Psy 20. Introduction to Cognitive Psychology

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Summary

How do 20 billion individual neurons give rise to cognitive functions? After developing a very basic understanding of neural information processing mechanisms, we will be exploring many different aspects of human thought (cognition), including attention and perception, memory, executive function, reward learning and decision making, and language. Amazingly, all these seemingly different cognitive functions can be understood using a small set of common neural mechanisms.

Computational models will be used to enrich the learning experience, because we routinely heard from students that they didn't really understand what problem the brain had to solve in a particular cognitive domain until they pulled up the computer model and played around with it.

At a more serious level, the use of computer models to understand how the brain works has been a critical contributor to scientific progress in this area over the past few decades. How could we possibly hope to understand how billions of interacting neurons produce complex human cognition, just by talking in vague verbal terms, or simple paper diagrams?

Grades will be based on weekly homework assignments (70%), final project (20%), and in-class contribution (10%).

Topics and Highlights

- **Perception:** We can effortlessly recognize countless people, places, and things. Why is this so hard for robots?
- **Attention:** Where's Waldo? We'll see how two visual processing pathways work together to help focus our attention in different locations in space (whether we are searching for something

or just taking things in), and why damage to one of these pathways leads people to ignore half of space.

- **Memory:** How can damage to a small part of our brain cause amnesia? We'll see how the structure of the hippocampus is critical for episodic memory, while the rest of the brain isn't well-suited to take on this job, but for other sorts of memories (e.g. semantic).
- **Executive Function:** How do we stay focused on tasks that we need to get done or things that we need to pay attention to, in the face of an ever-growing number of distractions (like email, text messages, and tweets)? We'll explore the “executive” part of the brain, the prefrontal cortex. We will see how this area is uniquely-suited to protect us from distraction, and how this can change with age.
- **Reward Learning and Decision Making:** Why do we get bored with things so quickly? Because our dopamine system is constantly adapting to everything we know, and only gives us rewards when something new or different occurs. We'll see how this all happens through interacting brain systems that drive phasic dopamine release.
- **Language:** What causes dyslexia, and why do people who have it vary so much in their struggles with reading? We'll explore these issues in a network that learns to read and pronounce nearly 3,000 English words, and generalizes to novel nonwords (e.g., “mave” or “nust”) just like people do. We'll see why damaging the network in different ways simulates various forms of dyslexia.

Resources

- Lecture notes
- Free Online textbook
- Additional Readings
- Emergent Neuronal Network simulator demonstrations