Pitch phenomena
Brain mechanisms of audition
Auditory localization
Auditory scene analysis/ perceptual organization

Pitch phenomena
• Octave generalization
• Circularity in perceived pitch
• Periodicity pitch
• Timbre and the tone envelope
Octave Generalization

- Deutsch (1973)
  Tone height vs. tone chroma
  (Octave generalization)
  Octave = 2x frequency

The tune was recognized when played in any of 3 octaves. When the sequence was played with notes chosen randomly from the same octaves the percentage correct recognition was not significantly different from that obtained when the sequence was played as a series of clicks with the pitch information omitted but the rhythm information retained. It is concluded that tune recognition took place along a channel independent from that which gives rise to octave generalization.

Limitations of Octave Generalization


The tune was recognized when played in any of 3 octaves. When the sequence was played with notes chosen randomly from the same octaves the percentage correct recognition was not significantly different from that obtained when the sequence was played as a series of clicks with the pitch information omitted but the rhythm information retained. It is concluded that tune recognition took place along a channel independent from that which gives rise to octave generalization.
Deutsch’s Tritone Circle

In the circle above, tone classes are presented so that opposing tones have half an octave between them.

Diana Deutsch has found that people mentally orient this circle in different ways, and that is why we perceive the tritone paradox differently. For example, the circle above is oriented so that C is in the 12 o’clock position, which means that the pattern C-F# would be perceived as descending. Some other person might orient the circle so that F# is in the 12 o’clock position, and this person would instead perceive the pattern C-F# as ascending. Why do we orient our mental pitch class circles in different ways then? Deutsch suggests that this might depend on the speech patterns that we are exposed to as children. She has found that, for example when people grown up in California frequently heard a pattern as ascending, a subject from southern England would hear it as descending, and vice versa. Also, people who have been living for long times in more than one geographical region sometimes produce mixed results.

Circularity in Perceived Pitch

- Circularity in pitch judgment
  (Roger Shepard, 1964; Jean Claude Risset)
Periodicity Pitch

- Periodicity pitch
  Pitch of the missing fundamental
- Virtual pitch

Virtual Pitch is not always as simple as computing the frequency difference between the components that are present.

All components shift up in frequency. Interval between components is constant at 200 Hz. Perceived pitch changes.
Tone envelope

• Timbre depends on
  Relative strengths of harmonics
  Attack and decay rates ("tone envelope")

Brain mechanisms of audition
In cat area A1

Narrowly tuned neuron

Broadly tuned neuron

Involved in evaluating complex sounds.

**tonotopic map** An arrangement of neurons within auditory brain regions such that the characteristic frequencies of the neurons gradually shift from lower at one end of the region to higher at the other end.
What vs. Where in the auditory system

Areas associated with what (yellow) and where (blue) auditory functions as determined by brain imaging. (Main, C., Aron, S. E., Harvey, S., Glickson, J., & Gadoy, C. L. (2001). “What” and “where” in the human auditory system. Proceedings of the National Academy of Sciences, 98, 12500–12506.)

(a) Colored areas indicate brain damage for J.G. (left) and E.S. (right). (b) Performance on recognition test (green bar) and localization test (red bar). The horizontal line indicates normal performance. (Clarke, S., Thiran, A. B., Maeder, P., Addleman, M., Werner, O., Reigl, L., Casanova, G., & Thiran, J.P. (2000). What and where in human auditory: Selective deficits following local hemorrhagic lesions. Experimental Brain Research, 147, 8–15.)