Hearing Practicals, Spatial Hearing: Overview

In this practical you should:

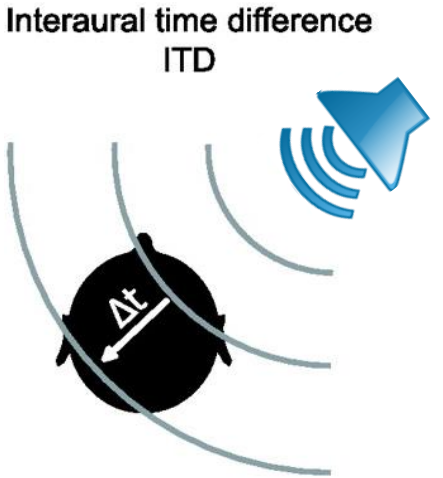
1. Watch video 2.1
2. Read the introduction
3. Watch video 2.2
4. Answer the questions on unilateral hearing loss
5. Read about spectral cues and consider the questions that follow (you may also complete the optional activity if you are interested and your personal circumstances allow you to do this safely)

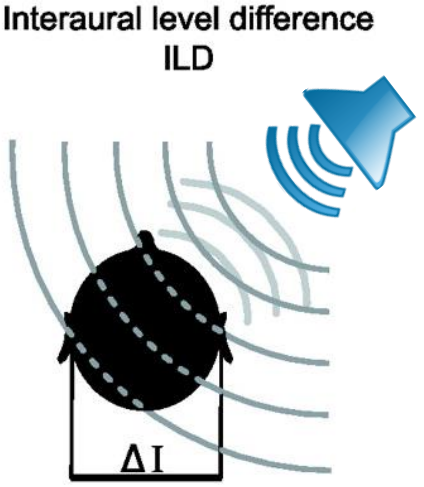
1. Video 2.1

Watch video 2.1.

2. Introduction

- If a sound is presented on one side of the head, it will be louder in the closer ear (i.e. an Interaural Level Difference will be created) and will arrive at the closer ear first (an Interaural Time Difference will be created). These binaural cues are used to locate sounds in the horizontal plane.
- A partial hearing loss in one ear will make sounds appear quieter in that ear, which will affect Interaural Level Differences. Certain forms of hearing loss may also delay the sound, which will affect Interaural Time Differences.
- Profound hearing loss will make one ear insensitive to sound, making it impossible for the brain to calculate either Interaural Time Differences or Interaural Level Differences. This can make it harder, if not impossible, to locate sounds.
- In the accompanying videos, you will experience what happens to spatial hearing (sound localization and spatial attention) following a severe simulated hearing loss in one ear. This will allow you to experience what it's like if binaural cues are degraded by hearing loss.





3. Video 2.2

Watch video 2.2.

4. Effect of unilateral hearing loss on spatial hearing

Having watched the videos, answer the following questions:

1. When you experience a hearing loss in one ear, are sounds perceived on the side of the good ear or the side of the ear with hearing loss?
2. Why do you think this happens (you may want to think about the impact of hearing loss on Interaural Level Differences and/or Interaural Time Differences)?
3. How does this explain why it is more difficult to listen to sounds in background noise if you have a hearing loss in one ear?

5. Importance of Pinna-based Spectral Cues [optional activity]

- In principle, people can also locate sounds using a single ear. This is because the pinna filters sound (changes its spectrum) in a direction-dependent way. So the spectrum of a sound in one ear provides information about the location of that sound. However, in practice, each person's pinnae are unique to them, which means that people must learn how to use their own pinnae to locate sound.
- Without the pinna-based spectral cues, it would be impossible to tell if sounds are above or below you (Interaural Level Differences and Interaural Time Differences don't change with elevation). It would also be impossible to tell whether sounds are in front of you or behind you (Interaural Time Differences and Interaural Level Differences only depend on distance from the midline. So, for example, if a sound is either directly in front of you or directly behind you, it will be equally loud in the two ears and arrive at the two ears at the same time).

1. [optional] If you want to test this on yourself, you can download a tone generator for your smart phone/tablet. You can then ask someone to play tones from different locations while you keep your eyes closed. You will find it relatively easy to tell if 500Hz and 4000Hz tones are presented on your right or left. But you will find it extremely difficult to tell if these tones are presented either in front or behind of you, or above or below. This is because pure tones do not provide pinna-based spectral cues.

5. Importance of Pinna-based Spectral Cues

Because binaural cues do not change with elevation, people with normal hearing must learn to use their pinna-based spectral cues to locate sounds above or below them (and also in front of and behind them). However, they typically don't learn to use their pinnae to distinguish between left and right because this can be done using Interaural Time Differences and Interaural Level Differences.

1. What do you think would happen if someone was deaf in one ear for a long time? Would they learn to distinguish between sounds on the left and right without binaural cues?
2. Do you think the answer to the above question depends on the age at which hearing loss is acquired?

These are the kinds of questions that are currently being studied.