Language and Lateralization

Both hemispheres are capable of carrying out the same essential functions

Some functions are slightly lateralized

- Functions with a “preference” for a hemisphere
- Hemispheres with a “preference” for a type of task/stimuli
- Example: Right hemisphere seems slightly better at making judgements about the duration of visual stimuli compared to the left hemisphere

A few functions are heavily lateralized

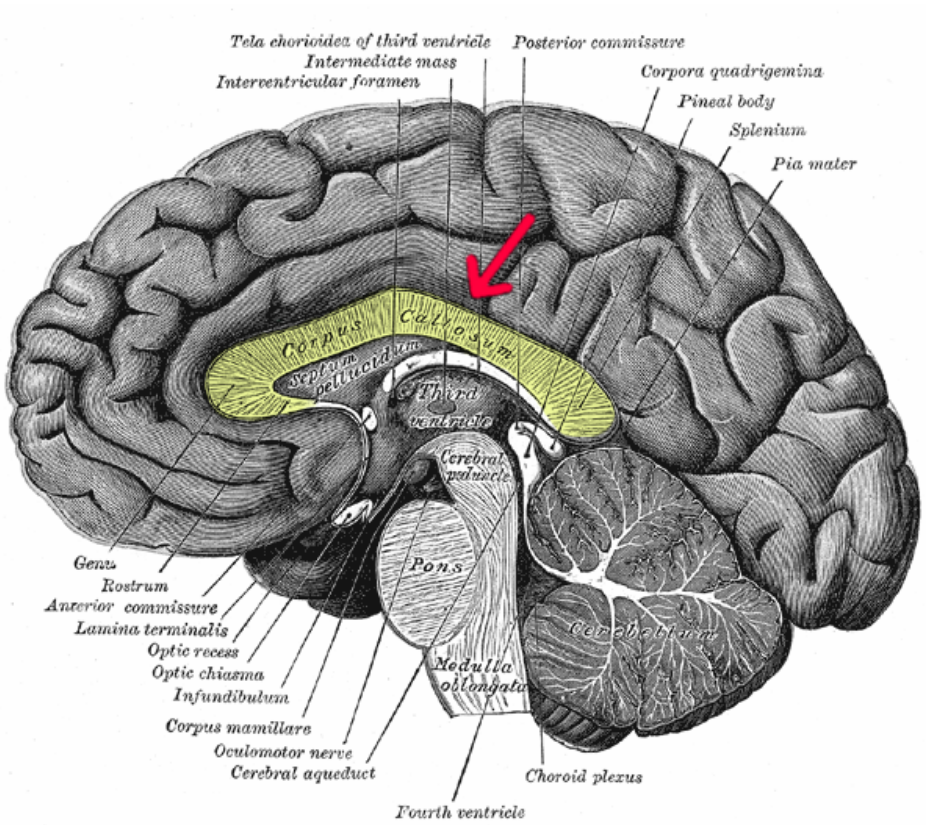
- Language is dominated by left hemisphere structures

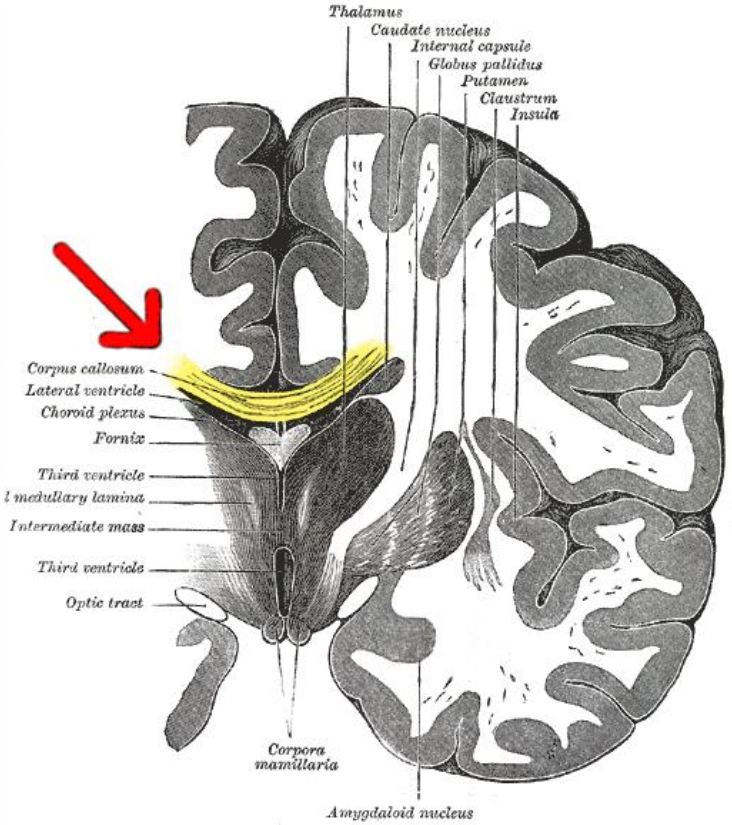
Bilateral symmetry

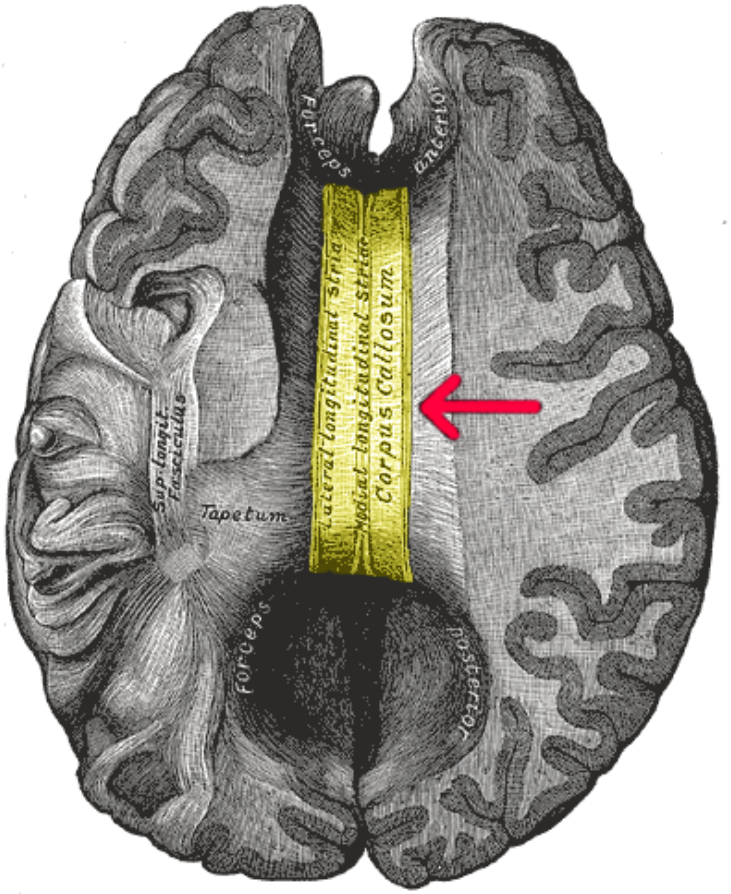
- Externally humans are
- Internally, not so much
- Brain – looks bilaterally symmetrical more or less

