

## Preliminary Course Information

### PSYC G4222 – The Cognitive Neuroscience of Aging Drs. Stephanie Cosentino and Adam Brickman Spring 2010

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#### **I. Bulletin description**

PSYC G4222. The Cognitive Neuroscience of Aging (seminar).

4 pts. F: 10:10-12, 405 Schermerhorn

Prerequisites: Courses in introductory psychology, cognitive psychology, and instructor permission.

Comprehensive overview of various conceptual and methodologic approaches to studying the cognitive neuroscience of aging. The course will emphasize the importance of combining information from cognitive experimental designs, epidemiologic studies, neuroimaging, and clinical neuropsychological approaches to understand individual differences in both healthy and pathological aging.

#### **II. A full description of the content of the course**

Each class will begin with background information provided by one of the primary instructors, or a guest lecturer, followed by discussion. After an introductory session, the course will begin by reviewing changes in brain structure and cognition across the lifespan. Discussions will cover MRI studies of brain structure, including grey and white matter global and regional changes across the lifespan. There will be a particular focus on vascular-related changes, individual differences, and predictors of rates of decline. Students will be introduced to MRI quantification techniques and their application to both clinical and experimental work. A complementary session will review “developmental” changes in “traditional” cognitive domains, including memory, executive function, speed, attention, language, and spatial function across the adult lifespan. It will introduce students to approaches towards measurement of these cognitive domains and theories of cognitive aging.

A session on cognitive reserve (the brain’s ability to cope with pathology) will serve to present an overview of many of the topics to be covered in the remaining discussions. Epidemiologic evidence for the concept of cognitive reserve will be reviewed. Functional imaging studies that explore the neural basis of cognitive reserve will be discussed, with an emphasis on imaging modalities, the selection of cognitive activation tasks, and image analysis.

The next two sessions will review issues related to cognitive experimental studies of older adults, including when elders might be used as a control population versus a study population, how neuropsychological data can be incorporated into cognitive experiments to understand cognitive aging, and what human factor issues should be considered regarding elder participation in cognitive studies. Emphasis will be placed on studies related to speed / accuracy tradeoff, psychomotor speed, timing, and executive functioning.

Three sessions will be dedicated to the use of neuroimaging techniques to understand cognitive aging. The first will address specific considerations when performing an imaging study in an aged population including age related physiological alterations in the functional imaging signal such as alterations in neurovascular coupling and decreases in grey matter. Aging also alters the networks of brain regions involved in performance of a task resulting in either increased or decreased brain activity in elders as compared to young participants. The various theories to describe these results will be reviewed.

Functional neuroimaging studies from the Cognitive Neuroscience Division at CUMC will be reviewed in a second session, and the third session will take an in-depth look at how neuroimaging substrates of aging and neurodegenerative disease can be used as markers for early disease diagnosis. Background material featuring the most promising blood-based and structural biomarkers for Alzheimer's disease will be discussed in a general introduction. A brief and easy-to-understand methodological introduction about Receiver Operator Curve statistics and cross-validation will also be given. Further, the possible conceptual and methodological differences of deriving biomarkers versus understanding disease mechanisms will be covered. After this preparation, some real-world examples from our neuroimaging practice will be shown and discussed.

An important component of this course will also be introducing students to the utility of non-experimental designs for understanding cognitive aging. One session will be dedicated to describing the value of cross-cultural research in understanding issues of measurement, validity, universals of cognitive processes, and cognitive flexibility. Research on cognitive aging across cultural groups must contend with the fact that assessment of cognitive function is susceptible to culturally-dependent definitions and are quantified by measures that are sensitive to cultural and educational background. Students will gain an appreciation for how to consider cultural and educational factors when assessing cognitive function among older adults.

