Lecture 1: Lab in Human Cognition

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Agenda for Today

• Give a short overview of course for those still considering if they will enroll
• Go over tentative syllabus
• Fill out pre-course survey
• Why study human cognition and what is it?
• Assign Readings
First

Who are you (i.e., me)?
Instructor
Todd Gureckis

Office: Meyer 859

Hours: After class or by appt.

Email: todd.gureckis@nyu.edu

How to email me:
Teaching Assistant
Lisa Fiorenzo

Office: TBD

Hours: TBD

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How to email me:
Writing Instructor
Matt McClelland

Office: 411 Lafayette, Rm 412

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Email: msm8@nyu.edu

How to email me:
Second
Pragmatics
Pragmatics

http://smash.psych.nyu.edu/courses/spring11/lhc

- Course webpage (not using blackboard):
- All lectures, handouts, announcements, etc... will be made in here. Check back often!
- Easy to find if you forget just Google “nyu cognition”, find my webpage (second link down) and follow there is a link to the course page!
Grading

- 10% Attendance, participation, and in-class assignments
- 25% Final Project
- 15% Assignments based on readings
- 50% Lab reports (12.5% each)
More on readings

- We will read a variety of different kinds of papers during the semester.
- Some will be articles related to the labs, other will be general issues in experimental approaches to human cognition, and some will be about data analysis and communicating scientific results.
- Typically will assign reading on a wednesday, we will have an in-class discussion to clarify/dig deeper.
- You are responsible for reading, there may be quizzes.
More on labs

- Labs are “boot camp” for your final project.

- We run classic experiments on ourselves and analyze the data. The purpose is to expose everyone to key concepts and to help you better construct your final project.

Steps:

- We will collect data on ourselves in the class

- Analyze it

- Write up the results in an APA formatted paper (4-8 pages plus figures/graphs)

- Graded on accuracy of statistical analysis, interpretation, and quality/clarity of writing
More on final project

• Can work in teams of 2-3 people
• Design your own experiment
• Have your peers/collaborators in class run in your experiment
• We (Sara and I) will help you develop the system to test people with the computer (e.g., to measure reaction time accurately)
• Each group will turn in a final APA-styled paper based on the experiment and the results.
• The group will make a presentation to the class based on their results.
• (more on this later today)
Books and Software

- **Books:** None!
- **Software:** Free!
- **Software** will be a combination of custom experiment-running system written in Python (a general purpose computer programming language) and R (a open-source statistical analysis tool)
More on R

- Why R? Other labs use things like SPSS which are point and click analysis tools

- These types of tools hide true understanding of what you are doing (all the thinking is done for you)

- R is more flexible, letting you learn to look at your data many different ways

- This is how real science is done these days. But not just science!! Marketing research, finance, business, medicine, research, all are turning to quantitative methods. Good, employable skill to master/expose yourself to now.

- Free! You can install at home or work on laptop in class.
Data Analysts Captivated by R’s Power

Reading posted online.
Is R hard?

- Not really. Requires learning some basic programming concepts and ACCURATE typing.

- Are you attentive to detail? You will do well and find it easy.

- If you have trouble, I am always free to chat. Just make an appointment.

- If I don’t make sense to you, talk to Sara.

- If she doesn’t make sense to you either, consultation is available via the NYU Statistical Consulting office.

- Bobst library on 6th floor (620, 621) or via email data.service@nyu.edu, phone: (212)998-3434

- [http://www.library.nyu.edu/forms/research/classes.html](http://www.library.nyu.edu/forms/research/classes.html)
Ethics and Academic Misconduct

- Plagiarism or cheating is lazy and unethical.
- There will be consequences to students who cheat, including copying labs from previous semesters or copying from online/library sources.
- Falsification of any data is also unacceptable. You are not graded on the significance of the result, but on the quality of the hypothesis and your analysis.
Why should I take this course?