Connections between hemispheres of the brain

- Commissures
  - Largest: corpus callosum



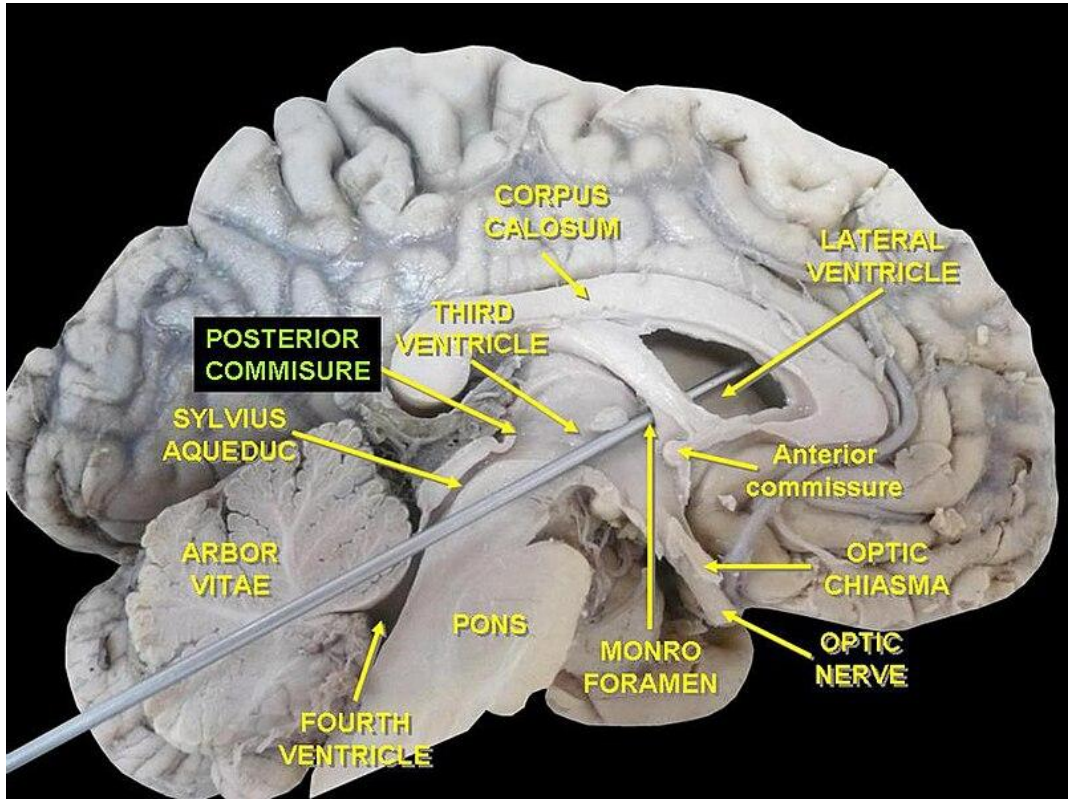




Public domain (Gray's Anatomy)

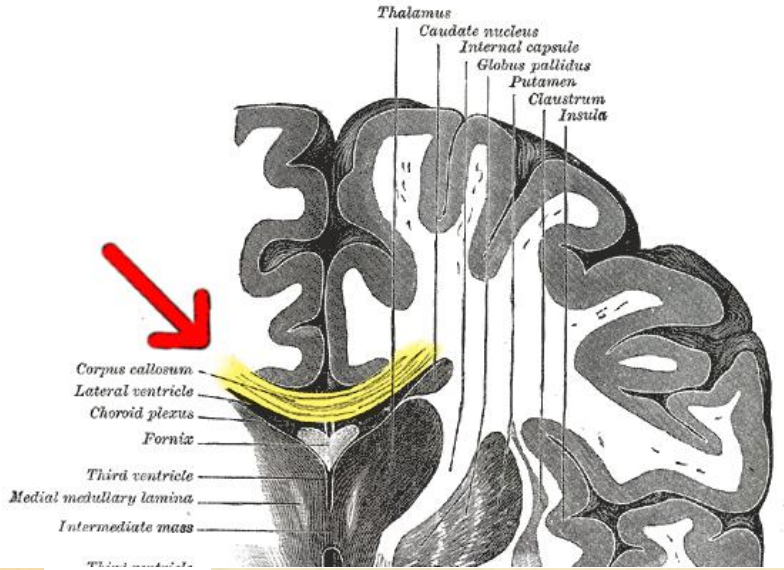
Other commissures

- Anterior commissure
- Posterior commissure
- Aside: AC-PC plane



Other commissures

- Hippocampal commissure (commissure of fornix)



