Introduction to COGS 1

- **TA / IA Introduction**
  - Office Hours and E-mail on the board

- **Quizzes**
  - Graded quizzes at the end of every section, lowest quiz score 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
  - Quizzes will be at the end of section

- **Piazza**
  - 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.
Section A Objectives:

- Intro to Cogs
- Circadian Rhythms
- Degenerative Diseases
Intro to Cog Sci: Lecture 1

1. What is cognitive science? What are the main objectives of the field?
2. How are the disciplines related?
3. 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?
4. What does it mean to “read the mind”? What is BCI?
5. What was special about the robotic hand?
6. How does cognitive science differ from computer science, neuroscience, philosophy, and linguistics?
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

The Mind
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?

The Mind
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
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.

How does cognitive science differ from computer science, neuroscience, philosophy, psychology, and linguistics?
Circadian Rhythms
Sleep, Cognition, Alzheimer’s readings and lectures

1. What happens to your body when you fall asleep?
2. What is the role of melatonin and light in regulating circadian rhythms?
3. How does light help the body predict tomorrow?
4. What is so important about blue light?
5. How does the superchiasmatic nucleus (SCN) synchronize the body clocks?
6. What is a zeitgeber? What are some examples from the lectures and readings?
7. How are we similar to cyanobacteria?

(more questions on following slide)
8. How is the functionality of insulin affected by time of day?
9. Why does Klerman (in the reading) state: “When you go to bed affects how long you sleep, no matter how tired you are?”
10. What factors are associated with your ability to sleep?
11. What is sleep hygiene?
   a. Compare the effects of good and bad hygiene
   b. What are the components of good sleep hygiene?
   c. Can sleeping aides overcome the effects of poor sleep hygiene? Why or why not?
12. What are the effects of chronic sleep deprivation? (e.g., what happens when people have REM sleep behavior disorder, sleep apnea, etc)

(more questions on following slide)
Sleep, Cognition, Alzheimer’s readings and lectures

13. What are the short and long term effects of sleep deprivation?
14. How is cognition affected by lack of sleep? Why? Examples
16. How could lifestyle choices alter the onset of cognitive impairment?
17. What is the glymphatic system? How does that relate to the removal of toxins and solutes in the brain?
18. What is sleep inertia?
19. What is the cognitive and physical performance of someone who has not slept in a 24 hour period?

(more questions on following slide)
20. How is sleep regulated (Neurotransmitters, brain regions, homeostatic system, etc.)
21. ‘Plaques and tangles’ are the hallmark of what neurodegenerative disease?
22. What role might the glymphatic system have in forestalling the onset of Alzheimer’s disease (AD)?
23. What are lifestyle changes that one could implement to lower the risk of AD?
24. What is Amyotrophic Lateral Sclerosis (ALS)
   a. What type of neurons are most affected by ALS?
25. What regions of the brain are most affected by Huntington’s Disease?
26. What behaviors would you expect to see in patients with AD? ALS? Huntington’s? Parkinson’s?
27. What happened to drug addicts who used MPTP?
What happens to your body when you fall asleep?

Phases of healthy sleep:

**Sws**
- muscle relaxation
- ↓HR, BP, body temperature

**REM**
- 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.
What is the role of melatonin and light in regulating circadian rhythms?
How does light help the body predict tomorrow?
What’s so special about blue light?
How does the SCN synchronize the body clocks?
What is a zeitgeber?

Examples
Sleep, predictive power, & metabolism

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?
How is the functionality of insulin affected by the time of day?
Why does Klerman say “When you go to bed affects how long you sleep, no matter how tired you are?”
What factors are associated with our ability to go to sleep?
Lifestyle choices: Sleep hygiene

A good sleep hygiene includes:

- Not looking at an electronic screen (blue light) right before sleeping!
- Not consuming nicotine, caffeine and alcohol close to bedtime
- Exercise at **consistent** times
- Have **regular** mealtimes and not too much or too little food before sleeping
- Go to bed at a **consistent** time

The sleep after taking sleeping medication is less effective as regular sleep. Sleeping aids suppress Stage 4 sleep and thus “impair the restorative value of sleep” and increase the risk of parasomnia.
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
## Effects of sleep deprivation

<table>
<thead>
<tr>
<th>Short term sleep deprivation leads to:</th>
<th>Long term sleep deprivation leads to:</th>
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</thead>
<tbody>
<tr>
<td>● Cognitive and behavioral changes</td>
<td>● Cardiovascular stress (elevated heart rate and blood pressure)</td>
</tr>
<tr>
<td>● Decreased ability to concentrate</td>
<td>● Disruption of the glymphatic system and thus build up of toxins</td>
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<tr>
<td>● Decreased short-term memory</td>
<td>● Impaired executive functions</td>
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<tr>
<td>● Paranoia and hallucinations</td>
<td>● Impaired emotional responses</td>
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<td></td>
<td>● Impaired decision making</td>
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In children chronic sleep deprivation may lead to hyperactivity and impaired interpretation of social cues
How is cognition affected by lack of sleep? Why? Examples
The influence of sleep disruption on diabetes, AD, learning and tetris?

- metabolic disruption
- weight gain, obesity
- impaired immunity
- cognitive malfunction

How could lifestyle choices alter the onset of cognitive impairment?
What is the glymphatic system? How does that relate to the removal of toxins and solutes in the brain?
What is sleep inertia?
What is the cognitive and physical performance of someone who has not slept in a 24 hour period?
How is sleep regulated (neurotransmitters, brain regions, homeostatic system, etc.)
‘Plaques and tangles’ are the hallmark of what neurodegenerative disease?
What role might the glymphatic system have in forestalling the onset of Alzheimer’s disease? (AD)
What are lifestyle changes that one could implement to lower the risk of AD?
What is Amyotrophic Lateral Sclerosis (ALS)?

What type of neuron is most affected by ALS?
What regions of the brain are most affected by Huntington’s Disease?
What behaviors would you expect to see in patients with AD? ALS? Huntington’s? Parkinson’s?
What happened to drug addicts who used MPTP?
Internal Regulators of Sleep & Wakefulness (cont…)

- **Orexin** (hypothalamus)
- **Melatonin** (SCN - bundle of cells located in hypothalamus)
- **Adenosine** (Basal forebrain and cortex, ↑ awake time ↑production)
What is the glymphatic system? How does it relate to removal of toxins from the brain?

Restorative mechanism activated during sleep whereby neurons shrink to 40% of their usual volume. This forces extracellular fluid to rush into cells and “powerwash” accumulated debris (such as toxic protein aggregates) away.

What is sleep inertia?

Impaired alertness and feeling of grogginess immediately after sleep

What is the cognitive and physical performance of someone who has not slept in a 24 hour period?

Like the performance of someone with 0.1 BAC
Neurodegenerative Diseases

How are they related to sleep?
How do these diseases provide insights into cognitive processes?
<table>
<thead>
<tr>
<th></th>
<th>AD</th>
<th>PD</th>
<th>Huntington’s</th>
<th>ALS</th>
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</thead>
<tbody>
<tr>
<td><strong>Sporadic or inherited?</strong></td>
<td>Mostly sporadic, sleep disruption? Can result from MPTP consumption</td>
<td>Mostly sporadic, sleep disruption?</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>
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<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>
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Sleep and neurodegenerative diseases

What role might the glymphatic system have in forestalling the onset of AD?

It removes toxins like accumulated beta-amyloid or tau protein during sleep.

What lifestyle changes could one implement to lower the risk of AD?

Good sleep hygiene, healthy nutrition, exercise.

What happened to drug addicts who used MPTP?

Their neurons degenerated similar to the pathology in PD.