COGS1
Section A

Professor Boyle mboyle@ucsd.edu Office Hours: Monday 2:30-4pm @ CSB 130
Sylvia shz008@ucsd.edu Office Hours: Monday 1-1:50pm @ CSB 226
Kevin kjenson@ucsd.edu Office Hours: Tuesday 2-2:50pm @ CSB 229
Jason jcg002@ucsd.edu Office Hours: Wednesday 11-11:50am @ Price Theatre Lobby
Zoe tzcheng@ucsd.edu Office Hours: Thursday 9:30-10:20am @ SSRB 235
Elena edreisba@ucsd.edu Office Hours: Friday 12-12:50pm @ Geisel 2nd Floor East, Audrey's Cafe
Angelica yus174@ucsd.edu Office Hours: Monday 4:30-5:20pm @ Geisel 2nd Floor East, Active Learning Lab
Some important information before we start

- Quizzes
  - **Graded** quizzes will be at the end of every section (~15mins)
  - Lowest quiz score will be dropped
  - Online *extra credit* reading quizzes starting week 3

- Readings
  - The syllabus will describe which segments of the posted readings you should do

- Section procedure
  - I will present a pool of topics we can discuss. Because we might not have time to go over everything, we will take a vote over which material you want to go over the most.

  - Please use this tool to your advantage by asking questions and answering other students’ questions. Please make sure your question hasn’t already been answered before you post.
Brief review for the topics of last week

- Introduction of cognitive science
- Sleep, Cognition, Alzheimer’s
Introduction to Cognitive Science
Review questions

1. What is the definition of cognitive science?
   • What are its main disciplines?
   • How are the disciplines related to and different from each other?
   • What are the main objective of the field?

2. The ability to learn and understand language is an extremely complex process. Is there something intrinsic in the human brain that enables language or is it experience?

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

4. What was special about the robotic hand?
1. What is the definition of cognitive science?

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

Defines key questions: What is reasoning, meaning?

Create systems that simulate cognitive processes and output

How is meaning/information represented and conveyed?
1. What is the definition of cognitive science?

**Definitions:** Cognitive science is the interdisciplinary study of the mind and its processes; it investigates how information is acquired, represented, processed, and transformed into physical/behavioral output.
Language: Nature v. Nurture?

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”

What does it mean to “read the mind”?

What is BCI?

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

...sensors to record electrical activity, which computer decodes in order to control external device accordingly.
What was special about the bionic hand shown in class video?

Prosthetic stimulates nerves, producing texture, fragility feedback so hand applies appropriate pressure to grab objects.

Review questions

1. What are the consequences of sleep deprivation?
2. What is the role of melatonin and light in regulating circadian rhythms?
3. What is the SCN? What does it do?
4. How human circadian rhythm work? What does it do? What will happen when this rhythm is disrupted?
5. What are the other internal clock systems that we’ve talked about in the class?
6. How blood sugar is regulated in our body?
7. Every cell has its own clock, for example, skin cell. What is the clock of skin cells?
8. What factors are associated with our ability to go to sleep?
1. What are the consequences 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 glymphatic 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.
2. What are the roles of melatonin and light in regulating circadian rhythms?

Light & Melatonin are the two most influential external cues that synchronize the circadian rhythm.

Sleep wake cycle is regulated by the circadian system.
3. What is the SCN? What does it do?
4. How human circadian rhythm work? What does it do? What will happen when this rhythm is disrupted?

- metabolic dysregulation
- obesity
- impaired immunity
- cognitive malfunction
- and so on...
5. What are the other internal clock systems that we’ve talked about in the class?

- Pancreas
- Skin cell
6. How blood sugar is regulated in our body?
6. How blood sugar is regulated in our body?
7. Every cell has its own clock, for example, skin cell. What is the clock of skin cells?

Every cell has its own clock!

SKIN CELLS

24 HOURS

24 H

Video recorded for 42 days!

8. What factors are associated with our ability to go to sleep?

- Previous activities such as food and alcohol consumption
- Genetic components
- Environmental lights
- The time we go to sleep
Review questions - continued

9. What is the anatomy of neurons and the role of each structure in neuronal communication?

10. What are the stages of sleep and how to distinguish them? What are the characteristics of each stage? And how sleep deprivation can affect different stages?

