**PSYC G4440 – Cognitive Neuroscience in Clinical Populations**

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**Spring 2023**

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**I. Bulletin description**

PSYC G4440. Cognitive Neuroscience in Clinical Populations (seminar). 4 pts. Tuesdays: 10.10 AM-12.00 PM.

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

This course is a comprehensive overview of conceptual and methodological approaches to studying cognitive neuroscience in clinical populations. The course emphasizes 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 individual class will begin with background information provided by the primary instructor or a guest lecturer, followed by discussion. The overall progression of class throughout the term is as follows:

Introduction to the course (Dr. Leavitt)

This lecture will give an overview of the course schedule and discuss different approaches to the study of cognitive neuroscience through work in specific clinical populations with a broad listing of the most noticeable behavioral changes that are seen in the context of neurological disorders. Dr. Leavitt will introduce the overarching topic of resilience- individual differences in protection against cognitive decline- which will be referred to frequently throughout the course, as it relates to each of the clinical populations that we focus on. Organizational details will be discussed as well as grading and plagiarism policies.

Methodological overview (Dr. Habeck)

This lecture will be didactic in nature and review elementary concepts of statistical inference that are needed in age-related comparisons frequently found in brain-imaging, epidemiological, psychological, and medical research dealing with aging. The second part of the lecture will specifically focus on biomarkers of aging and dementia. A brief and easy-to-understand methodological introduction about Receiver Operator Curve statistics and cross-validation will 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.

Functional network changes, diet, and cognitive aging (Dr. Gaynor)

This session addresses the ways in which aging alters the networks of brain regions involved in performance of a task resulting in either increased or decreased brain activity in older adults compared with younger participants and focuses on modifiable factors that may influence changes in cognitive aging, such as diet.

PET and MRI Neuroimaging in Alzheimer’s Disease (Dr. Lao)

In this class, students will learn about ways in which specific neuroimaging techniques can permit insights into the etiology of a neurologic disease and hold implications for development of targeted treatments.

Cognitive neuroscience in pediatric autism (Dr. Goldman)

This session will discuss interventional approaches to maximize cognitive health in a neurological population. We will review the basic methodology for evaluating multidomain cognitive and psychosocial function in pediatric autism, as well as discuss interventional studies and interpret evidence for the efficacy of cognitive training and exercise interventions.

Diet and Cognition Across the Adult Lifespan (Dr. Gu)

This session will expose students to the fundamentals of goals, design, and analysis of epidemiological research in aging, focusing on observational studies, which a particular focus on diet in aging. 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.

Electrophysiological correlates of everyday functioning during the prodromal dementia period (Dr. De Sanctis)

Language networks and primary progressive aphasia (Dr. Assuras)

In this session, students will learn about how focusing on a specific functional network can inform understanding of clinical manifestations of dysfunction. In addition, students will be exposed to the concept of differential diagnosis and clinical phenotypes through the example of PPA subtypes that will be discussed.

Neuropsychological testing (Dr. Cosentino)

This class will cover the ways in which cognitive testing in a clinical setting can be used for diagnostic purposes, e.g., to dissociate AD from normal aging and other dementias, and to make inferences about the distribution of neuropathology in individual patients.

Multimodal imaging of the aging brain (Dr. Gazes)

Each imaging technique conveys one dimension of neural aging. Combining the various imaging techniques (DTI, ASL, T1, FLAIR, etc.) into the same analysis will enable a more comprehensive view of the aging mechanism. Analytical techniques for combining different imaging modalities into one analysis, such as PCA and SEM, will be discussed. Theoretical considerations rather than technical aspects of the issues will be the focus of the lecture.

Bilingualism, cognitive reserve, and dementia risk (Dr. Arce)

The Impact of COVID-19 on Dementia Risk (Dr. Pyne)

Cognitive neuroscience of psychiatric populations (Dr. Dworkin)

Functional Brain Network Alterations in a neurological disease of early adulthood (Multiple Sclerosis) (Dr. Leavitt)

In this class, we will discuss ways in which advanced neuroimaging techniques can be used to address hypothesis-driven questions about cognition in a clinical population. Using the example of memory change in MS, we will engage in a broader discussion of how to develop an answerable, scientifically justified question that can be addressed through neuroimaging methods. For this final lecture, we will also discuss grantsmanship, and how to develop a strategy for building a successful career in science.

