

PSY 348

Music and the Brain

Jonny Saunders — j.saunders@uoregon.edu

Summer 2019, 6/24-7/21
McKenzie 229
M, T, W, Th., 12:00-1:50PM

Office Hours:
LISB 206
M, W, 2:30-3:30PM

Music is by no means like the other arts, [it is] a copy of the will itself. For this reason the effect of music is so very much more powerful and penetrating than is that of the other arts, for these others speak only of the shadow, but music of the essence.

— Schopenhauer, The World as Will and Representation

1: Overview

What is music and how do we experience it?

This course uses music as a unifying theme to explore fundamental concepts and open questions in acoustics, auditory neuroscience, and psychology. We will approach music as both musicians and as neuroscientists, attempting to bridge the two by taking four perspectives:

Sound: What is the physical basis of music?

We begin by describing music from the “outside in,” as an acoustic phenomenon derived from basic properties of gases through its structuring into the basic elements of music – harmonics, tonality, and rhythm.

Audition: How is music sensed?

We then take the complementary view, considering music from the “inside out,” exploring the neural systems that capture, transform, and represent sound.

Acoustics: How do we make music for the brain?

We consider the ways the auditory system reflects itself in the instruments we use, how we produce music, and the music we listen to.

Hearing: How does music affect us?

We finish with the way we are shaped by music through development, theories about how the auditory system computes higher-order musical features, how music can heal us, and how music can become a pathology.

2: Schedule

Problem sets and project assignments are due by 11:59PM on the days listed below

	Date	Topic	Pre-Reading	Post-Reading	Problem Set	Project
1: Sound	06-24	Evolving Hearing	[Tra15]	[Fit06]		
	06-25	Sound Waves	[Fey63a]	[Pul15]		
	06-26	Tonality & Harmonics	[Fey63b]			
	06-27	Rhythm	[Iye+97]	[Gám+19]		
	06-28	— no class —			Submit PS1	Idea
2: Audition	07-01	The Ear & Pitch	[Ekd16]	[LZB14]	Review PS1	
	07-02	Subcortical Auditory System	[Win+05]	[Bar13]		Feedback
	07-03	Auditory Cortex	[Wan13]	[ZCP07]		
	07-04	— no class —				
	07-05	— no class —			Submit PS2	Outline
3: Acoustics	07-08	Instruments & Synthesis		[Bis08]	Review PS2	
	07-09	Grouping	[Ben+12]			Workshop
	07-10	Speech & Hip-Hop	[HP07]	[Liu+12]		
	07-11	Psychoacoustics	[Mus08]	[Dav+13]		
	07-12	— no class —			Submit PS3	Draft
4: Hearing	07-15	Auditory Development	[ML09]	[KK07]	Review PS3	
	07-16	Auditory Models	[BC13]	[DW18]		Workshop
	07-17	Music & Emotion	[Koe14]	[FTK16]		
	07-18	Auditory Pathology	[Kam+14]	[Ste+06]		
	07-19	— no class —			Submit PS4	
	07-22	— no class —				Final

3: Course Structure & Expectations

3.1: Objectives

In this course, you should ...

- Investigate and gain an intuitive understanding of the set of course topics that interest you.
- Be exposed to a broad array of methods, theories, and open questions in neuroscience.
- Practice expressing yourself and your ideas by collaboratively writing with your classmates.

3.2: Grading

This course assumes no previous knowledge of music theory or neuroscience, but will introduce basic concepts and methods relevant to these fields. I assume that everyone will enter the course with a different level of expertise in all topics. As such, grading is not designed to ensure everyone reaches a certain minimum competence on a specific list of topics. Instead, **work will be graded primarily based on effort and improvement** — you are asked to make an honest effort to engage with the material in assignments, and you will not be harshly penalized for inaccuracy as long as you describe your reasoning and incorporate feedback to improve your work in future assignments.

Problem Sets (4)	40%		
		Idea	5%
		Outline	5%
Project	60%	Draft	10%
		Final	30%
		Group Participation	10%

Late work will be penalized 20% for every day it is late. It is especially important that project components are turned in on time so that the other members of your **writing group** have time to review them. Please tell me if you need to turn an assignment in late, I am very accomodating if I know your circumstances in advance.

3.3: Class Sessions

Time spent in class will be split between writing groups, reviewing problem sets, and lectures on new material. Each Monday we will review the previous week's problem set, and two Tuesdays will begin with a peer review workshop with your writing groups. I will survey the class and offer additional explanation of difficult topics, or extension of topics that the class is interested in as needed. **Attendance is not required except for peer review workshops with your writing groups** (see **Schedule**).

