Top-down effects on perception

Department of Psychology – Columbia University

PSYC3476 - Course Syllabus – Fall 2026

Instructor: Dr. Tiago Altavini **E-mail**: ts3595@columbia.edu
Course Time: Mondays 12:10 PM to 2 PM
Course Location: 200C Schermerhorn Hall
Office Hours: Monday 2:10 PM – 4:00 PM, Wednesday 2:10 PM – 4:00PM
Office: 709 Uris Hall

Course Description:

For much of the history of neuroscience, perception was viewed as a rigid hierarchical process. A bottom-up network beginning with the transduction of different sensory modalities into action potentials, relay distribution through the thalamus and finally cortical processing from early sensory areas to the frontal lobe. Once thought to fully explain perception, evidence from the last few decades suggests that is an incomplete view. Expectation, attention, memories, tasks and emotions can affect perception and sensory processing even in early cortical stages. These top-down effects suggest that the subjective reality each one of us experience is not determined solely by the shapes of objects, frequency of air vibrations or structure of odorant molecules. Reality is built at the intersection between the physical attributes of the world and our brains' internal processes.

Course Prerequisites:

Instructor permission is required to take the course. Undergraduate students should have already taken The Science of Psychology (PSYC1001) and either Cognitive Neuroscience (PSYC2430), Behavioral Neuroscience (PSYC2450), or Fundamentals of Human Neuropsychology (PSYC2470). Students who have not taken a prerequisite course but have taken other relevant courses should contact the instructor for approval.

Course Role in the Department:

PSYC3476 Top-down effects on perception is a seminar designed for undergraduates majoring in Psychology or Neuroscience & Behavior. It fulfills the following degree requirements:

- For the Psychology major or concentration in Columbia College and in the School of General Studies
- For the Neuroscience and Behavior major, this course fulfills the P5 Psychology (Advanced Psychology Seminar) requirement.

Coursework:

Coursework will consist of weekly readings, weekly responses to questions about the readings, the research project (research paper and poster), and leading the class discussion.

Readings:

The course readings are scientific journal articles that are selected to help you better understand how different sensory modalities are affected by top-down networks. Articles include research done in healthy participants, patients with sensory disorders and animal models. Each week we will read at least one article based on human research and one on an animal model. We will discuss the main findings of each paper and their experimental design, as well as compare findings of different articles and evaluate if they present converging evidence. The goals are to gain knowledge about how sensory systems function and to develop a broad and critical understanding of how unifying theories are developed in neuroscience.

Weekly Reading Questions:

The purpose of the weekly reading questions is to help orient you to the major takeaways from the readings (related to both the major findings and the methodology). Responses to reading questions are to be submitted by the day before seminar each week.

Research Project:

Over the course of the semester, you will investigate the relationship between higher cognitive functions and early sensory processing. You will synthesize your research into a 10-page research paper that you will submit in the second half of the semester. You will also present your findings to the class at a digital poster session during our final seminar. The first draft of your project will be submitted for peer review. Each student will review one other student's work. The goal of the research project is to help develop science communication skills (both written and oral), critical thinking, research skills, and quantitative reasoning. More detailed instructions for the research paper, the poster presentation, and the peer review can be found in the Research Project Guidelines. Example topics include but are not limited to:

- Expectation effects on visual receptive fields
- Attention effects on object recognition
- Emotional state effects on auditory frequency discrimination
- The mechanisms of perceptual learning
- Priming effects on determining minimal recognizable configurations

Seminar Discussion Leader:

Each student will have the opportunity to lead the seminar discussion once during the semester. Being the discussion leader will consist of three parts: planning the discussion, leading the discussion, and writing a reflection about the experience. The goals of being a discussion leader are to help you practice science communication, critical thinking, and

community engagement and inclusion as you plan out, lead, and reflect on the discussion. More details can be found in the Discussion Leader Guidelines.

Course Website:
The most up-to-date information, including changes to the syllabus or to the class schedule, announcements, lecture slides and additional materials are contained on the course website on CourseWorks (Canvas). Be sure you are familiar with it, that you are easily able to login to the website, and that you always have the readings with you (whether printed or digital).

