

**Psychology 4600: *Neural Representations***  
**Spring 2023, MW 2:45-4:00 pm**  
**438 Uris Hall**

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**Office hours:** By appointment

**Learning Goals:**

After completion of this course, students should have gained:

- (1) A understanding of the operations and interactions of neural systems in the brain, how they are able to represent and manipulate different types of information, and how this can be measured,
- (2) An appreciation for the sophistication of neural systems design across multiple levels of organization, and how each level constrains the operations of those above it, as well as the necessary tradeoffs among time, precision, space, and energy that arise when constructing a working system,
- (3) In particular, an integrated understanding of the olfactory system, across levels of organization and analysis, and
- (4) An improved ability to navigate the research literature, and to critically evaluate and interpret scientific results and claims when they are encountered in the literature or media.

**Website:** <https://canvas.cornell.edu/courses/51263>

This is home base for the course. Materials, supplementary materials, assignments, commentary, suggestions, tips, introductions to material, etc., all will be posted here. In particular, please access Perusall papers via the assignment links posted on Canvas rather than directly, because of how the two applications interact.

**Required texts:**

We will be reading original papers and other selections, which will be made available via Canvas.

**The Course:**

Fundamentally, this course is about how brains encode and manipulate information. This is a big topic, and one of our goals is to better appreciate just how big it is, and how diverse the computations and solutions that have evolved in our brains are. For this, we need a core subject on which to focus our efforts. We will focus on the vertebrate olfactory system, across levels of analysis and organization, and on how it constructs odor perception from environmental information. We also will repeatedly digress from this core subject into related topics and comparable systems in order to appreciate the complexity and diversity of brain mechanisms.

The goal of this class is not that you memorize all of the information presented, but rather that you internalize the overarching lessons that there are many difficult physical problems to be solved, for which animals' brains have evolved a highly diverse set of solutions, trading off factors such as time, energy, volume, and ancillary behaviors to produce an adequately functional system. More to the point: active engagement is critical for this course, but it is fine with me if all of your active engagement is questions. The most difficult demand that I will make of you this semester is to get over whatever reluctance you might have to “reveal your ignorance” by speaking up with a question or idea. Scientists have to get used to being wrong if they want to not be terrible at their jobs, and if a scientist isn't ignorant of many of the aspects of the questions they are asking, then they are not asking particularly interesting questions.

## The Rhythm:

For the most part, we will start a new “unit” on Wednesdays by introducing the topic in a lecture/discussion. (There may be some reading assignments to do before a given Wednesday class, which can be accessed via Canvas). There then will be roughly three assigned papers on that topic to read for discussion on the following Monday. These discussions will be led by student presenters/discussion leaders who will spend additional effort that week to be thoroughly familiar with their assigned paper(s) and construct presentations as discussed below.

Specifically: after each Wednesday class, before the following Saturday evening, everybody will read the assigned papers for the following Monday, and use Perusall to discuss them and annotate the papers with key questions, comments, answers, and insights. (There may also be other papers, video links, etc. posted to Canvas as optional, supporting information for your reference and enjoyment). Sundays are reserved for that week’s student presenters/discussion leaders to incorporate any thoughts and questions posted to Perusall into their Monday presentations.

## Assignments and Grading:

The goal of this course is to have rich discussions that can bring everybody new insights into the diversity and sophistication of multiscale neural systems and how they represent information. Often, a person can’t do that very well if they are scared about being judged about everything they do or don’t know. And of course the whole class will be the poorer if everybody doesn’t speak up and contribute. So, this is the plan.

You will be graded on three things:

- (1) Your performance as presenter/discussion leader over the course of the semester. You don’t need to know everything or explain all of the details of your paper, but you do need to have put in the effort to understand the gist and to have assembled enough interesting questions to keep us going during discussion. Try to interrelate ideas drawn from the other papers studied in class with those of the current paper. In your presentation, please also respond to the questions and topics raised by your classmates over the preceding week via their Perusall annotations.

