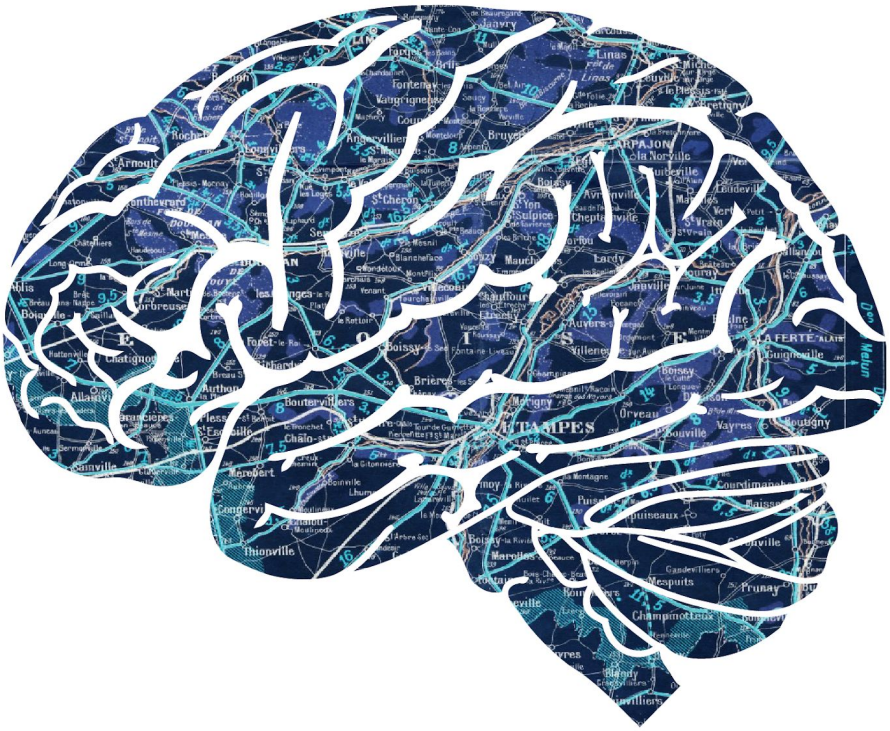
Neuro 101J

Maps of the Brain - *How the Brain Organizes the World*



2020-2021 Syllabus

Julien Grimaud - Harvard University

Instructor and Contact Information

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Course Information

Time and location: Thursday 4:30-5:45pm EDT, on Zoom.
Office hours: TBA (you can email the instructor to request extra office hours)
Course website: https://canvas.harvard.edu/courses/77258
Prerequisites: LS 1a, MCB 80, permission of the instructor.

Course Description

Neurons close to each other in the brain often get activated by parts of the world that are also close to each other: connected body parts, similar sounds, words with related meanings. This organized pattern of activity gives rise to brain maps of our surroundings. In this course, we will explore how the brain creates, uses, and updates such maps to make sense of the world around us.

Each week, we will take a look at neuronal circuits in different parts of the brain (eg, somatosensory cortex, olfactory system, hippocampus) to see how scientists discover new neuronal maps, how these maps function and develop, and how they evolve with experience.

Course Components & Evaluation

- **Typical weekly workload**

Each week, you are assigned one scientific paper, either a primary research article or a review. You are expected to (1) have read the assigned paper prior to class, and (2) come to class ready to discuss it. All the articles listed in this syllabus will be available on the course website. You are expected to spend ~ 3 hrs/wk preparing for the course. As you become efficient at reading scientific literature, the time you spend preparing for the course will decrease.

Each week, before coming to class, you will be asked to answer a pre-class quiz made of 1 to 3 short reading reflection questions. The quiz will be available on the course website at least 3 days before class. Responses must be submitted 1 hour prior to class. The weekly pre-class quizzes will count for 20% of the final grade.

During class, the students are expected to participate in the weekly discussion. Presence and participation will be graded on a predetermined rubric and count for 10% of the final grade.

- **Office hours**

Office hours will be held on a weekly basis (see time and location on the first page of this syllabus). Students who wish to meet at a different time are encouraged to contact the instructor to schedule an extra office hour.

- **End of the first semester**

At the end of the first semester, the students will write a review of a research article in the format of a Journal of Neuroscience Journal Club paper:

http://www.jneurosci.org/content/jneurosci-journal-club

A list of potential research articles to review will be provided by the instructor. Students who wish to review an article not listed need to get permission from the instructor.

The article review will be graded on a predetermined rubric and count for 35% of the final grade. Students have the opportunity to submit their final essay either individually or in group.

- **End of the second semester**

At the end of the second semester, the students will write a science communication review in the format of a Frontiers for Young Minds Core Concept article:

https://kids.frontiersin.org/participate/authors

The review will be graded on a predetermined rubric and count for 35% of the final course grade. Students have the opportunity to submit their final essay either individually or in group.

