Pitch Perception

- Attribute of auditory sensation that allows ordering of sounds on a musical scale
- Related to frequency(ies) and waveform
  - Obvious for pure tones
  - Less so for complex tones

Pitch of a Pure Tone

- Pitch $\neq$ Frequency

  (note: Hyperphysics web-site over-generalizes this)
- Different pitch sensation due to place of greatest response of the basilar membrane. Certain hair cells agitate specific auditory nerve strands which then cause the perception of distinct pitch.
- Tantamount to spectral analysis of sound

Can you Detect the Difference?

- You will hear 4 tone pairs near 1000 Hz

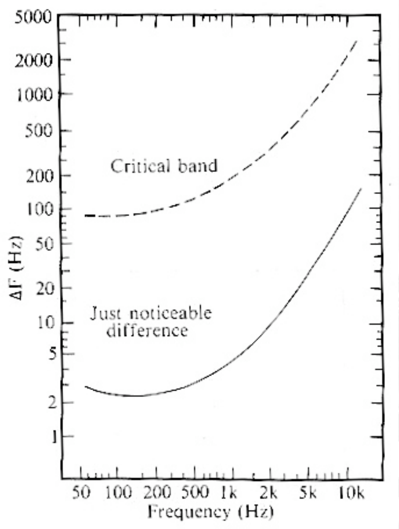
↗ first tone lower, second tone higher
↘ first tone higher, second tone lower
(pairs are in random order)

- First f-difference will be 10 Hz, then the difference decreases until it is 1 Hz

This is What you Heard

1	Δf =10Hz	↗	↘	↗	↗
2	Δf = 9 Hz	↗	↘	↘	↘
3	Δf = 8 Hz	↘	↗	↗	↘
4	Δf = 7 Hz	↘	↗	↗	↘
5	Δf = 6 Hz	↗	↘	↗	↘
6	Δf = 5 Hz	↗	↘	↗	↗
7	Δf = 4 Hz	↘	↘	↗	↗
8	Δf = 3 Hz	↗	↘	↗	↘
9	Δf = 2 Hz	↘	↘	↘	↗
10	Δf = 1 Hz	↘	↗	↗	↘

Pitch Discrimination



- Frequency difference limen or *jnd*

  Smallest frequency difference that can be distinguished

- *jnd* depends on frequency

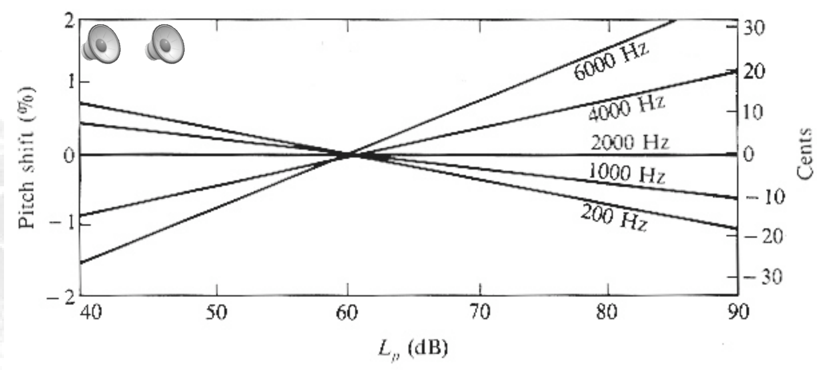
- *jnd* related to c.b.

  jnd ≈ c.b./30

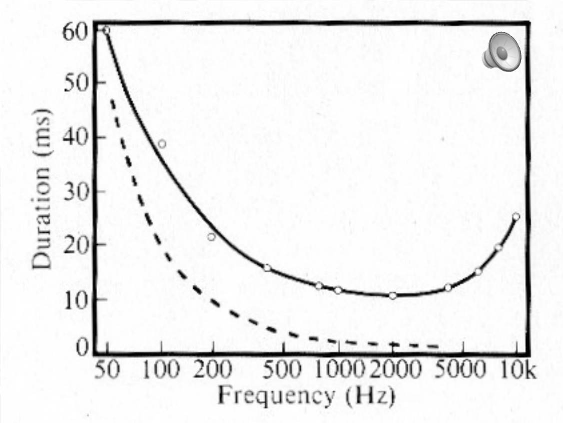
Pitch also depends on …

- Sound Level
- Duration
- Interfering Sounds

Pitch and Sound Level



Pitch and Duration



Pitch and Interfering Sounds

- Pitch of a tone is influenced by the presence of another tone or noise with close frequency
- If the interfering tone/noise is lower in frequency the pitch of a test tone is perceived as shifted up.
- The opposite is true for test tones below 300 Hz.

Pitch of Complex Tones

- Fundamental Tracking or Virtual Pitch
- Pitch assignment does not depend on the presence of the fundamental

  Show this with 440 Hz synthesizer and
  on waveform adding spreadsheet

Analytic and Synthetic Pitch

Pitch depends on how you are listening

- Analytic Listening

  Focus on the various frequency components separately

- Synthetic Listening

  Focus on the whole sound without noticing its components

Pitch Perception: Two Theories

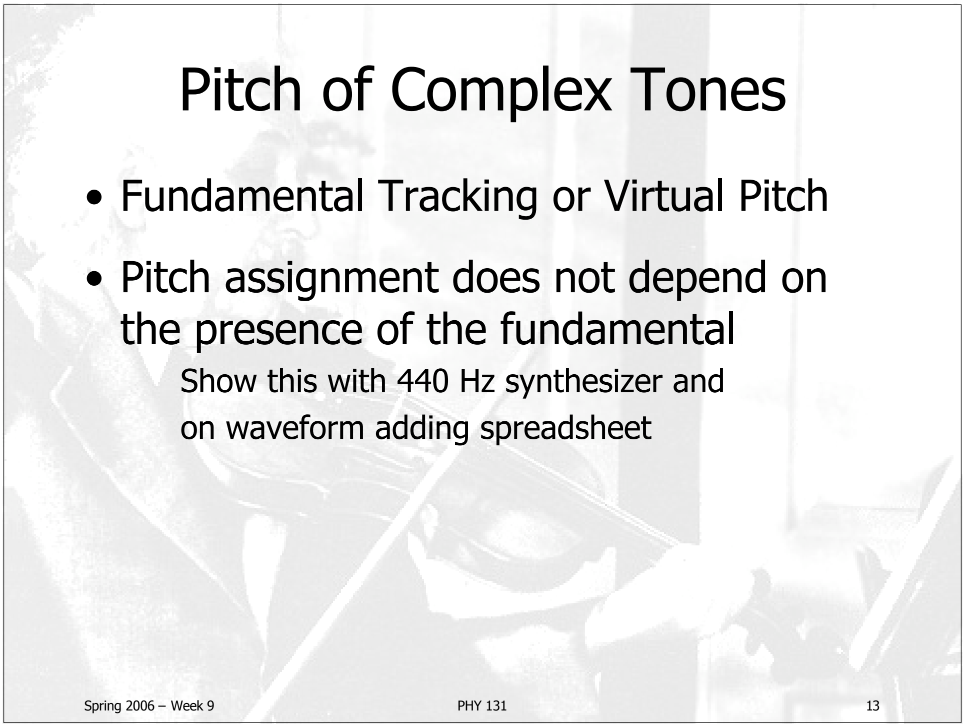
1. Place Theory

   Frequency analysis on the basilar membrane

2. Temporal Theory

   Analysis of waveform takes place

   Rate of nerve impulse firings is related to the repetition rate of the waveform



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