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

This course provides a comprehensive overview of conceptual and methodological approaches to studying cognitive neuroscience in clinical populations with an overarching focus on resilience: individual differences in ability to maintain cognitive function in the face of brain changes due to disease or aging. It is intended to introduce students to the relevance and challenges of studying cognition in clinical population. The primary instructor as well as guest lecturers will come from the interdisciplinary faculty of the Cognitive Neuroscience Division in the Sergievksy Center at Columbia University Irving Medical Center. The course emphasizes 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. Throughout the course, there will also be an emphasis on developing clinically meaningful, scientifically justified questions to inform a successful research career.

This advanced seminar is best 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 seminar offerings in cognitive neuroscience and provide an important developmental component to students’ training.

PSYC G4440 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 G4440 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, G4440 meets the Group I (Perception and Cognition) distribution requirement.
* For the Neuroscience and Behavior joint major, G4440 will fulfill the 5th 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, G4440 will count as one term of the natural science requirement, provided that students obtain the necessary permission and have taken the prerequisite psychology courses. 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 G4440 will fulfill the advanced seminar requirement.
* For the Barnard Psychology major, PSYC G4440 will fulfill the senior seminar requirement.

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

Each class session will be roughly organized as**:**

* 15-minute recap
* 45 - 60-minute invited presentation
* 15 - 30-minute student presentation
* Discussion of the presentation and student questions

Readings are available as PDFs on https://courseworks.columbia.edu and are posted at least two weeks prior to the corresponding lecture date.

**Session Topic and Speaker** (subject to revision):

1. 1/17/2023 Vicky Leavitt- Course Overview / Modeling Brain Resilience in a Neurological Disease
2. 1/24/2023 Chris Habeck- Multivariate Analysis in Cognitive Neuroscience
3. 1/31/2023 Alexandra Gaynor- Functional Network Changes in Aging
4. 2/07/2023 Patrick Lao- PET and MRI Neuroimaging in Alzheimer’s Disease
5. 2/14/2023 Jordan Dworkin- Cognitive Neuroscience in Psychiatric Populations
6. 2/21/2023 Sylvie Goldman – Cognitive Neuroscience in Pediatric Autism
7. 2/28/2023 Yian Gu- Diet and Cognition across the Lifespan
8. 3/07/2023 Pierfilippo De Sanctis- Electrophysiological correlates of everyday functioning during the prodromal dementia period
9. 3/14/2023 NO CLASS- Spring Break
10. 3/21/2023 Steph Assuras – Language Networks and Primary Progressive Aphasia
11. 3/28/2023 Steph Cosentino- Neuropsychological Testing
12. 4/04/2023 Elaine Gazes- Multimodal imaging of the aging brain
13. 4/11/2023 Miguel Arce- Bilingualism, cognitive reserve, and dementia risk
14. 4/18/2023 Jeffrey Pyne- The Impact of COVID-19 on Dementia Risk
15. 4/25/2023 Vicky Leavitt- Functional Brain Network Alterations in a Neurological Disease

**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 make a presentation. Students should prepare a presentation as well as thought-provoking questions addressed to the class. The presentation should be comprehensive but open enough in format to allow for ongoing discussion. In advance, students will meet to discuss topic and format of the presentation with the lecturer affiliated with the class for which they signed up. Typically, the student will present an article from the required readings; however, format and content is open and should be coordinated with the primary lecturer for the chosen class.

**Questions generated by the readings**

Each student is required to read assigned papers before class in order to ensure lively discussion in class. Each student will also be responsible for composing one substantive question relevant to each of the readings and posting their questions on Courseworks each week **by Sunday 9PM**. Students are not allowed to replicate already posted questions. Discussion leaders should incorporate these questions into their presentation but are not required to post questions the week they are presenting. 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 the instructor anytime during the semester, it is required that you submit your paper idea by midterm (March 14, 2023) and meet with the instructor once (preferably 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. 12 pages maximum. Any pages exceeding 12 will be disregarded. 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 **May 2, 2023**, via CourseWorks.

**Class Participation**

Active participation in class discussion is essential to gaining a full understanding of the course materials. Therefore, each student is allowed one absence with prior notice. After that, each absence will result in 1.5 (20% points/13 classes) %points deducted from the final course grade.

**Grading will be determined as follows:**

20% Class Participation

20% Content and Timeliness of Posted Discussion Questions

30% Presentation / Discussion leadership

30% Paper