I neither require nor prefer polished Powerpoint (etc) presentations. Your goal isn’t to give a lecture, it is to provide an overview, organize and motivate discussion, and to keep something interesting on the screen for us to look at and discuss. You are welcome to use Powerpoint or equivalent to help organize your discussion, but be warned that too much polish can shut down discussion and engagement. It is just fine to keep the paper and perhaps a couple of other related papers on screen and pull figures up as needed. A combination might be most effective – some key points of yours on Powerpoint or equivalent with most of the discussion focused around elements of the papers that everybody has access to.

- (2) Your annotations on the ~three papers each week, via Perusall. You need to make at least five meaningful Perusall annotations per paper each week. (Perusall may judge you on these using its algorithm, but its judgment will not directly govern my assessment). Note that these annotations can all be questions! The idea is to help you and all of your classmates understand the paper and the underlying core concepts better by asking for clarification, defining terms, pointing out unclear statements or results that can’t be understood without background in experimental electrophysiology or whatever. Answer one another via those same annotation tools when you know something. I also will do so. And of course we will follow up with these in class. **Please start these well before the following class so that there is plenty of time for others to respond.** There is no need to do all of your Perusalling in one session – it is best if we all revisit the Perusall pages a few times during each week.

This Perusall work is important both to ensure that we all read the papers in some depth (and hence can talk about them) and to show the presenters where the difficult parts are, what the interesting (to us) questions are, and such, so that the presenters can devote effort particularly to those points. Accordingly, these annotations must be complete before the Saturday night prior to class (11:59 pm) so that the presenters have some time to compile and address them in their class presentation.

Samantha Carouso-Peck, recently a postdoc in our department, created a video describing how to use Perusall. You can access it here: <https://vimeo.com/456924216>. (She is referring to a different course, though, so don't mistake her references to "all you need are three tiny comments on one single paper" and the like as meaningful for our course). There are of course other such videos as well.

- (3) Your in-class engagement – ask questions, raise points, share links, argue, generalize, integrate, compare and contrast. This is important. You need to participate, actively and frequently, to receive a good grade. This does not mean that you need to have the answers. Questions are participation.

Those taking the graduate version (PSYCH 6600) will have one additional requirement:

- (4) One additional session as presenter/discussion leader, for a paper that you select yourself after discussion with the instructor. The paper should be chosen to highlight some important principle of neural representation – considered broadly – and to relate to other topics studied in class. Hopefully it also will relate to a key interest of your own that you can share with the class. These papers must be finalized by the end of spring break – i.e., before the first class following spring break – so that they can be organized and posted to Perusall. These presentations will take place during the last two class sessions of the semester.

There are no exams. My goal is for the learning experience to arise from our Perusall and in-class discussions, where repeated discussions and invocations of key principles will sink in over the course of the semester.

### **Discussion Board:**

There is a discussion board on our course Canvas site for questions and discussions regarding course topics and material. Feel free to start new discussion headings or otherwise engage as you see fit. I'm unsure how useful this will be, given that we are a small discussion-centric course, but we will see. Please feel free to create and/or participate in discussion threads about the course material that may arise for any reason. I will check the discussion boards regularly and will try to answer any questions that may arise.

### **Students with Disabilities:**

Please give me your Student Disability Services (SDS) accommodation letter early in the semester so that I have adequate time to arrange your approved academic modifications. Meeting with me in my office hours will help ensure confidentiality. If you need an immediate accommodation for equal access, please speak with me after class or send an email message to me at [tac29@cornell.edu](mailto:tac29@cornell.edu) and/or SDS at [sds\\_cu@cornell.edu](mailto:sds_cu@cornell.edu). If the need arises for additional accommodations during the semester, please contact SDS.

### **Plagiarism and Academic Integrity:**

I encourage you to work together so as to better understand the material presented in this course. However, the work you do must be your own. University policies regarding plagiarism and academic integrity can be found at <http://cuinfo.cornell.edu/aic.cfm> and <https://plagiarism.arts.cornell.edu/tutorial/index.cfm>.