

## PSYC 410 Syllabus

### COGNITIVE and SOCIAL NEUROSCIENCE

**Instructor:** Jeanine Stefanucci  
**Office:** Gilmer 117  
**Office Hours:** M 1-2; by appt  
**Phone:** 982-4744  
**Email:** [jks8s@virginia.edu](mailto:jks8s@virginia.edu)

#### **Course Description:**

Cognitive neuroscience is one of the hottest areas of study in psychology. Through the use of many techniques, psychologists and neuroscientists in this field investigate the relationship between the brain and behavior. In this course, we discuss the current methodologies used to study the brain-behavior relationship, including neuroimaging techniques (fMRI and PET), clinical neuropsychological studies, research on animals, and newer techniques like transcranial magnetic stimulation and optical imaging. In addition, we critically evaluate the strengths and weaknesses of these approaches for a variety of behavioral tasks.

The question of how the mind works is relevant for many areas of cognitive and social psychology. This course is broken down into parts that examine different aspects of these areas of psychology. Part I will provide a basic understanding of the brain and the methods used for studying it. In particular we will study the gross anatomy of the brain, but we will also examine the structures and functions of individual cells in the brain. In Part II, we begin to examine functional aspects of the brain. Perception of objects, faces, and attentional factors that modulate perception will be covered. Part III moves us into higher-level cognitive functioning, that which builds directly on the perceptual system. We will cover working memory, then long-term storage of objects, words, and facts. We will also examine memory for actions that may occur outside of consciousness. In Part IV, we cover ways of interacting with the world that demand higher-level functioning, such as physical actions and motor control, decision-making processes, and language. Finally, in Part V we examine social functions, the most debated area of cognitive neuroscience at the moment. Topics will include emotion, consciousness and hemispheric differences in the brain that affect states of consciousness. We conclude with an examination of how the brain changes as it ages.

#### **Course Prerequisites:**

Students must have completed PSYC 305 or be completing PSYC 306. Preference will be given to 4<sup>th</sup> year psychology majors. It is helpful, but not necessary for students to have taken PSYC 215 (Intro to Cognition), PSYC 230 (Intro to Perception) or PSYC 220 (Intro to Psychobiology).

#### **Course Requirements:**

**1. Attendance & Participation:** Attendance and participation in class are mandatory. Class will start on time and students are expected to be punctual. If a student is late more than twice, their final grade will be lowered by 1/3 of a grade. Absences will also result in the loss of 1/3 of a grade. Because lectures will be based on the readings, students are expected to do the readings

before coming to class and to actively participate in the discussions of the readings during the lecture. To facilitate this discussion, students are asked to bring a written question with them to class about one of the readings (other than the text reading). Questions must be turned in to the instructor before class begins. Students may be excused from this assignment twice during the semester without penalty.

**2. Written and Group Assignments:** The written and group assignments are designed to provoke critical thinking about the methodologies used to study cognitive neuroscience and the differences in studying social and cognitive phenomena using cognitive neuroscience as a tool. Students will be expected to complete all of the assignments and to contribute equally to group projects.

**Assignment 1: *Cognitive Neuroscience in the Popular Press.*** Recently, cognitive neuroscience findings and other studies of the brain have received much attention in the press. For this assignment, I would like you to find a discussion of a cognitive neuroscience result in either a periodical or a nationally recognized newspaper (like the *Washington Post* or the *New York Times*). Please write a summary of the researchers' findings and evaluate the main implications that these findings have for the average person. The main questions you should address are: What methodology was used? What was the purpose of the study? Did the researchers use the appropriate methodology to answer their research question? Are there other techniques that could be used to expand or validate these findings? Please write a **2-3 page paper** addressing these questions with a focus on the methodology used in the study. Think creatively about what other measures could be used to enhance the generality of the findings.

**Assignment 2: *fMRI Group Projects and Research Proposals.*** The class will be divided into two large groups. One group will be the "cognitive" group and the other will be the "social" group. The purpose of the assignment is to gain experience in planning and participating in an imaging study while also seeing the differences between cognitive and social neuroscience experiments. Each student in the two groups will be required to read an article based on a topic of the group's choice. It would be best for group members to collaborate on the literature review and read articles that are related to each other (i.e., that cite each other). After reading the articles, the group will convene and decide on a simple paradigm with which they would like to do an imaging experiment. The topics and paradigm must be approved by the instructor. A group presentation will be given which reveals the predicted findings and design used to gather the imaging data. In addition, students will be required to either participate in or observe an imaging study being run at the MR4 research center over the course of the semester.