A second session will expose students to the fundamentals of goals, design, and analysis of epidemiological research, focusing on observational studies. Understanding the epidemiologic approach is critical for cognitive aging research because these studies strive to understand how biological factors and social conditions affect the onset or course of cognitive outcomes. Older adults have accumulated the effects of a lifetime of exposure, and studies must be designed in a way that exposures of interest can be measured in a valid manner, critical periods of influence can be identified, and cognitive outcomes can be measured cross-sectionally and longitudinally. Causal inference in epidemiological studies of cognitive aging will be discussed.

The next session will focus on syndromes of pathological aging. It will summarize the most common dementias including Alzheimer's disease, Vascular dementia, Lewy Body dementia, Frontotemporal dementia, Normal Pressure Hydrocephalus, and Prion diseases. Topics will include the frequencies and risk factors of the various syndromes, symptomatology, clinical signs, diagnostic work-up, underlying neuropathological alterations and genetic abnormalities, treatment, clinical course and prognosis. Students will gain an overview of the field, including features distinguishing dementias from healthy aging and from each other as well.

In the final two sessions of the semester we will discuss cognitive and metacognitive profiles of individuals with Alzheimer's disease and other dementias. These classes will cover: 1) the ways in which cognitive testing in a clinical setting can be used to dissociate AD from normal aging and other dementias, and to make inferences about the distribution of neuropathology in individual patients; and 2) both the challenges and rewards of implementing cognitive experimental designs in research with dementia populations.

### **III. The rationale for giving the course**

This course will provide a comprehensive overview of various conceptual and methodologic approaches to studying the cognitive neuroscience of aging and is intended to introduce students to the relevance and challenges of studying the aging brain. In spring 2010, the primary instructors as well as guest lecturers will come from the interdisciplinary faculty in the Cognitive Neuroscience Division in the Sergievsky Center at CUMC. The course will emphasize the importance of combining information from cognitive experimental designs, epidemiologic studies, neuroimaging, and clinical neuropsychological approaches to understand individual differences in both healthy and pathological aging.

This advanced seminar will be well suited to students who have completed two or more lecture courses beyond W1001, such as W1010 (Mind, Brain, and Behavior), W2210 (Cognition: Basic Processes), W2215 (Cognition and the Brain), W2220 (Cognition: Memory and Stress), or W2480 (Developing Brain).

It will complement our seminar offerings in cognitive neuroscience, and ameliorate a serious shortage of developmental offerings.

PSYC G4222 is an advanced seminar, designed particularly for graduate students, for advanced undergraduates who are majoring in Psychology or in Neuroscience and Behavior, and for students participating in the Postbac Psychology Program. These students will have priority in registration, followed by junior majors followed by non-majors.

It fulfills the following degree requirements:

- For Psychology Graduate Students, PSYC G4222 will apply toward the “two seriously graded seminars” requirement of the Master’s degree.
- For the Psychology major or concentration in the College and in G. S., for the Psychology minor in Engineering, and for the Psychology Postbac, G4222 meets the Group I (Perception and Cognition) distribution requirement.
- For the Neuroscience and Behavior joint major, G4222 will fulfill the 5<sup>th</sup> Psychology requirement: “one advanced psychology seminar from a list approved by the Psychology Department advisor to the program.”
- For non-majors in the College and GS, G4222 will count as one term of the natural science requirement, provided that students obtain the necessary permission and have taken the prerequisite psychology courses. Graduate students, and students who are majoring in Psychology or in Neuroscience and Behavior, will have priority over students who are taking the course for the science requirement, and we anticipate the course will rarely be used for the latter.
- For the Psychology Postbac certificate, PSYC G4222 will fulfill the advanced seminar requirement.
- For the Barnard Psychology major, PSYC G4222 will fulfill the senior seminar requirement.

#### **IV. The reading list and weekly syllabus**

Below is a list of suggested readings for each course. Most readings are available online through CLIO. If not, they will be placed on <http://courseworks.columbia.edu>.

