

Psychology 620 Section 27 “Cognitive Neuroscience Seminar”
Topic: Prefrontal cortex and Cognition
Spring Semester, 2007

Meetings:
Th 2:20 – 3:40
Psych B, Room 256

Instructor: Dr. Hoi-Chung Leung
Office: Psych B, Room 314
Office Hours: By appointment.

Course Description

This seminar course is a survey of current research findings, theories, and empirical approaches towards the understanding of the role of prefrontal cortex network in cognition. The aim of this course is to discuss how one might investigate the neural basis of higher-order cognitive functions (with a focus on memory and executive functions) and to evaluate the strengths and weaknesses of the cognitive neuroscience approaches.

Class Format

The class will be in the format of short presentation, interactive discussion and open debate between seminar participants. To facilitate dialogue, each member is expected to briefly present points raised in their reaction papers (see below) as a starting point for discussion.

Class Requirements

1. Weekly Readings

There is no textbook requirement. Weekly readings are listed below. Articles discussed in each class will be available on “blackboard” for download (<http://blackboard.stonybrook.edu/>). Those not available online can be copied from the instructor. Copies will also be made available in the Graduate mailroom.

2. Weekly reaction papers (Due in my office no later than 5pm on the day prior to each class.)

Class members are expected to write a short reaction paper (as if you are a reviewer) on each reading. The reaction papers should be concise, not to exceed one page long per reading. You are recommended to first write a brief summary (not exceeding 100 words) and then summarize your reactions to the followings:

- i) General comments you have about the readings (e.g., what is the significance and potential impact);
- ii) Why you agree or disagree with the theoretical arguments, approach and/or the empirical findings;
- iii) Suggestions you have for further analysis, experiments and/or theoretical clarifications.
- iv) Find at least one additional article to support your view and integrate it into your arguments. Recent papers are preferred, but it is more important to find a paper that offers strong evidence and/or theoretical significance. (Remember to properly cite your source of information.)

3. Weekly presentation and discussion

Each week, class members are expected to give presentations and lead discussions on assigned readings. (Presentations can be in overhead or powerpoint format.) One group of students will be designated to present the assigned paper and leading the discussion (e.g., offering views to support the theory propose by the paper). Another group of students should prepare for counter arguments or alternative views. Use the assigned paper and the paper(s) you may have found in these discussions. *The aim is (1) to critique the paper presented and (2) to develop an alternate design for an experiment to address the concerns and/or follow-up experiments to further address the question.*

4. Term paper

The term paper (*in proposal format*) is to explore a topic in additional depth, by either following up on an issue raised in class or pursuing a topic of interest not covered in the course but within the field of cognitive neuroscience. The length of the proposal should be between 10 -15 pages (double spaced and font size 12 pt; page number does not include references). The proposal must include the following sections: Abstract, Introduction, Methods, Predicted results, Alternative hypothesis, Discussion and References. The format of all reference sections of the paper is APA.

Term paper Schedule:

First draft: Submit a title and abstract of your topic with a list of at least 10 references. Make an appointment to meet with the instructor during week 8 (on or before March 16, 5pm).

Final paper: Submit the final paper (1 paper version and 1 electronic version) to the instructor during week 13 (on or before April 20, 5pm). All papers will be published on blackboard for the class.

Final presentation: Each student will give a final presentation (15 min) on his/her paper.

Review process: Everyone will be given 3 papers to review and score each one according to a specific guideline. The scoring decision should be primarily based on the quality of the paper (i.e., significance, approach, and innovation). Your review will remain anonymous. The final reviews will be due on the last day of class (May 4, 5pm).

All students should keep in mind that the principle of Academic Honesty requires that this paper be the original work of the student who submits it, and must include appropriate citations for statements and ideas that are the original work of others. If in doubt, cite your sources.

If you have a physical, psychological, medical or learning disability that may impact on your ability to carry out assigned course work, I would urge that you contact the staff in the Disabled Student Services office (DSS), Room 133 Humanities, 632-6748/TDD. DSS will review your concerns and determined, with you, what accommodations are necessary and appropriate. All information and documentation of disability is confidential.