**Assignment 3: *Group Debate.*** There are many debates within the field of cognitive neuroscience. It is important for students to see that there are often two legitimate ways of interpreting the same data. To this end, the class will be divided into two groups and each group will be responsible for arguing one side of a current debate in cognitive neuroscience. The group will need to collect articles that support their side and will be asked to present their argument in a debate format in class.

**There will be THREE EXAMS:**

**1. Neuroanatomy and Research Methods:** A short quiz will be given following the completion of Part I of the course. Because much of the course depends on a basic understanding of brain areas and imaging techniques, students will be required to pass a quiz on this aspect of the course before advancing to the discussion of functional studies. The quiz will include diagrams to be labeled, short answer questions, multiple choice questions, and identifications (term definitions from the readings).

**2. Exam I:** Upon completion of Part III, students will be given a midterm exam that covers materials and readings from Parts II and III of the course. The format of the quiz will be similar to that of the Neuroanatomy quiz, with diagrams, short answer essays, identifications and multiple choice questions.

**3. Exam II:** The second exam will be cumulative (with emphasis on Parts IV and V) and will be the same format as Exam I.

**Course Grade:**

Final grades will be determined on the following basis:

1. Attendance & Participation:	10%
2. Written and Group Assignments:	
a. Assignment 1	10%
b. Assignment 2	15%
c. Assignment 3	10%
3. Neuroanatomy and Methods Quiz:	15%
4. Exam I:	20%
5. Exam II:	20%

**Required Text:**

Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (2002). *Cognitive Neuroscience: The Biology of the Mind*. (2nd ed.) New York: W. W. Norton & Company, Inc.

**Optional Software:**

Williams, S. M. (2000). *Sylvius 2.0: Fundamentals of Human Neural Structure*, Pyramis Studios, Inc. (Sinauer Associates, Inc.)

## Topics and Required Readings

### Jan. 20 Introduction – Brief Background of Cognitive Neuroscience

*Key Questions:*

- How old is the field of Cognitive Neuroscience?
- Where are its roots?

*Required Readings:*

None.

### Part I: Introduction to the Brain and How it is Studied

### Jan. 25 Cellular Bases of Cognition and Neurophysiology

*Key Questions:*

- How do neurons in the brain work and communicate?
- Do we believe that adults can grow new neurons?

*Required Readings:*

1. Text: Chapter 2
2. Gould, E., & Gross, C. G. (2002). Neurogenesis in adult mammals: some progress and problems. *The Journal of Neuroscience*, 22, 619-623.
3. Shors, T. J., Mieseages, G., Beylin, A., Zhao, M., Rydel, T., & Gould, E. (2001). Neurogenesis in the adult is involved in the formation of trace memories. *Nature*, 410, 372-376.

### Jan. 27 Gross Anatomy of the Brain

**\*\* Introduce Sylvius CD for studying brain areas**

*Key Questions:*

- Why would the brain be divided into two cerebral hemispheres; what is the possible evolutionary significance for that?
- What is the spatial layout of the brain?

*Required Readings:*

1. Text: Chapter 3
2. Gan, W. B., Gruntzender, J., Wong, W. T., Wong, R. O., & Lichtman, J. W. (2000). Multicolor “DiOlistic” labeling of the nervous system using lipophilic dye combinations. *Neuron*, 27(2), 219-225.

**Feb. 1**

**Methods of Cognitive Neuroscience**

**\*\* In class video of fMRI study example and TMS study example**

*Key Questions:*

- What is the optimal method for studying cognitive functioning and its relationship to neural structures? Is there an optimal method?

*Required Readings:*

1. Text: Chapter 4

**Feb. 3**

**Methods of Cognitive Neuroscience (cont'd)**

**→ Groups organized for fMRI projects and Class Debate**

*Key Questions:*

- If a combination of methods is better than using one method, which combination of methods would be most effective in discovering the functional significance of brain areas?

