Atoms and Atomism

Music and Psychoacoustics
Issues and Music and Sciences
Dr. David John Baker
HU Berlin, Winter 2020

Outline

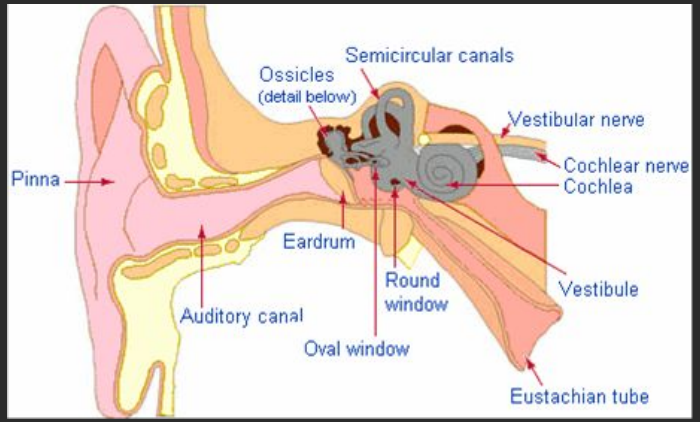
I. Today we take brief tour of how sounds gets into our heads (an important part of studying music)
II. Though there are a lot of biological and physical processes involved, cognition will affects your reality
III. Again many pitfalls when using your senses to think about the world
IV. Even more pitfalls when we try to generalize the musical experience using the building blocks of music

Hearing and Sound

https://www.audiolabs-erlangen.de/resources/MIR/FMP/C1/C1.html

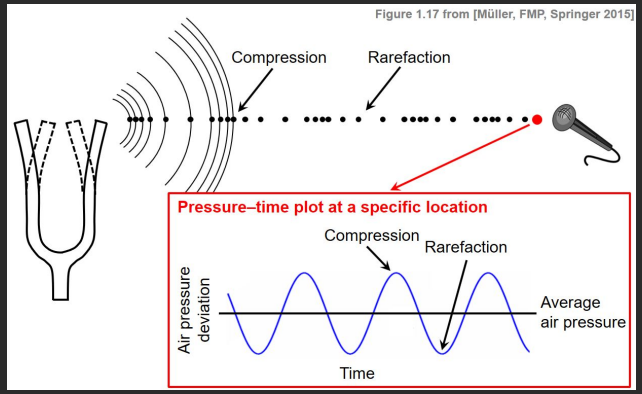
Hearing and Sound

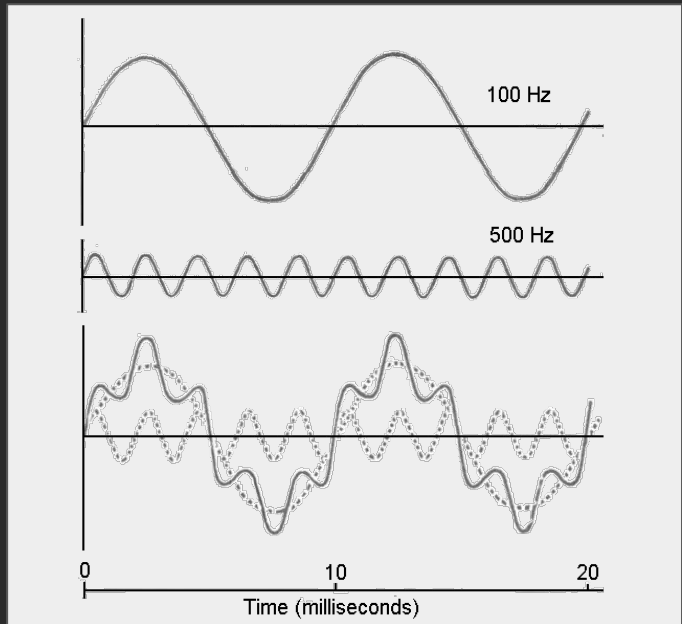
- Sound is a nearly ubiquitous demarcator that separates music from non-musical activities
- In all Western musical contexts, sound is the perceptual feature of focus
  - Musical performances
  - Music for mood setting (mood, vibe)
  - Absence of sound (4’ 33”, John Cage)
- What constitutes sound (and provides a frame to study music) will be constrained by auditory system



