Facts about the field of study

- Humans utter and perceive 10-15 speech sounds per second in everyday speech
- In order for such a rapid decoding of the soundscape to be possible, we automatically group speech sounds into categories where unimportant differences are ignored and the important ones are amplified
- Foreign language learning requires adaptation to foreign speech sound categories
- This adaptation is necessary early in the learning process in order to facilitate the learning of many other new aspects of the foreign language, e.g. new vocabulary and new morphology and syntax
- Not all speech sound categories are equally clearly defined in our auditory perception: Some sound categories are pronounced with more variation than others and are therefore characterized by a less well-defined auditory profile in our perception than the categories with less variation

About Andreas Højlund Nielsen

Andreas Højlund Nielsen is a linguist and a semiotician with his area of specialization in cognitive neuroscience. He produced his PhD dissertation at the Department of Linguistics, Cognitive science and Semiotics, as well as at the Center of Functionally Integrative Neuroscience (CFIN), Aarhus University. During his PhD, he has spent a research stay at the Donders Institute, Radboud University, in Nijmegen, the Netherlands.

The studies in this dissertation were also supported by the Danish National Research Foundation's grant to CFIN, the MINDLab grant from the Danish Ministry of Science, Technology and Innovation, and seed funding from the Interacting Minds Centre, Aarhus University.

Time and place for defence

Wednesday, May 27, 13.00 hrs.
Auditorium 1 (1441-012), Taasingegade 3, DK-8000 Aarhus C

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DEFENCE

"TA-DA!"

INVESTIGATING PHONOLOGICAL CATEGORIES IN BRAIN AND BEHAVIOR – USING EEG AND MEG

PhD dissertation by Andreas Højlund Nielsen

AARHUS UNIVERSITET

"TA-DA!" INVESTIGATING PHONOLOGICAL CATEGORIES IN BRAIN AND BEHAVIOR – USING EEG AND MEG

Summary of the main points of PhD dissertation ""TA-DA!" Investigating phonological categories in brain and behavior – using EEG and MEG" by Andreas Højlund Nielsen, Department of Linguistics, Cognitive science and Semiotics, Aarhus University.
The dissertation investigates how adult second language learners adapt their auditory perception to foreign speech sounds, as well as how native speech sounds can be perceived differently depending on the given sound context. The results of the dissertation are based on a collection of behavioral and neurophysiological measurements (incl. electroencephalography (EEG) and magnetoencephalography (MEG)).

Early and rapid adaptation to foreign speech sounds

The results from the study investigating two groups of language officer cadets learning either Arabic or Dari in only 20 months showed that the group of Dari learners after only 3 weeks had improved their identification and discrimination of a pair of Dari sounds that do not exist in Danish. The group of Arabic learners did not show any similar learning effects to a pair of Arabic sounds – perhaps because the difference between the Arabic sounds was very subtle. These results speak to an early and rapid adaptation to foreign speech sounds during adult second language learning.

No signs of neuronal adaptation during 19 months of intensive language training

Somewhat surprisingly, none of the two groups of language officer cadets' brains showed any signs of neuronal adaptation to the foreign speech sounds – at least not on the measurements used in this study. The explanations for such "null-findings" can be many, but it is possible that even further experience with the foreign language is needed before the adaptation to the foreign speech sounds can be traced with neurophysiological measurements, e.g. an extended stay in a culture where the foreign language in question is the dominating language.

Asymmetry in the perception of Danish speech sounds

The results from the study of adult native Danish listeners showed that their perceptions of the Danish sounds [t] and [d] were asymmetric. The asymmetry refers to easier detection of [t] as different from [d] than the detection of [d] as different from [t]. This asymmetri may be due to the speech sound category /t/ being realized (or pronounced) in many ways in Danish (e.g. [t], [d] and [ð]), whereas the speech sound category /d/ more consistenly is realized as mainly [d] (and to some extent [ð]). [t] is therefore more easily perceived as different from [d] because Danish has a clearer and more distinct perception of the speech sound category /d/.

Intensive language training pays off

The results from the study of the language officer cadets showed that their intensive and comprehensive language training has an effect on their perception of their target language's new sounds after only 3 weeks of teaching (at least for one of the groups). This is just as fast as experiments with very focused training on just one set of foreign sounds have shown. However, it is surprising that this early adaptation was not also measurable in the group of Dari learners' brains. This could suggest that, besides for the early and rapid adaptation, the process of adaptating to the foreign speech sounds persists throughout several years of second language learning.

Aspiration is a vague category in Danish

The results from the study of the Danish speech sounds categories /t/ and /d/ showed that they seem to be perceived differently by native Danish listeners. The results suggest that /t/ is less clearly defined in the Danes' auditory perception than /d/ is. It will be interesting to investigate further whether this also holds for similar contrasts in Danish, such as /p/ vs. /b/, and /k/ vs. /g/. Furthermore, it will be useful to investigate whether other aspects of auditory perception play any roles in this perceptual asymmetry, e.g. whether the high frequency noise in the aspiration is driving the asymmetry via more low-level auditory processing.

Facts about the empirical basis of the dissertation

EEG and MEG measure activity from large groups of neurons with a temporal resolution of 1 ms
Language officer cadets go through a very intensive and comprehensive learning process learning a foreign language from scratch in only 20 months. This intensive process makes investigating foreign language learning within a realistic time frame possible
In Danish we distinguish between the sounds [t] and [d] when they are uttered at the beginning of a word, but not at the end of a word. This difference in distinction makes it possible to investigate one and the same sound contrast under different circumstances