The Neurobiology of Consciousness and Evolution of Language

Class description: Your brain is a bizarre device, set in place through natural selection of your ancestors and your own experience. One thing that clearly separates your brain from the brain of any other non-human animal is the propensity of your brain for imagination and creativity. In this class we will dive into the neuroscience of imagination: from neurons to memory to neurological mechanism of generating novel conscious experiences. We will study what makes your brain unique and the selectional forces that shaped the brains of our ancestors. We will discuss what makes human language special and how it evolved. This interdisciplinary class is intended for paleoanthropologists who want to learn neuroscience, psychologists who are interested in the question of the origin of language, biologists who are interested in the uniqueness of the human mind, neuroscientists who want an exposure to paleoanthropology and linguistics, philosophers fascinated by neurological basis of behavior and other students interested in an understanding of the mind of a man and the evolution of the brain.

Instructor: Andrey Vyshedskiy, email: vysha@bu.edu (please do not send homeworks to this email)

Education: PhD in Neurobiology, MS in Biomedical Engineering, BS in Astrophysics.

Class website: http://stethographics.com/a3/

Textbook: On The Origin Of The Human Mind, Second Edition, by Andrey Vyshedskiy,
Paperback is available at Amazon: http://www.amazon.com/gp/product/1492963615

Office hours: 1 hour after the lecture

Grading:
- Journal articles presentations (three students per article) 25%
- If your group is not presenting, read the assigned journal article and generate at least one question for class discussion of the article (email the question along with the homework) 5%
- Homeworks (available on the website; write the answers, save as MWord, PDF, or make a photograph of your answers and email the file before the class to homeworksaddress@gmail.com; PLEASE do not email to my other email addresses! Expect to spend several hours working on each homework.) 20%
- Quizzes (6 questions, 10 min, at the end of every lecture starting with lecture 4. Each quiz is based on the homework questions that we have already discussed in class. Quizzes can also include rephrased questions from previous quizzes.) 50%

Guidelines for a journal article presentation:
- As a scientist, you will make hundreds of presentations. It only makes sense to learn to enjoy making presentations as early as possible.
- I will assign journal articles to each group of students. You will create a Power Point presentation and present these articles in class. When presenting an article please:
  - Clearly state the research questions addressed in the article
  - Provide background information for context
  - Select and carefully describe the most important results using the figures and tables from an article. Do the results adequately address the question? How well?
  - Describe methods as appropriate for understanding the results (What were they? Were they appropriate? Why?)
- If you did not understand something, we will try to figure it out together in class.

Participation in discussion of journal articles:
Discussion of the scientific literature is important. It trains us all to be more rigorous. As you listen to the presentations, consider the work carefully and prepare your questions. Regular contributions during Discussion and during class are expected.

Research slide presentation (the Summer class only):
If you are taking this class, you probably have THE QUESTION that you wanted to answer for a long time. Any question. Really. Let’s dig into literature and investigate. I will help you.
If you need a suggestion for a research topic, please talk to me.
- When preparing your presentation, aim to make it informative and interesting.
- A good presentation involves careful preparation and practice. Aim for a 15-20 min presentation followed by a 5 min discussion.
Grading

92-100 = A | 88-92 = A- | 84-88 = B+ | 80-84 = B | 76-84 = B- | 72-76 = C+

Homeworks and presentations are graded on completion. Quizzes are worth 50% of the grade. Therefore:

If you completed all HW and presentations and your quiz total = 84% or more, your grade is A
If you completed all HW and presentations and your quiz total = 76% to 84%, your grade is A-
If you completed all HW and presentations and your quiz total = 68% to 76%, your grade is B+
If you completed all HW and presentations and your quiz total = 60% to 68% your grade is B
If you completed all HW and presentations and your quiz total = 52% to 60% your grade is B-
If you completed all HW and presentations and your quiz total = 44% to 52% your grade is C+

Legend: T =Topic of the lecture; R=Reading materials for the lecture; W=Watch these related videos; J=Journal club topic discussed at the end of the lecture

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<tr>
<td>1</td>
<td>Open questions in evolutionary neuroscience. We start with evolution. Facts of hominin development. The main thing: language. But what is language? What makes modern humans so much different from other animals?</td>
<td>-Becoming Human - 3 parts long Documentary: <a href="https://www.youtube.com/watch?v=oaBfUfqPq6M">https://www.youtube.com/watch?v=oaBfUfqPq6M</a></td>
<td>-Part 2, Chapter 7</td>
<td>No journal article presentation in the first lecture</td>
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<td>2</td>
<td>Where is consciousness in the nervous system? Organization of the brain. Neocortex-hippocampus system of encoding long-term memories of people, objects, facts and events; other memory systems. Functional localization in neocortex. Cortical plasticity.</td>
<td>-Karolinska Research Lectures: Itzhak Fried (50min 2013): <a href="https://www.youtube.com/watch?v=oA8fUfqPq6M">https://www.youtube.com/watch?v=oA8fUfqPq6M</a></td>
<td>Appendix 2</td>
<td>All students - Ian Tattersall, “How we came to be Human” SciAm Dec 2001</td>
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Legend: AV: August 2020, 2/27/2020

2
Overview of Cognitive Neuroscience

5 T Neuronal binding by synchronization. Local vs. global synchronization. In this lecture, we are still staying inside the sensory posterior cortex.