Soundwaves

- Pressure waves in air
- If wave has regular pattern (periodicity), we hear it as a tone
- Properties of the wave map to perceptual correlates
- In addition to making bigger faster (next slide?) Can also add them together
- Results in what is called COMPLEX wave
- Can manipulate this synthetically to make different sounds





https://www.mq.edu.au/about/about-the-university/faculties-and-departments/medicine-and-health-sciences/departments-and-centres/department-of-linguistics/our-research/phonetics-and-phonology/speech/acoustics/speech-waveforms/adding-waveforms-and-phase

Soundwaves II

- Amplitude → Loudness
- Frequency → Pitch
- Period → Synthesis

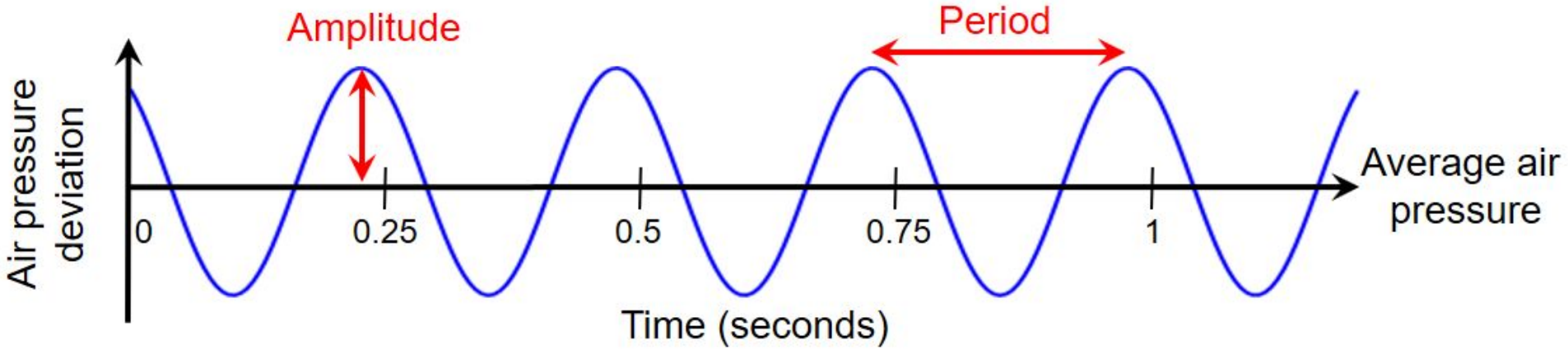


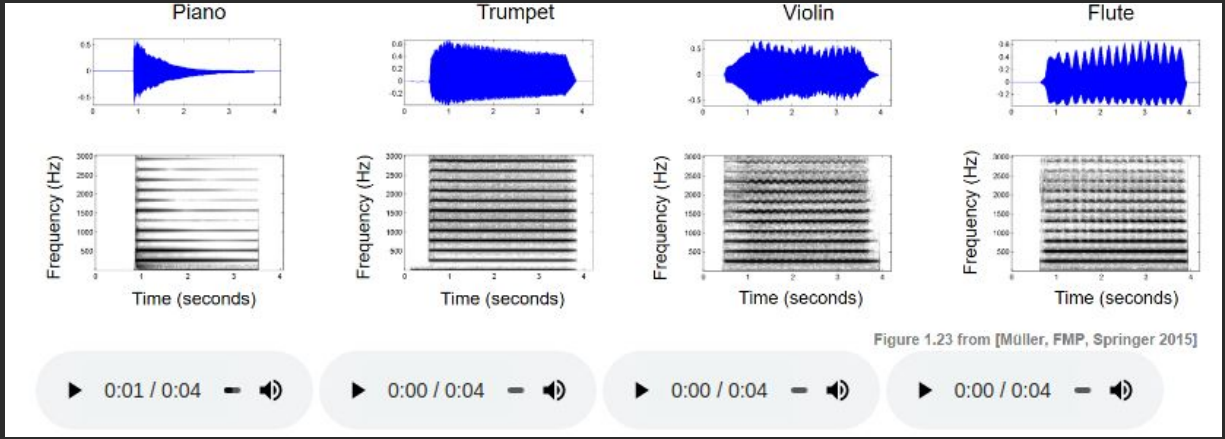
Figure 1.19 from [Müller, FMP, Springer 2015]

Hearing Spectrum

- Just like light, only part of hearing spectrum is accessible to human hearing
- Does not mean other parts are not experienced, boom of bass affecting body
- Dependent on the ear (and rest of body)
- Human hearing ranges from 20 -- 20,000 Hz
- Audio Example
- Bounds become important because not going to find a lot of music composed outside that spectrum
    - Does exist of course, music for dogs
    - Important for cross species work that we will talk about

