Exam scope: All of the readings and lectures for weeks 1, 2 and 3.

Read and think about the review questions for each week.

Write out short answers for the questions....

TIP: Try to do it without your notes.
EXAM DETAILS:

- Please bubble in your PID and EXAM number on your scantron.
- Write your name on the exam and scantron.
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- Show your student photo ID when turning in BOTH your exam and scantron.
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  I also understand that if I violate those policies I could potentially be asked to leave UCSD.
  I acknowledge that it is my responsibility to fully understand and comply with these policies.

Signature: Student Date: Feb 4, 2020

Thank you.
Share your knowledge: Participate on Piazza, call mom, tell your roommate...
When you actively process the information that is when the magic of learning happens.
INTRODUCTION TO COGNITIVE SCIENCE

- Boyle
- Week 1
- Quiz A
- Readings

Week 1.
Dr. Mary Boyle - Why Can't We Sleep.
read

Week 1.
Dr. Mary Boyle - Brain Facts Review Chapters 6 and 12
read

INTRODUCTION TO COGNITIVE SCIENCE
Mary ET Boyle, Ph.D.
Department of Cognitive Science
UCSD
THE BIG QUESTION FOR THIS LECTURE:

WHAT IS COGNITIVE SCIENCE ANYWAY?
What is Cognitive Science?

Interdisciplinary study of mind and its processes. **Main objective**: Understand how information is acquired, processed, transformed into behavioral output.

What are its main disciplines?

- Neuroscience
- Philosophy
- Computer science
- Linguistics
How are these disciplines related?

Neuroscience
How does neural activity represent, store information and how does it translate to behavior?

Philosophy
Defines key questions: What is reasoning, meaning?

Computer science
Create systems that simulate cognitive processes and output

Linguistics
How is meaning/information represented and conveyed?
PERCEPTION

Cognitive Science

Mind

Emotion

Language

Reasoning

Memory
This is what some linguists study and argue about! Some main theories by:

**Pinker**, argues language is innate human ability

**Elman**, argues language use arises from experience, it is learned
BCI

Reading Minds
BCI: “READING MINDS”

What is BCI? What does it mean to “read the mind”?

Brain Computer Interface. Field of research, uses...

...sensors to record electrical activity, which computer decodes in order to control external device accordingly.
HOW DOES COGNITIVE SCIENCE DIFFER FROM...

computer science,
neuroscience, philosophy,
psychology, and
linguistics?

Independently, each field could investigate questions unrelated to cognition.

Cognitive science, however, requires each field’s input in order to form a complete picture of cognition.
SLEEP

• Boyle
• Week 1
• Quiz A
• Assigned Readings:
  – Clocks Within Us
  – Why Can’t We Fall Asleep?
  – The Work We Do While We Sleep
  – The Walking Dead
  – Brain Facts Chapter 6: Sleep
  – Brain Facts Chapter 12: Degenerative Disorders

“Sleep is the golden chain that ties health and our bodies together.”

Thomas Dekker

Mary ET Boyle, Ph. D.
Department of Cognitive Science, University of California, San Diego
WHAT IS SLEEP?
WHAT IS ITS RELATIONSHIP TO COGNITION?
HOW DOES IT RELATE TO YOUR HEALTH?

THE BIG QUESTIONS FOR THIS LECTURE ARE:
What does sleep have to do with it anyway?

Grade point average by amount of sleep

<table>
<thead>
<tr>
<th>Hours of sleep per week</th>
<th>Mean GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>3.0</td>
</tr>
<tr>
<td>5 to 6</td>
<td>3.2</td>
</tr>
<tr>
<td>7 or more</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Sleep and Well-Being

FACTORS:
- Purpose
- Social
- Financial
- Community
- Physical Activity

Sleep and Well-Being
How people scored on the Gallup-Healthways Well-Being Index, by nightly hours of sleep

<table>
<thead>
<tr>
<th>SLEEP</th>
<th>WELL-BEING SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4 hours</td>
<td>51.4</td>
</tr>
<tr>
<td>5 hours</td>
<td>56.5</td>
</tr>
<tr>
<td>6 hours</td>
<td>59.4</td>
</tr>
<tr>
<td>7 hours</td>
<td>64.2</td>
</tr>
<tr>
<td>8 hours</td>
<td>65.7</td>
</tr>
<tr>
<td>9-10 hours</td>
<td>64.7</td>
</tr>
</tbody>
</table>

Note: The well-being index, scored on a scale of 0 to 100, measures five elements of well-being: purpose, social, financial, community and physical.

