COGS 107B
Monday 2pm Sections

Tom Donoghue
FINAL EXAM - THURSDAY MARCH 10th

Plan

- TA Evaluations
- Review Motor & Pre-Frontal Cortex
- Exam Questions

Office Hours (CSB 226):
Tuesday & Wednesday afternoon
- by appointment
TA Evaluations:
bit.ly/RateTA
Motor System – Circuitry

4 inputs for motor control:
corticospinal, vestibulospinal, reticulospinal, rubrospinal

- M1 motor neurons (corticospinal): converge & diverge
- Alpha motor neurons: one-to-one to flow or fast twitch muscles.
- Spinal cord interneurons: mixed inputs, interconnected, + or –, project other areas of spinal cord
Motor Control - Vocab

- Motor Control: coordinating muscle synergies
- Slow & Fast twitch fibres
- Population firing rate vectors
- Convergence / Divergent connections
- Homunculus: synergy coding vs. direction coding
Population Coding
PFC - Overview

PFC - involved in more complex or abstract encoding of information:

- Planning, ordering actions
- Mapping perceived to actual motions (mirroring)
- Abstract representations (ex - count)
- Working Memory (also - time intervals)
- Categorization
- Top-down attention
the pattern of efferent projections from prefrontal cortex suggests three different pathways by which prefrontal cortex can enact ‘top-down’ influences on other regions of cerebral cortex (e.g., in some forms of attention)

1. direct projections
2. projections to neuromodulatory systems
3. projections to thalamus
PFC - Abstract Response Fields
EXAM QUESTIONS
True / False

Recall of a memory renders it 'labile' or vulnerable to erasure.
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True
re-remembering: memories in the amygdala are ‘labile’ – their recall makes them vulnerable to erasure or consolidation

curing PTSD by taking advantage of the ‘labile’ nature of some memories:
Synaptic efficacy changes can occur through a number of mechanisms. Name two that pertain to the physical structure of axons and/or dendrites.
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**Spine Maturation & Adding / Removing Spines**
visualization of potentiating, depressing, and unchanged synapses following stimulation of hippocampal CA3 inputs into CA1 region of hippocampus

dendritic spines of cortical neurons in fragile-X mice (mental retardation) are longer / immature

unchanged

depression

potentiation

Dolan et al., Neuron, 2007

Becker et al., Neuron, 2008

mature synaptic spine

immature synaptic spine
In what state might decreases in synaptic efficacy occur irrespective of the ordering of firing of the presynaptic and postsynaptic neuron.

A. Texas
B. waking
C. NREM sleep
D. REM sleep
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co-activity rules for synaptic efficacy change depend on neuromodulatory systems

no ACh, no NE (as in NREM sleep)  ACh + NE (as in waking)

synaptic change

spike-timing (post minus pre)

NE, no ACh (??)  ACh, no NE (e.g., REM sleep)

synaptic change

spike-timing (post minus pre)
True / False

Increased ACh release in the hippocampus favors expression of a procedural memory.
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False
implicit/procedural learning III: basal ganglia versus hippocampus – an ACh-based competition

if the rat is asked this question early in training (within the first couple of days), one tends to see a ‘place’ strategy and ACh is high in the hippocampus.

if the rat is asked this question late in training, one tends to see a ‘response’ strategy and ACh is high in the basal ganglia.
The spatial and episodic memory functions of the hippocampus are made compatible because of these two forms of spatial position coding.
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Prospective & Retrospective
episodic memory (memory for events and their ordering - a form of explicit memory):

- hippocampal cell activity in a ‘place’ often depends on the places previously or subsequently visited (this is termed retrospective and prospective place coding)

- some hippocampal neurons fire in a certain place, but only if they reached that place from the N as opposed to the S side – their activity depends on the character of the full episode and is termed ‘retrospective’

- other hippocampal neurons are ‘prospective’ – they fire in a certain place depending on where the animal will go from that place – they too have activity dependent on the full episode
Delay-firing neurons of the prefrontal cortex are of more than one type. Two of the following words/phrases are used to describe them.

A. position-dependent  
B. cue/stimulus  
C. associative  
D. action
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Learning & Memory II - Slide 8

The diagram illustrates neural activity during different stages:

- **Cue + delay**
  - Parietal neurons
  - Delay period: Activity shown with n = 16
- **Delay + action**
  - Parietal neurons
  - Delay period: Activity shown with n = 3
- **Saccade**
  - Activity shown
- **Cue period**
  - Prefrontal neurons
  - Cue period: Activity shown with n = 9
True / False

Individual motor neurons of the ventral spinal cord synapse upon both slow-twitch and fast-twitch muscle fibers.
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False
motor neurons and muscle fibers: one motor neuron → one muscle, but to many fibers (but all of the same type)

- slow-twitch: 50 ms to peak force, relatively small force, non-fatiguing (aerobic), useful for tonic movements as in maintaining posture, innervated by type S motor neurons

- fast-twitch: 25 ms to peak force, large force, fatigue easily (glycolysis), useful for quick powerful movements. (jerk), innervated by type F motor neurons capable of high firing rates
Name the term used to describe activation patterns across the musculature that allow coordinated action and which are encoded through the activity of motor cortex neurons.
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Synergies
common, repeatedly utilized behaviors such as walking, chewing, withdrawal (e.g., a finger from a hot stove) imply the workings of central pattern generators - these are, in turn, formed of muscle ‘synergies’ that evolve over time
Premotor neurons are involved in which of the following features of motor control.

A. execution of an action  
B. planning an upcoming action  
C. perception of an action  
D. mapping of actions according to position in a sequence
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premotor cortex – a more indirect role in motor control

1. activity, as in primary motor cortex, may directly reflect present action
2. activity accompanies actions as well as planning for actions
3. action-related activity may depend on ordering of actions in a sequence
4. activity may reflect perceived actions as opposed to actual movements (as in ‘mirroring’)
True / False

Top-down attention is mediated by the parietal cortex.
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True
working memory: holding items in memory \((7+/-2)\) is achieved through interaction of the prefrontal and parietal cortex.
Name two of the four features of behavioral tasks that prefrontal neurons were shown to map through their activity patterns.

_______   _______
Name two of the four features of behavioral tasks that prefrontal neurons were shown to map through their activity patterns.

**Beginning & End of Sequences;**

**Time Intervals;**

**Count;**

**Action Sequence Categories;**
firing properties related to more abstract features of a motor task III: dorsolateral prefrontal cortex neurons ‘count’

firing properties related to more abstract features of a motor task IV: dorsolateral prefrontal cortex neurons map action sequence categories

firing properties related to more abstract features of a motor task I: dorsolateral prefrontal cortex neurons mark the beginning and ending of a behavioral episode

firing properties related to more abstract features of a motor task II: dorsolateral prefrontal cortex neurons track time intervals
The work of Ghose and Maunsell shows that attention is a temporally dynamic process. In their experiment, neurons in V4, for instance, show attentional modulation according to

A. activity of neuromodulatory neurons
B. action category
C. a hazard function
D. a withdrawal function
The work of Ghose and Maunsell shows that attention is a temporally dynamic process. In their experiment, neurons in V4, for instance, show attentional modulation according to

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the ‘attention index’ changes in accord with the probability that the stimulus will change orientation – that is, attention has a temporal component

Note: As discussed in class, this conditional probability that the attention index tracks is also known as a ‘hazard function’