PSYC GU4265 Auditory Perception Fall 2023

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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 textbook chapters, classic and current literature. Our reading of the literature will be critical, with a focus on good scientific design.

This course systematically reviews the main topics of auditory perception such as relationships between acoustics and perception, how the ear and brain encode sound, and how we perceive speech and music. We will read and discuss classic and current literature on humans and other animals.

Course requirements

Professor Woolley's permission to join the class is required. Each week, class time is devoted to the presentation and discussion of journal articles. The background reading provides information on the relevant topics, prepares students for reading and discussing the research papers, and serves as a stimulus for discussion. Two students lead the discussion each week, with my help. Each student takes the midterm exam and writes a paper on a chosen research topic at the end of the semester.

Course material

Book chapters and review papers are background reading for understanding the data papers that we discuss in class. Data papers on weekly topics are read by all students before class and presented by 1 to 2 students each week, with help from Professor Woolley. All of the reading material is posted on the course website. There are no textbooks to buy.

Grading

One exam is taken at the end of the first month (20% of final grade). Each student leads two class discussions of the assigned papers (35% of final grade). Each student researches and writes a short paper on a chosen topic, near the end of the semester (20% of final grade). All students participate in weekly discussion of assigned papers (25% of final grade).

Reading list and weekly schedule

Week 1 Sept 7 – Course overview/Introduction to sound and the auditory system

Professor Woolley introduces the course material and structure. Professor Woolley presents fundamental principles of sound, hearing and auditory function.

Week 2 Sept 14 - Sound intensity and loudness perception

Background reading
Pickles ch 1 The physics and analysis of sound
PNS ch 30 The inner ear
PNS ch 31 The auditory central nervous system
Yost ch 13 Loudness
Moore ch 4 The perception of loudness

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

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

Week 3 Sept 21 - Frequency representation
Background reading
Pickles ch 1 The physics and analysis of sound
PNS ch 31 The auditory central nervous system
Pickles Frequency resolution
Moore ch 4

Papers

Han, YK, Kover, H, Insanally, MN, Semerdjian, JH, Bao, S (2007) Early experience impairs perceptual discrimination. *Nature Neurosci* **10**:1191-1197.
Presenter:

Bitterman et al., (2008) Ultra-fine frequency tuning revealed in single neurons of human auditory cortex. *Nature* **451:** 197-201.
Presenter:

Week 4 Sept 28 - Temporal processing

Background reading
Pickles ch 1 The physics and analysis of sound
PNS ch 31 The auditory central nervous system
Moore ch 5 Temporal processing in the auditory system

Papers
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
Presenter:
Boemio et al. (2005) Hierarchical and asymmetric temporal sensitivity in human auditory cortices. *Nat Neurosci* **8:** 389-395.
Presenter:

Week 5 Oct 5 - Sound localization

Background reading
Pickles ch 7.3 Cortical processing of sound location
McAlpine, D (2005) Creating a sense of auditory space. *J Physiol* **566**: 21-28.

Papers
Knudsen, EI, Konishi, M (1978) A neural map of auditory space in the owl. *Science* **200:** 795-797.
Presenter:

Brown AD, Tollin DJ (2016) Slow Temporal Integration Enables Robust Neural Coding and Perception of a Cue to Sound Source Location. *J Neurosci* **36**: 9908-21.
Presenter:

Week 6 Oct 12 - Auditory attention

Background reading
TBA
Papers

Mesgarani, N, Chang, E (2012) Selective cortical representation of attended speaker in multi-talker speech perception. *Nature* **485:** 233-236.
Presenter:

Gutchalk, A, Micheyl, C, Melcher, JR, Rupp, A, Scherg, Oxenham, AJ (2005) Neuromagnetic correlates of streaming in human auditory cortex. *J Neurosci* **25**: 5382-5388.
Presenter:

Week 7 Oct 19 - Midterm exam

Week 8 Oct 26 - Auditory scene analysis

Background reading
Yost ch 4 Complex sounds

Papers
Schneider, DM, Woolley, SMN (2013) Sparse and background-invariant coding of vocalizations in auditory scenes. *Neuron* **79**: 141-152.
Presenter:

Puuvada, KC, Simon, JZ (2017) Cortical representation of speech in a multitalker auditory scene. *J Neurosci* **37**: 9189-9196.
Presenter:

Week 9 Nov 2 – Speech Perception

Background reading
PNS ch 60 Language
Diehl, RL, Lotto, AJ, Holt, LL (2004) Speech Perception. *Ann Rev Psychol* **55**: 149-79.

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

TBA
Presenter:

Week 10 Nov 9 - Neural Basis of Speech Perception

Background reading
Hickok, G, Poeppel, D (2007) The cortical organization of speech processing. *Nat Rev Neurosci* **8:** 393-402.

Papers
Mesgarani, N, Cheung, C, Johnson, K, Chang, EF (2014) Phonetic feature encoding in human superior temporal gyrus. *Science* **343**: 1006-1010.
Presenter:

TBA
Presenter:

Week 11 Nov 16 - Auditory communication in nonhuman animals

Background reading
Doupe, AJ, and Kuhl, PK (1999) Birdsong and human speech: common themes and mechanisms. *Annu Rev Neurosci* **22:** 567-631.
Papers
James, L, Sakata, JT (2017) Learning biases underlie "universals" in avian vocal sequencing. *Curr Biol* **27**: 3676-3682.
Presenter:

Takahashi, DY, Liao, DA, Ghazanfar, AA (2017) Vocal learning via social reinforcement by infant marmoset monkeys. *Curr Biol* **27:** 1844-1852.
Presenter:

Week 12 Nov 23 – Thanksgiving

Week 13 Nov 30 - Music Perception

Background reading
Koelsch, S, Siebel, W (2005) Toward a neural basis of music perception. *Trends Cog Sci* **9:** 578-584.

Papers
McDermott, J, Schultz, A, Undurraga, E, Godoy, R (2016) Indifference to dissonance in native Amazonians reveals cultural variation in music perception. *Nature* **535**: 547-550.
Presenter:

Fritz, T et al. (2009) Universal recognition of three basic emotions in music. *Curr Biol* **19:** 573-576.
Presenter:

Week 14 – Dec 7 Neural Basis of Music Perception

Background 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.

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

TBA
Presenter:

TERM PAPERS ARE DUE THE FIRST DAY OF FINAL EXAMS