*Required Readings:*

1. Coltheart, M. (2001). Assumptions and methods in cognitive neuropsychology. In Brenda Rapp (Ed.), *The Handbook of Cognitive Neuropsychology: What Deficits Reveal About the Human Mind*. (pp.3-21).
2. D'Esposito, M., Zarahn, E., & Aguirre, G. K. (1999). Event-related functional MRI: Implications for cognitive psychology. *Psychological Bulletin*, *125*(1), 155-164.
3. Savoy, R. L. (2001). History and future directions of human brain mapping and functional neuroimaging. *Acta Psychologica*, *107*, 9-42. (skim)

**Part II: How We Encode the World**

**Feb. 8**

**Perception I- Basic Vision**

**→ Neuroanatomy and Methods Quiz at the beginning of class**

*Key Questions:*

- How is the visual system organized to process the visual information in the world?

*Required Readings:*

1. Text: Chapter 5 (to page 185)
2. Croner, L.J., & Albright, T. D. (1999). Seeing the big picture: Integration of image cues in the primate visual system. *Neuron*, *24*, 777-789.
3. Livingstone, M., & Hubel, D. (1988). Segregation of form, color, movement, and depth: anatomy, physiology, and perception. *Science*, *240*, 740-749.

**Feb. 10**      **Perception II- Two Visual Streams of Processing**  
**\*\* In class videos of agnosic and ataxic PTs**

*Key Questions:*

- Why would we have two separate streams of visual processing: one for recognition and one for action?
- Are these streams really distinct?

*Required Readings:*

1. Text: Chapter 6- pgs. 193-205
  2. Goodale, M. A. & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, 15(1), 20-25.
  3. Ungerleider, L. G. & Haxby, J. V. (1994). 'What' and 'where' in the human brain. *Current Opinion in Neurobiology*, 4, 157-165.
- Optional: excerpt from Oliver Sachs book

**Feb. 15**      **Object Recognition**

*Key Questions:*

- How do we perceive the same objects across grossly varying situations?
- How do we discriminate between objects?

*Required Readings:*

1. Text: Chapter 6- pgs. 205-226
2. Logothetis, N. K., & Sheinberg, D. L. (1996). Visual object recognition. *Annual Review of Neuroscience*, 19, 577-621.

**Feb. 17**      **Face Recogniton**

**\*\* In-class Debate (Assignment 3):**

*Side 1: There is a specialized brain area that is solely involved in face recognition and is distinct from other object recognition areas.*

*Side 2: There is no specialized brain area that is solely involved in face recognition and is distinct from other object recognition areas.*

*Required Readings:*

1. Chapter 6- pgs. 226-237; class will find readings for their side of the debate

**Feb. 22**      **Attention**

**\*\* In-class videos of Balint and Neglect PTs**

*Key Questions:*

- Is attention focused on an object or a specific place in space?
- What are the best ways of measuring attention in the brain?
- What evidence has been provided to support or rule out competing theories?

*Required Readings:*

1. Text: Chapter 7

2. Vallar, G. (1998). Spatial hemineglect in humans. *Trends in Cognitive Sciences*, 2, 87-97.
3. Wojciulik, E., Kanwisher, N., & Driver, J. (1998). Covert visual attention modulates face-specific activity in the human fusiform gyrus: fMRI study. *Journal of Neurophysiology*, 79, 1574-1578.

### **Part III: How We Remember the World**

#### **Feb. 24      Working Memory**

*Key Questions:*

- Is working memory actually a separate system from long-term memory?
- What is the neuropsychological and imaging evidence for the existence of subsystems in working memory?

*Required Readings:*

1. Text: Chapter 8- pgs. 301-313.
2. Postle, Berger, and D'Esposito (1999). Functional neuroanatomical double dissociation of mnemonic and executive control processes contributing to working memory performance. *Proceedings of the National Academy of Sciences*, 96, 12959-12964.
3. Smith, E. E., & Jonides, J. (1998). Neuroimaging analyses of human working memory. *Proceedings of the National Academy of Sciences*, 95, 12061-12068.

#### **Mar. 1      Episodic Memory Encoding**

*Key Questions:*

- Are some brain areas implicated only in memory encoding?
- Are there areas that can predict successful retrieval if activated during encoding?