THE WALL STREET JOURNAL
HOW DO WE FALL ASLEEP?

External Cues

- What is a zeitgeber? Examples?
- What is the role of melatonin and light in regulating circadian rhythms?
- What is so important about blue light?
- What factors are associated with our ability to go to sleep?
Internal Regulators of Sleep & Wakefulness

**SUPRACHIASMATIC NUCLEUS (SCN)**

- What is it?
- Where is it?
- What is its function?

How does it perform this function?

![Diagram showing connections between SCN and various tissues: Fat tissue, Liver, Digestive tract, Muscle]
MORE REGULATORS...

Hypothalamus: produces **orexin** (a hormone that excites arousal system, leads to release of norepinephrine which ultimately leads to melatonin suppression).

- **Orexin** (hypothalamus)
- **Melatonin** (SCN - bundle of cells located in hypothalamus)
- **Adenosine** (Basal forebrain and cortex, ↑ awake time ↑ production)

Basal forebrain and cortex: produce **adenosine** in proportion with how long you’ve been awake.
ME AND YOU AND CYANOBACTERIA:

How are we similar to cyanobacteria?

- Predict rather than respond!
- Anticipate metabolic demands by increasing or suppressing protein expression, hormone, and neurotransmitter release

Why does “When we go to bed affects how long you sleep, no matter how tired you are.”?

How is the functionality of insulin affected by time of day?
What happens to your body when you fall asleep?

**PHASES OF HEALTHY SLEEP:**

- **SWS** (slow wave sleep)
  - muscle relaxation
  - ↓HR, BP, body temperature

- **REM** (rapid eye movement)
  - atonia (muscle paralysis; exceptions for respiratory muscles-yay! And eye muscles)

- Both duration of overall sleep and the duration of individual stages of sleep vary over the course of development.

- Fasting
- Release of hormones
- Immune system activity
- Resting
EFFECTS OF SLEEP DEPRIVATION:

**Short term** sleep deprivation leads to:
- Cognitive and behavioral changes
- Decreased ability to concentrate
- Decreased short-term memory
- Paranoia and hallucinations

**Long term** sleep deprivation leads to:
- Cardiovascular stress (elevated heart rate and blood pressure)
- Disruption of the lymphatic system and thus build up of toxins
- Impaired executive functions
- Impaired emotional responses
- Impaired decision making

In children chronic sleep deprivation may lead to hyperactivity and impaired interpretation of social cues
CHRONIC SLEEP DEPRIVATION DISORDERS

REM-sleep behavior disorder

- Paralysis during REM sleep does not occur → dreams are acted out
- Increased risk for neurodegenerative diseases

Sleep apnea

- Breathing pauses for seconds to minutes during sleep → body briefly jolts to continue breathing
- Cognitive impairments
- Increased risk for diabetes, cardiovascular diseases
As you get older, you experience changes in sleep habit such as:

1. Increased sleep fragmentation
2. Nighttime awakenings
3. Increased daytime sleep

A DEEPER CUT

For the peptide amyloid-β to be released into the space between cells, the outermost portion of the membrane protein amyloid precursor protein (APP) must first be cleaved off by the enzyme β-secretase. Another enzyme, γ-secretase, then cuts the remaining membrane-bound portion of the protein, freeing amyloid-β. Because γ-secretase can cut APP at a number of sites, the length of amyloid-β can vary.