3.4: Problem Sets

A problem set will be released each Monday. They are due (uploaded to Canvas) that Friday at 11:59PM. Text should be submitted as a word document (.doc/.docx), a PDF, or a plain text (.txt) file. Audio should be submitted as a .mp3 or .wav file. If you would like to submit a handwritten document there are free document scanners available in the Knight and Science Libraries. *Please do not submit pictures of text.*

Some problem sets may require you to use programs that are not available on public computers, if you have difficulty accessing a computer that allows you to answer the problem sets please contact me and we will make other arrangements.

Problem sets are meant to be challenging, and are often open-ended without a single correct answer. You will be graded primarily on effort: try to answer a problem to the best of your abilities. If you aren't satisfied with your answer, describe your reasoning and what you are unsure of. We will review difficult questions on the problem sets the Monday following their due date. You are welcome to ask me for help, work with your classmates, and use whatever other resources are available to you. Your final submission, however, must be your own work.

3.5: Project

You will work on one major project throughout the term. A full set of guidelines and suggestions will be available on Canvas. You have a great deal of freedom in choosing the topic and medium of your project. Its topic should be related in some way to music and the brain, but you are encouraged to choose something that you find personally interesting rather than re-describing course material. You are welcome to propose something that isn't a research paper like composing a piece of music, conducting an experiment, or writing a program.

Topics must be approved after being submitted on the first Friday of class (06/28), but can be changed until the first draft is due (07/12) with an additional submission. **The final version of your project must be submitted by 11:59PM on Monday, July 22nd.**

Writing Groups

All projects need to have some written component, and good writing needs a few rounds of feedback. After your initial topic submission you will be placed in writing groups of four or five, roughly by similarity of topic. You will give and receive written feedback of your initial ideas, and meet twice in class to collectively review your group's outlines and project drafts. Project assignments will be turned in by 11:59 each Friday and distributed to group members as soon as possible. You will need to have reviewed the material from the other members of your group before class each Tuesday.

3.6: Readings

There is no required textbook for this course, but I do provide a draft textbook written by Dr. Wehr who normally teaches this course. I will provide primary and summary literature for each topic that I suggest, but do not require that you read. I invite you to read everything that helps you answer the problems in the problem sets, advances your project, and deepens your understanding of the topics that you are interested in.

To help narrow the scope of recommended readings, when possible I have designated one piece of "pre-reading" for each lesson that I believe will help you get the most out of that lesson, and one piece of "post-reading" that extends the lesson.

If you ever have trouble accessing a paper or article for this class, please contact me and I will get it for you. If you come across papers that you think would be beneficial to the course, send them to me. I also encourage you to make use of the discussion board on canvas to ask questions about the papers you are reading.

4: Support & Conduct

4.1: Accessibility

This course is intended for all students, including those with mental and physical disabilities or any other condition that negatively affects one's equal access to education. Please let me know if you need any reasonable (or even seemingly "unreasonable") accommodation and I will do my best to make the course work better for you. This is especially true for students with non-visible disabilities who mask, pass, or otherwise compensate for them.

Writing is a large proportion of your grade in this course, which has the potential to systematically disadvantage those for whom English is not their first language. **If English is not your first language and you feel comfortable telling me that, please do so and we will work on appropriate accommodations together.**

Laptops are permitted, but please do not distract those around you by using them for playing video games, browsing social media, etc. Attendance is not required, and you are welcome to leave class if you need to.

I will provide a space in Canvas where you can send me anonymous feedback or requests if you are uncomfortable identifying yourself.

Resources

- Request accommodations: <https://aec.uoregon.edu/request-accommodations>
- Accessible Technology: <https://aec.uoregon.edu/accessible-technology>
- Accessible Education Center
 - 360 Oregon Hall
 - 541-346-1155
 - uoaec@uoregon.edu
 - <https://aec.uoregon.edu>

4.2: Diversity & Inclusion

Science is plagued by its history of being written by a few privileged voices. I acknowledge that the reading for this course, as well as much of the discussion of music history and theory, is heavily reliant on the western scientific and musical tradition. Each time I teach this course I try to build in a greater diversity of musical traditions and perspectives, but it is still very far from perfect. I encourage you to challenge me (in class, in person, electronically, or anonymously if you prefer) when the course content or my lectures are exclusionary, and welcome any additional sources and perspectives that you may contribute.

