



Language-specific automatic auditory processing: Evidence from Mismatch Negativity (MMN) studies



Gregor Kohls^{1,2}, Gabriele Christmann¹, Anna Jaremkiwicz¹, Verena Maas¹, Tanja Rinker¹, Swantje Zachau^{1,2}, Klaus Hennighausen², Michael Schecker¹

¹ Neurolinguistic Laboratory, University of Freiburg, Germany

² Department of Child and Adolescent Psychiatry and Psychotherapy, University of Freiburg, Germany

Correspondence to first author: gregor.kohls@zfn-brain.uni-freiburg.de

Introduction

Over the past decades, many researchers have hypothesized that the processing mechanisms for linguistic information may somewhat differ from those dealing with other types of input. However, our knowledge about central-auditory (language-specific) processing in- and outside the focus of attention is still rather limited. In particular, one question under debate is *whether* and *how* top-down feedback influences early stages of pre-attentive information processing (Schröger et al., in press).

Review

Correct speech perception is based on language-specific memory traces, developed during language acquisition and represented in long-term memory (Näätänen, 2001). It is suggested that speech is a specialised type of complex auditory input. Investigations using the MMN or MMNm provide evidence that not only single or gestalt-like acoustic features/feature combinations are automatically extracted from the sensory input stream, but even abstract linguistic categories like phonemes and morphemes are represented in the early low-level auditory system.

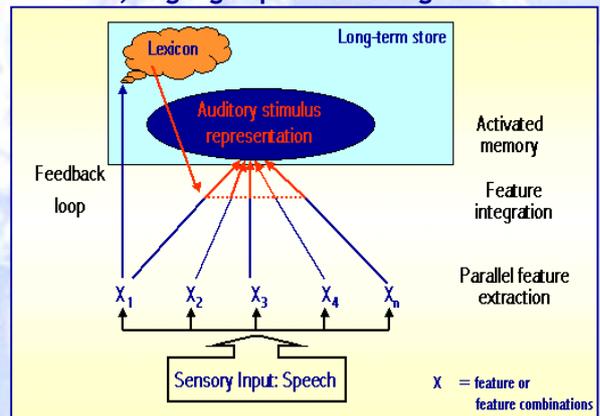
Linguistic categories	Selected Mismatch Negativity studies
▪ Phonemes	Jacobsen et al. (2003), Shestakova et al. (2002), Phillips et al. (2000), Dehaene-Lambertz (1997)
▪ Grammatical morphemes	Shtyrov & Pulvermüller (2002a)
▪ Lexical morphemes/ words	Jacobsen et al. (in press), Shtyrov & Pulvermüller (2002b), Korpiolahti et al. (2001), Pulvermüller et al. (2001)

Discussion

The reported MMN data suggest that abstract linguistic features trigger central-auditory processes specific for speech encoding. Moreover, there might not only be a language-specific processing of auditory stimuli, but that the processes involved might even depend on the specific language.

Kohls & Zachau et al. (2003) propose a language-specific tuning process, probably such as a 'lexical effect', that influences the establishment of the auditory stimulus representation (see figure). A similar suggestion is made by Jacobsen et al. who found that „even when not attending to a given stream of speech, we still establish whether its elements are 1) legal and 2) meaningful in our own language“ (in press, p.23).

The 'language-specific tuning effect'



To conclude, in speech perception top-down processes which are based on the knowledge of complex linguistic patterns might be of great importance even at the early stages of discrimination and selection mechanisms.

References

- Dehaene-Lambertz, G. (1997). Electrophysiological correlates of categorical phoneme perception in adults. *Neuroreport*, 8, 919-924.
- Jacobsen, T. et al. (in press). Pre-attentive auditory processing of lexicality. *Brain and Language*.
- Jacobsen, T. et al. (2003). Pre-attentive vowel categorization from dynamic speech stimuli. *Journal of Cognitive Neuroscience*, 15 (Suppl.), 138.
- Kohls, G. & Zachau, S. et al. (2003). Neurophysiological approaches to language-specific automatic auditory processing. *Talk held at the 3rd International Workshop on Mismatch Negativity and Auditory Functions and Dysfunctions*. Lyon (F), May.
- Korpiolahti, P. et al. (2001). Early and late mismatch negativity elicited by word and speech-like stimuli in children. *Brain and Language*, 76, 332-339.
- Näätänen, R. (2001). The perception of speech sounds by the human brain as reflected by the mismatch negativity (MMN) and its magnetic equivalent (MMNm). *Psychophysiology*, 38, 1-21.
- Phillips, C. et al. (2000). Auditory cortex accesses phonological categories: an MEG mismatch study. *Journal of Cognitive Neuroscience*, 12, 1038-1055.
- Pulvermüller, F. et al. (2001). Memory traces for words as revealed by the mismatch negativity. *Neuroimage*, 14, 607-616.
- Schröger, E., Tervaniemi, M. & Huotilainen, M. (in press). Bottom-up and top-down flows of information within auditory memory: electrophysiological evidence. In: C. Kaernbach, E. Schröger & H.J. Müller (Eds.), *Psychophysics beyond sensation: Laws and Invariants of human cognition*. Hillsdale, NJ: Erlbaum.
- Shestakova, A. et al. (2002). Abstract phoneme representations in the left temporal cortex: magnetic mismatch negativity study. *Neuroreport*, 13, 1813-1816.
- Shtyrov, Y. & Pulvermüller, F. (2002a). Memory traces for inflectional affixes as shown by mismatch negativity. *European Journal of Neuroscience*, 15, 1085-1091.
- Shtyrov, Y. & Pulvermüller, F. (2002b). Neurophysiological evidence for memory traces for words in the human brain. *Neuroreport*, 13, 521-525.