Class Schedule

Week/Date

Discussion Topic

Week 1

Course organization and Introduction

1/23 Course objectives, format, requirements, and additional resources (reference books/articles; web sites)

1/25 Lecture: The Prefrontal Cortex and Cognitive Neuroscience

Recommended reading:

Mountcastle, V. (1995). The evolution of ideas concerning the function of the neocortex. *Cereb Cortex*, 5(4), 289-295

Kolb & Whishaw (2003) *The Fundamentals of Human Neuropsychology*. 5th edition, Chapter 16, The frontal lobes.

Milner, B., Squire, L. R., & Kandel, E. R. (1998). Cognitive neuroscience and the study of memory. *Neuron*, 20(3), 445-68. (Note: Try not to become bogged down by details; instead, read at a global level with the goal of getting a sense of how neuroscience has transformed our understanding of cognition such as memory.)

Week 2

Methods in Cognitive Neuroscience

Question: How have brain-mapping techniques been used in studying cognitive neuroscience? What are their advantages and limitations?

1/30 Friston, K.J. (1997). Imaging cognitive anatomy. *Trends in Cognitive Sciences*, 1(1), 21-27.

2/1 Walsh, V., & Cowey, A. (2000). Transcranial magnetic stimulation and cognitive neuroscience. *Nat Rev Neurosci*, 1(1), 73-9.

2/1 Hillyard, S. A. and M. Kutas. Event-related potentials and magnetic fields in the human brain. In: D. Charney, J. Coyle, K. Davis and C. Nemeroff (Eds.). *Neuropsychopharmacology: The Fifth Generation of Progress*. Baltimore: Lippincott, Williams and Wilkins, Chapter 32, pp. 427-439, 2002.

Recommended reading:

Savoy, R. L. (2001). History and future directions of human brain mapping and functional neuroimaging. *Acta Psychol (Amst.)*, 107(1-3), 9-42.

** check Supplementary Materials and Blackboard for additional readings and resources

Prefrontal Cortex Theories

Week 3

Functional organization of the prefrontal network

Question: How is the prefrontal cortex functionally organized – domain-specific vs. process-specific models?

2/6 Goldman-Rakic, P. S. (1999). The physiological approach: functional architecture of working memory and disordered cognition in schizophrenia. *Biol Psychiatry*, 46(5), 650-61.

2/8 Petrides, M. (2005). Lateral prefrontal cortex: architectonic and functional organization. *Philos Trans R Soc Lond B Biol Sci*, 360(1456), 781-95.

Background readings:

Grafman, J. (1999) Experimental assessment of adult frontal lobe function. In: The human frontal lobes: functions and disorders. Chapter 1. New York: Guilford Press. (*Read the first few pages for a brief overview of several PFC models.*)

Neuropsychology of Prefrontal Cortex

Week 4 Patients with frontal lobe damage

Question: Is the prefrontal cortex necessary for maintenance of information and executive control?

2/13 Owen, A. M., Morris, R. G., Sahakian, B. J., Polkey, C. E., & Robbins, T. W. (1996). Double dissociations of memory and executive functions in working memory tasks following frontal lobe excisions, temporal lobe excisions or amygdalo-hippocampectomy in man. *Brain*, 119(Pt 5), 1597-615.

2/15 Chao, L. L., & Knight, R. T. (1998). Contribution of human prefrontal cortex to delay performance. *J Cogn Neurosci*, 10(2), 167-77.

Recommended reading:

D'Esposito, M., & Postle, B. R. (1999). The dependence of span and delayed-response performance on prefrontal cortex. *Neuropsychologia*, 37(11), 1303-15.

Week 5 Development and Aging

Question: How does the relationship between brain function and cognitive function change across life span?

2/20 Scherf, K. S., Sweeney, J. A., & Luna, B. (2006). Brain basis of developmental change in visuospatial working memory. *J Cogn Neurosci.*, 18(7), 1045-58. (*Evaluate the brain specialization theory.*)

2/22 Reuter-Lorenz, P. A., Jonides, J., Smith, E. E., Hartley, A., Miller, A., Marshuetz, C., & Koeppe, R. A. (2000). Age differences in the frontal lateralization of verbal and spatial working memory revealed by PET. *Journal of Cognitive Neuroscience*, 12(1), 174-87. (*Evaluate the under-recruitment vs. compensation theory.*)

Recommended readings:

Reuter-Lorenz, P. A., & Lustig, C. (2005). Brain aging: reorganizing discoveries about the aging mind. *Curr Opin Neurobiol.*, 15(2), 245-51.

