

## PSYC W3265 Auditory Perception Fall 2008

Dr. Sarah M. N. Woolley

**Office:** 317 Schermerhorn Hall

**Office Hours:** Mondays 4-5

**Email:** sw2277@columbia.edu

### Introduction

How does the human brain make sense of the acoustic world? What properties of sound are important for the discrimination and recognition of sounds with specific meaning? What aspects of auditory perception do humans share with other animals? How does the brain perform the computations necessary for skills such as sound localization? How do we focus our auditory attention on one voice in a crowd? What acoustic cues are important for speech perception? What's special about music? We will address these questions and more by studying the basics of auditory perception in a textbook, and reading classic and current literature to understand the scientific progress in the field today. Our reading of the literature will be critical, with a focus on good scientific design.

This course will systematically review the main topics of auditory perception such as: 1) the physics of sound; 2) the anatomy and physiological functioning of the auditory system; 3) perception of loudness; 4) frequency selectivity and discrimination; 5) perceptual phenomena such as forward and backward masking; 6) temporal processing; 7) pitch and timbre perception in simple and complex sounds; 8) auditory attention; 9) scene analysis; 10) speech and music perception. We will examine the current literature on such topics as sound localization in humans and other animals, how the brain forms a map of auditory space, acoustic communication in humans, birds and other mammals, and how the brain may be specialized to encode the unique communication sounds of individual species. We will analyze the studies demonstrating categorical perception and lateralization of the brain for language processing. And we will study how people perceive and process music.

### Course requirements

Professor Woolley's permission to join the class is **required**. Attendance at the first day of class is **required**. Each week, students will participate in a two-hour seminar. Class time will be devoted to the presentation and discussion of book chapters and journal articles. The reading is intended to provide background knowledge on the relevant topics, to cover the current and most exciting research on those topics, and to serve as a stimulus for discussion. Two students sign up to lead the discussion each week.

## **The reading list and weekly schedule**

**Textbook:** Moore, B. C. J. (2003) An Introduction to the Psychology of Hearing. (5<sup>th</sup> edition) Academic Press Inc. San Diego, CA.

### **Week 1 – Sept 8**

The physical properties of sound, the ear, the auditory system, functions of hearing, model systems in understanding auditory perception

#### Reading

Moore, chapter 1

Students select presentation topics this week

### **Week 2 – Sept 15**

Sound Intensity and Loudness Perception

**Presenters:**

#### Reading

Moore, chapters 2 and 4

Hellman, R, Miskiewicz, A, Scharf, B (1997) Loudness adaptation and excitation patterns: Effects of frequency and level. *JASA* **101**:2176-2185.

Dean, I, Harper, NS, McAlpine, D (2005) Neural population coding of sound level adapts to stimulus statistics. *Nature Neurosci* **8**:1684-1689.

### **Week 3 – Sept 22**

Processing Frequency and Temporal Information

**Presenters:**

#### Reading

Moore, chapters 3 and 5, first part (up to sec. 4) of chapter 6-

Yan, W, Suga, N (1998) Corticofugal modulation of the midbrain frequency map in the bat auditory system. *Nature Neurosci* **1**: 54-58.

Lu, T, Liang, L, Wang, X (2001) Temporal and rate representations of time-varying signals in the auditory cortex of awake primates. *Nature Neurosci* **4**:1131-1138

Bendor, D, Wang, X (2005) The neuronal representation of pitch in primate auditory cortex. *Nature* **436**: 1161-1165.

#### Week 4 – Sept 29

##### Sound Localization

**Presenters:**

##### Reading

Moore, chapter 7

Konishi, M (2003) Coding of auditory space. *Annu Rev Neurosci* **26**:31-55.

Bergan, JF, Ro, P, Ro, D, Knudsen, EI (2005) Hunting increases adaptive auditory map plasticity in adult barn owls. *J Neurosci* **25**: 9816-9820.

McAlpine, D (2005) Creating a sense of auditory space. *J Physiol* **566**: 21-28.

#### Week 5 – Oct 6

##### Auditory Attention

**Presenters:**

##### Reading

Carlyon, RP (2004) How the brain separates sounds. *Trends Cog Sci* **8**:465-471.

Alain, C, Arnott, SR (2000) Selectively attending to auditory objects. *Front Biosci* **5**: D202-12.

Suga, N, Xiao, Z, Ma, X, Ji, W. (2002) Plasticity and Corticofugal Modulation for Hearing in Adult Animals. *Neuron* **36**: 9-18.