Course Objectives:
This course is designed to help you develop the following Core Competencies: written communication, community engagement and inclusivity, creativity and innovation, critical thinking, knowledge, oral communication, quantitative literacy, and research. At the completion of this course students will be equipped to:

- Describe the bottom-up network (from receptors to cortical processing) for each sensory system: visual, auditory, olfactory, gustatory and somatosensory.
- Describe the different cortical areas involved and their roles in processing sensory information
- Describe how various higher cognitive processes – like attention, expectation, task engagement, etc. - can affect perception
- Discuss how theories about the neurogenesis of perception shifted from a hierarchical bottom-up perspective to considering top-down effects.
- Find, read, interpret, and synthesize information from primary research articles.
- Communicate science, both in written and oral form, to the general public.
- Engage in discussion about scientific findings.
- Provide meaningful feedback to peers and also reflect on one's own work.

Course Schedule: Any changes will be announced in class and posted as an announcement on CourseWorks. Students should complete the assigned reading before coming to class:

September 14th, 2024: Seminar 1. Course Intro: Sensory systems, bottom-up and top-down networks definitions

Firestone C, Scholl BJ. Cognition does not affect perception: Evaluating the evidence for "top-down" effects. Behavioral and Brain Sciences. 2016;39:e229. doi:10.1017/S0140525X15000965

September 21st, 2026: Seminar 2. Olfactory – Attention and behavior modulation

Human

Singh, A.K., Touhara, K. & Okamoto, M. Electrophysiological correlates of top-down attentional modulation in olfaction. *Sci Rep* **9**, 4953 (2019). https://doi.org/10.1038/s41598-019-41319-6

Rodents

Aqrabawi, A., Browne, C., Dargaei, Z. *et al.* Top-down modulation of olfactory-guided behaviours by the anterior olfactory nucleus pars medialis and ventral hippocampus. *Nat Commun* **7**, 13721 (2016). https://doi.org/10.1038/ncomms13721

September 28th, 2026: Seminar 3. Olfactory – Social and affective modulation

Submission of topic for Research Project

Human

Camille Ferdenzi, S. Craig Roberts, Annett Schirmer, Sylvain Delplanque, Sezen Cekic, Christelle Porcherot, Isabelle Cayeux, David Sander, Didier Grandjean, Variability of Affective Responses to Odors: Culture, Gender, and Olfactory Knowledge, Chemical Senses, Volume 38, Issue 2, February 2013, Pages 175–186, https://doi.org/10.1093/chemse/bjs083

Rodents

Lars-Lennart Oettl, Namasivayam Ravi, Miriam Schneider, Max F. Scheller, Peggy Schneider, Mariela Mitre, Miriam da Silva Gouveia, Robert C. Froemke, Moses V. Chao, W. Scott Young, Andreas Meyer-Lindenberg, Valery Grinevich, Roman Shusterman, Wolfgang Kelsch Oxytocin Enhances Social Recognition by Modulating Cortical Control of Early Olfactory Processing
Neuron, 2016; 90, 609-621

October 5th, 2026: Seminar 4. Gustatory – sweet/bitter balance

Rodents

Jin H, Fishman Z, Ye M , Li W, Zucker C.
Top-Down Control of Sweet and Bitter Taste in the Mammalian Brain
Cell, 184, 257-271.e16

Humans

Woods, A. T. , Lloyd, D. M. , Kuenzel, J. , Poliakoff, E. , Dijksterhuis, G. B. & Thomas, A. (2011). Expected taste intensity affects response to sweet drinks in primary taste cortex. NeuroReport, 22 (8), 365-369. doi: 10.1097/WNR.0b013e3283469581.