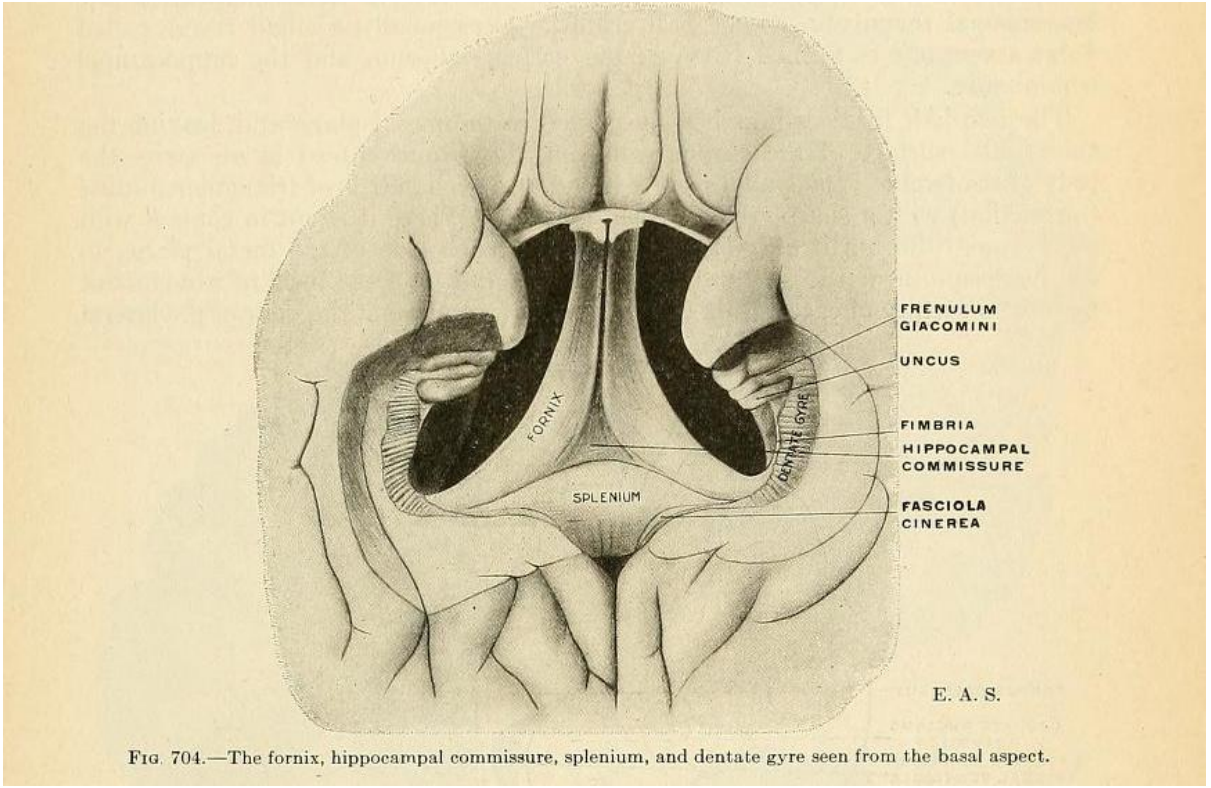


Fig. 704.—The fornix, hippocampal commissure, splenium, and dentate gyre