- **Course grading**

Assignment:	*% total grade:*
In class presence and participation	10% (5% 1st semester + 5% 2nd semester)
Pre-class quiz	20%
"Journal Club" article review	35%
“Core Concept” topic review	35%

The course may be curved (if the median class score is below the B range), but the following cut-offs will never be raised:

A: > 93%	A-: 90-93%	
B+: 85-90%	B: 80-85%	B-: 75-80%
C+: 70-75%	C: 65-70%	C-: 60-65%
D+: 55-60%	D: 50-55%	D-: 45-50%
E: < 50		

- **Key dates and submission deadlines**

Pre-class quiz	1h prior to each class
"Journal Club" article review	December 9th 2020, 6pm EDT (end of the 1st semester)
“Core Concept” topic review	May 5th 2021, 6pm EDT (end of the 2nd semester)

Course Policies

- **Attendance and participation**

Students are expected to attend and participate in all weekly discussions. Absences may be excused at the instructor discretion, with prior approval and supporting documentation. The instructor will take attendance at the beginning of each class. Each student is allowed one unexcused absence per semester. Further unexcused absences will negatively affect the "presence and participation" grade (see corresponding rubric).

- **Zoom etiquette**

Compared to in-person classes, online classes present their one set of benefits (no need to run across the campus between classes, more flexible office hours, lecture recordings easily available...) and challenges (Zoom fatigue, power or Internet outage, noisy roommates...). Here are some guidelines to ensure a smooth transition to online classes:

- When in front of your computer, please keep your webcam on. If your camera remains off most of the lecture, then you will be counted as absent. However feel free to turn your camera off if you need to take a quick break!
- If you are experiencing technical issues (camera / microphone not working, unstable Internet etc) email the instructor as soon as possible, so we can arrange an alternative assignment to make up for your presence and participation.

- When not talking, keep your microphone off. General discussion etiquette still applies (e.g. do not talk over someone else, be polite etc).
- Make sure you have a class-appropriate background. If not, you can use Zoom virtual backgrounds.
- Look at the camera, rather than yourself, when talking.
- Eliminate as much distraction as possible during class. In particular, please refrain from checking emails and social media during class.
- Zoom "private" messages in the chat are **not** private: the host can see all messages at the end of the meeting on the chat transcript.
- Recordings of the lectures will be made available on the course website. Watching a lecture's recording is **not** an alternative to live classes (unless otherwise discussed with the instructor).

- **Late work**

All work is expected to be turned in on time. Late assignments may be excused at the instructor discretion, with prior approval and / or supporting documentation. It is the student's responsibility to seek excuse for a late assignment. Unexcused late assignments will automatically receive a 0% grade.

- **Classroom environment**

This course is mainly based on in-class discussion. As such, each student is expected to come to class prepared to discuss the assigned articles. In other words, each student must have read the assigned articles prior to class, in order to be ready to engage in a thoughtful, inclusive, and respectful discussion with their peers each week. In class participation will be graded (see corresponding rubric).

- **Collaboration and academic integrity**

Students are encouraged to discuss the assignments with their peers outside of class. For the written assignments, the students are expected to acknowledge any help they received. They are also expected to properly cite all of the sources used to complete the assignments. More generally, the students must adhere to the Harvard College Honor Code: https://honor.fas.harvard.edu/honor-code

- **Course schedule**

The content of this syllabus, including, but not restricted to, the schedule, readings, and assignments, are subject to change during the course. Students will be notified of such changes. In particular, changes of schedule and readings will be notified at least one week in advance.

- **Accommodations for students with disabilities**

Students who need accommodations must present their Faculty Letter from the Accessible Education Office and speak with the instructor by the end of the second week of each semester. Failure to do so may result in the instructor's inability to respond in a timely manner.

Schedule and Readings: Fall Semester

Introduction (week 1)

Week 1 (08/20): Introduction to the course *(no required reading)*

Somatosensory Maps (weeks 2 to 5)

Week 2 (09/03): Somatosensory maps (lecture)

- Harding-Forrester S, Feldman DE. Somatosensory maps. Handb Clin Neurol. 2018;151:73-102. *Read pages 73-85*

Week 3 (09/10): How to build a map: example of the barrel cortex

- Welker C. Receptive fields of barrels in the somatosensory neocortex of the rat. J Comp Neurol. 1976 Mar 15;166(2):173-89.

Week 4 (09/17): Movement representations in the motor cortex of monkeys

- Graziano MS, Aflalo TN, Cooke DF. Arm movements evoked by electrical stimulation in the motor cortex of monkeys. J Neurophysiol. 2005 Dec;94(6):4209-23.

Week 5 (09/24): A (very incomplete) introduction to biostatistics

- Fay D, Gerow K. A biologist's guide to statistical thinking and analysis *in* WormBook: The Online Review of C. elegans Biology, 2013. *Please pay attention to Part 1 "The Basics" p.3-11.*

Orientation Columns of V1 (weeks 6 to 8)

Week 6 (10/01): Brain maps of the visual system (lecture)

- Hubel DH, Wiesel TN. Brain mechanisms of vision. Scientific American 241(3):150-63.

Week 7 (10/08): Imaging the orientation columns

- Yacoub E, Harel N, Ugurbil K. High-field fMRI unveils orientation columns in humans. Proc Natl Acad Sci USA. 2008 Jul 29;105(30):10607-12.

