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 ≠ 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

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<th>Δf =10Hz</th>
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<td>Δf = 9 Hz</td>
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<td>9</td>
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<td>10</td>
<td>Δf = 1 Hz</td>
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Pitch Discrimination

- Frequency difference limen or jnd
  Smallest frequency difference that can be distinguished
- jnd depends on frequency
- jnd related to c.b.
  \[ jnd \approx c.b./30 \]

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
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