 1

The role of rhythmic pattern in speech segmentation has been tested through a comparison between the effects of the usual iambic pattern and of the reverse trochaic pattern on parsing judgements and response times. Within each rhythmic condition, embedded monosyllabic word frequency was varied in order to appreciate the relations between this lexical parameter and rhythm processing.

Method

Test stimuli were 48 two-syllable sequences, each disyllabic word embedding two monosyllabic words ("marmotte": "mare", "motte"). Sequences were built by concatenating monosyllabic items recorded in isolation by a male speaker. Hence, the two-syllable stimuli contained no inter-syllabic coarticulation cue. Frequency of disyllables was medium-low, frequency of monosyllables was either very high or low. For each combination of monosyllable frequency (HH, HL, LH, LL), two rhythmic patterns were realized, short-long and long-short. Duration difference between both versions of a syllable was about 35%. Intensity was equalized and F0 was held as flat as possible. Each of the four combinations of syllabic structure, CV or CVC, was equally represented for each frequency range. 96 fillers were added. Half of the fillers were disyllabic words without embedded words, and the remaining half were sequences of two monosyllabic words that did not constitute a disyllable.

Eight subjects were presented stimuli and fillers (two counterbalanced orders), one item every 3 seconds. They were instructed to determine as quickly as possible whether they heard just one disyllabic word or more words. Response times (RT) were measured from the sequence acoustic offset.

Results and discussion

Iambic rhythm induced more disyllable identifications than the reverse rhythm did (73% vs. 54%; $F(1, 7) = 13.5, p < .01$). The effect of monosyllable frequency was also significant ($F(3, 21) = 4.6, p < .01$) as was the Rhythm x Frequency interaction (Fig. 1, Exp. 1). In fact, frequency did not yield any difference for iambic pattern, whereas for trochaic pattern a high frequency word in final sequence position induced far more multi-word responses than a low frequency final word did (55% vs. 37%). Syllabic structure yielded no significant effect. "One-word" responses were in the average 62 ms faster than "multi-word" responses, especially for iambic patterns (92 ms faster), but these differences in RT were not statistically significant. RTs were not correlated with the duration of whichever syllable.

These results suggest that rhythm is used as a cue to segmentation: Lexical decomposition is facilitated by a long-short pattern, impeded by a short-long pattern. Processing of this last pattern is insensitive to frequency effects: In spite of the suppression of intersyllabic coarticulation cues, a high frequency monosyllabic word in initial position does not trigger lexical access more often than does a low frequency word. Likewise lengthening does not facilitate monosyllabic word identification. However, the RT data suggest that the stimulus set failed to induce strong rhythmic expectancies: RTs for iambic patterns are not faster globally than for trochaic patterns. The next experiment was designed to bias subjects' attention towards the timing structure of the test stimuli, in order to investigate the time course of rhythm processing.

EXPERIMENT 2

Method

Experiment 2 reduplicated Experiment 1, except that all the fillers presented the same structure: The two-syllable sequences were constructed by concatenating two monosyllabic words of the same length and 80% did not constitute a disyllabic word (10 subjects).

Results and discussion

An ANOVA revealed a significant effect of rhythm both on parsing judgements (Figure 2,

Exp. 2) and on RTs. Iambic rhythm induced more numerous and faster one-word responses than trochaic rhythm did (73% vs. 62%, $F(1, 9) = 24.3$, $p < .001$; 786 ms vs. 911 ms, $F(1, 9) = 36$, $p < .0005$). One-word responses were reliably faster than multi-word responses (808 ms vs. 948 ms). Syllabic structure complexity facilitated multi-word identification, but had no effect on RTs. Finally, as in Experiment 1, RTs were not correlated to syllable length.

Assuming that rhythm is a cue to lexical parsing, focusing listeners' attention on timing structure had the predicted effect: Rhythm facilitates or impedes segmentation. The lack of interaction between rhythmic pattern and frequency suggests that rhythm processing is not post-lexical, but is processed in parallel with lexical access.

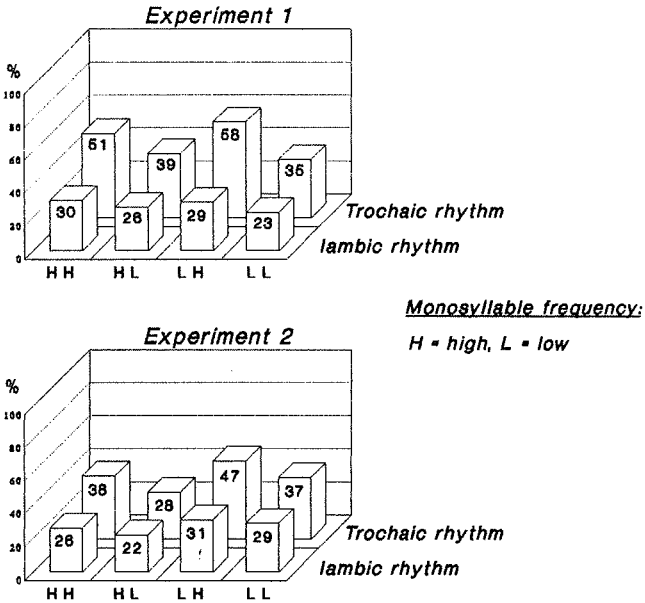


Figure 1. Percent of multi-word responses as a function of rhythm and frequency.

GENERAL DISCUSSION

Cutler and Clifton (1984) claimed that stress plays no role in lexical access whereas Pitt and Samuel (1990) concluded that the advantages for "expected-stress" syllables are small. In French, rhythm regularity may provide a stable structure that the processing system can use to anticipate word boundaries. However rhythmic expectancies take time to develop, and the disyllabic representation is not activated faster than the monosyllabic one for iambic patterns except when attention is attracted on timing structure. A reverse pattern deceives listeners' expectancies and improves parsing of disyllables into their embedded components. Thus rhythm appears as selectively tuning speech processing towards lexical parsing rather than affecting directly lexical access.

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