seen from the basal aspect.

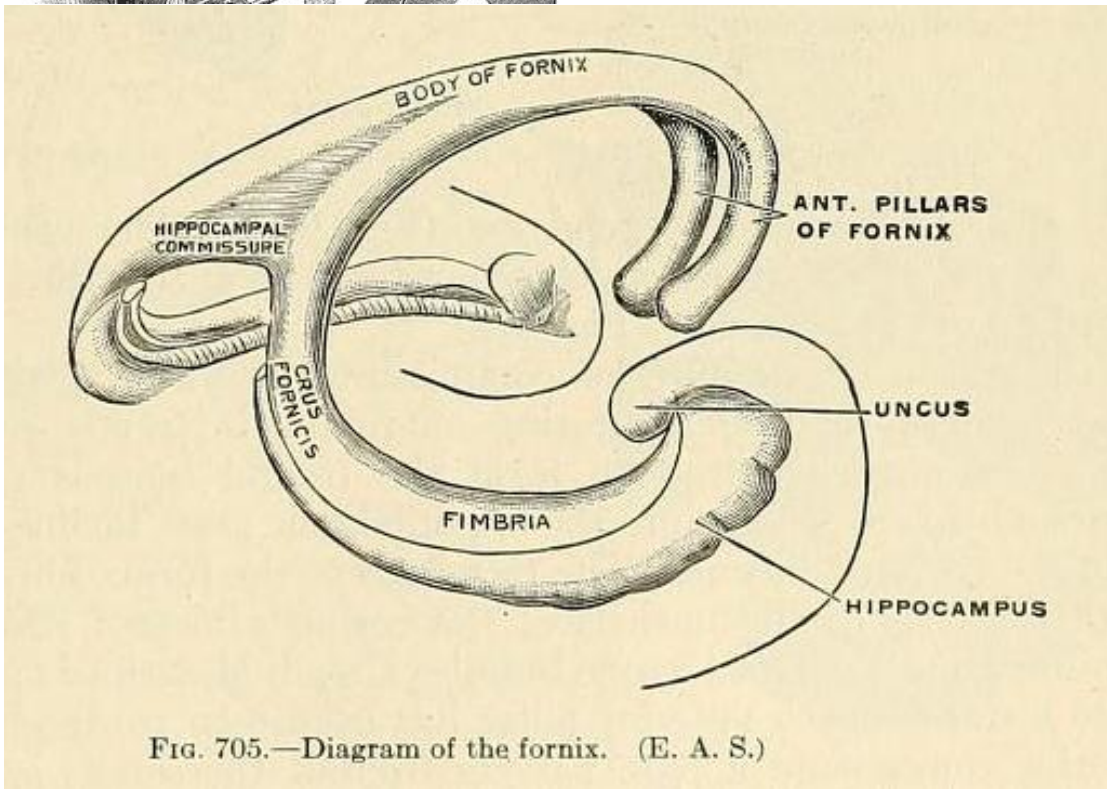
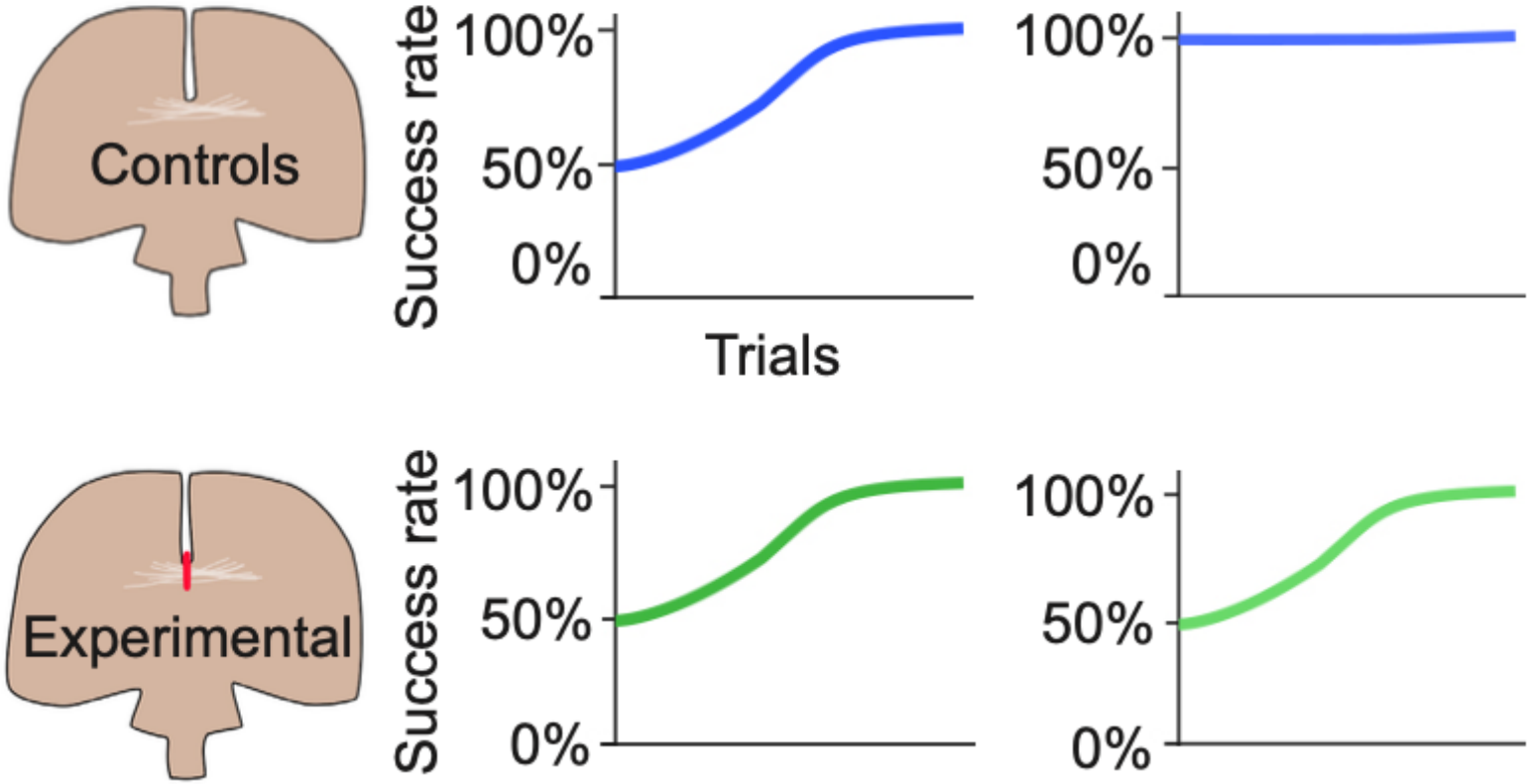