**Weekly Topic, Speaker, and Readings** (subject to revision):

- 1. Course Overview (Drs. Cosentino and Brickman)**
- 2. Structural Brain Changes with Healthy Aging (Dr. Adam Brickman)**

Brickman, A.M., Zimmerman, M.E., Paul, R.H., Grieve, S.M., Tate, D.F., Cohen, R.A., Williams, L.M., Clark, C.R., & Gordon, E. (2006). Regional white matter volume and neuropsychological functioning across the adult lifespan. *Biological Psychiatry*, 60, 444-453.

Zimmerman, M.E., Brickman, A.M., Paul, R.H., Grieve, S.M., Tate, D.F., Gunstad, J., Cohen, R.A., Williams, L.M., Clark, C.R., & Gordon, E. (2006). The relationship between frontal gray matter volume and cognition varies across the healthy adult lifespan. *American Journal of Geriatric Psychiatry*, 14, 823-833.

Brickman, A.M., Habeck, C., Zarahn, E., Flynn, J., & Stern, Y. (2007). Structural MRI covariance patterns associated with normal aging and neuropsychological functioning. *Neurobiology of Aging*, 28, 284-295.

Brickman, A.M., Schupf, N., Manly, J.J., Luchsinger, J.A., Andrews, H., Tang, M.X., Reitz, C., Small, S.A., Mayeux, R., DeCarli, C., & Brown, T.R. (2008). Brain morphology in elderly African

Americans, Caribbean Hispanics, and Caucasians from northern Manhattan. *Archives of Neurology*, 65, 1053-1061.

Raz, N., Rodrigue, K.M., Kennedy, K.M., & Acker, J.D. (2007). Vascular health and longitudinal changes in brain and cognition in middle-aged and older adults. *Neuropsychology*, 21, 149-157.

Raz, N. & Rodrigue, K.M. (2006). Differential aging of the brain: Patterns, cognitive correlates, and modifiers. *Neuroscience and Biobehavioral Reviews*, 30, 730-748.

### **3. Cognitive Aging (Dr. Adam Brickman)**

Zimmerman, M.E. & Brickman, A.M. (in press). Neuropsychology of healthy aging. In R.H. Paul, N. Sactor, K. Toshima, & V. Valcour (Eds.), *HIV and the Brain: New Challenges in the Modern Era* Totowa, NJ: Humana Press. (~20 manuscript pages)

Brickman, A.M. & Stern, Y. (in press). Memory and normal aging in humans. In L. Squire (Ed.), *New Encyclopedia of Neuroscience*. New York, Elsevier. (~10 manuscript pages)

Salthouse, T.A. (2005). Relations between cognitive abilities and measures of executive functioning. *Neuropsychology*, 19, 532-545.

Salthouse, T.A., Atkinson, T.M., & Berish, D.E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal aging. *Journal of Experimental Psychology: General*, 132, 566-594.

Salthouse, T.A. & Ferrer-Caja, E. (2003). What needs to be explained to account for age-related effects on multiple cognitive variables? *Psychology and Aging*, 18, 91-110.

### **4. Cognitive Reserve (Dr. Yaakov Stern)**

Stern, Y. Cognitive Reserve. *Neuropsychologia*. in press. (~15 manuscript pages).

Zarahn E, Rakitin B, Abela D, Flynn J, Stern Y. Age-related changes in brain activation during a delayed item recognition task. *Neurobiology of Aging*. 2007 May;28(5):784-98.

Stern Y, Zarahn E, Habeck C, Holtzer R, Rakitin BC, Kumar A, Flynn J, Steffener J, Brown T. A common neural network for cognitive reserve in verbal and object working memory in young but not old. *Cereb Cortex*. 2008 Apr;18(4):959-67.

### **5. Design, Human Factors, and Analytical Issues in Cognitive Experiments with Healthy and Pathological Aging Participants (Dr. Brian Rakitin)**

Holtzer, R., Stern, Y., & Rakitin\*, B. C. (2004). Age-related differences in executive control of working memory. *Memory & Cognition*, 32, 1333-1345.

Holtzer, R., Stern, Y, & Rakitin\*, B. C. (2005). Predicting age related dual-task effects with individual differences on neuropsychological tests. *Neuropsychology*, 19, 18-27.