Timbre

Tone color that allows you to distinguish between sounds of same amplitude and frequency



The Ear

Tour of the Ear

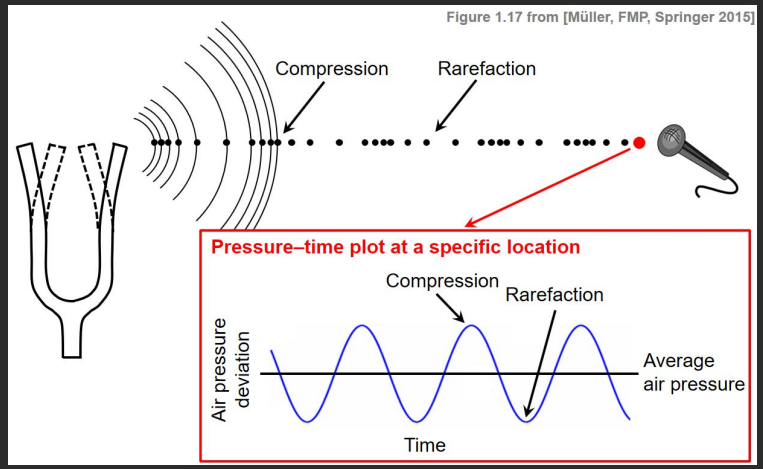
→ Learn about this process to see how beautiful the process is

→ Foundation of psychoacoustics

→ Easily investigate questions of falsifiability and causation

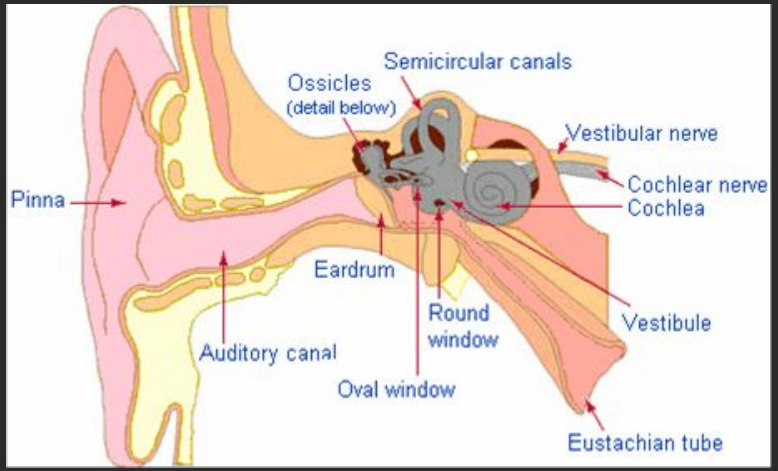
Sound Outside the Ear

- Sound is generated by a source
  - Sound with periodicity → pitch
  - Sound without periodicity → doorslam
- Causes air molecules around it to expand and contract Travels at 343 meters/second from source until the wave contacts your ear
- Wave will have changed a bit in process (bouncing off wall, depends how far you are away, direction your head is facing, if you are covering your ears)