Fig. 705.—Diagram of the fornix. (E. A. S.)

Public domain (Gray's Anatomy)

Myers and Sperry

- Experimental: corpus callosum and optic chiasm severed



Recall: organization of the visual system (Chap 7)

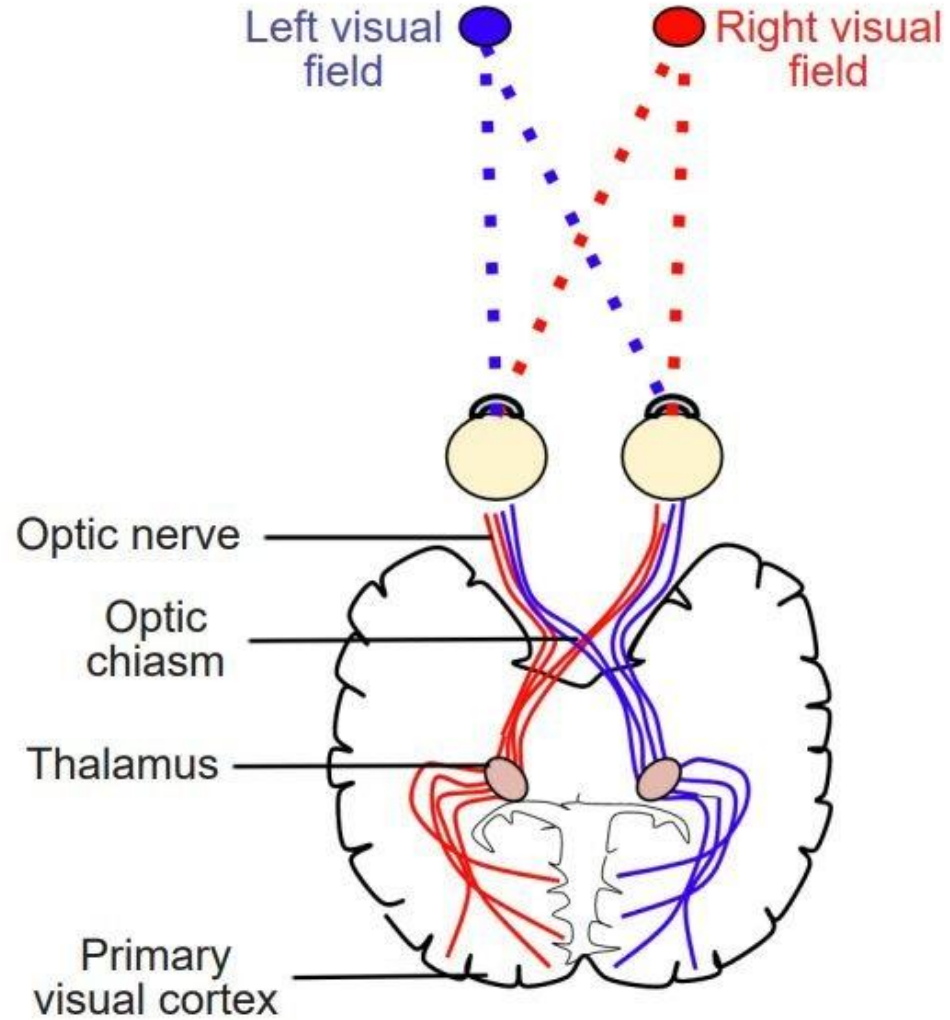
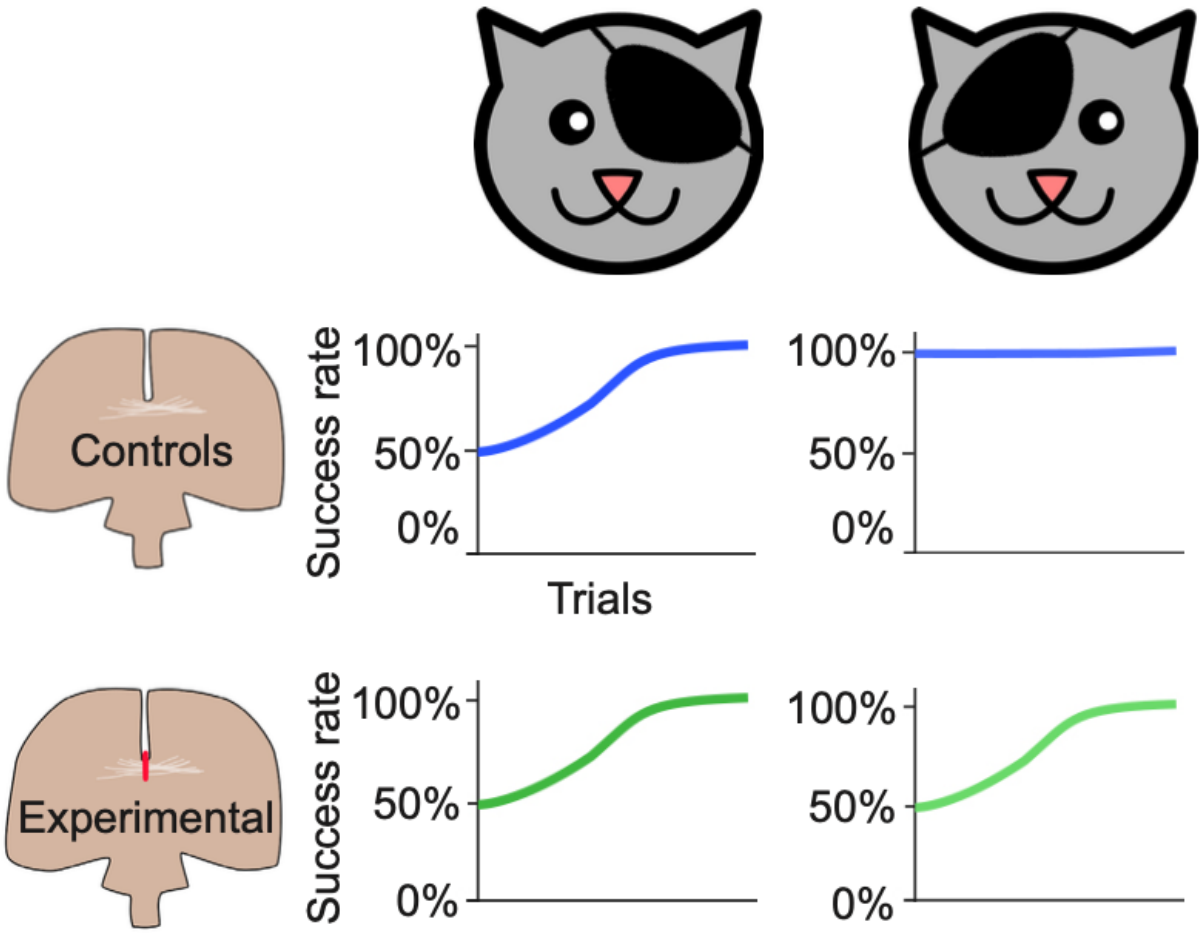


Figure 7.17 Visual information from the left visual field (blue) is carried into the right hemisphere of the brain, and visual information from the right visual field (red) is carried into the left hemisphere.

How might the cat "defeat" the eyepatch?



