Different Adaptation Mechanisms for Binaural Localization Cues

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Human sound localization relies on the binaural cues between the ear canal signals. For horizontal sound localization, the most important cues are interaural time and level differences (ITDs and ILDs, respectively). Exposure to adaptor stimulus carrying specific localization information is known to bias lateralization of the target stimulus: potentially because the adaptor suppresses the activation of the ITD/ILD channel tuned to that side. Here, a psychoacoustical experiment was conducted to test whether the ITD channel is less prone to adaptation, reflecting the emphasized role of low-frequency ITD in localization.

First, white noise signals and measured head-related transfer functions (HRTFs) of a human subject were used to generate HRTF, ITD and ILD target stimuli that had the frequency-dependent ITD and/or ILD cues. Specifically, the ITD and ILD targets were designed to share the phase and magnitude responses of the HRTF corresponding to horizontal angles in the range from -15° to 15° with a 5° resolution. Subsequently, left-right discrimination of such stimuli was investigated to acquire psychometric functions for laterality before and after exposure to an adaptor sequence. Two adaptation paradigms were employed following Phillips and Hall (Hear. Res., 202, 2005): One asymmetric having an ILD adaptor on one side and an ITD adaptor on the other, and the other symmetric having an ITD adaptor on both sides of the midline. In both paradigms, the adaptors (pink noise bursts) were presented in an alternating sequence having directional cues corresponding to ±60°.

The preliminary results (eight normal-hearing volunteers) show that the asymmetric adaptor shifts the psychometric functions of all target stimuli towards the ILD adaptor. Hence, it seems that the ILD adaptor on the left suppresses the activation of the ILD channel of the right hemisphere substantially more than the ITD adaptor on the right affects the ITD channel of the other hemisphere. As a consequence, sound events are lateralized more to the right when the spatial location is determined by analyzing the relative activation rates of populations at the two hemispheres. On one hand, symmetric adaptation reduces the slope of the psychometric function but only in the case of the ITD target. This implies that the ITD channel is not immune to adaptation either. Consequently, the results bolster the idea that the adaptation mechanisms for the binaural cues are indeed different. In other words, ITD provides a more robust cue for localization, which correlates well with the existing psychoacoustical literature.