Hateful or discriminatory speech and writing is not welcome in this course. We all experience music differently, and I require that you treat your classmates and their perspectives with respect while participating in the class.

4.3: Plagiarism

Plagiarism is taken very seriously and is grounds for failure or expulsion. You are responsible for understanding what constitutes plagiarism and how to avoid it in your work. Proper citation is required in all assignments. I don't care about the format of your citations as long as I can find the source. If you are uncertain whether something specific in one of your assignments constitutes plagiarism, please contact me before turning it in.

- [UO Student Conduct Code](#)
- [UO Library guide to avoiding Plagiarism](#)

Reading List

- [Bar13] Edward L. Bartlett. “The Organization and Physiology of the Auditory Thalamus and Its Role in Processing Acoustic Features Important for Speech Perception.” In: *Brain and language* 126.1 (July 2013), pp. 29–48. doi: [10.1016/j.bandl.2013.03.003](https://doi.org/10.1016/j.bandl.2013.03.003). pmid: [23725661](https://pubmed.ncbi.nlm.nih.gov/23725661/).
- [BC13] Jennifer K. Bizley and Yale E. Cohen. “The What, Where and How of Auditory-Object Perception.” In: *Nature Reviews Neuroscience* 14.10 (Oct. 2013), pp. 693–707. doi: [10.1038/nrn3565](https://doi.org/10.1038/nrn3565).
- [Ben+12] Alexandra Bendixen et al. “Regularity Extraction from Non-Adjacent Sounds.” In: *Frontiers in Psychology* 3 (2012). doi: [10.3389/fpsyg.2012.00143](https://doi.org/10.3389/fpsyg.2012.00143).
- [Bis08] George Bissinger. “Structural Acoustics of Good and Bad Violins.” In: *The Journal of the Acoustical Society of America* 124.3 (Sept. 1, 2008), pp. 1764–1773. doi: [10.1121/1.2956478](https://doi.org/10.1121/1.2956478).
- [Dav+13] William J. Davies et al. “Perception of Soundscapes: An Interdisciplinary Approach.” In: *Applied Acoustics*. Applied Soundscapes: Recent Advances in Soundscape Research 74.2 (Feb. 1, 2013), pp. 224–231. doi: [10.1016/j.apacoust.2012.05.010](https://doi.org/10.1016/j.apacoust.2012.05.010).
- [DW18] Susan L. Denham and István Winkler. “Predictive Coding in Auditory Perception: Challenges and Unresolved Questions.” In: *European Journal of Neuroscience* (2018). doi: [10.1111/ejn.13802](https://doi.org/10.1111/ejn.13802).
- [Ekd16] Eric G. Ekdale. “Form and Function of the Mammalian Inner Ear.” In: *Journal of Anatomy* 228.2 (Feb. 2016), pp. 324–337. doi: [10.1111/joa.12308](https://doi.org/10.1111/joa.12308). pmid: [25911945](https://pubmed.ncbi.nlm.nih.gov/25911945/).
- [Fey63a] Richard Feynman. *The Feynman Lectures on Physics Vol. I Ch. 47: Sound. The Wave Equation*. 1963. URL: http://www.feynmanlectures.caltech.edu/I_47.html (visited on 06/23/2019).
- [Fey63b] Richard Feynman. *The Feynman Lectures on Physics Vol. I Ch. 49: Modes*. 1963. URL: http://www.feynmanlectures.caltech.edu/I_49.html (visited on 06/23/2019).
- [Fit06] W. Tecumseh Fitch. “The Biology and Evolution of Music: A Comparative Perspective.” In: *Cognition* 100.1 (May 2006), pp. 173–215. doi: [10.1016/j.cognition.2005.11.009](https://doi.org/10.1016/j.cognition.2005.11.009).
- [FTK16] Sascha Frühholz, Wiebke Trost, and Sonja A. Kotz. “The Sound of Emotions—Towards a Unifying Neural Network Perspective of Affective Sound Processing.” In: *Neuroscience & Biobehavioral Reviews* 68 (Sept. 1, 2016), pp. 96–110. doi: [10.1016/j.neubiorev.2016.05.002](https://doi.org/10.1016/j.neubiorev.2016.05.002).
- [Gám+19] Jorge Gámez et al. “The Amplitude in Periodic Neural State Trajectories Underlies the Tempo of Rhythmic Tapping.” In: *PLOS Biology* 17.4 (Apr. 8, 2019), e3000054. doi: [10.1371/journal.pbio.3000054](https://doi.org/10.1371/journal.pbio.3000054).
- [HP07] Gregory Hickok and David Poeppel. “The Cortical Organization of Speech Processing.” In: *Nature Reviews Neuroscience* 8.5 (May 2007), pp. 393–402. doi: [10.1038/nrn2113](https://doi.org/10.1038/nrn2113).
- [Iye+97] Vijay Iyer et al. “A Novel Representation for Rhythmic Structure.” In: *Proceedings of the 23rd International Computer Music Conference* (1997), pp. 97–100.
- [Kam+14] Hiroharu Kamioka et al. “Effectiveness of Music Therapy: A Summary of Systematic Reviews Based on Randomized Controlled Trials of Music Interventions.” In: *Patient Preference and Adherence* 8 (2014), pp. 727–754. doi: [10.2147/PPA.S61340](https://doi.org/10.2147/PPA.S61340). pmid: [24876768](https://pubmed.ncbi.nlm.nih.gov/24876768/).
- [KK07] Alex S. Keuroghlian and Eric I. Knudsen. “Adaptive Auditory Plasticity in Developing and Adult Animals.” In: *Progress in Neurobiology* 82.3 (June 1, 2007), pp. 109–121. doi: [10.1016/j.pneurobio.2007.03.005](https://doi.org/10.1016/j.pneurobio.2007.03.005).
- [Koe14] Stefan Koelsch. “Brain Correlates of Music-Evoked Emotions.” In: *Nature Reviews Neuroscience* 15.3 (Mar. 2014), pp. 170–180. doi: [10.1038/nrn3666](https://doi.org/10.1038/nrn3666).