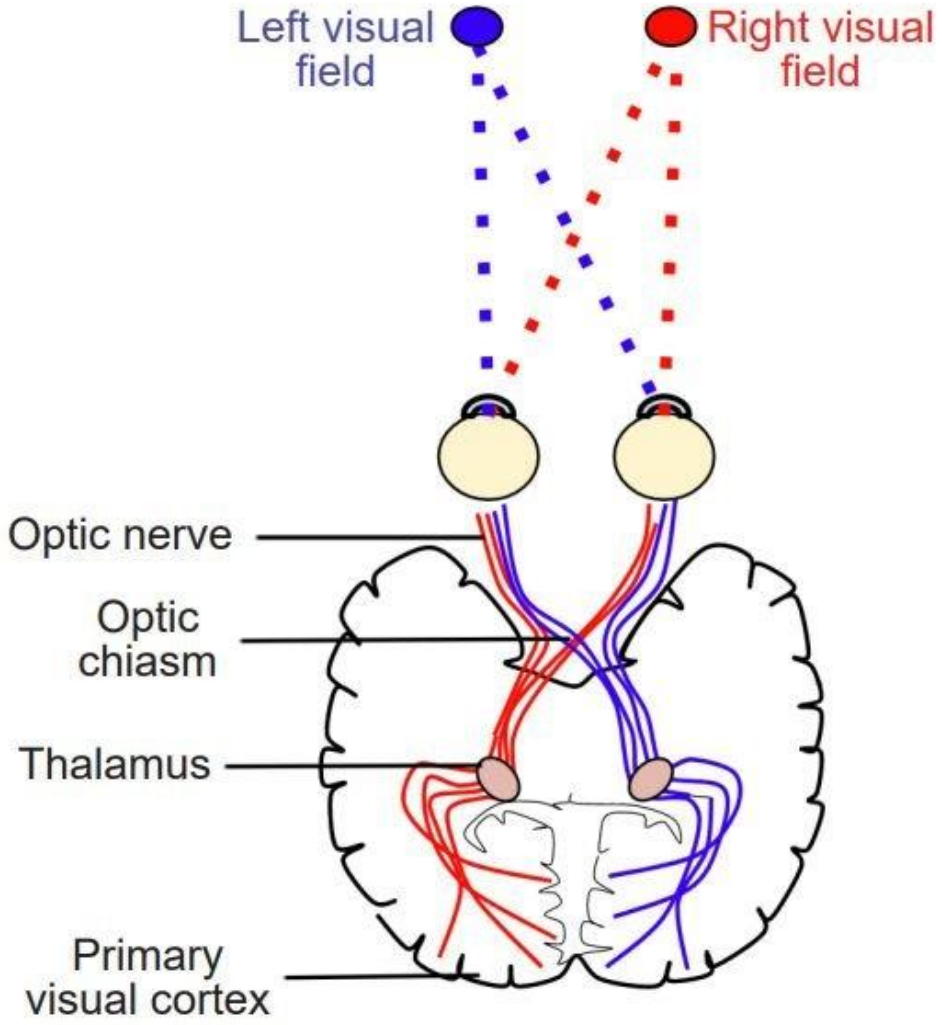
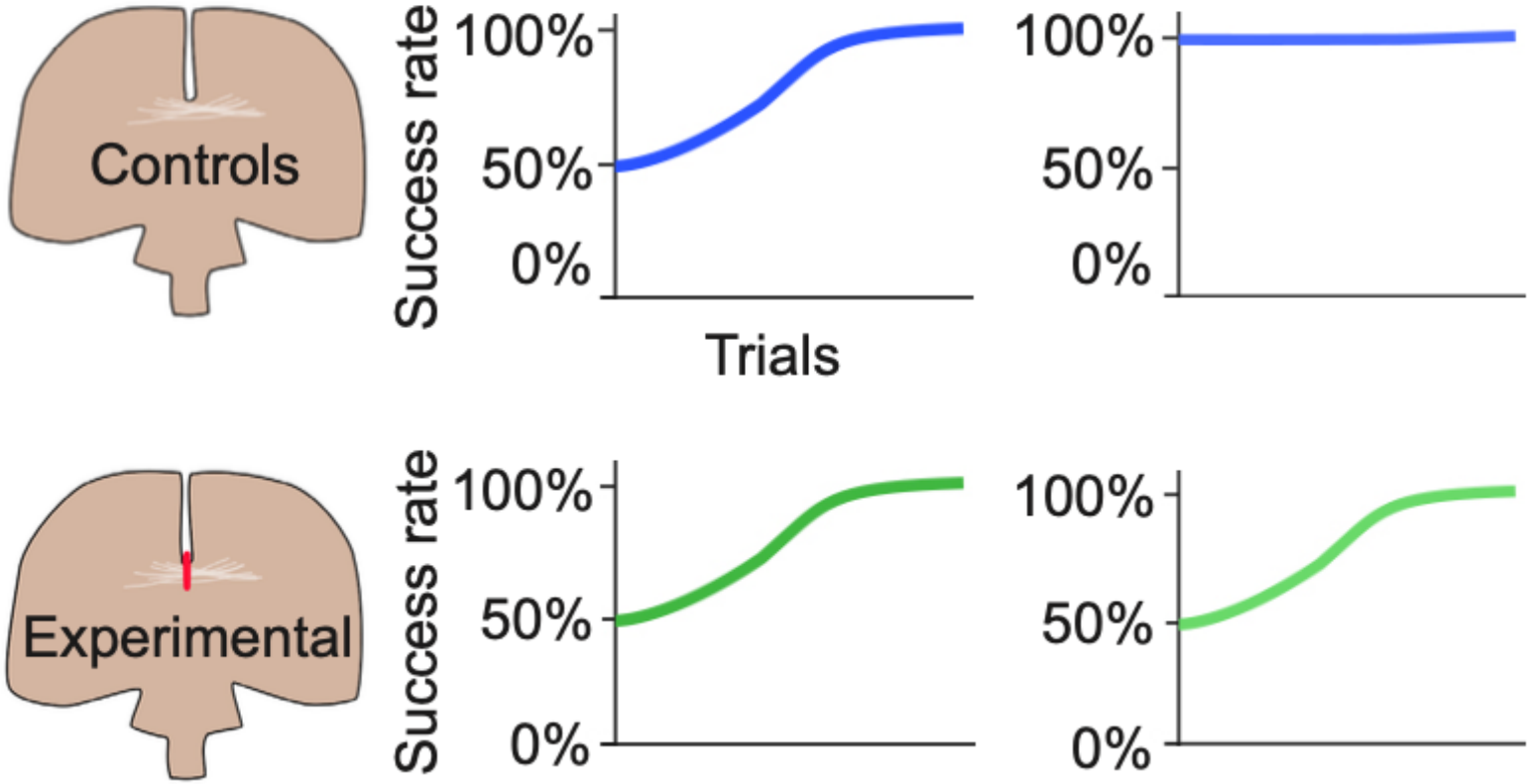


Figure 7.17 Visual information from the left visual field (blue) is carried into the right hemisphere of the brain, and visual information from the right visual field (red) is carried into the left hemisphere.

Other groups: What happened?

- Corpus callosum only severed
- Optic chiasm only severed



Patients with split-brain

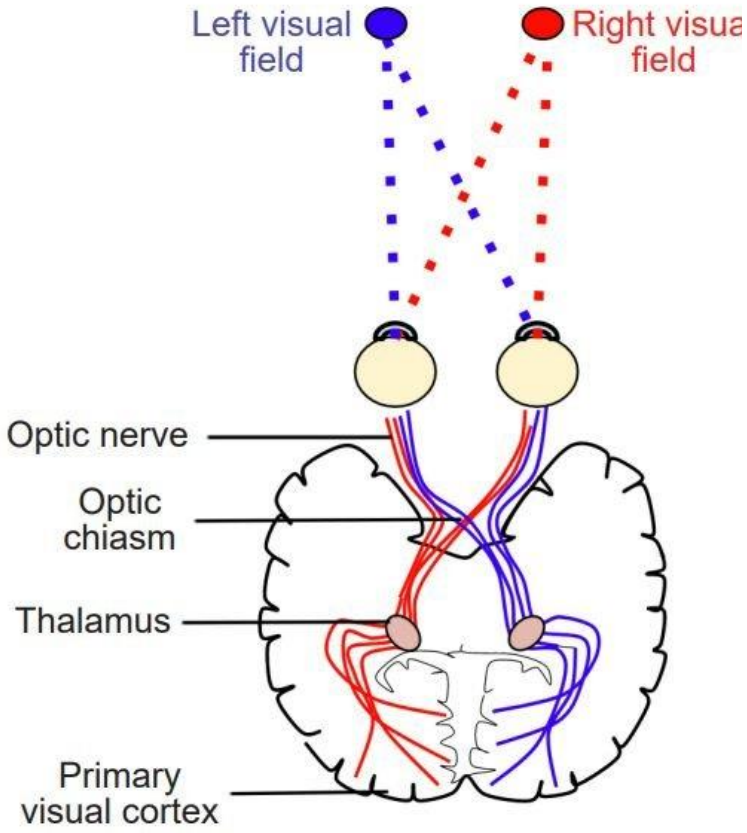
- https://www.youtube.com/watch?v=VMi7FoFdjZQ
- Younger patients with drug-resistant epilepsy are sometimes candidates for corpus callosum resection
- Severing the corpus callosum prevents the seizure electrical activity from reaching the 2nd hemisphere
  - Reduces number and severity of seizures experienced by the patient
  - No significant changes in intelligence, personality
  - Some deficits in memory, concentration