- You are interested in cognitive science, experimental psychology, computer science, marketing, business, sociology, and/or economics
- You have to
- You are generally interested in science and how scientists develop and test theories about the way the world works
- You like hands-on courses where you get to learn and explore the on your own
Why should I **NOT** take this course?

- You have trouble waking up before 2:00pm
- You have other things you are going to want to do at 2:00pm instead of attending class
- You hate computers and are unwilling to even try to touch one
- You hate working in groups on even a single project
Third

Who are you (i.e., you)?
Fourth
What is this course about?
Short Version
Experimental approaches to understand the structure of human thought
An introductory course on the use of various behavioral measures (accuracy, reaction time, etc...) to understand the structure of the human mind. Our goal is to use experiments to test alternative theories of cognitive function and to better understand the motivation and structure of human behavior. We will learn a basic set of skills for interacting with computers to run experiments, collect data, analyze it, and communicate the outcome to others.
What is “human cognition”?

The study of how the mind (or mind/brain) works. The study of how people think and solve problems.
What is “human cognition”?

Examples:

✦ How do people learn effective behavior through interaction with their environment?

✦ What are the stages of information processing the mind goes through to solve problems?

✦ How does the architecture of the mind interact with experience to determine what we know?

✦ How does human memory work? In what ways is human memory like computer memory? In what ways is it not?

✦ What is the format or “representation” of information that the mind uses?

✦ Can we develop theories that allow us to predict and explain human behavior? Can information we derive from these investigations enable us to build better artificial intelligence systems to solve problems?
Scientific Inference

A tale of two magnets
Scientific Inference

A tale of two magnets
Scientific Inference

Observations

Theories
Scientific Inference

- Natural Behavior
- Just ask people questions
- Test/quizzes (more controlled performance measures)
- Reaction Time (RT)
- Eye tracking
- Physiological measures (EKG, Galvanic skin response, heart rate)
- Brain measures (fMRI, EEG, MEG)
- Lesion studies/surgical interventions
Scientific Inference

- Theories of information processing inspired by modern computers
- Mind-as-a-computational device
- Build computational theories of the way we think the mind works, test the implication of those theories in new experiments, refine theories when needed.
The structure of scientific pursuit

Environment

Stimuli that are perceived by the body and nervous system

Behavior
Environment

Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Behavior
Environment

Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Behavior

Theory
Environment

Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Theory predicts

Behavior
Environment

Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Behavior

Theory

predicts

describes
**Stimuli that are perceived by the body and nervous system**

**Cognitive Mechanism** (representations, processes)

**Behavior**

**Environment**

**Model**

\[ P(\alpha_i) = \frac{x_i}{\sum_j x_j} \]
Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Environment

Behavior

Model

\[ P(a_i) = \frac{x_i}{\sum_j x_j} \]
Stimuli that are perceived by the body and nervous system

Cognitive Mechanism (representations, processes)

Environment

Experiment

Model

\[ P(a_i) = \frac{x_i}{\sum_j x_j} \]
Fourth
What is “cognitive science”?
Cognitive

“Cognition, as defined by Ulrich Neisser, involves all processes by which sensory input are transformed, reduced, elaborated, stored, recovered, and used.”


Science

“Science is the art of acquiring knowledge in such a manner that coherent structures of understanding can be erected on the basis of a critical evaluation of evidence”

Ragnar Granit, The Purposive Brain (p 21)
What makes a mind?

Debated for thousands of years. If you don’t have an immediate answer, don’t feel bad. Various proposals have been thrown around from by Plato, Buddha, Aristotle, Zoroaster, ancient Greek, Indian, and Islamic philosophers, and even a few folks at NYU.
What makes a mind?

What do they do?

Minds encompass our thoughts, which are the mental processes which allow us to deal with the world. These include not only explicit wishes, desires or intentions but unconscious processes as well.
What makes a mind?

Does MIND = BRAIN?