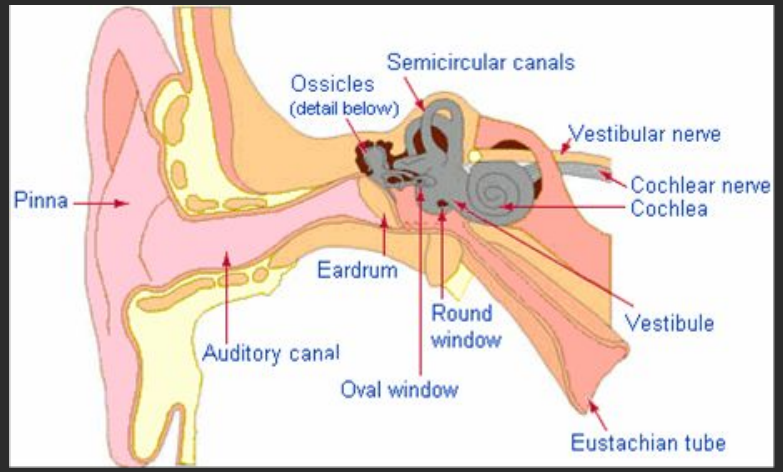
Outside Ear

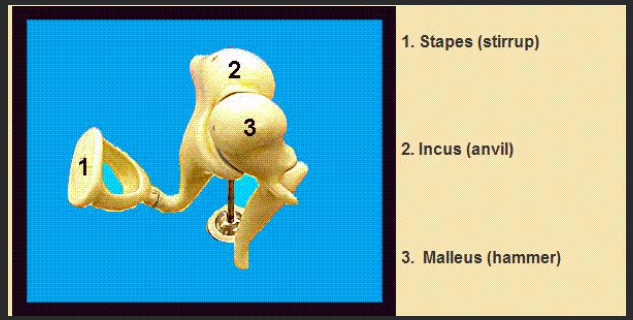
- Sound hits ear
- Ear is *not* just the pinna
- Important for source location
- Brain computes split second distance between sound at both ears
- Called Interaural time difference
- Eventually goes inside to auditory canal (where you find the earwax)

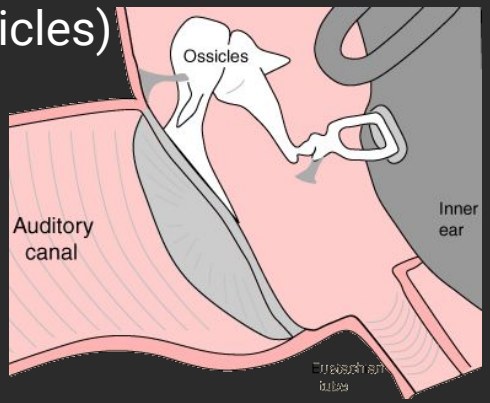


Inside Ear I

- Hits EARDRUM
- Vibrates similar to microphone
- Super fine grain vibrations picked up cause Eardrum/Tympanic Membrane to vibrate like needle on record
- Air vibrations picked up through three smallest bones in body (Ossicles)
- Then reaches cochlea

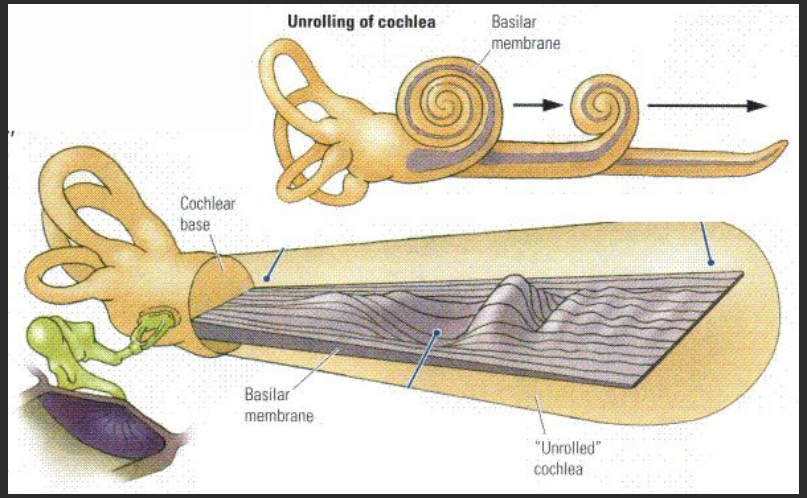






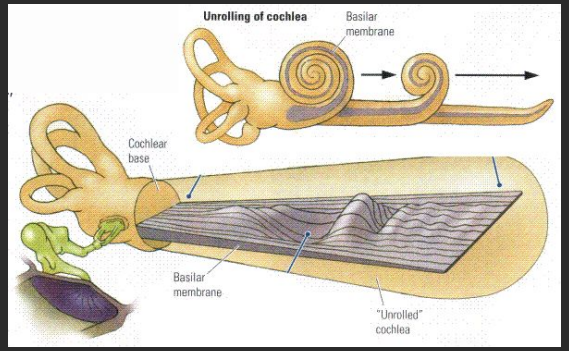
Inside Ear II

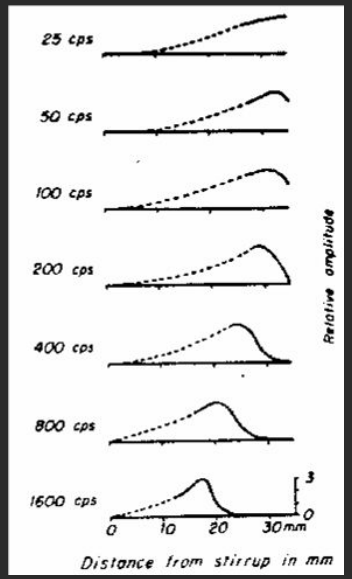
- In cochlea, sound goes up spiral
- Most interesting thing is tonotopic mapping
- Means that different parts of basilar membrane are sensitive to different frequencies
- Discovery by Georg von Békésy lead to 1961 Nobel Prize