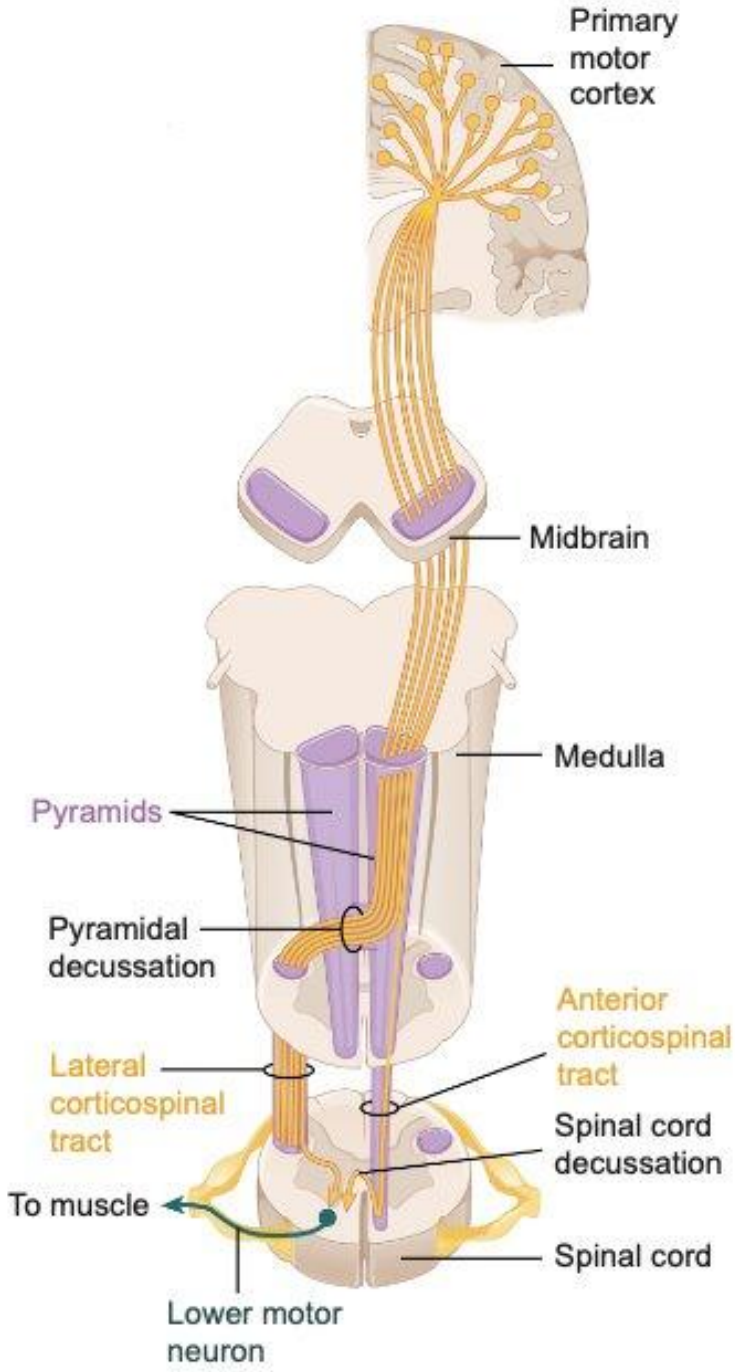
Alien hand syndrome

Testing the impact of split brain in the lab

- Recall: visual and motor system organization
- Also: Language is left-lateralized