Casey, B. J., Galvan, A., & Hare, T.A. Changes in cerebral functional organization during cognitive development. *Curr Opin Neurobiol.*, 12, 239-244.

Animal Research of Prefrontal Network

Week 6 Cellular basis of cognition – monkey electrophysiology

Question: What is being represented by the activity of prefrontal neurons?

2/27 Constantinidis, C., Franowicz, M. N., & Goldman-Rakic, P. S. (2001). The sensory nature of mnemonic representation in the primate prefrontal cortex. *Nat Neurosci*, 4(3), 311-6.

3/1 Wallis, J. D., Anderson, K. C., & Miller, E. K. (2001). Single neurons in prefrontal cortex encode abstract rules. *Nature*, 411(6840), 953-6.

Recommended Readings:

Goldman-Rakic, P. S. (1995). Cellular basis of working memory. *Neuron*, 14(3), 477-85.

Freedman, D. J., Riesenhuber, M., Poggio, T., & Miller, E. K. (2003). A comparison of primate prefrontal and inferior temporal cortices during visual categorization. *J Neurosci*, 23(12), 5235-46.

Takeda, K., & Funahashi, S. (2002). Prefrontal task-related activity representing visual cue location or saccade direction in spatial working memory tasks. *Journal of Neurophysiology*, 87(1), 567-88.

Week 7 Neuropharmacology

Question: How dopamine influences prefrontal function and cognitive behavior?

- 3/6 Williams, G. V., & Goldman-Rakic, P. S. (1995). Modulation of memory fields by dopamine D1 receptors in prefrontal cortex. *Nature*, 376(6541), 572-5.
- 3/8 Seamans, J. K., Floresco, S. B., & Phillips, A. G. (1998). D1 receptor modulation of hippocampal-prefrontal cortical circuits integrating spatial memory with executive functions in the rat. *J Neurosci.*, 18(4), 1613-21.

Recommended Readings:

- Arnsten, A. F., & Li, B. M. (2005). Neurobiology of executive functions: catecholamine influences on prefrontal cortical functions. *Biol Psychiatry.*, 57(11), 1377-84.
- Wang, M., Vijayraghavan, S., & Goldman-Rakic, P. S. (2004). Selective D2 receptor actions on the functional circuitry of working memory. *Science*, 303(5659), 853-6.
- Muller, U., von Cramon, D. Y., & Pollmann, S. (1998). D1- versus D2-receptor modulation of visuospatial working memory in humans. *J Neurosci.*, 18(7), 2720-8.

Human Research of Prefrontal Network

Week 8 Working Memory

****paper outline due at 5pm, March 16 (title, abstract, and at least 10 relevant references)***

Question: What is being represented by the fMRI signals during working memory tasks?

- 3/13 Curtis, C. E., Rao, V. Y., & D'Esposito, M. (2004). Maintenance of spatial and motor codes during oculomotor delayed response tasks. *Journal of Neuroscience*, 24(16), 3944-52.
- 3/15 Johnson, M. K., Raye, C. L., Mitchell, K. J., Greene, E. J., Cunningham, W. A., & Sanislow, C. A. (2005). Using fMRI to investigate a component process of reflection: prefrontal correlates of refreshing a just-activated representation. *Cogn Affect Behav Neurosci.*, 5(3), 339-61.

Recommended Readings:

- Nystrom, L. E., Braver, T. S., Sabb, F. W., Delgado, M. R., Noll, D. C., & Cohen, J. D. (2000). Working memory for letters, shapes, and locations: fMRI evidence against stimulus-based regional organization in human prefrontal cortex. *Neuroimage*, 11(5 Pt 1), 424-46. [see comments in the issue.]
- Shin, E., Fabiani, M., & Gratton, G. (2006). Multiple levels of stimulus representation in visual working memory. *J Cogn Neurosci.*, 18(5), 844-58.

Week 9 Attention

Question: Does covert attention and saccade preparation share the same neural process?