#### Week 6 – Oct 13

##### Midterm Exam

#### Week 7 – Oct 20

##### Complex Sounds, Streaming and Scene Analysis

**Presenters:**

##### Reading

Moore, chapters 6 and 8

Micheyl, C, Tian, B, Carlyon, RP, Rauschecker, JP (2005) Perceptual Organization of Tone Sequences in the Auditory Cortex of Awake Macaques. *Neuron* **48**:139-148.

DeWeese, MR, Zador, AM (2005) Neural Gallops across Auditory Streams. *Neuron* **48**: 5-7.

Gutschalk, A, Micheyl, C, Melcher, JR, Rupp, A, Scherg, M, Oxenham, AJ (2005) Neuromagnetic Correlates of Streaming in Human Auditory Cortex. *J Neurosci* **25**:5382-5388.

### **Week 8 – Oct 27**

#### **Speech and Categorical Perception**

**Presenters:**

#### **Reading**

Moore, chapter 9

Diehl, RL, Lotto, AJ, Holt, LL. (2004) Speech Perception. *Ann Rev Psychol* **55**: 149-79.

Kuhl, PK, Williams, KA, Lacerda, F, Stevens, KN and Lindblom, B (1992) Linguistic experience alters phonetic perception in infants by 6 months of age. *Science* **255**: 606-608.

### **Week 9 – Nov 3**

Academic Holiday

### **Week 10 – Nov 10**

#### **Neural Basis of Speech Perception**

**Presenters:**

#### **Reading**

Golestani, N, Paus, T, Zatorre, RJ. (2002) Anatomical Correlates of Learning Novel Speech Sounds. *Neuron* **35**:997-1010.

Dehaene-Lambertz, G, Hertz-Pannier, L Dubois, J (2006) Nature and nurture in language acquisition: anatomical and functional brain imaging studies in infants. *Trends Neurosci* **29**: 367-373.

Gentner, TQ, et al. (2006) Recursive syntactic pattern learning by songbirds. *Nature* **440**: 1204-7.

Marcus, GF (2006) Language: startling starlings. *Nature* **440**: 1117-8.

### **Week 11 – Nov 17**

No class - Annual Society for Neuroscience Meeting

### **Week 12 – Nov 24**

#### Auditory communication in nonhuman animals

**Presenters:**

#### Reading

Doupe, AJ, and Kuhl, PK (1999) Birdsong and human speech: common themes and mechanisms. *Annu Rev Neurosci* **22**: 567-631.

Braaten, RF, Reynolds, K (1999) Auditory preference for conspecific song in isolation-reared zebra finches. *Animal Behaviour* **58**: 105-111.

Egnor, SER, Iguina, CG, Hauser, MD (2006) Perturbation of auditory feedback causes systematic perturbation in vocal structure in adult cotton-top tamarins. *J Exp Biol* **209**: 3652-63.

Poulet, JFA, Hedwig, B (2005) Auditory orientation in crickets: pattern recognition controls reactive steering. *PNAS* **102**: 15665-69.

### **Week 13 – Dec 1**

#### Music Perception

**Presenters:**

#### Reading

Krumhansl, CL (2000) Rhythm and pitch in music cognition. *Psychol Bull* **126**:159-79.

Iverson, P, Krumhansl, CL (1993) Isolating the dynamic attributes of musical timbre. *JASA* **94**: 2595-603.

McDermott, J, Hauser, MD (2007) Nonhuman primates prefer slow tempos but dislike music overall. *Cognition* **104**: 654-68.

**Week 14 – Dec 8**

Neural Basis of Music Perception

**Presenters:**

Reading

Tervaniemi, M (2001) Musical Sound Processing in the Human Brain: Evidence from Electric and Magnetic Recordings. *Ann N Y Acad Sci* **930**:259-272.

Peretz, I, Zatorre, R (2005) Brain organization for music processing. *Ann Rev Psychol* **56**: 89-114.

Zatorre, RJ, Halpern, AR (2005) Mental Concerts: Musical Imagery and Auditory Cortex. *Neuron* **47**:9-12.

**THERE IS NO FINAL EXAM**

**Grading**

The students take a written midterm exam with essay questions covering the material in the textbook, the papers and the class discussions.	20%
During the second half of the semester, each student writes a 10 page term paper on a topic that we choose together.	30%
Participation and Presentations	50%