R Part 1, Chapter 2
W - Wolf Singer (74min, 2013) start on 27min to avoid philosophy: https://youtu.be/WgESWMdV1Q4w?t=1594
J Groups 4, 5, and 6 are presenting articles in the folder: 04_NeuronalEnsembles:

6 T PFC role in activation of neuronal ensembles. Self-activation of neuronal ensembles during dreams. Review of neuronal ensembles; Binding neurons of the temporal lobe.

R Appendix 3
J See the articles folder: 05_Neuronal binding by synchronization

7 I Imagination involves several neurologically distinct components. Imagining new objects in the process of Prefrontal Synthesis.

W 2002: Creating bizarre false memories through Prefrontal Synthesis: repeated PFS, participants not only reported that never presented bizarre actions were presented during Session 1, but also claimed that they had performed these actions. After five imaginations, people claimed that they had performed new bizarre actions 14.0% of the time. Although the increase in false did responses to bizarre actions was significant, it was less than the increase observed for familiar actions. After five imaginations, people claimed that a familiar action never presented during Session 1 had been performed 24.0% of the time.
J See the articles folder: 06_PFC role in activation of neuronal ensembles

8 T Role of the prefrontal cortex in working memory, Prefrontal Synthesis, and inhibition of urges. Functional imaging of the prefrontal cortex in healthy subjects; Neurological deficits associated with lesions of the prefrontal cortex; The prefrontal cortex in temporal organization of actions.


- Suzana Herculano-Houzel: What is so special about the human brain? https://www.ted.com/talks/suzana_herculano_houzel_what_is_so_special_about_the_human_brain
- Human Ape, Nat Geographic, 2008, DVD: footage of Povinelli, Bonobos Kanzi and Panbanisha and orangutans Knobi and Azzi are extensively shown in the film; FOXP2: Whereas the human child is shown to be imitating the steps taken by one researcher to open a box and get a reward, the apes quickly eliminate the redundant steps.
R Part 3, Chapter 12
J All groups re-read: Fuster, “The Prefrontal cortex”, Introduction
J See the articles folder: 07_MS_PFC

9 T Isoclinichy in isomorphic neural networks. Experience changes myelination in humans

R Part 3, Chapter 12
W - DANIEL J. POVINELLI (20min lecture, 2013) - https://www.youtube.com/watch?v=kX49dbfG9E; experiment with weight concept in chimpanzees (8min, 2012): https://www.youtube.com/watch?v=vdVhRs4zIC1
- The surprising science of alpha males | Frans de Waal: https://youtu.be/BPs5KKnL8N0s
J 08_PFC_evolution

Research topic decision is due.


J See the articles folder: 09_Isoclinichy

Evolutionary Neuroscience - “Nothing in Biology Makes Sense Except in the Light of Evolution” - Theodosius Dobzhansky


- Listen for podcast Words from radiolab: http://www.radiolab.org/story/91725
- TED talk presenting a critical period for phoneme tuning: https://www.ted.com/talks/patricia_kuhl_the_linguistic_genius_of_babies#t=437098
J See the articles folder: 10_CriticalPeriod

12 T Functional lateralization of cerebral hemispheres. Corpus callosum. Why language is localized to one hemisphere?

R Part 2, Chapter 10
Preparing for the class

Students with any level of neuroscience have enjoyed this class in the past. However, the more neuroscience background you have, the more you would enjoy the class. If you are considering to brush up your neuroscience, here are some resources:

1. The Fundamentals of Neuroscience online class | Harvard University: https://www.mcb80x.org/course
2. Introduction to Neuroscience I - Stanford: https://youtu.be/5031rWXgdYo

In addition, here are some popular books related to the class material that I have enjoyed:

1. Masters of the Planet: The Search for Our Human Origins by Ian Tattersall
2. Becoming Human: Evolution and Human Uniqueness by Ian Tattersall
4. The Consciousness Instinct: Unraveling the Mystery of How the Brain Makes the Mind by Michael S. Gazzaniga
5. Tales from Both Sides of the Brain: A Life in Neuroscience by Michael S. Gazzaniga
7. The Mind's Past by Michael S. Gazzaniga
8. The Gap: The Science of What Separates Us from Other Animals by Thomas Suddendorf
Finally, here are some serious neuroscience books that I have enjoyed:
1. The Prefrontal Cortex, Fifth Edition by Joaquin Fuster
2. Principles of Neural Science by Eric R. Kandel and James H. Schwartz
3. The Case for Mental Imagery (Oxford Psychology Series) by Stephen M. Kosslyn
4. Principles of Brain Evolution by Georg F. Striedter
5. Man the Hunted: Primates, Predators, and Human Evolution by Donna Hart and Robert Wald Sussman