

The role of the low frequency component of head related transfer function for median plane localization

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Abstract: Localization tests were carried out to investigate the role of the low frequency component of head related transfer function in median plane localization of broadband noise. The low and high frequency components of white noise stimuli separated at $f_c=4.8\text{kHz}$ were presented simultaneously from two different directions in the median plane. The results indicate that most of the sound images are not localized in the direction of the low frequency component, but in the direction of the high frequency component. Based on these results, it can be concluded that the low frequency component of head related transfer function does not provide the main spectral cues for median plane localization of broadband noise.

INTRODUCTION

It has been considered that the spectral cues for the median plane localization exist in the high frequency component ($>5\text{kHz}$) of head related transfer function (HRTF). Asano et al.(1), however, concluded that front-back cues exist in the low frequency component ($<2\text{kHz}$) of HRTF. This paper investigates the role of the low frequency component of HRTF in median plane localization of broadband noise by localization tests in which the high and low frequency components of white noise stimulus are presented simultaneously from two different directions in the median plane.

EXPERIMENTAL METHOD

The low and high frequency components of white noise stimulus were separated at 4.8kHz (-48dB/oct.), and as previously described, were presented simultaneously from two different directions in the median plane. Their directions were varied independent of each other from 0° to 180° in 30° steps. The stimulus was of 1682ms duration, with a level of $50\pm 0.2\text{dBA}$ followed by an interval of 5 seconds. All stimuli were repeated 10 times in random order. The tests in which the high and low frequency components were presented from the same direction were performed separately. Three subjects (TU, TM, SM) were tested individually. Each subject was seated with his head fixed in a darkened anechoic chamber during each experiment.

EXPERIMENTAL RESULTS AND DISCUSSION

Responses were read with a protractor to an accuracy of 1° . When the high and low frequency components were presented from the same direction, the subjects localized the sound images accurately as well as the past median localization tests.

To discuss localization accuracy, three kinds of averaged localization errors(2), are calculated. E_{both} indicates the average of absolute differences between the perceived direction and the direction of stimulus when the high and low frequency components were presented from the same direction. E_{high} and E_{low} indicate the average of absolute differences between the perceived direction and the direction of high frequency component and low frequency component respectively. The results are shown in Table 1. From the results, little difference is found between E_{both} and E_{high} . The difference is not significant ($p < 0.01$). The results for E_{low} are much higher than E_{both} and E_{high} , and these differences are significant ($p < 0.01$). These results show that the subjects did not perceive the sound image in the direction of low frequency component but in the direction of high frequency component.

TABLE 1. Three kinds of averaged localization errors.

| Subject | Eboth | Ehigh | Elow |
|---------|-------|-------|------|
| TU | 19 | 16 | 74 |
| TM | 17 | 28 | 66 |
| SM | 11 | 22 | 64 |

To discuss the details, the distribution of subject SM is shown in Fig.1 as an example. The figure expresses the relation between the perceived direction and the direction of high frequency component for each direction of low frequency component. The broken lines indicate the directions of low frequency component. Most of the responses are plotted near diagonals for all directions of low frequency component, indicating that the subject localized the sound image in the direction of high frequency component. This means that the main cues for median plane localization exist in the high frequency component. However, some responses are more scattered or concentrate to a different direction from the direction of high and low frequency component. This means that the low frequency component of HRTF influences the median plane localization. However, there is no systematic tendency such as the front-back confusion.

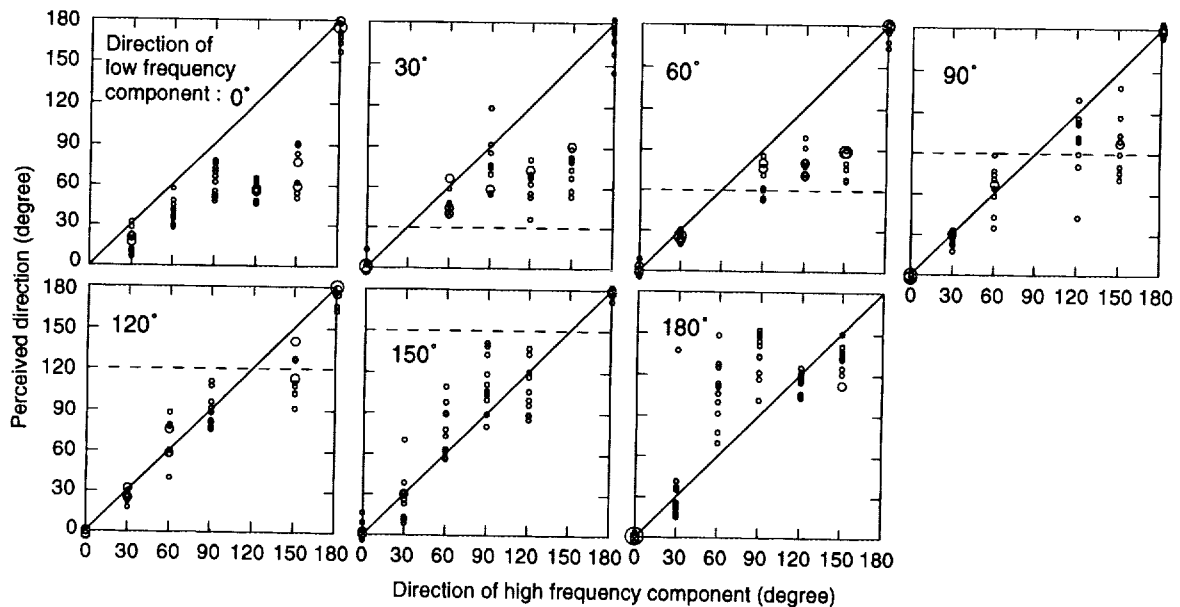


FIGURE 1. Responses to stimuli composed of high and low frequency components of white noise which were simultaneously presented from two different directions in the median plane. Subject : SM

CONCLUSION

In median plane localization, the auditory system takes information not only from the high frequency component but also from the low frequency component of head related transfer function. The main cues, however, exist in the high frequency component, and the low frequency component does not seem to provide the front-back cues and any other specific cues.

REFERENCES

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2. Morimoto, M. and Ando, Y., *J. Acoust. Soc. Jpn. (E)* **1**, 167-174, (1980).