

The Auditory System

Bi 399 – Winter 2017

Lecture (CRN 26395) 2-3 pm MWF 166 Lawrence hall

Lab/Discussion Section (Kla 5) (CRN 26396) 9-10a; (CRN 26397) 10-11a

Instructor: Terry Takahashi

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Office hrs: Thu 1:30-2:30pm Kla 32

Course materials:

Text - *The Sense of Hearing* by Christopher J. Plack (Lawrence Earlbaum Associates, Mahwah ISBN 0-8058-4884-3)

Spreadsheet - Microsoft Excel (download from <https://it.uoregon.edu/about-office-365>)

DAW - Audacity v 2.1.2 (freeware download from <http://www.audacityteam.org/>)

Headphones (bring your own)

Hearing is the ability to use sound. This simple statement encompasses the abilities to map out our environment without sight, to be moved by music, and to communicate with one another. Helen Keller said, “*Blindness separates people from things; deafness separates people from people.*”, thus emphasizing the importance of hearing to human life.

This course is an introduction to the physiology and psychophysics of hearing. We will start with the physics of sound and its analysis, and proceed into the auditory system starting at the periphery, with emphasis on the neural mechanism of auditory perception. Although most of the topics will be based on the normal function of the human auditory system, as time allows, I will introduce topics of clinical interest and the question of what it means to be deaf in a species, such as humans, where vocal communication is paramount. We will also study biosonar as used in bats and blind humans.

The lectures are accompanied by discussion sections in which students will explore the synthesis and analysis of sounds, discuss the primary literature, and explore the deafness culture.

Your grade is based on an average of the scores of a set of assignments, a midterm exam, and a non-cumulative final all equally weighted. The questions will be of the short-answer and multiple-choice types. Materials covered in lecture, readings, and discussions will be covered in the tests. To be successful in this class, you must keep up with the material. If you have any questions, ask immediately. The grading scale is as follows:

A 100 - 90

B 89 - 80

C 79 - 70

D 69 - 60

F < 59

The exam dates on the schedule are approximate and should not be used to plan trips etc that will cause you to miss class. Exams must be taken at the time and place scheduled. There are no early or make-up exams, except in the case of a medical emergency.

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.

2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or disabserv@uoregon.edu). I will work with you and Disabilities Services to help facilitate your learning experience.

Journal Articles (Available on Canvas)

- Baxter, C. S., B. S. Nelson and T. T. Takahashi (2013). The role of envelope shape in the localization of multiple sound sources and echoes in the barn owl. J Neurophysiol.
- Carr, C. E. and M. Konishi (1990). A circuit for detection of interaural time differences in the brain stem of the barn owl. J Neurosci **10**(10): 3227-3246.
- Clifton, R. K. (1987). Breakdown of echo suppression in the precedence effect. J Acoust Soc Am **82**(5): 1834-1835.
- Jusczyk, P. W. and P. A. Luce (2002). speech perception and spoken word recognition: Past and present. Ear & Hearing **23**: 1-39.
- Knudsen, E. I. and M. Konishi (1978). Space and frequency are represented separately in auditory midbrain of the owl. J Neurophysiol **41**(4): 870-884.
- Nelson, B. S. and T. T. Takahashi (2010). Spatial hearing in echoic environments: the role of the envelope in owls. Neuron **67**(4): 643-655.
- Simmons, J. A. (1979). Perception of echo phase information in bat sonar. Science **204**(4399): 1336-1338.
- Sullivan, W. E. and M. Konishi (1984). Segregation of stimulus phase and intensity coding in the cochlear nucleus of the barn owl. J Neurosci **4**(7): 1787-1799.
- Takahashi, T., A. Moiseff and M. Konishi (1984). Time and intensity cues are processed independently in the auditory system of the owl. J Neurosci **4**(7): 1781-1786.
- Yin, T. C. (1994). Physiological correlates of the precedence effect and summing localization in the inferior colliculus of the cat. J Neurosci **14**(9): 5170-5186.
- Zeng, F. G., S. Rebscher, W. Harrison, X. Sun and H. Feng (2008). Cochlear implants: system design, integration, and evaluation. IEEE Rev Biomed Eng **1**: 115-142.

Other Resources

Houtsma AJM, Rossing TD, Wagenaars WM 1987 *ASA Auditory Demonstrations*, Philips

Geisler CD 1998 *From Sound to Synapse*, Oxford Press, NY

Hartman WM *Signals, Sound, and Sensation*, Springer NY

Moore BCJ 1989 *An Introduction to the Psychology of Hearing 3rd edition*, Academic Press

Pickels JO, 1988 *An Introduction to the Physiology of Hearing 2nd edition*, Academic Press

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Approximate Schedule

Day	Lecture topic	Chpt	Source material
M	Intro	2	Basic acoustics.pdf
Tu	Excel – sinusoids	2	Sinusoids.docx
W	Basic acoustics & follow up on lab exercise	2	Basic acoustics.pdf
F	More basic acoustics	2	Basic acoustics.pdf
M	No classes MLK Day		
Tu	Excel - Fourier transform		Fourier.ppt; fourier_handout&lec.doc; Harmonics.docx
W	Anatomy of auditory periphery - pinna to cochlea		
F	Basilar membrane		
M	Hair cells – transduction		
Tu	Excel - synthesis & analysis of complex signals. OR using Audacity		Build & analyze AMs
W	Hair cells – transduction		
F	Auditory nerve physiology		
M	Auditory nerve physiology		
Tu	Cochlear implants		Zeng et al., 2008, IEEE Rev Biomed Eng 1:115-142 (read sxns I-IV.)
W	Cochlear nuclei		based on Sullivan & Konishi, 1984
F	Inferior colliculus		based on Knudsen & Konishi, 1978
M	Auditory cortex		Guest lecture: Prof. Mike Wehr
Tu	Review for midterm exam		
W	Midterm		Exact date tbd
F	Midterm		Exact date tbd
M	Pitch		
Tu	Audacity - missing fundamental and dominance of partials using pre-made wav files.		ASA demo 37-45; Also Fig. 7.1 pg 134 of Plack
W	Speech sounds		based on Juzyck & Luce, 2002
F	Non-human vocalizations - birdsong		based on Margoliash & Konishi, 1983
M	Spatial hearing - general principles (ITD, ILD, spectral shape)		

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Tu	Neural computation of ITD		Carr & Konishi, 1991 <i>J Neurosci</i> 10: 3227-3246
W	Spatial hearing		
F	Spatial hearing		
M	Complex acoustical environments - acoustical superposition, binaural correlation		
Tu	Precedence effect - traditional view w lateral inhibition		Yin 1994 <i>J Neurosci</i> 14: 5170-5186
W	PE - novel view		Nelson & Takahashi, 2010
F	PE & cocktail party effect		Baxter & Takahashi, 2013
M	Echolocation in bats - intro		
Tu	Evidence of x-corr in echo delay - hyperacuity		Simmons, 1979 <i>Science</i> 204: 1336-1338
W	Echolocation in bats		
F	Echolocation in bats		
M	Human echolocation		Guest spkr Ms. Heidi vonRavensberg
Tu	Psychoacoustical basis of human echolocation		Clifton <i>JASA</i> 1987 82:1834
W	Catch up		
F	Review for final		
Tu	Final Exam 2:45p		

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