The morphology of the N100 component of the long-latency auditory evoked potential: an electrophysiological cue for a better understanding of voicing perception

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In many languages the voicing distinction between stop consonants in initial position depends on laryngeal timing, i.e. the temporal relationship between voice onset/offset and the release of oral closure (Lisker & Abramson, 1971). This time interval between closure release and voice onset, called voice onset time (VOT), has been largely investigated since it is a salient acoustic cue. Specifically, it has been shown that the perception of voicing is categorical : pairs of phonemes situated across phonological boundaries are better discriminated than those within the same phonological category (Liberman, 1957).

Various researches have been led to evidence this mode of perception. Most of the behavioral methodologies have proposed identification and AX or ABX discrimination tasks to subjects who were instructed to tell the experimenter what they had subjectively heard. These results were assumed to be a measure of the phonological awareness of the subject. We recently used this kind of methodology, to show that the phonological boundary to which French-speaking adults are sensitive when presented with /d_/ and /t_/ syllables is centered on 0 ms VOT, which corresponds to synchronized burst and voicing onsets.

As it is well known, infants before six months of age have not yet been sufficiently exposed to their mother tongue to have already tuned their perceptual space in favor of the phonemes present in their linguistic environment. As demonstrated by Lisker & Abramson (1964), below that age, children all over the world are sensitive to the same, universal voicing boundaries These universal boundaries represent the phonetic level of sound representation. Comparing 4- vs 8-month-old infants raised in a French environment, we demonstrated a shift from a phonetic mode of perception (i.e. sensitivity to the -30 and +30 ms voicing boundary) to a phonological mode of perception (i.e. sensitivity to the French 0ms voicing boundary).

The above-mentioned studies have mainly been concerned with **how** : How does the perceptual system develop across time? How does the human infant switch from a phonetic mode of perception to a phonological mode of perception? According to which perceptive boundaries? Cross-linguistic studies documented the VOT values on which phonological boundaries are centered. They showed that in some languages, among which English, one of the phonetic boundary becomes phonological whereas in other two-category languages, another, entirely new, perceptive boundary located at 0 ms VOT, is used for separating pre-voiced stops from those with fairly long voicing lags.

However, it remains unknown **why** this perceptual development evolves in such a way. Why the universal and phonetic boundaries to which the newborn is predisposed to perceive are centered on -30 and +30ms VOT? Why in some languages one of the phonetic boundary tend to disappear in favor of the other one? Why in some other languages, as in French, Dutch and Spanish, the 0 ms VOT value of the phonological boundary is located midway between the phonetic boundaries?

Animal research data suggest that basic auditory mechanisms underlie these perceptual abilities. Some researchers (i.e. Kuhl & Miller, 1975) found that animals are sensitive to the same universal boundaries as those evidenced by Lisker & Abramson (1964). In 1994 and 1995, Steinschneider, Schroeder, Arezzo & Vaughan parsed the neural encoding of voicing in three male monkeys by examining the neural responses to /da/ and /ta/ syllables within primary auditory cortex. They showed that the distinction between voiced and unvoiced sounds is based upon "detection of the non simultaneous onsets of consonant release and voicing onset". For stimuli with a VOT of 0ms, they recorded a single response time-locked to syllable onset (called "single-on response") while for stimuli with longer VOT value, neural responses where characterized by two neural responses (called "double-on response") : one time-locked to the burst and the other one to the periodical vocal fold vibrations. These studies fuelled the idea that the non-monotonic mechanism of categorical perception is built upon a more basic but still non-monotonic auditory mechanism that Humans share with other animals.

In 1999, Sharma & Dorman also studied the neural encoding of voicing by recording Auditory Evoked-Potentials (AEP) in English-speaking adults. The N100 component is particularly of interest since it is an obligatory evoked response which reflects sensory encoding of auditory stimulus attributes (Näätänen, 1992). Moreover its morphology can reveal the neural encoding of the stimulus. Indeed, Sharma & Dorman recorded N100 components with a single negative peak when evoked by stimuli with short VOT value (0 to 30 ms) and N100 components with a double negative peak when evoked by sitmuli with longer VOT values (50 to 80 ms).

We are now wondering what might happen in French, a language characterized by a phonological boundary (0ms VOT) which corresponds to none of the phonetic boundaries. Our hypothesis is that neural encoding reflected by the N100 components is linked to the acoustic level of sound representation. Therefore, French-speaking subjects, might exhibit the same pattern of results than the one found by Sharma & Dorman with English-speaking adults even if their phonological boundary differs. Preliminary results obtained with French-speaking adults will be presented.

Main references :

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