Week 8 (10/15)**:** Salt-and-pepper organization in the visual cortex

- Ringach DL , Mineault PJ, Tring E , Olivas ND, Garcia-Junco-Clemente P, Trachtenberg JT. Spatial clustering of tuning in mouse primary visual cortex. Nat Commun 2016 Aug 2;7:12270.

Odor Representations in the Brain (weeks 9 to 11)

Week 9 (10/22): Olfactory representations in the brain (lecture)

- Giessel AJ, Datta SR. Olfactory maps, circuits and computations. Curr Opin Neurobiol. 2014 Feb;24(1):120-32.

Week 10 (10/29): Odor maps in the olfactory bulb

- Mombaerts P, Wang F, Dulac C, Chao SK, Nemes A, Mendelsohn M, Edmondson J, Axel R. Visualizing an olfactory sensory map. Cell. 1996 Nov 15;87(4):675-86.

Week 11 (11/05): Odor representations in the cortex

- Sosulski DL, Bloom ML, Cutforth T, Axel R, Datta SR. Distinct representations of olfactory information in different cortical centres. Nature. 2011 Apr 14;472(7342):213-6.

Lexical Maps (weeks 12 & 13)

Week 12 (11/12): Discovering lexical maps

- Damasio H, Grabowski TJ, Tranel D, Hichwa RD, Damasio AR. A neural basis for lexical retrieval. Nature 1996 Apr 11;380(6574):499-505.

Week 13 (11/19): Computing lexical maps

- Huth AG, de Heer WA, Griffiths TL, Theunissen FE, Gallant J. Natural speech reveals the semantic maps that tile human cerebral cortex. Nature. 2016 Apr 28;532(7600):453-8.

No class on 11/26: Thanksgiving recess

Week 14 (12/03): Semester wrap-up

Schedule and Readings: Spring Semester

Spatial Localization in the Barn Owl (weeks 15 to 17)

Week 15 (01/28): Spatial mapping and plasticity in the auditory system (lecture)
- Knudsen EI. Instructed learning in the auditory localization pathway of the barn owl. Nature. 2002 May 16;417(6886):322-8.

Week 16 (02/04): A spatial localization map in the midbrain
- Knudsen EI. Auditory and visual maps of space in the optic tectum of the owl. J Neurosci. 1982 Sep;2(9):1177-94.

Week 17 (02/11): Remodeling of the spatial localization map
- DeBello WM, Feldman DE, Knudsen EI. Adaptive axonal remodeling in the midbrain auditory space map. J Neurosci. 2001 May 1;21(9):3161-74.

Brain Maps and Navigation (weeks 18 to 20)

Week 18 (02/18): Neurons and navigation (lecture)
- Geva-Sagiv M, Las L, Yovel Y, Ulanovsky N. Spatial cognition in bats and rats: from sensory acquisition to multiscale maps and navigation. Nat Rev Neurosci. 2015 Feb;16(2):94-108.

Week 19 (02/25): Grid cells in rodents
- Hafting T, Fyhn M, Molden S, Moser MB, Moser EI. Microstructure of a spatial map in the entorhinal cortex. Nature. 2005 Aug 11;436(7052):801-6.

Week 20 (03/04): Social place cells in bats
- Omer DB, Maimon SR, Las L, Ulanovsky N. Social place-cells in the bat hippocampus. Science. 2018 Jan 12;359(6372):218-224.

Plasticity of Somatosensory Maps (weeks 21 to 23)

Week 21 (03/11): Plasticity of Somatosensory Maps (lecture)
- Harding-Forrester S, Feldman DE. Somatosensory maps. Handb Clin Neurol. 2018;151:73-102. *Read pages 85-90*

No class on 03/18: Spring recess

Week 22 (03/18): Somatosensory remapping after injury
- Merzenich MM, Nelson RJ, Stryker MP, Cynader MS, Schoppmann A, Zook JM. Somatosensory cortical map changes following digit amputation in adult monkeys. J Comp Neurol. 1984 Apr 20;224(4):591-605.

Week 23 (04/01): Somatosensory remapping after training
- Jenkins WM, Merzenich MM, Ochs MT, Allard T, Guíc-Robles E. Functional reorganization of primary somatosensory cortex in adult owl monkeys after behaviorally controlled tactile stimulation. J Neurophysiol. 1990 Jan;63(1):82-104.

Critical Periods (weeks 24 & 25)

Week 24 (04/08): Critical period in the mammalian V1
- Hubel DH, Wiesel TN. The period of susceptibility to the physiological effects of unilateral eye closure in kittens. J Physiol. 1970 Feb;206(2):419-36. *Also: review material from week 6*

Week 25 (04/15): Critical period in the midbrain of the barn owl
- Brainard MS, Knudsen EI. Sensitive periods for visual calibration of the auditory space map in the barn owl optic tectum. J Neurosci. 1998 May 15;18(10):3929-42. *Also: review material from week 13*

Week 26 (04/22): Semester wrap-up