

Setup: Get into small groups and nominate one person in each group to wear one of the blindfolds provided. Use the tone generators to produce sounds that have energy at a single frequency (narrowband sounds). Clap your hands to produce sounds that have energy at lots of different frequencies (broadband sounds).

Testing: Present these different sounds to the blindfolded subject from different locations and ask them to point to where they heard the sound coming from. For each sound type (tones or claps), assess the subject's ability to discriminate between sounds presented:

1. To the left of the subject versus the right (e.g. alternate sounds randomly between left/right; start far away from the midline and move closer to the midline if the subject is correct)
2. Above the subject versus below
3. In front of the subject versus behind

Simulated hearing loss: Repeat the left/right test above using tones, but ask the subject to block one ear to simulate a mild conductive hearing loss. Blocking your ear changes the timing and intensity differences between the two ears.

Answer the following questions:

1. Is it easier to locate tones or clicks/claps? Does the answer depend on whether you're trying to judge left/right, front/back or up/down?
2. Is it easier to locate high or low frequency tones?
3. 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?
4. Why do you think this happens (read the summary of key points on the next page if you're not sure)?
5. How do you think a hearing loss in one ear would affect your ability to listen to sounds in background noise? Why do you think this is the case?

Sound Localization Cues

Sounds can be located using a variety of different 'acoustical cues' (i.e. aspects of the sound that provide information about its location). These include:

- **Interaural Time Differences (ITDs)**: a sound on one side of the head will arrive at the nearer ear first, producing a timing difference between the two ears.
- **Interaural Level Differences (ILDs)**: a sound on one side of the head will be louder in the nearer ear, producing a difference in sound level between the two ears.
- **Spectral cues**: when sound hits the pinna, it bounces around inside it in a way that amplifies some frequencies and attenuates others. This changes the spectrum of the sound (i.e. the amount of energy at different frequencies), but does so in a way that depends on the direction of the sound.

Horizontal and Vertical Sound Localization

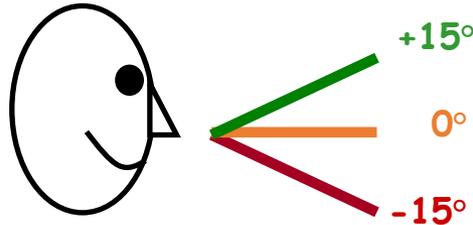
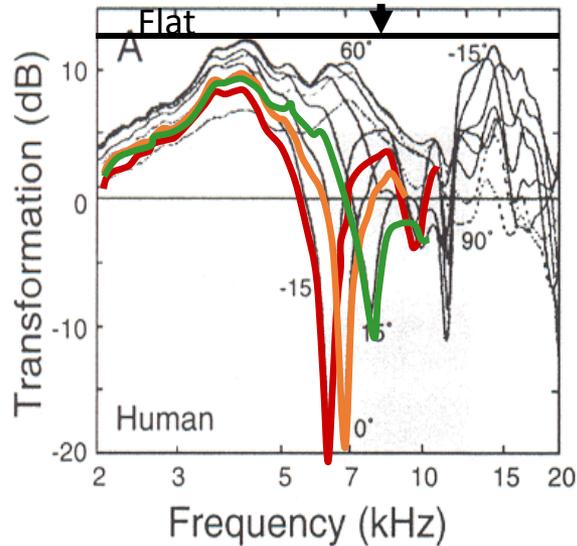
- by comparing the timing and/or level of sound at the two ears, the brain can tell whether a sound is on the **left or right**.
- by comparing the amount of energy at different frequencies (i.e. looking at the spectrum of a sound), the brain can tell the **elevation** of a sound as well as whether it is in **front or behind**.

Locating Sounds at Different Frequencies

- At **low frequencies** (<1500 Hz), the brain primarily relies on ITDs because ILDs and spectral cues are very small.
- At **high frequencies** (>1500 Hz), the brain primarily relies on ILDs and spectral cues because the brain is not very sensitive to high-frequency ITDs. This is because phase-locking in the auditory nerve provides crucial information about the precise timing of sounds. But at high frequencies, phase-locking fails (because auditory nerve fibres can't keep up with the extremely rapid peaks and troughs in the sound, although the auditory nerve may still keep track of the envelope)

Spectral Cues

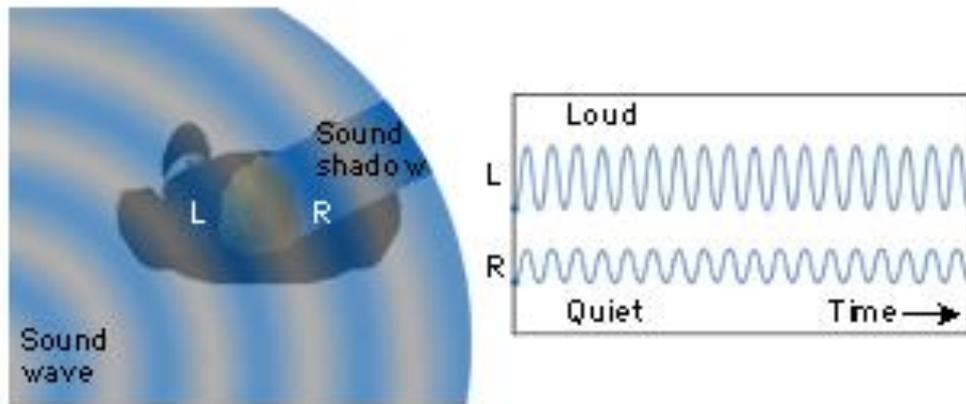
Original Spectrum =



Spatial Cues:

- Spectral (monaural, pinna-dependent, best at frequencies above 4 kHz)
- Interaural Time Differences (binaural, better at frequencies < 1.5 kHz)
- Interaural Level Differences (binaural, better at frequencies > 1.5 kHz)

Interaural Level Differences



Interaural Time Differences

