260-2017-01-20-neuranatomy

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Prelude

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Today's topics

- Logistics for Monday and Wednesday
- Wrap up on functional methods
- Neuroanatomy
  - Through song and dance

Next week's logistics

Mon, January 23

- A-L: Tour of Social, Life, & Engineering Sciences Imaging Center (SLEIC). Meet in lobby of Chandlee.
- M-Z: Neuroanatomy Lab

Wed, January 25

- A-L: Neuroanatomy Lab
- M-Z: Tour of Social, Life, & Engineering Sciences Imaging Center (SLEIC). Meet in lobby of Chandlee.

Wrap-up on functional methods

Which of the following methods has *temporal* resolution on the order of seconds?

- A. functional MRI
- B. EEG
- C. MEG
- D. single-unit recording

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Which of the following methods has high/fine *spatial* resolution?

- A. functional MRI
- B. PET
- C. EEG
- D. Optogenetic stimulation

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Evaluating stimulation methods

- Spatial/temporal resolution?
  - Assume stimulation mimics natural activity?
  - Optogenetic stimulation highly similar, others less so
- Deep brain stimulation as therapy
  - Parkinson's Disease
  - Depression
  - Epilepsy

Deep brain stimulation

Simulating the brain

- Computer/mathematical models of brain function
- Example: neural networks
- Cheap, noninvasive, can be stimulated or "lesioned"

Spatial and Temporal Resolution

[(Sejnowski, Churchland, and Movshon 2014)](http://doi.org/10.1038/nn.3839)

Neuroanatomy

Brain anatomy through dance

Finding our way around

Anterior/Posterior

Medial/Lateral

Superior/Inferior

Dorsal/Ventral

Rostral/Caudal

Directional image

https://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/Blausen_0019_AnatomicalDirectionalReferences.png/800px-Blausen_0019_AnatomicalDirectionalReferences.png

Bipeds vs. quadripeds

https://upload.wikimedia.org/wikipedia/commons/thumb/0/00/1303_Human_Neuroaxis.jpg/800px-1303_Human_Neuroaxis.jpg

No matter how you slice it

Horizontal/Axial

Coronal/Transverse/Frontal

Sagittal (from the side)

Slice diagram

http://www.scienceteacherprogram.org/biology/chillemistudentguide1-06/brain_directions_planes_sections___directions_-_small.gif

Supporting structures

Meninges

Ventricular system

Blood supply

Meninges

Dura mater

Arachnoid membrane

Subarachnoid space

Pia mater

Meninges

https://upload.wikimedia.org/wikipedia/commons/thumb/8/8e/Meninges-en.svg/1280px-Meninges-en.svg.png

Ventricular system

https://upload.wikimedia.org/wikipedia/commons/d/d4/Blausen_0896_Ventricles_Brain.png

Ventricles

Lateral (1st & 2nd)

3rd

Cerebral aqueduct

4th

Cerebrospinal fluid (CSF)

- Clears metabolites during sleep (Xie et al. 2013).

Blood Supply

http://surgery.med.miami.edu/images/Circulation_of_brain.gif

Blood Supply

Arteries

- Circle of Willis

Blood/brain barrier

- Cells forming blood vessel walls tightly packed
- Active transport of molecules typically required

Blood/brain barrier

http://www.nature.com/nrn/journal/v7/n1/images/nrn1824-f3.jpg

Area Postrema

- Brainstem, blood-brain barrier thin

Area Postrema

http://www.nature.com/nrendo/journal/v9/n10/images/nrendo.2013.136-f2.jpg

Organization of the Nervous System

Central Nervous System (CNS)

- Brain
- Spinal Cord
- Everything encased in bone

Peripheral Nervous System (PNS)

Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Forebrain	Lateral	Telencephalon	Cerebral cortex Basal ganglia Hippocampus, amygdala
	Third	Diencephalon	Thalamus Hypothalamus
Midbrain	Cerebral Aqueduct	Mesencephalon	Tectum, tegmentum

Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Hindbrain	4th	Metencephalon	Cerebellum, pons
	–	Mylencephalon	Medulla oblongata

Hindbrain

Structures adjacent to 4th ventricle

- Medulla oblongata
- Cerebellum
- Pons

Medulla oblongata

https://upload.wikimedia.org/wikipedia/commons/6/69/1311_Brain_Stem.jpg

Medulla

- Cardiovascular regulation
- Muscle tone
- Fibers of passage
- Cranial nerves VI-XII

Cerebellum

- "Little brain"
- Dorsal to pons
- Movement coordination, simple learning

Pons

- Bulge on brain stem
- Neuromodulatory nuclei
- Relay to cerebellum
- Cranial nerve V

Midbrain

http://antranik.org/wp-content/uploads/2011/11/the-brain-stem-mid-brain-left-lateral-view-superior-colliculus-inferior-cer
jpg

Midbrain components

Tectum

Tegmentum

Tectum

https://upload.wikimedia.org/wikipedia/commons/0/0b/Gray719.png

Tectum

- Tectum -> “roof”
- Superior and inferior colliculus
- Reflexive orienting of eyes, head, ears

Tegmentum

- Tegmentum -> “floor”
- Species-typical movement sequences
- Cranial nerves III, IV
- Neuromodulatory nuclei
  - Dopamine (DA)
  - Norepinephrine (NE)
  - Serotonin (5-HT)

Forebrain

http://classconnection.s3.amazonaws.com/252/flashcards/1048252/png/forebrain1328987872235.png

Forebrain Components

Diencephalon

Telencephalon

Diencephalon

https://upload.wikimedia.org/wikipedia/commons/a/a0/1310_Diencephalon.jpg

Diencephalon Components

- Thalamus
- Hypothalamus

Thalamus

http://neurobiologychapter3.weebly.com/uploads/1/4/1/8/1418733/5118342.jpg?401x231

Thalamus functions

- Input to cortex
- Functionally distinct nuclei (collection of neurons)
- Lateral geniculate nucleus (LGN), vision
- Medial geniculate nucleus (MGN), audition

Hypothalamus

- Four Fs: fighting, fleeing, feeding, and reproduction
- Controls pituitary gland ("master" gland)
  - Anterior (indirect release of hormones)
  - Posterior (direct release of hormones)
    * Oxytocin
    * Vasopressin

Hypothalamus

http://higheredbcs.wiley.com/legacy/college/tortora/0470565101/hearthis_ill/pap13e_ch14_illustr_audio_mp3_am/simulations/figures/hypothalamus.jpg

Next time...

- SLEIC or neuroanatomy lab

References

Sejnowski, Terrence J, Patricia S Churchland, and J Anthony Movshon. 2014. "Putting Big Data to Good Use in Neuroscience." *Nature Neuroscience* 17 (11). Nature Publishing Group: 1440–1. doi:10.1038/nn.3839.

Xie, Lulu, Hongyi Kang, Qiwu Xu, Michael J Chen, Yonghong Liao, Meenakshisundaram Thiyagarajan, John O'Donnell, et al. 2013. "Sleep Drives Metabolite Clearance from the Adult Brain." *Science* 342 (6156). American Association for the Advancement of Science: 373–77. doi:10.1126/science.1241224.