Auditory Perception: Sense of Sound

85-385/785 Spring 2017

Professor: Laurie Heller

Classroom: Baker Hall 342F (sometimes Cluster 332P)

Time: Tuesdays and Thursdays 1:30-2:50

Office hour: Thursday 3:00-4:00, Baker Hall 254P, 268-5256

Course topics and goals:

This course explores how our sense of hearing allows us to interact with the world of sound. Students will learn about basic principles of sound, basic auditory physiology, spatial sound, sound quality, hearing impairment, auditory perception, and auditory cognition. After dealing with simple laboratory-generated signals, we will tackle more complex sounds such as those in our everyday environment as well as music and speech. Students will gain some in-class experience with generating sounds and analytic listening. After students reach a sophisticated level of understanding of the auditory fundamentals they will apply their knowledge to the study of several current issues in auditory research. (Prerequisites: 85-102 or 85-211.)

Students will use what they learn about the ear, hearing, acoustics, signal analysis, perceptual grouping, musical instruments, sound recording, and digital sound manipulation to build a deep understanding of auditory sensation, perception and cognition. They will acquire the expertise required to independently read and comprehend original source material (research articles rather than textbook summaries).

Students will explore these diverse topics with a variety of tools, including: hands-on manipulation of materials, mathematics, computers, and journaling. The tools they acquire will enable them to continue answering sound-related questions for themselves long after the class has ended.

Materials, activities, and assignments:

The texts for this course are Why You Hear What You Hear, by Eric Heller and The Universal Sense by Seth Horowitz. We will also use some material from An Introduction to the Psychology of Hearing by B.C.J. Moore and from Listening: An Introduction to the Perception of Auditory Events, by Stephen Handel. We will have articles assigned for discussion, copies of which will be either handed out in class or available online.

There will be two problem-sets (10pts each), two reading responses (10 pts each), one in-class lab (2 pts), one test (10 pts), one set of sounds to create (2 pts), one project (19pts), 2 colloquium Question sets (1 pt each), and one presentation (15pts), spaced throughout the semester. Regular class participation and discussion counts for 10 pts. This totals to 100 pts for the semester.

Our reading responses will relate to the Horowitz book. These must be written in your own words, with no phrases copied directly from the book. Late assignments lose 10% per 24 hours until they are worth only 50%. They remain worth 50% until they are 3 weeks late, at which point they are not accepted.

One of the projects will revolve around designing a hypothetical museum exhibit on acoustics and auditory perception. It will be done in a group but written up individually.

There is a seminar on Monday April 3rd from 12-1:15pm in 336B that you are encouraged to attend and write a response to. The speaker will present research on music cognition and he will also visit our class the next day for half an hour. You will be expected to read his articles or attend the seminar in order to prepare questions for this visit. Also encouraged is a talk on Monday May 1st at 4:30 (probably in an auditorium in the basement of Baker Hall). The May 1st presenter also has a noon talk in 336B on the same day, as alternate time for those who are unable to make a 4:30 time.

We plan to visit a sound science exhibit on March 8th from 11:30-1:30 and an alternative time on Sat March 4th from 3-5pm. Those who can't make those times will be expected to visit the museum at another time of their choosing, before March 8th.

Auditory Perception Schedule (as of March 3, 2017)

Jan 17, 19: Sound. Anatomy and physiology: Structure and function of the outer ear. The auditory stimulus. Simple and complex waveforms. Frequency, phase, and amplitude. Decibel notation, intensity and power. A conceptual introduction to linear systems and spectral analysis.

Reading: Heller Chapter 21 Mechanisms of Hearing, Horowitz Intro and Chapter 1

Jan 24, 26: Anatomy and physiology: Structure and function of outer, middle, and inner ear. Mechanical response and neural excitation. Hair cells. Afferent and efferent innervation.

Reading: Heller, Chapter 1, 2. Horowitz Ch. 2

Due: Start of Reading Response 1 (24th): Horowitz Intro and Ch. 1

Jan 31: Music Cognition. Guest lecture by Prof. Richard Randall.