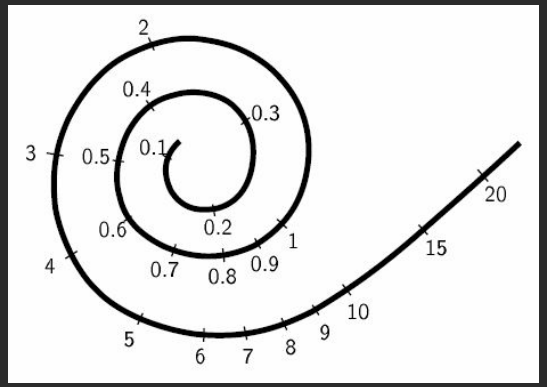


Inside Ear III

- Essentially that complex wave gets decomposed into parts just like waves
- Done with little hairs that open up ion passages that turn physical signal into electrical
- Electrical information is sent to Auditory Nerve
- Received by rest of brain for more processing







Learning about role of each part of ear by making hypotheses

If you had a theory (pretend I didn’t just tell you) that the basilar membrane is tonotopically mapped (each part responsible for different frequencies) how would you TEST this hypothesis?

If sound goes in the same way for everyone, does that everyone will always hear the same thing?

If sound goes in the same way for everyone, does that everyone will always hear the same thing??

While we all will have similar (but not exact!) waves hitting our eardrum, we also have to deal with the cognitive processing that will affect perception.

Need to consider context as well…

New Terminology

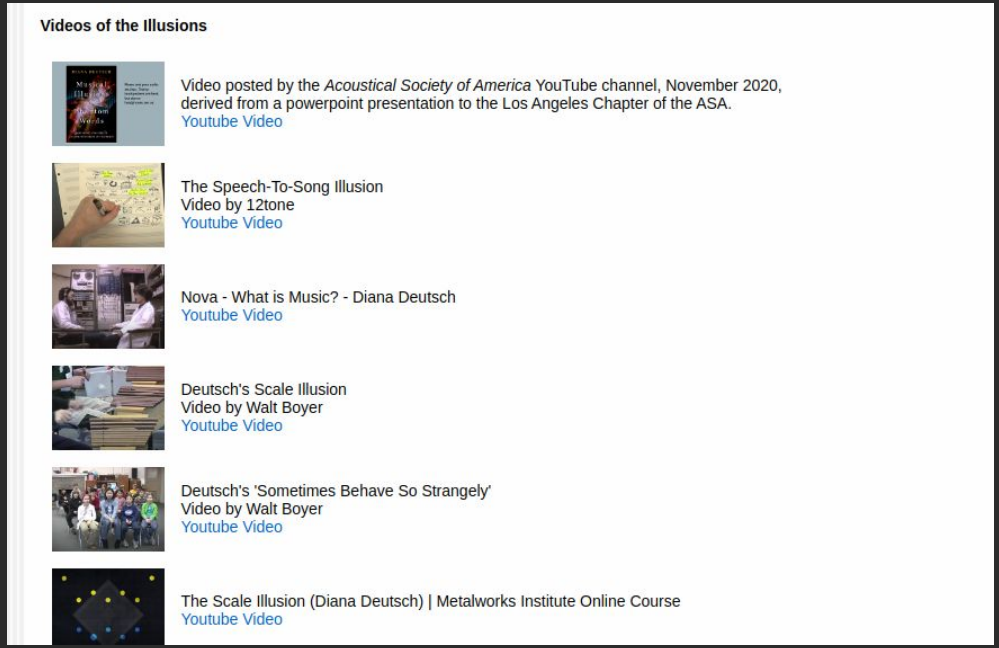
- **Bottom up** → Information from sensory sources (sounds, touches, smells, sights)
- **Top down** → Information from cognitive processes (past memories, constraints of auditory system)

Auditory Illusions

Strange Example

- Incoming (bottom up) information will be actively attended to by top down processes
- Can happen over a very short time span
- Exemplified by auditory illusions
- Speech-to-Song Illusion
- https://deutsch.ucsd.edu/psychology/pages.php?i=212

