

University of Cambridge

Cognitive Science and Behavioral Psychology

1. Program Background

Psychology is a science that studies human psychological phenomena and their mental functions and behavioral activities under their influence, taking into account outstanding theory and application (practice). Psychology includes basic psychology and applied psychology, whose research involves many fields such as perception, cognition, emotion, thinking, personality, behavior habits, interpersonal relations, social relations, artificial intelligence, IQ, personality and so on. It is also related to many fields of daily life -- family, education, health, society and so on.

Cognitive science is a new interdisciplinary discipline including linguistics, anthropology, psychology, neuroscience, philosophy and artificial intelligence. Its research object is the understanding and cognition of human, animal and artificial intelligence mechanism, that is, the complex system of information processing that can acquire, store and transmit knowledge. With the development of technology, especially the rapid development of artificial intelligence in recent years, new ideas have been brought to the research and application of cognitive psychology. The ecological behavior data obtained by artificial intelligence and big data improves the internal and external validity of the research results.

2. Program Description

The project aims to introduce students to the frontier of psychology research -- human cognitive science, mainly including the basic theory of the discipline and the overview of the research field. The program will focus on guiding students to explore topics such as human perception, attention, long and short term memory, cultivate students' critical thinking, and encourage students to actively connect what they have learned with other scientific research fields.

Psychology topics and lesson plans include:

- 1) Prejudice and Discrimination (implicit bias)
- 2) Philosophy of Identity (Economic Theory of the Individual and Philosophy of the Self)
- 3) Psychological experiments, data collection and analysis, and design
- 4) Sessions on critical thinking and scientific writing

- 5) Overview of Theory of Mind (TOM)
- 6) Dual processes of human cognition and priming and Stroop tasks

3. Targeting Students

High school students, college students (students interested in economics, psychology, neurobiology or related majors)

4. Professor Introduction



Professor Vestergaard

Professor of Wolfson College, Cambridge University; Department of Physiology, Development and Neuroscience

Professor Vestergaard is a neuroscientist interested in the psychology of decision-making, mental health & communication

Martin's research interests include mechanisms of automatic processing in sensory systems and their evolutionary basis, cognitive aspects of auditory perception, and behavioural and neural aspects of economic decision-making. He uses psychophysical, electrophysiological and neuroimaging methods to identify behavioural and neural indices of reward processing and auditory specialization. A key finding in his early work is that humans and other animals may have evolved an ability to judge the competence of suitors and predators by gauging skeletal size from their communication signals.

Martin received his PhD in Psychological Acoustics from the Technical University of Denmark (DTU) where he had previously earned his MSc and EE degrees following undergraduate and graduate studies in Electrical Engineering and Communications at DTU and in Systèmes électroniques et Informatiques Industrielles at Polytech Nantes. He was a

Research Fellow at the Centre for the Neural Basis of Hearing, Cambridge before he moved on to study cognitive aspect of the reward system in the Department of Physiology, Development and Neuroscience.

He became a Fellow and Tutor in Wolfson College in 2011, and since 2016 he has held the role as Deputy Senior Tutor.

5. Syllabus

1. Introduction to cognitive psychology

In this lesson we first look at philosophy of identity and the Self as a basis for studying psychology. We then cover mental processes such as auditory and visual perception, problem solving, reasoning and language. We also look at Theory of Mind (ToM) and the Stroop effect.

2. Experimental psychology

In this lesson we look at research methods in experimental psychology, how to design an experiment, collecting and analyzing data, critical thinking and scientific writing, Bayesian inference, evidence, prior, likelihood, optimization, generative model and cost function.

3. Psychology of choice

This lesson is an introduction to behavioural decision-making. We cover basic axioms of preference, utility maximization, decisions under risk, risk aversion, loss aversion, temporal discounting, trust and cooperation, prospect theory, opportunity costs, decoy effect, sunk costs, and anchoring.

4. Neuropsychology

This lesson introduces brain imaging techniques such as fMRI, EEG, MEG, TMS and single cell recordings and their application in investigations of the reward system. We look at how computational models used in fMRI research can be used to study brain the mechanisms underlying psychological phenomena.

5. Biases and errors in human cognition

In this lesson, we look at biases of human cognition, confirmation bias, Dunning – Kruger effect, cognitive dissonance, framing effect and endowment effect. We also look at errors in psychology research, survivor bias, selection bias, collider bias and type I vs type II error and

the biological basis for type I error bias of human cognition.

6. Dual-processes in human cognition

In this lesson, we cover the dichotomies in psychology that underlie dual-process theory of human thought. Often termed System 1 and System 2, the psychological processes are characterised as implicit vs explicit, automatic vs controlled, unconscious vs conscious, goal directed vs habitual, model-based vs model free, analytical vs intuitive, or declarative vs procedural.

7. Case-study: Irrational decision-making in humans

In this lesson, we go through an example of neuroimaging research. We start from the initial observation of a human behaviour, then go through psychology theory and modelling to the identification of brain mechanism responsible for irrational decision-making in humans. This lesson can also serve as model for a Journal Club, i.e. a lab meeting in which research students present a journal article in detail to their colleagues, which prospective graduate students will need to learn.

8. Practical applications, revision and poster presentation

In this lesson we look at everyday instances of the theory covered in the course. We go over different strategies of decision-making and coping mechanisms that may be used to prevent failure in rational decision-making that is hardwired into the human brain. We summarise the main learning outcomes from the course and discuss how to present psychology results as Poster.

9. Program Review and Presentation

10. Project Paper and Publication