- 3/20 Sato, T. R., & Schall, J. D. (2003). Effects of stimulus-response compatibility on neural selection in frontal eye field. *Neuron.*, 38(4), 637-48.
- 3/22 Grosbras, M. H., & Paus, T. (2002). Transcranial magnetic stimulation of the human frontal eye field: effects on visual perception and attention. *J Cogn Neurosci.*, 14(7), 1109-20.

Recommended Readings:

- Astafiev, S. V., Shulman, G. L., Stanley, C. M., Snyder, A. Z., Van Essen, D. C., & Corbetta, M. (2003). Functional organization of human intraparietal and frontal cortex for attending, looking, and pointing. *Journal of Neuroscience*, 23(11), 4689-4699.
- Chambers, C. D., & Mattingley, J. B. (2005). Neurodisruption of selective attention: insights and implications. *Trends Cogn Sci.*, 9(11), 542-50. Epub 2005 Oct 7.

Week 10 Long-Term Memory

Question: Are there separate memory processes: encoding vs. retrieval & recollection vs. familiarity?

- 3/27 Prince, S. E., Daselaar, S. M., & Cabeza, R. (2005). Neural correlates of relational memory: successful encoding and retrieval of semantic and perceptual associations. *J Neurosci*, 25(5), 1203-10

- 3/29 Daselaar, S. M., Fleck, M. S., & Cabeza, R. (2006). Triple dissociation in the medial temporal lobes: recollection, familiarity, and novelty. *J Neurophysiol.*, 96(4), 1902-11.

Recommended Reading

- Buckner, R. L., & Wheeler, M. E. (2001). The cognitive neuroscience of remembering. *Nat Rev Neurosci.*, 2(9), 624-34.
Rugg, M. D., & Yonelinas, A. P. (2003). Human recognition memory: a cognitive neuroscience perspective. *Trends in Cognitive Sciences*, 7(7), 313-319.

Week 11 4/2 – 4/7 Spring Break

Week 12 Social, Emotion & Cognition

Question: How social and emotional factors influence brain function and cognitive behavior?

- 4/10 Kensinger, E. A., & Schacter, D. L. (2006). Amygdala activity is associated with the successful encoding of item, but not source, information for positive and negative stimuli. *J Neurosci.*, 26(9), 2564-70.
4/12 Richeson, J. A., Baird, A. A., Gordon, H. L., Heatherton, T. F., Wyland, C. L., Trawalter, S., & Shelton, J. N. (2003). An fMRI investigation of the impact of interracial contact on executive function. *Nat Neurosci.*, 6(12), 1323-8.

Recommended Reading

- Dolan, R. J. (2002). Emotion, cognition, and behavior. *Science.*, 298(5596), 1191-4.
Adolphs, R. (2003). Cognitive neuroscience of human social behaviour. *Nat Rev Neurosci.*, 4(3), 165-78.

Week 13 Thought and Mind Reading

Question: What does neuroimaging tells us about thought and mind?

- 4/17 Ganis, G., Kosslyn, S. M., Stose, S., Thompson, W. L., & Yurgelun-Todd, D. A. (2003). Neural correlates of different types of deception: an fMRI investigation. *Cereb Cortex.*, 13(8), 830-6.
4/19 Vogeley, K., Bussfeld, P., Newen, A., Herrmann, S., Happe, F., Falkai, P., Maier, W., Shah, N. J., Fink, G. R., & Zilles, K. (2001). Mind reading: neural mechanisms of theory of mind and self-perspective. *Neuroimage.*, 14(1 Pt 1), 170-81.

Recommended Reading

- Haynes, J. D., & Rees, G. (2006). Decoding mental states from brain activity in humans. *Nat Rev Neurosci.*, 7(7), 523-34.
Farah, M. J. (2005). Neuroethics: the practical and the philosophical. *Trends Cogn Sci.*, 9(1), 34-40.

*** final paper due at 5pm, April 20**

Week 14 Modern Prefrontal Theory

- 4/24 Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, 24, 167-202.

4/26 Term Paper Presentation

Week 15

5/1 Term Paper Presentation

5/1 Term Paper Presentation

*** final reviews due at 5pm, May 4**