Other Auditory Illusions



Videos of the Illusions

Video posted by the *Acoustical Society of America* YouTube channel, November 2020, derived from a powerpoint presentation to the Los Angeles Chapter of the ASA.
Youtube Video

The Speech-To-Song Illusion
Video by 12tone
Youtube Video

Nova - What is Music? - Diana Deutsch
Youtube Video

Deutsch's Scale Illusion
Video by Walt Boyer
Youtube Video

Deutsch's 'Sometimes Behave So Strangely'
Video by Walt Boyer
Youtube Video

The Scale Illusion (Diana Deutsch) | Metalworks Institute Online Course
Youtube Video

https://deutsch.ucsd.edu/psychology/pages.php?i=201

Learning from Auditory Illusions

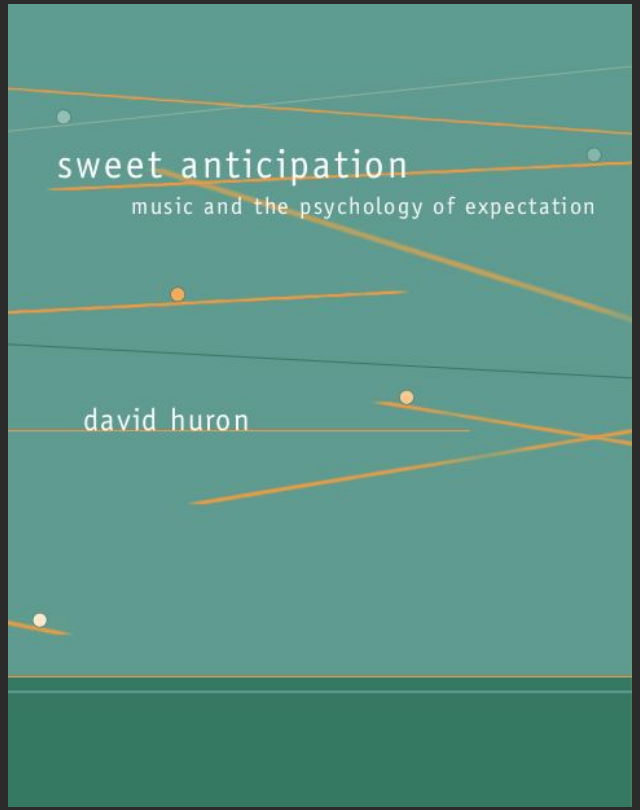
- Your senses do not provide perfect mapping to reality
- Belief that your senses are perfect representation of world is NAIVE REALISM

→ **What are other examples of your senses not providing a reliable, stable representation of the world?**

Learning from Auditory Illusions

- Your senses do not provide perfect mapping to reality
- Belief that your senses are perfect representation of world is NAIVE REALISM
- What are other examples of your senses not providing a reliable, stable representation of the world?
  - Optical Illusions
  - Not everyone has same hearing/vision (colorblind)
  - Neuroscience lecture we will see interesting perception