Rakitin, B. C., & Malapani, C. (2008). Effects of feedback on time production errors in aging participants. *Brain Research Bulletin*, 75, 22-33.

Kumar, A., Rakitin, B. C., Nambisan, R., Habeck, C., & Stern, Y. (2008). Response-signal methods reveal age-related differences in object working memory. *Psychology & Aging*, 23, 315-29.

Hultsch, D. F., Strauss, E., Hunter, M. A; MacDonald, S. W. S. (2008). Intraindividual variability, cognition, and aging. Craik, Fergus I. M (Ed); Salthouse, Timothy A (Ed). The handbook of aging and cognition (3rd ed.). (pp. 491-556). New York, NY, US: Psychology Press.

## **6. Review of Findings regarding previous discussion (Dr. Brian Rakitin)**

## **7. Imaging the Aging Brain (Dr. Jason Steffener)**

Persson, J., Nyberg, L. Chapter 4 Altered brain activity in healthy seniors: what does it mean?

(2006) *Progress in Brain Research*, 157, pp. 45-56,385

D'Esposito, M., Deouell, L.Y., Gazzaley, A. (2003) Alterations in the bold fMRI signal with ageing and disease: A challenge for neuroimaging. *Nature Reviews Neuroscience*, 4 (11), pp. 863-872.

Hedden, T. and J.D. Gabrieli, Insights into the ageing mind: a view from cognitive neuroscience. *Nat Rev Neurosci*, 2004. 5(2): p. 87-96.

## **8. Functional Imaging Work from the Cognitive Neuroscience Division (Dr. Jason Steffener and Dr. Chris Habeck)**

Zarahn E, Rakitin B, Abela D, Flynn J, Stern Y. Age-related changes in brain activation during a delayed item recognition task. *Neurobiology of Aging*. 2007 May;28(5):784-98.

Stern Y, Zarahn E, Habeck C, Holtzer R, Rakitin BC, Kumar A, Flynn J, Steffener J, Brown T. A common neural network for cognitive reserve in verbal and object working memory in young but not old. *Cerebral Cortex* 2008; 18(4); 959-67.

Brickman AM, Habeck C, Zarahn E, Flynn J, Stern Y. Structural MRI covariance patterns associated with normal aging and neuropsychological functioning. *Neurobiol Aging* 2007; 28(2): 284-95.

Scarmeas N & Stern Y. fMRI evidence of compensatory mechanisms in older adults at genetic risk for Alzheimer disease. *Neurology* 2005;65:1514-1515.

## **9. Neuroimaging Biomarkers of Aging and Age-Related Disorders (Dr. Chris Habeck)**

Habeck C, Foster NL, Perneczky r, Kurz A, Alexopoulos P, Koeppe RA, Drzezga A, Stern Y. Multivariate and univariate neuroimaging biomarkers of Alzheimer's disease. *Neuroimage*. 2008 May 1; 40 (4): 1503-15.

Drachman A. Aging of the brain, entropy and Alzheimer's disease. *Neurology* 2006; 67:1340-1352.

Shaw, L. M., Korecka, M., Clark, C. M., Lee, V. M., & Trojanowski, J. Q. Biomarkers of neurodegeneration for diagnosis and monitoring therapeutics. *Nat Rev Drug Discov* 2007; 6(4), 295-303.

Wikipedia entry for Receiver operator characteristic curve  
[http://en.wikipedia.org/wiki/Receiver\\_operating\\_characteristic](http://en.wikipedia.org/wiki/Receiver_operating_characteristic)

## 10. Aging, Culture, and Cognition (Dr. Jennifer Manly)

### **Critical Considerations in Health Research among Ethnically Diverse Elders:**

Geronimus, A. T., M. Hicken, et al. (2006). "Weathering" and Age Patterns of Allostatic Load Scores among Blacks and Whites in the United States. *American Journal of Public Health* 96(5): 826-833.

