0515 Tamagawa Academy

Exploring the physical basis for the premise of qualia in anterior-posterior sound recognitions revealed by the head model

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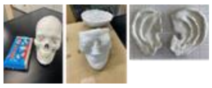
Abstract

This study focuses on the qualia and perceptions regarding the directions of sound. We created a head model to investigate the anterior-posterior spectral differences noted in previous research. We hypothesized that diffraction and reflection due to wavelength cause this difference, and confirmed the hypothesis using an open tube column model and wave simulations.

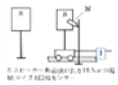
１. Introduction

We examined the ability to discern sound direction, questioning how we distinguish between front and back sounds. While the distance between the sound source and the ears creates time and volume variations from left to right, no such difference exists for front and back. We hypothesized reflections at the auricle and diffractions at the head's front and back sides could cause a standing wave sound pressure distribution.



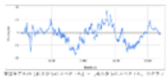
２. Theory and Experiment

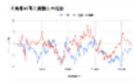
We created a head model, investigating the spectral anterior-posterior difference using white noise. Special-shaped ears examined the auricle's effect. We explored the sound pressure distribution on the head's side and its relationship with frequency.

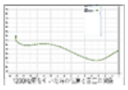


３. Results

The posterior side was more significant in the 1000Hz-2000Hz range. Different trends were observed for 40000Hz and above, depending on auricle shape. A standing-wave-like sound pressure distribution was confirmed on the head's side.

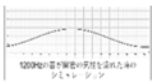






４. Discussion

Sound waves around 1000Hz, close to the head's size, likely cause sound diffraction and reflection waves at the head's front and back, resulting in a standing wave sound pressure distribution. For frequencies above 30000Hz, the auricle's shape may cause reflections due to its smaller wavelength. The simulation of planar progressive waves on a cube's side confirmed similar sound pressure distribution.



５. Conclusion

The qualia of distinguishing front and back sounds may have a physical basis in the sound pressure distribution of the open tube column generated by auricle reflections and head diffractions, resulting in spectral anterior-posterior differences. Humans could acquire this physical phenomenon as they grow, developing sound direction discerning abilities. This understanding helps advance the science of consciousness.

６. References

[1] Fujii Kounen "Fundamental and clinical study on the sense of front and back of sound" Japan Otological Society Report 1965 Volume 68 Issue 11 Pages 1423-1451

[2] Sunege simulation "diffraction" https://sunege.github.io/wave/diffraction/diffraction.html#

７. Key words

Sound direction perception, spectral anterior-posterior difference, sound pressure distribution, diffraction, head model