Naive Realism in Research



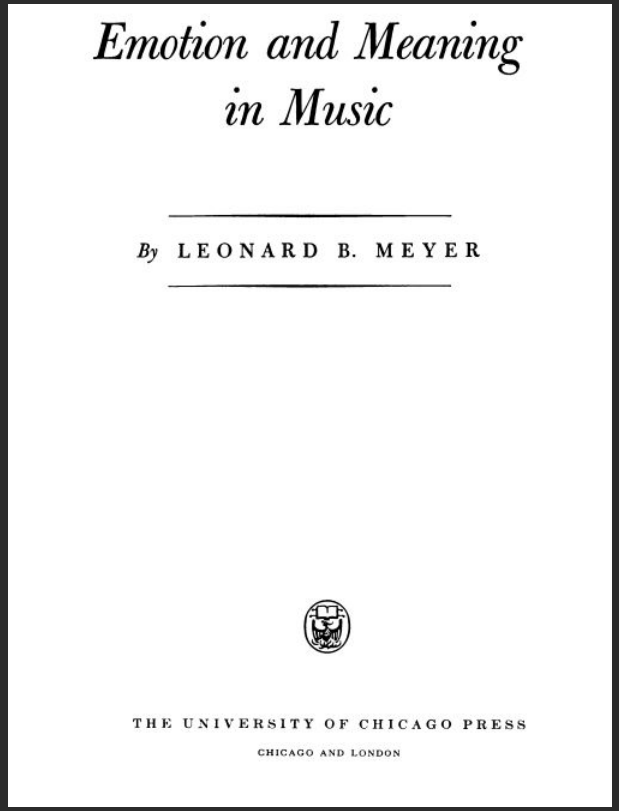
Naive Realists

Another lesson arising from the last two chapters is a sobering one for music theorists. Philosophers have described an intellectual position known as *naive realism*. Realists believe that there exists a world external to ourselves. Naive realists believe that our senses provide unbiased windows through which we directly apprehend this world.[15] Modern perceptual psychology has amply demonstrated that naive realism is not tenable. Perceptual research shows that our senses interpret the world in ways that typically distort our experiences in systematic ways. Some of these distortions occur because of "imperfections"—such as the eye's blind spot. Other distortions are "useful" deceptions.[16]

Breaking down music

- In realm of psychoacoustics, easier to look at both stimuli and people in very isolated context
- Moving up from bleeps and bloops, things become more complicated
- More sophisticated, broad, multi-sensory the incoming signal, more aspects to consider
- If we don’t consider, we run into three big disasters
  - ATOMISM
  - UNIVERSALISM
  - HEDONISM

Meyer in Music



The psychology of music has, since its beginnings, been plagued by three interrelated errors: hedonism, atomism, and universalism. Hedonism is the confusion of aesthetic experience with the sensuously pleasing. As Susanne Langer writes:

> Helmholtz, Wundt, Stumpf, and other psychologists . . . based their inquiries on the assumption that music was a form of *pleasurable sensation*. . . . This gave rise to an aesthetic based on liking and disliking, a hunt for a sensationist definition of beauty. . . . But beyond a description of tested pleasure-displeasure reactions to simple sounds or elementary sound complexes . . . this approach has not taken us. . . .[4]

The attempt to explain and understand music as a succession of separable, discrete sounds and sound complexes is the error of atomism. Even the meager achievement which Mrs. Langer allows to studies of this kind must be still further depreciated. For the tested pleasure-displeasure reactions are not what most of the psychologists tacitly assumed them to be: they are not universals (good for all times and all places) but products of learning and experience.

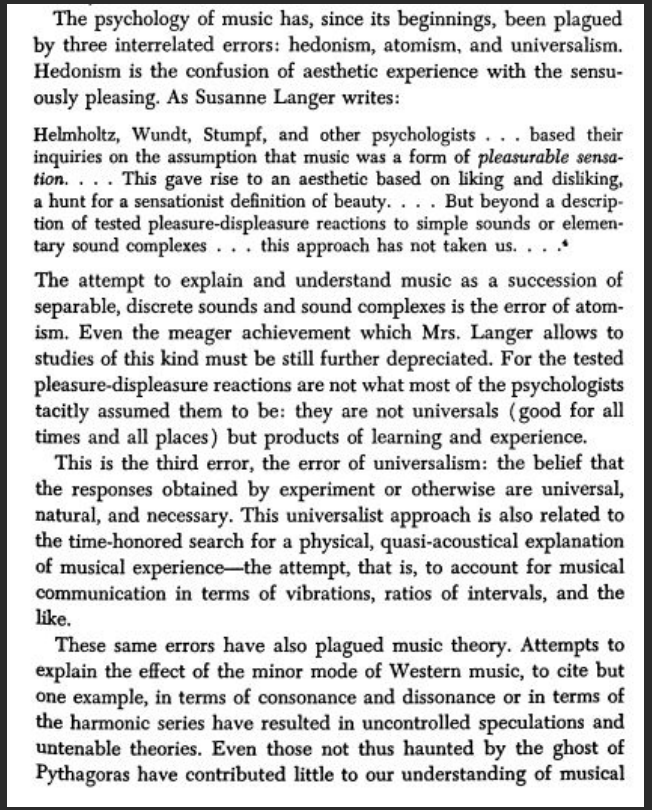
This is the third error, the error of universalism: the belief that the responses obtained by experiment or otherwise are universal, natural, and necessary. This universalist approach is also related to the time-honored search for a physical, quasi-acoustical explanation of musical experience—the attempt, that is, to account for musical communication in terms of vibrations, ratios of intervals, and the like.

These same errors have also plagued music theory. Attempts to explain the effect of the minor mode of Western music, to cite but one example, in terms of consonance and dissonance or in terms of the harmonic series have resulted in uncontrolled speculations and untenable theories. Even those not thus haunted by the ghost of Pythagoras have contributed little to our understanding of musical

Hedonism

- Confusing aesthetic experience with sensory pleasure

- Can you think of an area of music research where sensory pleasure might be confused with aesthetic experience?



