Phrasal prosody constrains word segmentation
in French 16-month-olds

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Abstract

Infants who are in the process of acquiring their mother tongue have to find a way of segmenting the continuous speech stream into word-sized units. We present an experiment showing that French 16-month-olds are able to exploit phonological phrase boundaries in order to constrain lexical access. Using the conditioned head-turning technique, we showed that infants trained to turn their head for a bisyllabic word responded more often to sentences that contained this word, than to sentences that contained both syllables of this word separated by a phonological phrase boundary. We compare these results with similar results obtained with English-speaking infants, and
In previous work, we showed that phonological phrase boundaries block lexical activation (Christophe et al., 1994; Millotte, Frauenfelder, & Christophe, 2007; see also Salverda, Dahan, & McQueen, 2003; Shukla, Nespor, & Mehler, 2007). Thus, French adults who were asked to detect a monosyllabic word (such as ‘chat’ / cat) were slowed down when that word belonged to a string of syllables with a local lexical ambiguity, showing evidence of multiple activation (e.g., [un chat grimpant], a grumpy cat containing the potential competitor word ‘chagrin’ sorrows was processed more slowly than [un chat grimpant] a doped cat that contains no potential competitor, since no word in French start with ‘chad...’). In contrast, when the lexical competitor straddled a phonological phrase boundary, there was no delay in lexical recognition (e.g., [son grand chat] grimpant..., his big cat was climbing potential competitor ‘chagrin’, was not delayed relative to the non-ambiguous control). These results show that a potential lexical competitor that straddles a phonological phrase boundary does not get activated; this
phonemes in word-medial position). Importantly, we also observed that none of the sentences had a pause at the phonological phrase boundary.

Table 2: Pitch and energy of the vowels constituting the critical sequences ('balcon' and 'vipère', V1 and V2 respectively), as well as one vowel before the critical sequence to compute pitch movements before phonological phrases (visible on the ellipses drawn on Fig. 1).

<table>
<thead>
<tr>
<th></th>
<th>PP boundary</th>
<th>No boundary</th>
<th>Difference</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pitch (Hz)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V0</td>
<td>272 (8.4)</td>
<td>307 (11.2)</td>
<td>-35</td>
<td>2.9</td>
</tr>
<tr>
<td>V1 (a / i)</td>
<td>349 (8.7)</td>
<td>373 (8.7)</td>
<td>26</td>
<td>0</td>
</tr>
</tbody>
</table>

Another experimenter in the control room observed the infant on a video monitor and judged whether the infant looked into the camera. Throughout all sessions, parent and assistant listened to acoustic masking over noise-attenuation headphones. At any time, the experimenter could also ask the assistant to change her behaviour, via a microphone connected to the assistant's headphones. The experimenter initiated trials when infants' attention was focused at midline by pressing the left mouse button. When the infant turned its head towards the loudspeakers, the experimenter pressed the right mouse button to signal a head-turn. The computer delivered reinforcement only if it was an appropriate head turn (i.e. to a target word).

The training session comprised the shaping and the criterion phases. During this session, infants heard a background word which was played continuously, presented at a comfortable listening level (68 dB SPL-b) with 1000 ms inter-stimulus interval. When a stimulus was delivered, the
The testing session began with two review phases: in the first one, the background and the target words were presented sentence-finally in short sentences (e.g., "Regarde la vipère!" "Look at the viper!" or "C'est le balcon!" "It is the balcony"). In the second one, the target or background words appeared in the middle of slightly longer sentences (such as "J'alimente que mon balcon soit tout en bois" "I would like my balcony to be made of wood" or "La petite vipère se prélassait au soleil" "The small viper was resting in the sun"). When a trial was requested, the infant had 3.5 seconds, starting from the beginning of the target word, to respond; the target sentence was repeated twice (in the first review phase), or once (in the second review phase). The first trials of each phase were delivered at an intensity level 8 dB higher than the background level. This intensity was progressively lowered in 4 dB steps each time the infant correctly turned its head to the loudspeakers until it reached the background intensity level.

The test phase then began. The infants were presented with the 24 experimental sentences of their group (12 ‘balcon’-sentences and 12 ‘bal’-sentences, or 12 ‘vampire’-sentences and 12 ‘vire’-sentences). The background was constituted by ‘vampire’- and ‘vire’-sentences for the ‘balcon’ was constituted by group (and vice-versa) which were continuously played until a trial was requested. Infants had 2.5 seconds to respond, starting from the beginning of the test word. If an infant did not turn its head on 3 monosyllabic group showed the reverse pattern with more headturns on ‘bal’-sentences than on ‘balcon’-sentences (27% versus 44.2%, F(1,14)=15.7, p<.001; F(1,22)=20.7, p<.001).
stream into syllable-sized units; at 12 months of age, they extracted the final (or initial) syllables of the target bisyllabic words rather than segmenting the target words as coherent units. The word "frogs" would thus be represented as...
What are the factors that may account for the fact that French appears to be harder to segment than English? One factor that may play a role is the fact that in English, strong and weak syllables alternate, whereas in French, all syllables possess an approximately equal weight. It has been suggested that these syllable weighting factors are important for English-language phonology.

Nespor, Guasti, & van Ooyen, 2003; Gleitman & Wanner, 1982; Hirsh-Pasek, Nelson, Jusczyk, Cassidy, Druss, & Kennedy, 1987; Jusczyk, 1997. This information can be exploited in two different ways. Firstly, to constrain distributional analyses of the speech input. Thus, function words and morphemes tend to occur at the edges of syntactic phrases, and therefore also
Acknowledgments

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