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Solving the naming ambiguity of auditory localization mechanisms: HRTF & HRSL, and ILD, ITD, IPD

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Abstract

This work aims to establish unambiguous names for auditory localization mechanisms. Auditory localization relies on neural mechanisms processing information based on physical sound features. One key mechanism in three-dimensional auditory localization is the Head-Related Transfer Function (HRTF). However, this name (HRTF) is currently used for two distinct mechanisms, leading to ambiguity.

The first mechanism involves a perceptual process used by our auditory system to locate sound sources in 3D space. The second mechanism is a technological sound processing, which attributes characteristics of distant sound sources to near artificial sources (e.g., headphones).

To solve this problem, we propose to keep the name “Head Related Transfer Function” for the technological mechanism that describes the artificial manipulation of sound. For the perceptual mechanism, however, the new proposed name is “Head Reflected Sound Localization” (HRSL), which maintains structural consistency with the previous name, and clearly describes the nature of the perceptual mechanism.

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Introduction

The purpose of this work is to define unambiguous names for some mechanisms related to the auditory localization. Auditory localization in humans is based on the application of neural mechanisms of information processing, to specific physical features of the perceived sound. An example is the ILD, which allows to measure the lateralization of sound as a function of the difference in sound intensity between the two ears.

A really interesting and powerful localization mechanism is the one we refer to as HRTF (Head Related Transfer Function), which plays an important role in three-dimensional auditory localization. However, the names used for some mechanisms are ambiguous, because they are used indifferently to refer to processes that are very different in nature.

HRTF: two different mechanisms, with the same name

Today, the name “Head Related Transfer Function” refers to two different mechanisms:

- The first is a perceptual mechanism of spatial localization, carried out by our auditory system to localize a sound source in three-dimensional space. Its purpose is to allow the listener to identify the relative position of a sound source. This perceptual mechanism is based on a physical pre-processing of sound: the sound wave is modified and enriched by the reflection and diffraction on the anatomical structures of the torso and head, before reaching the inner ear (Zhang, Kennedy, Abhayapala, & Zhang, 2011). Thus, this complex train of waves is processed by our perceptual system, which has developed the ability to interpret it and reconstruct the origin of sound (Risoud et al., 2018).
- The second mechanism, in contrast, is a technological sound processing - typically, a digital processing. This processing aims to artificially attribute to a sound the characteristics of a distant origin in 3D space that, in reality, it does not have (the sound is typically diffused via a headset). To achieve this effect, this mechanism reproduces the sound modifications operated by the anatomical structures of the torso and head (Inoue, Nishino, Itou, & Takeda, 2005; Zotkin, Hwang, Duraiswaini, & Davis, 2003).

It is easy to imagine a common origin, and how the same name has ended up being used in the two contexts. But it's also clear that the two mechanisms are very different in nature, and that one is not the model for the other. For this reason, it seems more appropriate to assign them two distinct names, both making appropriate reference to the nature of the underlying mechanism.

Two mechanisms, two names

The name “Head Related Transfer Function” contains a reference to a “transfer function”, which is consistent and

appropriate to describe the artificial processing of sound. Therefore, it seems appropriate to retain this name for the technological process, and to assign a new and more appropriate name to the perceptual mechanism.

The proposed new name for the perceptual mechanism is: **‘Head Reflected Sound Localization’ (HRSL)**

This new name presents two advantages:

- it maintains a structure equivalent to the previous name
- its terms more appropriately define the nature of the mechanism of spatial localization.

The juxtaposition of consistent keywords, and the explicitation of the localization function, emphasize the nature and purpose of the mechanism, and simplify identification and mnemonic grasp.

ILD, ITD, IPD: physical feature or perceptual mechanism?

ILD, ITD, IPD mechanisms share the same general scheme of operation: all are based on a perceptual processing mechanism, which measures and interprets a physical feature of the sound.

In the literature, these names are used to refer indifferently to the physical feature and the perceptual mechanism. A more explicit indication in the name can obviate the fact that it is only the context that guides the reader to understanding. A suffix can be appended to clearly identify which aspect is meant (F = physical feature, P = perceptual mechanism). In this way, ILD_F refers to the physical feature of the sound, while ILD_P refers to the perceptual mechanism.

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Conflicts of interest

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