- [Liu+12] Siyuan Liu et al. “Neural Correlates of Lyrical Improvisation: An fMRI Study of Freestyle Rap.” In: *Scientific Reports* 2 (Nov. 15, 2012), p. 834. DOI: [10.1038/srep00834](https://doi.org/10.1038/srep00834).
- [LZB14] J. Laudanski, Y. Zheng, and R. Brette. “A Structural Theory of Pitch.” In: *eNeuro* 1.1 (Dec. 4, 2014), ENEURO.0033–14.2014. DOI: [10.1523/ENEURO.0033-14.2014](https://doi.org/10.1523/ENEURO.0033-14.2014).
- [ML09] Jean K. Moore and Fred H. Linthicum. “The Human Auditory System: A Timeline of Development.” In: *International Journal of Audiology* 46.9 (July 7, 2009). DOI: <https://doi.org/10.1080/14992020701383019>.
- [Mus08] Manne-Sakari Mustonen. “A Review-Based Conceptual Analysis of Auditory Signs and Their Design.” In: (June 2008).
- [Pul15] Ville Pulkki. “Communication Acoustics, Chapter 2: Physics of Sound.” In: *Wiley.Com*. 2015, pp. 15–42.
- [Ste+06] Lauren Stewart et al. “Music and the Brain: Disorders of Musical Listening.” In: *Brain* 129.10 (Oct. 1, 2006), pp. 2533–2553. DOI: [10.1093/brain/awl171](https://doi.org/10.1093/brain/awl171).
- [Tra15] L. J. Trainor. “The Origins of Music in Auditory Scene Analysis and the Roles of Evolution and Culture in Musical Creation.” In: *Philosophical Transactions of the Royal Society B: Biological Sciences* 370.1664 (Feb. 2, 2015), pp. 20140089–20140089. DOI: [10.1098/rstb.2014.0089](https://doi.org/10.1098/rstb.2014.0089).
- [Wan13] Xiaoqin Wang. “The Harmonic Organization of Auditory Cortex.” In: *Frontiers in systems neuroscience* 7 (December Dec. 17, 2013), p. 114. DOI: [10.3389/fnsys.2013.00114](https://doi.org/10.3389/fnsys.2013.00114). PMID: [24381544](https://pubmed.ncbi.nlm.nih.gov/24381544/).
- [Win+05] Jeffery A. Winer et al. “Auditory Thalamocortical Transformation: Structure and Function.” In: *Trends in Neurosciences* 28.5 (May 2005), pp. 255–263. DOI: [10.1016/j.tins.2005.03.009](https://doi.org/10.1016/j.tins.2005.03.009).
- [ZCP07] Robert J. Zatorre, Joyce L. Chen, and Virginia B. Penhune. “When the Brain Plays Music: Auditory–Motor Interactions in Music Perception and Production.” In: *Nature Reviews Neuroscience* 8.7 (July 2007), pp. 547–558. DOI: [10.1038/nrn2152](https://doi.org/10.1038/nrn2152).