October 12th, 2026: Seminar 5. Gustatory – Visual cues and taste pleasantness

Humans

Ohla K, Toepel U, le Coutre J, Hudry J (2012) Visual-Gustatory Interaction: Orbitofrontal and Insular Cortices Mediate the Effect of High-Calorie Visual Food Cues on Taste Pleasantness. PLoS ONE 7(3): e32434. https://doi.org/10.1371/journal.pone.0032434

Rodents

Burgess C, Ramesh R, Sugden A, Levandowski K, Minnig M, Fenselau H, Lowell B, Andermann M. Hunger-Dependent Enhancement of Food Cue Responses in Mouse Postrhinal Cortex and Lateral Amygdala. Neuron, 2016; 91, 1154-1169. https://doi.org/10.1016/j.neuron.2016.07.032

October 19th, 2026: Seminar 6. Somatosensory – Expectation affects touch perception thresholds

First draft of Research Project

Humans

Metzger, A., Mueller, S., Fiehler, K. *et al.* Top-down modulation of shape and roughness discrimination in active touch by covert attention. *Atten Percept Psychophys* **81**, 462–475 (2019). https://doi.org/10.3758/s13414-018-1625-5

Rodents

Ramamurthy, D.L., Rodriguez, L., Cen, C. *et al.* Reward history guides focal attention in whisker somatosensory cortex. *Nat Commun* **16**, 5580 (2025). https://www.nature.com/articles/s41467-025-60592-w

October 26th, 2026: Seminar 7. Somatosensory – Attention and pain

Humans

Hauck M, Domnick C, Lorenz J, Gerloff C and Engel AK (2015) Top-down and bottom-up modulation of pain-induced oscillations. Front. Hum. Neurosci. 9:375. doi: 10.3389/fnhum.2015.00375

Rodents

Giulia Livrizzi, Janie Chang-Weinberg, Desiree A. Johnson, Susan T. Lubejko, Jingzhu Liao, Blake A. Kimmey, Chunyang Dong, Yuan Li, Kevin T. Beier, Gregory Corder, Lin Tian,

Matthew R. Banghart. Top-down control of the descending pain modulatory system drives multimodal placebo analgesia. Neuron, 2026.
https://doi.org/10.1016/j.neuron.2026.03.025

Supplemental video: https://www.youtube.com/watch?v=OdnkWSwAXjY

November 2nd, 2026: Academic Holiday, no class

November 9th, 2026: Seminar 8. Peer review day

November 16th, 2026: Seminar 9. Auditory – Top-down suppression of early processing

Humans
Bidet-Caulet, A., Bottemanne, L., Fonteneau, C. et al. Brain Dynamics of Distractibility: Interaction Between Top-Down and Bottom-Up Mechanisms of Auditory Attention. Brain Topography 28, 423–436 (2015). https://doi.org/10.1007/s10548-014-0354-x

Rodents
Wimmer, R., Schmitt, L., Davidson, T. et al. Thalamic control of sensory selection in divided attention. Nature 526, 705–709 (2015). https://doi.org/10.1038/nature15398

November 23rd, 2026: Seminar 10. Auditory – Top-down facilitates speech comprehension

Humans
Park H, Ince R, Schyns P, Thut G, Gross J.
Frontal Top-Down Signals Increase Coupling of Auditory Low-Frequency Oscillations to Continuous Speech in Human Listeners
Current Biology, 2015; 25, 1649-1653
https://doi.org/10.1016/j.cub.2015.04.049

Ferrets
Joshi, N., Ng, W.Y., Thakkar, K. et al. Temporal coherence shapes cortical responses to speech mixtures in a ferret cocktail party. Commun Biol 7, 1392 (2024).
https://www.nature.com/articles/s42003-024-07096-3

November 30th, 2026: Seminar 11. Vision – Expectation affects the processing of visual stimuli

Final version of Research Project

Humans

Gordon N, Tsuchiya N, Koenig-Robert R, Hohwy J (2019) Expectation and attention increase the integration of top-down and bottom-up signals in perception through different pathways. PLOS Biology 17(4): e3000233. https://doi.org/10.1371/journal.pbio.3000233

Non-human primate
T.S. Altavini,M. Chen,G. Astorga,Y. Yan,W. Li,W. Freiwald, & C.D. Gilbert, Expectation-dependent stimulus selectivity in the ventral visual cortical pathway, Proc. Natl. Acad. Sci. U.S.A. 122 (13) e2406684122, https://doi.org/10.1073/pnas.2406684122 (2025).