11. What is neuron metabolite? How does it get cleaned out?

12. What is Dementia?

13. What happens when you fall asleep?

14. What affects our ability to go to sleep?

15. What are different types of memory?

16. What can we learn from patient H.M.?

17. What are some other degenerative disorders other than Alzheimer’s Disease?

18. How does the Superchiasmatic Nucleus contrast with the peripheral clocks?
9. What is the anatomy of neurons and the role of each structure in neuronal communication?
10. What are the stages of sleep and how to distinguish them? What are the characteristics of each stage? And how sleep deprivation can affect different stages?

**SLEEP STAGES**

- **Stage 1**: 5-15 minutes
  - Very light sleep
  - Sense of falling is common
  - NREM

- **Stage 2**: 5-15 minutes
  - Light Sleep
  - Body temperature drops
  - Heart rate slows
  - NREM

- **Stage 3 & 4**: 5-15 minutes each
  - Slow wave sleep (SWS)
  - Stage 4: Delta waves
  - Body repairs itself
  - NREM

- **REM**: 10 minutes, first cycle
  - (Up to 1 hour in subsequent cycles)
  - Dreaming occurs
  - Brain activity similar to waking level:
  - Rapid Eye Movement (REM)
  - Sleep cycle restarts after REM

Sleep deprivation will increase REM, decrease deep sleep!
10. What are the stages of sleep and how to distinguish them? What are the characteristics of each stage? And how sleep deprivation can affect different stages?

Sleep deprivation will increase REM, decrease deep sleep!
11. What is neuron metabolite? How does it get cleaned out?

- Metabolite is the intermediate and product of metabolism
- Beta amyloid is a natural byproduct of neurons being active
- The glympathic system clears neuron metabolites
12. What is Dementia?
13. What happens when you fall asleep?

<table>
<thead>
<tr>
<th>SWS</th>
<th>REM</th>
</tr>
</thead>
<tbody>
<tr>
<td>muscle relaxation</td>
<td>atonia (muscle paralysis; exceptions for respiratory muscles-yay! And eye muscles)</td>
</tr>
<tr>
<td>↓HR, BP, body temperature</td>
<td></td>
</tr>
</tbody>
</table>

Both duration of overall sleep and the duration of individual stages of sleep vary over the course of development.
14. What affects our ability to go to sleep?
15. What are different types of memory?

• Long-term & short-term memory v.s. working memory
• Declarative memory v.s. non-declarative memory (procedural memory)
• Emotional aspects of memory
16. What can we learn from patient H.M.?

Henry Gustav Molaison (February 26, 1926 – December 2, 2008)
### 17. What are some other degenerative disorders other than Alzheimer’s Disease?

<table>
<thead>
<tr>
<th>Sporadic or inherited?</th>
<th>AD</th>
<th>PD</th>
<th>Huntington’s</th>
<th>ALS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sporadic or inherited?</strong></td>
<td>Mostly sporadic, sleep disruption</td>
<td>Mostly sporadic, sleep disruption Can result from MPTP consumption</td>
<td>Genetically inherited, expanded triplet repeat in huntingtin gene</td>
<td>Mostly sporadic</td>
</tr>
<tr>
<td><strong>Symptoms include</strong></td>
<td>Forgetfulness, disorientation, unpredictable behavior, sleep disturbances, depression</td>
<td>Slow movement, muscular rigidity, walking and balance impairment, tremor, changes in non-motor function</td>
<td>Involuntary jerking movements of the limbs, torso and facial muscles, mood swings, depression, irritability, slurred speech, clumsiness</td>
<td>Progressive paralysis starting in hand and feet or in muscles of speech and swallowing</td>
</tr>
<tr>
<td><strong>Pathologies (cellular and molecular)</strong></td>
<td>Plaques (beta-amyloid), Tangles (tau protein)</td>
<td>Loss of dopaminergic cells in substantia nigra pars compacta</td>
<td>Damage to neurons in the basal ganglia and cortex</td>
<td>Damage of motor neurons; loss control of voluntary muscle movements due to high levels of Glu, oxidative stress, environment, autoimmune disease</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>Drugs to regulate ACh and Glu levels</td>
<td>Dopamine enhancing drugs (e.g. levodopa), deep brain stimulation, pallidotomy</td>
<td>Currently no treatment</td>
<td>Anti-glutamate drugs, drugs to ease symptoms</td>
</tr>
</tbody>
</table>
18. How does the Superchiasmatic Nucleus contrast with the peripheral clocks?
Review questions - continued

19. What is a “social jet lag”?
20. What is so important about blue light?
21. What are the effects of chronic sleep deprivation? (REM sleep behavior disorder, sleep apnea, etc.)
22. What is sleep inertia?
23. What is the cognitive and physical performance of someone who has not slept in a 24 hour period?
24. What is sleep hygiene?
   • Compare the effects of good and bad sleep hygiene.
   • What are the components of good sleep hygiene?
   • Can sleeping aids overcome the effects of poor sleep hygiene? Why? Why not?
19. What is a “social jet lag”?
20. What is so important about blue light?
21. What are the effects of chronic sleep deprivation? (REM sleep behavior disorder, sleep apnea, etc.)