*Required Readings:*

1. Gabrieli, J. (1998). Cognitive neuroscience of human memory, *Annual Review of Psychology*, 49, 87-115.
2. Tulving, E., Kapur, S, Craik, F. I. M., Moscovitch, M., & Houle, S. (1994). Hemispheric encoding/retrieval asymmetry in episodic memory: Positron emission tomography findings. *Proceedings of the National Academy of Sciences*, 91, 2016-2020.
3. Wagner, A.D., Schacter, D. L., Rotte, M., Koutstaal, W., Maril, A., Dale, A. M., Rosen, B. R., & Buckner, R. L. (1998). Building memories: remembering and forgetting of verbal experiences as predicted by brain activity. *Science*, 281, 1188-1191.

**Mar. 3**      **Episodic Memory (Retrieval)**  
→ **Assignment 1 (Cognitive Neuroscience in the Press Paper) Due**

*Key Questions:*

- Are there brain areas that are activated only during retrieval?
- What is the possible interaction between these areas?

*Required Readings:*

1. Buckner, R. L., Koutstaal, W., Schacter, D. L., Wagner, A. D., & Rosen, B. R. (1998). Functional-Anatomic study of episodic retrieval using fMRI: I. Retrieval effort versus retrieval success. *Neuroimage*, 7, 151-162.
2. Dolan, R. J., & Fletcher, P. F. (1999). Encoding and retrieval in human medial temporal lobes: An empirical investigation using functional magnetic resonance imaging. *Hippocampus*, 9, 25-34.
3. Milner, Squire, & Kandel, (1998). Cognitive neuroscience of the study of memory, *Neuron*, 20, 445-468.

**Mar. 15**      **Semantic Memory**

*Key Questions:*

- How is semantic memory organized?
- How is this memory system different from other memory systems?

*Required Readings:*

1. Martin, A., & Chao, L. L. (2001) Semantic memory and the brain: structure and processes. *Current Opinion in Neurobiology*, 11(2), 194-201.
2. Saffran, E. M. & Schwartz, F. F. (1994). Of cabbages and things: Semantic memory from a neuropsychological perspective. In Umiltà, C. & Moscovitch, M., editors, *Attention and Performance XV*, pages 507-536. MIT Press, Cambridge, MA.; Moore & Prize (1999).

**Mar. 17**      **Implicit Memory**  
→ **fMRI Groups hand in a short proposal for experimental design**

*Key Questions:*

- Can we acquire memories outside of our awareness?
- If so, is this a separate memory system or a separate process from explicit memory?
- Is there data from cognitive neuroscience studies that support a system approach over a process approach?

*Required Readings:*

1. Text: Chapter 8 – pgs. 315-336

2. Grafton, S. T., Hazeltine, E., Ivry, R. (1995). Functional mapping of sequence learning in normal humans. *Journal of Cognitive Neuroscience*, 7(4), 497-510.
3. Henson R., Shallice, T., & Dolan, R. (2000). Neuroimaging evidence for dissociable forms of repetition priming. *Science*, 287, 1269-1272.

**Mar. 22** → **EXAM I on Parts II and III**

### **Part IV: How we Act in the World**

**Mar. 24** **Language**

*Key Questions:*

- What are the brain areas that underly the perception and production of language?

*Required Readings:*

1. Text: Chapter 9
2. Pinker, S. (1994). *The Language Instinct*: Harper Collins - Chapter 10

**Mar. 29** **Actions and Motor Control I**

**\*\* In class videos of PTs with motor disorders**

*Key Questions:*

- How do we control our actions?
- What is the structure of the motor system?
- What are the functional roles of each part of the system?

*Required Readings:*

1. Text: Chapter 11 to page 469
2. Gao, J. H., Parsons, L. M., & Fox, P. T. (1996). Cerebellum implicated in sensory acquisition and discrimination rather than motor control. *Science*, 272:545;
3. Georgopoulos, A. P. (2000). Neural mechanisms of motor cognitive processes: Functional MRI and neurophysiological studies. In M. S. Gazzaniga (Ed.) *The Cognitive Neurosciences* (pp. 525-538). Cambridge, MA: MIT Press.
4. Iacoboni, M., Woods, R. P., Brass, M., Bekkering, H., Mazziotta, J. C., Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science*, 286(5449), 2526-2528.

