# A study on admissible range for individualization of Head-Related Transfer Function in median plane

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Head-Related Transfer Function (HRTF) is the transfer function from a sound source to eardrums of a listener. When we convolve HRTF into a sound wave, three-dimensional presentation of the sound to listeners becomes possible. However, there is a big problem that the HRTF is dependent on head, body, and auricle shapes of the listeners. If an inappropriate HRTF is used, wrong sound localization and less sense of presence occur. In order to present a highly accurate sound image in the three-dimensional space, HRTF should be as accurate as possible for each listener. However, measurement of HRTF requires large-scaled equipment and much time. Thus, it is important to provide an individualizing method of HRTF for each listener.

HRTF includes Interaural Time Difference (ITD) and Interaural Level Difference (ILD) for the cue of the horizontal plane. In order to judge the median plane, spectral cues are used. The control of sound localization on the median plan is very difficult, due to no information of ITD and ILD rather than that on the median plan. Therefor, in order to discuss the indivisualization of HRTF, spectral cues as well as ITD and ILD are an important topic.

Iida et al. suggested that the sound localization in the median plane can be done by using only N1, N2 notches and P1 peak in the amplitude spectrum of HRTF. This assumption was ensured by other reports that, when N1 and N2 are gone out by blocking the hollow of the ear of the listener, accuracy of elevation perception degrades. Other reports showed that resonances in the ear involves the origin of peaks and notches. However, there are still less discussion how large mismatches of individualization for P1, N1 and N2 affect on sound localization. If we can discuss an admissible range for P1, N1 and N2, this can provides new knowledge of individualization of the HRTF in median plane.

This study discusses admissible ranges for P1, N1 and N2. We carry out a listening experiments for this purpose. We select the n-best HRTFs from the database based on the listening experiments, and then analyze the P1, N1 and N2 and obtain the variance of the HRTFs. We revealed that N1 should be accurate; admissible range is narrow, and P1 and N2 is not strict, strict tuning of P1 and N2 is not required. Moreover, we observed the selected HRTFs in which variations of N1 according to the change of elevation. The result suggested that the control of N1 is especially important. This indicated necessity of adapting slope of the N1 when human beings perceive the change of elevation.

In our future work, if we could establish a control model of P1 and N1, we would be able to obtain easier individualization method of HRTF on the median plane.