**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
22. What is sleep inertia?
23. What is the cognitive and physical performance of someone who has not slept in a 24 hour period?
24. What is sleep hygiene?

Five things that stop a good night’s sleep

- Light: Confuses body clock
- Noise: Disturbs light sleep
- Busy mind: Can’t fall asleep
- Hot room: Confuses body clock
- Alcohol: Disrupts sleep
- Caffeine: Less deep sleep
- Heavy meal: Heartburn & discomfort

http://www.bbc.co.uk/science/0/20427553
Review questions - continued

25. How is sleep regulated? (Neurotransmitters, regions of the brain, homeostatic system, etc.)
26. ‘Plaques and tangles’ are a hallmark of which neurodegenerative disease?
27. How role might the glympathic system have in forestalling the onset of Alzheimer’s Disease (AD)?
28. What are the lifestyle changes that one could implement to lower the risk of AD?
29. What is Amyotrophic Lateral Sclerosis (ALS)?
30. What type of neurons are most affected by ALS?
31. What regions of the brain are most affected by Huntington’s Disease?
32. What behaviors would you expect to see in a patient with Huntington’s Disease? ALS? Alzheimer’s Disease? Parkinson’s Disease?
33. What happened to drug addicts who used MPTP?
25. How is sleep regulated? (Neurotransmitters, regions of the brain, homeostatic system, etc.)

- Supra/Superchiasmatic Nucleus
- Upper brainstem neurotransmitters:
  - Norepinephrine (REM-suppressive)
  - Serotonin (REM-suppressive)
  - Acetylcholine (activates various brain regions; REM-generating)
  - Glutamate (REM-generating)
- Hypothalamus
  - Orexin (excitatory to arousal system; loss causes narcolepsy)
- Ventrolateral Preoptic Area (VLPO)
  - SCN -> Subparaventricular Nuc -> dmHypohalamus -> VLPO + Hypothalamus
  - Galanin and GABA (damage leads to irreversible insomnia; REM-suppressive)
25. How is sleep regulated? (Neurotransmitters, regions of the brain, homeostatic system, etc.)

- Homeostatic Mechanisms:
  - While awake:
    - ATP -> Adenosine
    - Adenosine reduces neural activity
    - Initially found mostly in *basal forebrain* and then everywhere
  - During sleep:
    - ATP stores built back up

* This is one of the mechanisms by which coffee works
25. How is sleep regulated? (Neurotransmitters, regions of the brain, homeostatic system, etc.)
26. ‘Plaques and tangles’ are a hallmark of which neurodegenerative disease?

Alzheimer’s
- Beta amyloid
- Tau proteins
27. What role might the glymphatic system have in forestalling the onset of Alzheimer’s Disease (AD)?

- Clear out beta amyloid peptides,
- Beta amyloid appear to have a role in bringing about Alzheimer’s

https://www.youtube.com/watch?v=ci5NMscKJws
28. What are the lifestyle changes that one could implement to lower the risk of AD?

• Cognitive activity
• Heart healthy diets
• Better sleep
• Physical activity
29. What is Amyotrophic Lateral Sclerosis (ALS)?
30. What type of neurons are most affected by ALS?
31. What regions of the brain are most affected by Huntington’s Disease?

- Basal Ganglia
- Cortex
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- Basal Ganglia
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32. What behaviors would you expect to see in a patient with Huntington’s Disease? ALS? Alzheimer’s Disease? Parkinson’s Disease?

- Huntington’s Disease: Involuntary jerking movements of the limbs, torso, and face. Eventually, decision making, mood, and memory are affected.
- ALS: Difficulty walking, clumsiness with the hands, slurred speech, general motor pathologies.
- Alzheimer’s: Anterograde amnesia
- Parkinson’s Disease: Slowness of movement, muscular rigidity, and walking/balance impairment. Also, some decision making.
33. What happened to drug addicts who used MPTP?