December 7th, 2026: Seminar 12. Vision – Perception and mental imagery

Humans
Dijkstra, N., Zeidman, P., Ondobaka, S. et al. Distinct Top-down and Bottom-up Brain Connectivity During Visual Perception and Imagery. Sci Rep 7, 5677 (2017). https://doi.org/10.1038/s41598-017-05888-8

Rodents
Chongxi Lai, Shinsuke Tanaka, Timothy D. Harris and Albert K. Lee. Volitional activation of remote place representations with a hippocampal brain–machine interface. Science, 2023, Vol 382, Issue 6670, pp. 566-573. DOI: 10.1126/science.adh5206

December 14th, 2026: Seminar 13. Poster presentations

Grades:
Your overall course grade will be determined by your effort in the following areas:

- **In-class preparation and participation** **20%**
  - Weekly reading questions (10%)
  - In-class contributions (10%)
- **Leading class discussion** **30%**
  - Plan for the discussion (10%)
  - Leading the discussion (10%)
  - Reflection of the discussion (10%)
- **Research project** **50%**
  - Research paper (30%)
  - Poster presentation (10%)
  - Peer review of another student's work (10%)

Letter Grade Assignment:

99-100%: A+	87-89.9%: B+	77-79.9%: C+	67-69.9%: D+	<60%: F
94-98.9%: A	84-86.9%: B	74-76.9%: C	64-66.9%: D	
90-93.9%: A-	80-83.9%: B-	70-73.9%: C-	60-63.9%: D-	

Note about A+ grades: A+ grades are earned by portion of students who have achieved high mastery of the material. If extra credit opportunities are provided, they cannot be used to move a student from an A to an A+ grade.

Course Policies: please read the following policies carefully!

Disability Services:
Students must register with their school's Disability Services office to receive disability-related accommodations and must complete the testing accommodation request form. More information is available at:
Columbia: https://health.columbia.edu/content/disability-services
Barnard: https://barnard.edu/disabilityservices/register-cards

Seminar Attendance and Participation:
Attendance and active participation are a critical component of your grade. Attendance will be taken at each seminar. Each unexcused absence will result in lowering your grade, e.g. A will become a B+ following two unexcused absences. 75% attendance is required to pass the class.

Seminar will be discussion based. This is your chance to share your perspective, thoughts, critiques, and questions. We will be relying on one another's contributions to have lively discussions about the week's topic, focusing heavily on the readings. Active participation is expected from all students.

Electronics Policy:
It is strongly encouraged that you take handwritten notes. If you need to use a device, please be respectful of your classmates and your instructor by only accessing the document for class and not using the device to message or access the internet. Coming to class is of no value if you are not engaged in the discussions. Messaging friends, watching videos online, and browsing social media are not appropriate for the classroom. Remember to silence your phones before class.

Late Assignments:
Any assignment that is turned in late will have a late penalty applied, with a 10% deduction in points for each day after the deadline that it is turned in. Assignments turned in late by 5 or more days will receive a max score of 50%. Assignments are not accepted after the last day of class. Courseworks will automatically apply this deduction in points. If there are extenuating circumstances (death in the family, etc.) please notify me immediately. Note: to avoid the penalty for late submissions, do not wait until the last minute to submit an assignment. Courseworks is sometimes slow to upload. Submitting in advance of the deadline is your best bet.

Zoom Class Link:
If you need to join class remotely because of illness please email the instructor for the link. Importantly, to be admitted to class you must email up to one hour before the seminar

explaining why you are unable to attend in person. (The earlier you can notify me the better. You do not have to divulge personal details such as why you are sick, etc.) Failing to communicate before class regarding your absence will result in an unexcused absence. The same level of participation is expected if you join remotely.