Kaufman, J. S., R. S. Cooper, et al. (1997). Socioeconomic status and health in blacks and whites: the problem of residual confounding and the resilience of race. *Epidemiology* 8: 621-628.

Link, B. G. and J. Phelan (1995). Social conditions as fundamental causes of disease. *Journal of Health & Social Behavior. Spec*: 80-94.

Williams, D. R. and P. B. Jackson (2005). Social Sources of Racial Disparities in Health. *Health Affairs* 24(2): 325-334.

### **Cognitive Aging across Cultural Groups:**

Bialystok, E., Craik, F.I.M, Ryan, J. (2004). Bilingualism, Aging, and Cognitive Control: Evidence from the Simon Task. *Psychology and Aging*; 19: 290–303

Hedden. T. and Park, D.C. (2001). Culture, aging, and cognitive aspects of communication. In: Charness, N., Park, D.C., and Sabel, B. (Eds.). *Communication, technology, and aging*. Springer, New York, pp. 81–108

Manly, J.J. Race, Culture, Education, and Cognitive Test Performance among Older Adults. (2008). In Hofer, S. and Alwin, D. (Eds.). *Handbook on Cognitive Aging*. Sage, Thousand Oaks, CA, pp. 398 - 417.

Whitfield, K. E. and S. A. Wiggins (2003). The Impact of Desegregation on Cognition among Older African Americans. *29*: 275.

## 11. Epidemiological Studies of Cognitive Aging (Dr. Jennifer Manly)

### **Fundamentals of Epidemiological Study Design**

Bonita, R., Beaglehole, R., & Kjellström, T. (2006). Types of Studies. In: Bonita, R., Beaglehole, R., & Kjellström, T. *Basic epidemiology*, 2nd ed. World Health Organization, Geneva, pp. 39 – 60.

Ben-Shlomo, Y. & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives *Int. J. Epidemiol.* 31: 285-293.

Launer L.J. (2007). Next steps in Alzheimer's disease research: interaction between epidemiology and basic science. *Current Alzheimer Research*; 4:141-143.

### **Epidemiological Studies of Cognitive Aging and Dementia**

Glymour, M. M., I. Kawachi, et al. (2008). Does childhood schooling affect old age memory or mental status? Using state schooling laws as natural experiments. *Journal of Epidemiology and Community Health* 62(6): 532-537.

Kang JH, Logroscino G, DeVivo I, Hunter DJ, Grodstein F. (2005). Apolipoprotein E, cardiovascular disease and cognitive function in aging women. *Neurobiology of Aging*; 26: 475-484.

Launer, L. J., G. W. Ross, et al. (2000). Midlife blood pressure and dementia: the Honolulu-Asia aging study. *Neurobiology of Aging* 21: 49-55.

### **Controversies in Epidemiological Research**

Harman SM, Naftolin F, Brinton EA, Judelson DR. (2005). Is the estrogen controversy over? Deconstructing the Women's Health Initiative study: a critical evaluation of the evidence. *Annals of the New York Academy of Sciences*; 1052: 43-56.

## **12. Overview of Alzheimer's Disease and other dementias (Dr. Nikolaos Scarmeas)**

Current Diagnosis and Treatment NEUROLOGY; Editor J. Brust; Chapter 9: Dementia and Memory Loss; pages 78-99.

Knopman, D. S., S. T. DeKosky, et al. (2001). "Practice parameter: diagnosis of dementia (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology." *Neurology* 56(9): 1143-53.

Doody, R. S., J. C. Stevens, et al. (2001). "Practice parameter: management of dementia (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology." *Neurology* 56(9): 1154-66.

Petersen, R. C., J. C. Stevens, et al. (2001). "Practice parameter: Early detection of dementia: Mild cognitive impairment (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology." *Neurology* 56(9): 1133-1142.

Association, A. s. (2008). "2008 Alzheimer's Disease Facts and Figures." [http://www.alz.org/national/documents/report\\_alzfactsfigures2008.pdf](http://www.alz.org/national/documents/report_alzfactsfigures2008.pdf).

