Hemispheric interactions during for the pre-attentive change detection of different acoustic features in speech and non-speech sounds

C Jacquier[1], R Takegata[2], S Pakarinen[2], T Kujala[2], R Näätänen[2,3,4]*
[1] Laboratoire Dynamique Du Langage, CNRS UMR5596 and Université Louis Lumière Lyon 2, France
[2] Cognitive Brain Research Unit, Department of Psychology, University of Helsinki, Finland

[3] Department of Psychology, University of Tartu, Estonia
[4] Center for Functionally Integrative Neuroscience , Aarhus University, Denmark.

Human brain shows a functional hemispheric asymmetry for auditory processing. Different acoustic features activate the left and right hemispheres differently depending on their nature. In addition, speechness (speech vs. non-speech) may also influence the dominant hemisphere for processing the feature. Anomalous asymmetry for a certain acoustic feature, therefore, may provide a clue to identify the source of deteriorated speech perception. It was shown that dyslexic adults have an abnormal asymmetry of the efferent auditory pathways that may cause their difficulties in speech perception (e.g., voicing discrimination) (Jacquier, 2008). The present study examined the effects of the speechness (speech or non-speech) and the ear (left vs. right) of stimulation for pre-attentive change detection of four types of auditory features, using the mismatch negativity (MMN) as an index. Furthermore, speech and non-speech sounds were presented either alone (monaural condition) or in parallel (dichotic condition) to investigate possible interference effects.

Speech and non-speech stimulus sequences each comprised a frequent sound (standard: S) and four types of infrequent sounds (deviant: D) that differed from the standard in one acoustic feature: duration, frequency, intensity, or vowel (or an equivalent temporal-spectral change in non-speech stimuli). The standard and the deviant stimuli appeared alternately in one sequence (e.g., S $D_{Frequency}$ S $D_{Duration}$ S…), according to the multi-feature paradigm developed by Näätänen et al. (2004). In dichotic condition, speech and non-speech stimuli were presented alternately, with speech stimuli to the right ear and non-speech stimuli to the left ear. The stimulus-ear relation was reversed for half of the experiment. In monaural condition, either the speech or non-speech stimuli alone were presented to a single ear. Subjects watched silent films with subtitles and ignored the stimulus sounds.

Speechness enhanced MMN amplitude for the vowel change but had no significant effect on the MMN for other features. In addition, the amplitude of the vowel-change MMN did not change between conditions although the overall MMN amplitude was significantly smaller in the dichotic than monaural condition. Whereas stimulation ear did not have influence on MMN amplitude in monaural condition, the left-ear stimuli elicited larger MMNs than right-ear in dichotic condition although this effect did not reach significant. The observed effects may reflect (1) the robustness of processing phonologically important features and (2) differential hemispheric interactions for the processing of different acoustic features embedded in speech and non-speech sounds.