Reading: article by Prof Randall, Horowitz Ch. 3

Feb 2: Psychoacoustic methods and theories. Auditory sensitivity: threshold, masking, frequency selectivity. Lab work using Audacity.

Reading: Heller, Chapter 3 (signals), Horowitz, Ch. 4

Feb 7, 9: Auditory sensitivity: threshold, masking, frequency selectivity, dprime and signal detection theory.

Reading: Chapter 22. Horowitz, Ch. 5

Due: Rest of Reading Response 1 (Feb 9th): Horowitz Ch. 2-5.

Feb 14, 16: Loudness, intensity perception, spectral shape: Weber's law, loudness level, profile analysis. Rate-level functions

Reading: Chapter 26. Horowitz, Ch. 6

Due: Problem Set 1 (14th)

Feb 21, 23: Pitch: harmonics, combination tones, beats, the missing fundamental, pitch coding, timbre. Temporal coding in the auditory nerve and tonotopic maps. Acoustics of musical instruments. Tuvan Throat singing. Signal to noise radio.

Reading: Moore spatial perception chapter. Horowitz, Ch. 7

Feb 28: Binaural hearing, spatial hearing: the perception of direction, distance, spaciousness. Monaural cues to localization. Auditory-visual interactions in space. Auditory virtual reality and stereos.

Reading: Horowitz, Ch. 8, 9

Due: Loudness/annoyance/soundscape demos (group)

Mar 2: Sounds in the City. (Joint with Neuroscience and the city). 232M Baker Hall Conference Room in Statistics Dept.

Reading: Loudness chapter, newspaper article, youtube video.

Mar 4: Alternate field trip to Carnegie Science center, 3-5pm.

Mar 7: Auditory pattern and object perception, sound source determination, perceptual organization, Auditory demonstrations.

Reading: Moore Excerpts, Horowitz, Ch. 10 , and Problem Set 2.

Due: Reading Response 2 (Horowitz Chapters 6-10).

Mar 8: Field trip to Carnegie Science Center, 12:00-12:45pm (11:30 depart CMU, 1:20 return). Sci-Tech days special program on The Science of Sound.

Mar 9: Class discussion of field trip, group formation, demo possibilities. Finish up misc topics and review.

Reading: review notes on field trip. cochlear implant article

Project design begin: museum exhibit

Mar 14, 16: CMU spring break.

Mar 21, 23: Current topics in hearing: environmental sounds, release from masking, informational masking, otoacoustic emissions, hearing impairment, practical applications. **Midterm test (23rd).**

Mar 28: Chris Brown guest lecture on cochlear implants.

Reading: Cochlear Implant article up on BB in Readings folder.

Due: your source materials for your in-class presentation. Your museum group.

Mar 30: Special topics requested by students. Discuss museum proposals.

Reading: Prof Levitin music cog article. Other articles chosen by students (from now on).

Due: April 2nd, submit questions for Prof Levitin

April 3rd Daniel Levitin: Perception Action and Learning seminar, 12:00 in 336B (music cognition). (His Psychology colloquium, 4:30-6 pm in Baker basement is no longer on music cog)

Apr 4: 1:30-2 visit from Prof Levitin, and in-class paper presentations.

Due: museum project proposals.

Apr 6: In-class paper presentations. Colloquium write up due.

Apr 11, 13: In-class paper presentations.

Apr 18 (no class on 20th, carnival) – Catch-up

Apr 25, 27 In-class demo and discussion of projects (museum exhibits)

Reading: Prof Bortfeld paper, submit questions for Prof Bortfeld

May 1st: Psychology Colloquium, 4:30-6pm, Heather Bortfeld (Infant language) or alternatively, 12:00 noon in 336B, her Developmental Discussion Group seminar.

May 2: 1:30-2 visit from Prof. Bortfeld, and in-class projects.

May 4: In-class projects, review.