## **13. Cognitive Profile of Alzheimer's Disease (Dr. Stephanie Cosentino)**

Overman, A., & Becker, J. (2004). Information Processing deficits in episodic memory in Alzheimer's disease. In R. Morris and J. Becker (Eds.), *Cognitive Neuropsychology of Alzheimer's Disease* (pp.121-140).

Garrard, P., Patterson, K., & Hodges, J., (2004). Semantic Processing in Alzheimer's disease. In R. Morris and J. Becker (Eds.), *Cognitive Neuropsychology of Alzheimer's Disease* (pp.179-196).

Price, B, Gurvit, H., Weintraub, S., Geula, C., Leimkuhler, E., Mesalun, M. (1993). Neuropsychological patterns and language deficits in 20 consecutive cases of autopsy-confirmed Alzheimer's disease. *Archives of Neurology*, 50, 931-937.

Johnson JK, Head E, Kim R, et al. Clinical and pathological evidence for a frontal variant of Alzheimer disease. *Arch Neurol*. Oct 1999;56(10):1233-1239.

## **14. Metacognition in Aging / Dementia (Dr. Stephanie Cosentino)**

Souchay, C., Isingrini, M., & Espagnet, L. (2000). Aging, episodic memory feeling-of-knowing, and frontal functioning. *Neuropsychology*, 14: 299-309.

Cosentino, S., & Stern, Y. (2005). Metacognitive theory and assessment in dementia: Do we recognize our areas of weakness? *Journal of the International Neuropsychological Society*, 11(7), 910-919.

Cosentino, S., Metcalfe, J., Butterfield, B., & Stern, Y. (2007). Objective Metamemory Testing Captures Awareness of Deficit in Alzheimer's Disease. *Cortex*, 43(7), 1004-19.

Rankin, KP., Baldwin, E., Pace-Savitsky, C., Kramer, JH., & Miller, BL., (2005). Self awareness and personality change in dementia. *Journal of Neurology, Neurosurgery, and Psychiatry*, 76(5): 632-9.

## **V. Course requirements and grading**

### Discussion leadership:

On the first day of class, students will sign up for 1-2 class meetings (depending on number of students) during which he/she will present an article from the required readings. Students should prepare a presentation as well as thought-provoking questions addressed to the class. The presentation should be comprehensive, but be open enough in format to allow for ongoing discussion. Students will meet with one of the primary instructors for assistance in preparing their presentation.

### Questions generated by the readings:

Students are required to read assigned papers before class in order to ensure lively discussion in class. Students will compose questions relevant to the readings and post their questions on Courseworks no later than 24 hours before class. Students are not allowed to replicate already posted questions. Additionally, to ensure that the questions are distributed across readings, there will be a limit placed on how many questions may be posted per reading. Discussion leaders should incorporate these questions into their presentation. Evaluation of the quality and quantity of participation will be included in final grade.

### Research paper:

This should take the form of a critical review paper. The topic can be of your choosing, however we strongly recommend that you do your paper on the topic that you will be presenting in class. Although you can discuss your paper with one of the instructors anytime during the semester, it is required that you submit your paper idea by midterm and meet with an instructor twice, at least one month prior to the due date, for discussion. Your paper should be based not only on the assigned readings, but also on any suggested readings and a set of additional readings to be agreed upon during this meeting. Important criteria for grading will be evidence that you are not simply outlining or regurgitating the readings, but are attempting to synthesize them, organize them around a theoretical perspective, point out areas of controversy and most importantly, suggest a novel perspective or avenue for future research. 15 pages (double-spaced) should suffice. Even if the class presentation of your chosen topic is toward the end of the semester, you should begin research on your topic fairly early in the semester so that you can develop and reflect on your ideas throughout the class.

Papers will be due on the Monday after the last class.

### Grading will be determined as follows:

20%	Discussion / participation
20%	Questions
30%	Discussion leadership
30%	Paper