ACADEMY OF FINLAND

Research project of the Human Mind Research Programme

LEARNING OF SPEECH SOUND DISCRIMINATION – INSIGHTS FROM BRAIN ACTIVITY RECORDINGS IN HUMANS AND RATS

MIELI MIND

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Being able to discriminate and produce phonemes of a non-native language properly is essential for learning a foreign language and communication in that language, not only when meeting people face-to-face but especially when communicating over distances or in noisy situations. Current theories emphasize the role of conscious effort in language learning, and there are only a few studies on how passive exposure to a language affects its learning. With electrophysiological methods, we elucidate the neural basis of receptive language learning and especially learning to discriminate foreign speech sounds. Brain's electrical responses based on electroencephalography (EEG) are measured in Chinese and Finnish adults and infants. In these measurements, lexically meaningful speech sounds in one language but not the other (i.e. duration for Finnish and lexical tone in Chinese) are compared. In addition, effects of long-term exposure to non-native speech sounds are studied in adults. Different types of exposure are compared: exposure during night-time sleep, exposure during waking but without attention and active training. Changes in brain activity in these different conditions are measured before and after the exposure as well as during the exposure.

In addition to studies in humans, an animal model based on electrophysiological recordings in rodents is employed. Rodents provide a feasible model for our purposes since they share many of the auditory cognitive abilities with humans. Electrophysiological responses obtained directly from the cortical and subcortical structures in rodents will add to the knowledge about brain structures and neural mechanisms involved in receptive language learning. Furthermore, optogenetics, a method enabling temporary inhibition of action potentials in neurons of choice, will be used to inhibit new hippocampal neurons in animals during exposure to speech sound (contrasts in lexical tone and in duration). This experimental manipulation will inform us whether new hippocampal neurons are critical for auditory perceptual learning.

By exploring and comparing the brain responses in the all subject groups, we will be able to conduct versatile analyses which will give novel and important information on the influence of brain's linguistic potential and native language environment on speech sound processing.

The research project is conducted in Finland (University of Jyväskylä, Department of Psychology) and China (Beijing Normal University, Department of Psychology).

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