1. APP spans the cell membrane.
2. β-secretase cleaves APP.
3. γ-secretase cleaves the remaining membrane-bound portion.
4. Amyloid-β is released from the cell. The length of this peptide reflects the site at which γ-secretase makes its cut.
5. All forms of amyloid-β aggregate into oligomers, fibrils and then plaques. However, longer fragments are thought to aggregate more readily.
How the evidence stacks up for preventing Alzheimer’s disease

Scepticism towards the idea that lifestyle choices can reduce the risk of dementia is waning.

As evidence from larger and longer-term studies accumulates, other risk factors for Alzheimer’s disease, including depression and a lack of sleep, are emerging. Indeed, a 2017 meta-analysis\(^\text{13}\) of 27 studies found that sleep problems raise the risk of cognitive impairment by 65%, and that dysfunctional sleep could explain as many as 15% of cases of Alzheimer’s disease.

https://www.nature.com/articles/d41586-018-05724-7
Deep sleep cleanses the brain

As with other organs, the brain accumulates waste as a result of metabolism, which must be removed. In other parts of the body, this waste management is carried out by lymphatic circulation, but the brain has a cleaning system of its own, something described by researchers as recently as 2012 (Iliff, Nedergaard & al, *Sci Transl Med*).

This system, known as the glymphatic system, mainly functions during sleep (Xie L et al. *Science 2013*) and makes cerebrospinal fluid flow through the brain tissue, thus flushing out waste, such as proteins. The recently published study demonstrated that to function efficiently, the system requires deep sleep.

OTHER SLEEP STUFF TO MAKE SURE THAT YOU UNDERSTAND:

- Where and what is the master clock?
- What is the big deal about blue light?
- What is sleep inertia?
- What is the cognitive and physical performance of someone who has not slept in a 24-hour period?
The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players

Cheri D. Mah, MS, Kenneth E. Mah, MD, MS, [...] and William C. Dement, MD, PhD

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3119836/
Conclusions:

Improvements in specific measures of basketball performance after sleep extension indicate that optimal sleep is likely beneficial in reaching peak athletic performance.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3119836/
early NREM when sleep pressure is high and dream reports are rare

late NREM when sleep pressure dissipates and dream reports are more frequent

REM sleep when dreams are most common

What are the two different arousal systems? Where do they project? (1 of 2)

1st arousal system:
- Acetylcholine
- Thalamus - gate to alertness; activated by ACh neurons in brainstem
- Fire fastest during awake states and REM sleep
What are the two different arousal systems? Where do they project? (2 of 2)

2nd arousal system:

- Norepinephrine (a.k.a. noradrenaline)
- Most active during awake states
- Lesions => profound sleepiness or even coma
- Inhibits VLPO when active
What is ATP and how does it work?

- Working and thinking requires energy -> Dephosphorylation of ATP
- Eventually dephosphorylates to Adenosine, which is a signal for sleep in the brain
- Signals the VLPO
What is caffeine and how does it affect the brain?

- VLPO promotes sleep and is active during it;
- Inhibits the arousal system
- VLPO lesions lead to insomnia
- Use of energy by the brain during wakefulness leads to production of adenosine
- Adenosine binds to VLPO making you sleepy; caffeine interferes with this process
- During sleep adenosine levels decrease
The main questions for this week are:

Split brain – how is the brain organized?

How does language provide insight into cognition?
SPLIT BRAIN AND LATERALIZATION OF FUNCTION

- Boyle and Coulson
- Week 3
- Quiz C
- Assigned Readings
  - Seeing the Brain Speak
  - Brain Facts – Chapter 4
    Learning, Memory and Language
SPLIT BRAIN
BROCA'S AREA
WERNICKE'S AREA
WADA test
Wernicke’s-Geschwind model
What are the different lobes of the brain?

Where is:
- MI
- AI
- VI
- SI
- Broca’s area
- Wernicke’s area
- SCN
- Hippocampus
- Corpus callosum
- Dentate gyrus
- CA1, CA2, CA3

What does each lobe do?
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Thank you.
COMMENTS ON —

1. BEING PROFESSIONAL

&

2. KINDNESS
3. Be grateful - your IA's have worked very hard to help you. You will be happier & learn more, too. 😊