We know that we can’t have a mind or thoughts without a brain, but does that mean that minds and brain are synonymous?
A common philosophical approach is the “slippery slope” argument to try to convince us that minds are not literally brains, but encompass anything that is organized as a set of represented mind states that accurately reflect aspect of the world.
Figure 1.1 — The Brain/Mind Riddle. What is common to the minds of various sentient creatures that look at the scene in the center of this picture and see three objects? This question can be elaborated (by asking it about two cylinders and a sphere rather than "three objects"), or extended to other cognitive processes such as thought or discourse that need not involve vision or any other particular perceptual modality.
Edelman’s arguments

- What is common to all sober observers viewing the same scene and who are in agreement about what is viewed?

- Can’t literally be neurons. My neurons are my own, and you can’t borrow them to solve your own problems.

- Well maybe is the literal organization of the human nervous system (up to the limit of correspondence). However, we know (or at least believe) that cats have a very similar visual system and view the world much like we do. Is it the mammalian visual system? What about other animals?

- What about artificial systems formed of computers and video cameras that can accurately recognize the scene as well?

- The key to minds may be not the physical substrate in which they are embodied but the relations that various states of the system have to one another and to the environment/world.
The “organizational” view of the mind

- Minds aren’t human neurons or cat neurons or robot parts, but the organization of dynamic, continually evolving systems that relate ongoing internal (i.e., mind) states and external (i.e., world) states

- Correspondences can be made between the evolution of two systems to describe what they are doing independent of the exact things they operate on.

- Such correspondences are particularly well described in the language of computation, simply because the THEORY OF COMPUTATION offers us formal insight into how ostensibly dissimilar systems can be formally identical.

- Everything that can be expressed in one system can be expressed in a different, but functionally identical system.
The “organizational” view of the mind

Minds are what brains do

Brains perform computations

Computation is the manipulation of representations through various processes
Representation and Process

• What is a representation?

• Take the example of a calculator... there are operations you can perform (addition, multiplication) but someplace are are electronic representation of the operands (the numbers you are adding or multiplying)

• These are physical symbol systems because a physical state (be it electronic or neural) represents some other entity

• Whole branches of philosophy devoted to the idea of representation (semiotics)
Very nice description comes from Markman’s (1999) “Knowledge Representation” textbook

- Representations have four components

1. **A represented world**: what the representations are about

2. **A representing world**: the domain that contains the representations

3. **Representing rules**: the things that relate the two above things (basically a map that draws correspondences between the represented and representing systems)

4. **A process that uses the representations**: The first three just make the potential for representation. Representations are inert unless some process makes use of them
Representations can be entirely abstract (in Edelman's terms) because they don't have to resemble the represented world in any particular way.

Even more impressively, they don’t have to represent the past or present, but can extend to predict the future!!
Kinds of Representations

Analog

The representing world has a structure and the form of the isomorphism is not arbitrary.

Symbolic

The rules relating numerical forms to temperature is arbitrary. There is not direct, physical correspondance.

FIG. 1.2. Various ways of representing temperature. The top row depicts water that is frozen, at room temperature, and boiling. The next two rows depict possible analog representations. The two following rows show numerical temperature notations. Finally, the last row depicts temperature with the darkness of the square.
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2010
Arabic numerals

MMX
Roman numerals
Our goal this semester

- To explore (experimentally) how the brain \textbf{REPRESENTS} and \textbf{PROCESSES} information in solving tasks

- This requires us to be clever... we have to formulate \textbf{HYPOTHESES} about how the mind might function, then design ingenious experiments which can test those \textbf{HYPOTHESES}.

- This will involve testing various \textbf{THEORIES} of cognitive function that are essentially formalized as computer programs or algorithms

- We are licensed to do this due to the fundamental idea that the mind can be understood as an \textbf{ORGANIZATIONAL SYSTEM} that evolves according to particular rules, steps, or procedures
Finally,
Let’s talk about this final project!
For next time....

• Go to the website


• Also read the article on R from the NYTimes and read these before class next time.

• Be prepared to discuss the ideas in both of these articles

• Take the pre-course survey online and send me your answers before class next time