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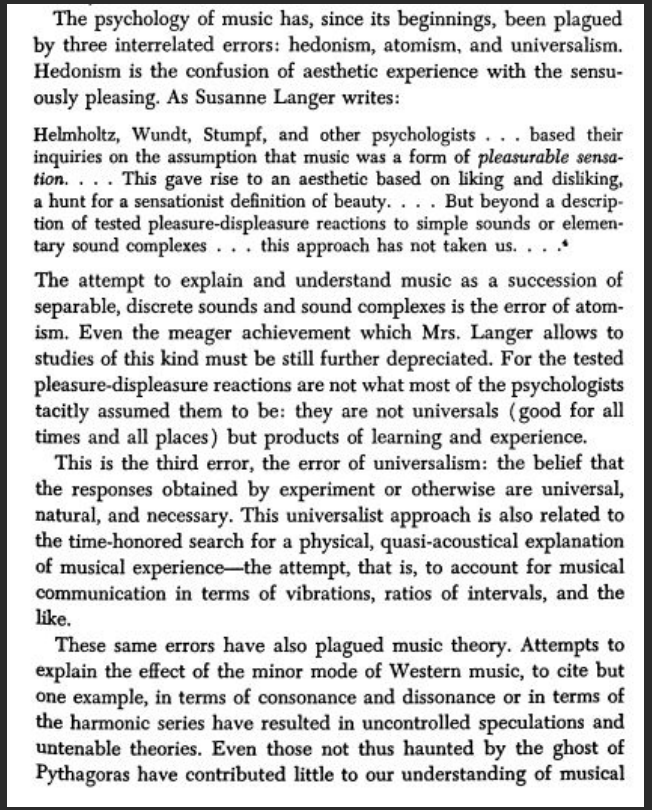
Atomism

- Attempting to explain music as succession of separable, discrete sounds

- Can you think of an area of music research where music is explained through small, discrete events?



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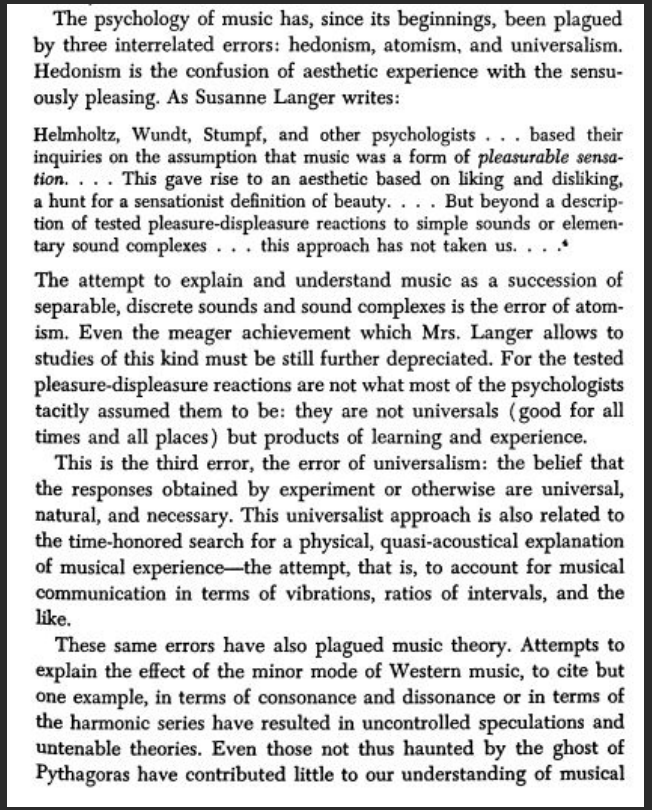
Universalism

- Response to an experiment are universal, natural, and necessary.
- Related to search for physical explanation of musical experience

- Can you think of an area of music research where effects would be assumed to generalize to all people?



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Music Theory (analysis)

- Not just the sciences have this problem (Back in 1950s!!)

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Check for Understanding

- What is meant by atomism, hedonism, universalism?
- Why is it important to understand how the ear works?
- Can you name three scientific/medical terms for parts of the ear?
- What are each parts of those responsible for?
- What parts of a wave would you manipulate to get the pitch higher?
- What does naive realism have to do with the study of music?

Terms for Review

Hedonism

Universalism

Atomism

Naive Realism

Pinna

Ossicles

Cochlea

Basilar Membrane

Top down

Bottom up