**Mar. 31**

**Actions and Motor Control II**

**\*\* In class videos of Parkinson's and Huntington's PTs**

*Key Questions:*

- What can we learn about the motor system from examining motor disorders?

*Required Readings:*

1. Text: Chapter 11 pgs. 476-end
2. Samuel, M., Ceballos-Baumann, A. O., Blin, J., Uema, T., Boecker, H., Passingham, R. E., & Brooks, D. J. (1997). Evidence for lateral premotor and parietal overactivity in Parkinson's disease during sequential and bimanual movements. A PET study. *Brain*, 120, 963-976.

**Apr. 5**

**Executive Functions and the Frontal Lobes**

*Key Questions:*

- What areas of the brain support higher-level cognitive functions, such as decision-making and problem-solving?
- Is it hard to localize these higher-level constructs?

*Required Readings:*

1. Text: Chapter 12
2. Baker, S. C., Rogers, R. D., Owen, A. M., Frith, C. D., Dolan, R. J., Frackowiak, R. S. J., & Robbins, T. W. (1996). Neural systems engaged by planning: A PET study of the Tower of London task. *Neuropsychologia*, 34:515.
3. Glisky, E. L., Polster, M. R., Routhieaux, B. C. (1995). Double dissociation between item and source memory. *Neuropsychology*, 9(2), 229-235.

**Part V: Social Processes and Consciousness- How we Interact with Others**

**Apr. 7**

**Emotion**

**\*\* In class demonstration of the Bechara et al. (1997) methodology**

*Key Questions:*

- What structures are consistently implicated in the processing of emotional stimuli?
- Do the functional roles of these structures differ?

*Required Readings:*

1. Text: Chapter 13
2. LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology*, 46:209-235.

## **Apr. 14      Emotion**

### *Key Questions:*

- How has patient data contributed to our knowledge of the cognitive neuroscience of emotion?

### *Required Readings:*

1. Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science*, 275, 1293-1294.
2. Phelps, E. A., O'Connor, K. J., Gatenby, J. C., Grillon, C., Gore, J. C., & Davis, M. (2001). Activation of the human amygdala to a cognitive representation or fear. *Nature Neuroscience*, 4, 437-441.
3. Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. *Nature*, 393, 470-474.

## **Apr. 19      Hemispheric Differences (Cerebral Assymetry)**

### *Key Questions:*

- Are there asymmetries in the gross anatomy of the brain that correlate with cognitive and social functioning?
- Which functional asymmetries are most strong?

### *Required Readings:*

1. Text: Chapter 10
2. LeDoux, J. E., Wilson, D. H., & Gazzaniga, M. S. (1977). A divided mind: Observations on the conscious properties of the separated hemispheres. *Annals of Neurology*, 2, 417-421.
3. Gazzaniga, M.S. (2000). Cerebral specialization and interhemispheric communication. *Brain*, 123, 1293-1326.

## **Apr. 21      Consciousness**

### *Key Question:*

- Can consciousness be localized in the brain?

### *Required Readings:*

1. Text: Chapter 16
2. Dehaene, S. et al. (1998). Imaging unconscious semantic priming. *Nature*, 395, 597-600.
3. Crick, F.C., & Koch, C. (1998). Consciousness and neuroscience. *Cerebral Cortex*, 8, 97-107.

**Apr. 26      The Aging Brain**

*Key Questions:*

- Are there changes in the brain over the lifespan that can explain deficits in cognitive or social functioning?
- If so, what are these changes and how are they characterized?

*Required Readings:*

1. Cabeza, R. et al. (1997). Age-related differences in neural activity during memory encoding and retrieval: A positron emission tomography study. *The Journal of Neuroscience*, 17(1), 391-400.
2. Reuter-Lorenz, P. A. (2002). New visions of the aging mind and brain. *Trends in Cognitive Sciences*, 6(9), 394-400.
3. Rypma, B., Prabhakaran, V., Desmond, J. E., Gabrieli, J. D. E. (2001). Age differences in prefrontal cortical activity in working memory. *Psychology & Aging*. 16(3), 371-384.

**Apr. 28      Group Presentations of Predicted fMRI Results**

**May 3      EXAM II → Cumulative, but with emphasis on Parts IV and V**