

**Psychology G9045 Research Seminar in Auditory Neuroscience Fall 2012**

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**I. Course description**, as it appears in the Bulletin:**G4445. Research Seminar in Auditory Neuroscience**

3 pts. S. Woolley. Th 10:00-11:50 A.M. Location Sch 252

Prerequisites: instructor permission

Auditory neuroscience is the study of the neural basis of hearing. Auditory processing and perception are studied from the physiological, anatomical and behavioral standpoints. The focus of this course is on the structure and function of the vertebrate auditory system, and how auditory processing relates perception and vocal communication. The course consists of a weekly seminar during which recently published papers and current data sets on auditory neuroscience and perception are presented and discussed.

**II. Rationale for giving the course**

Many of our graduate students in Psychology, Neurobiology and Behavior and Biology are interested in the auditory system and auditory perception. This seminar will bring those students and the auditory neuroscience faculty at Columbia together to discuss current studies in the field. This seminar will give our graduate students a theoretical foundation for understanding sensory coding and its relationship with perception using the auditory brain as a model system. It will also serve as of forum for students from different graduate programs to share ideas and knowledge.

It fulfills the following degree requirements.

This will be an elective seminar for graduate and undergraduate students currently involved in neuroscience research. It will not fulfill the seminar requirement of the Master's degree, the neuroscience and behavior major, or the postbac psychology certificate program.

Enrollment will be up to 10 students.

**III. A full description of the content of the course**

This course will focus on the neural bases of hearing, including the study of auditory coding by single neurons and populations of neurons in all area of the ascending auditory pathway and the vocal motor pathways that are controlled by auditory information. The neuroscience of hearing will be related to auditory perception and behaviors that depend on hearing such as vocal communication and scene analysis. We will approach auditory processing at both the ultimate (why) and proximate (how) levels. Modulation of auditory function will also be covered, including the analysis of the roles of internal factors such as hormonal state and external factors such as auditory experience/training in auditory processing. Auditory neuroscience is closely related to the fields of

psychology, speech and hearing sciences, ethology, cellular and systems neuroscience, neuroendocrinology, behavioral ecology and evolutionary biology.

We will begin by discussing the basics of the auditory system and hearing and the natural behaviors that depend on hearing such as vocal learning, sound localization, vocal communication in non-vocal learners, echolocation and speech perception in humans.

#### **IV. Course requirements**

Students will complete all assigned readings and will participate in weekly discussions of papers and data. Each week, one student will give a presentation and lead the discussion.

#### **V. Preliminary Course outline (with example readings for weeks 1-3)**

##### **Recommended texts:**

1. An Introduction to the Physiology of Hearing. James O. Pickles
2. From Sound to Synapse. C. Daniel Geisler
3. The Oxford Handbook of Auditory Science: the Auditory Brain. David R. Moore, editor
4. Development of the Auditory System. Edwin W Rubel, Arthur N. Popper, Richard R. Fay, editors
5. Auditory Neuroscience: Making Sense of Sound. Jan Schnupp, Israel Nelken, Andrew King

##### **Recommended journals:**

1. Journal of Neuroscience
2. Neuron
3. Nature Neuroscience
4. Journal of Neurophysiology
5. Nature
6. Animal Behaviour
7. Proceedings of the National Academy of Sciences

##### **Week 1**

*Role of auditory experience on human sound processing*

**Reading:** Long-term music training tunes how the brain temporally binds signals from multiple senses. Lee H, Noppeney U. Proc Natl Acad Sci U S A. 2011 Dec 20;108(51):E1441-50. Epub 2011 Nov 23.

Sensitive periods in human development: evidence from musical training. Penhune VB. Cortex. 2011 Oct;47(9):1126-37. Epub 2011 May 17.

##### **Week 2**

*Auditory feedback and vocal behavior*

**Reading:** Auditory experience refines cortico-basal ganglia inputs to motor cortex via remapping of single axons during vocal learning in zebra finches. Miller-Sims VC, Bottjer SW. J Neurophysiol. 2012 Feb;107(4):1142-56. Epub 2011 Dec 7. PMID:22157116 [PubMed - in process]

The role of auditory feedback in vocal learning and maintenance. Tschida K, Mooney R. Curr Opin Neurobiol. 2011 Dec 1. [Epub ahead of print]

**Week 3**

*Hormones and auditory processing/perception*

**Reading:** To modulate and be modulated: Estrogenic influences on auditory processing of communication signals within a socio-neuro-endocrine framework. Yoder KM, Vicario DS. Behav Neurosci. 2012 Feb;126(1):17-28. Epub 2011 Dec 26.

Neurochemical organization and experience-dependent activation of estrogen-associated circuits in the songbird auditory forebrain. Jeong JK, Burrows K, Tremere LA, Pinaud R. Eur J Neurosci. 2011 Jul;34(2):283-91. doi: 10.1111/j.1460-9568.2011.07743.x. Epub 2011 Jun 27.

**Week 4**

*Developmental auditory experience and auditory coding in animals*

**Week 5**

*Vocal learning and auditory response properties*

**Week 6**

*Hierarchical transformations in auditory coding of complex sounds*

**Week 7**

*Computational approaches to receptive field estimation*

**Week 8**

*Coding of complex versus simple sounds*

**Week 9**

*Auditory training, scene analysis and auditory processing*

**Week 10**

*Attentional mechanisms and the modulation of cortical auditory responses*

**Week 11**

*Sex differences in auditory recognition skills and neural sound processing*

**Week 12**

*Species differences in auditory processing and vocal behavior – songbirds*

**Week 13**

*Species differences in auditory processing and vocal behavior – aquatic frogs*

**Week 14**

*Seasonal changes in auditory coding and behavior*