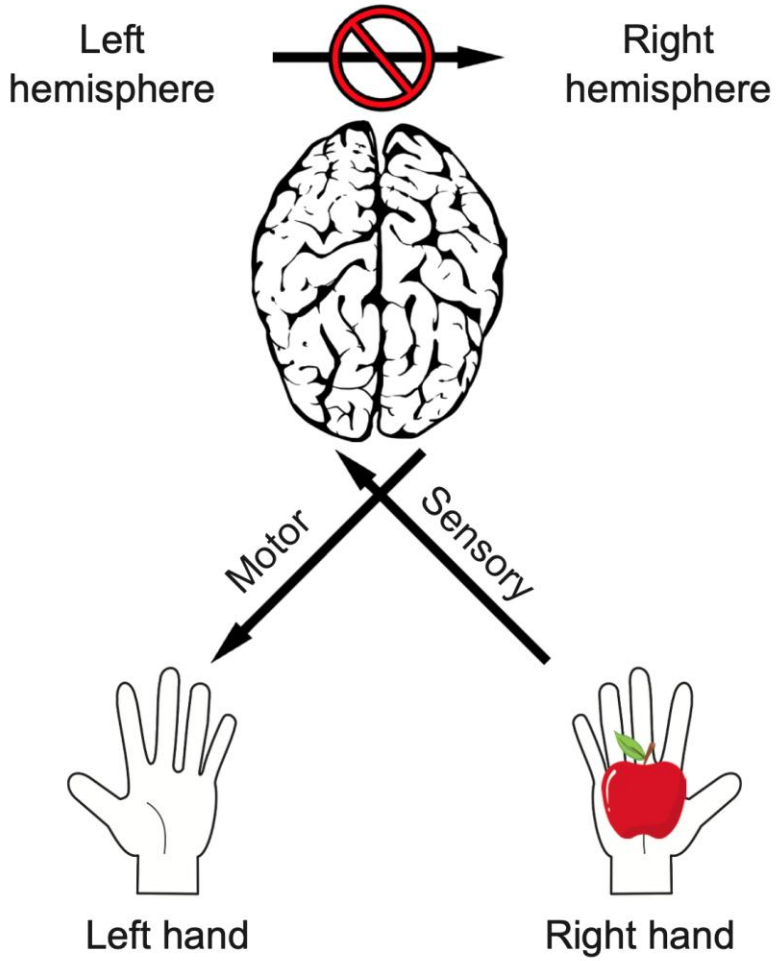
- Figures 7.17 and 10.23

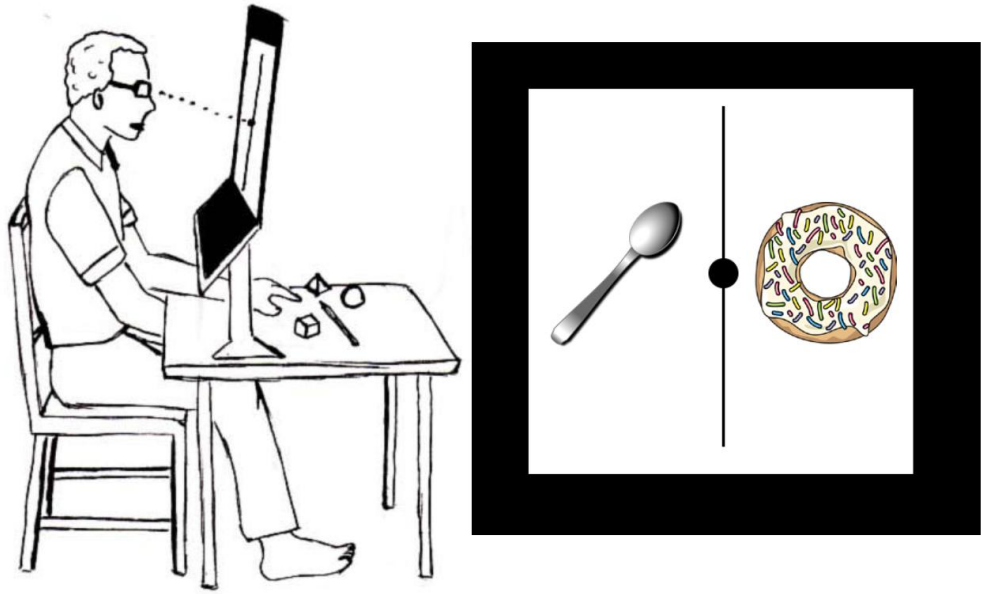




Testing the impact of split brain in the lab

- Figures 14.3 and 14.4

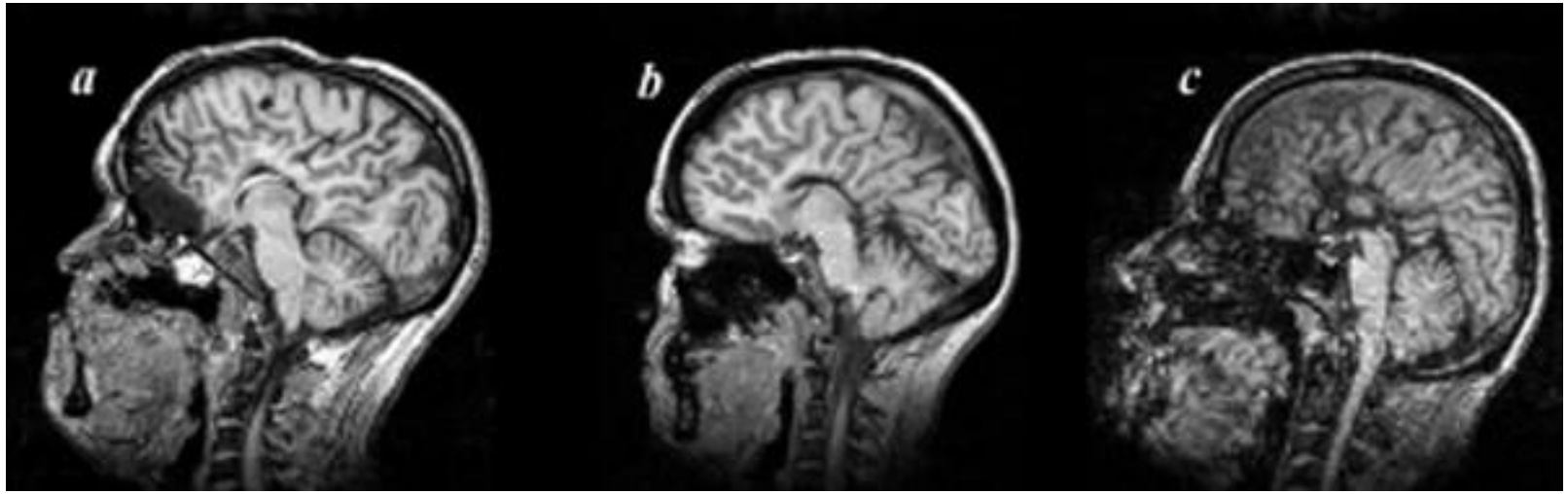




Testing the impact of split brain in the lab

- What procedures could help keep the information in the hemisphere to which it was presented?

Agenesis of the corpus callosum



MRI images of patients in the sagittal plane. MRI image showing complete agenesis of the corpus callosum and the preserved anterior commissure of (A) patient M.G. and (B) patient S.G., as well as complete agenesis of both the corpus callosum and the anterior commissure of (C) patient S.Pe. (Fecteau et al. BMC Neurology 2006 6:21 doi:10.1186/1471-2377-6-21; CC-BY 2.0)

https://commons.wikimedia.org/wiki/File:Agenesis.jpg

MRI images of patients in the sagittal plane with a corpus callosum (own work)

Plus my own image

Components of spoken language

- Phoneme
  - Individual sound that has no meaning on its own
  - “/ă/” (short a sound like in map)
- Morpheme
  - Combination of phonemes
  - Conveys an idea
  - “map” or “ing”
- Syntax
  - Rules about how meaning is derived from order of words
  - “They only study at night” versus “Only they study at night”
- Semantics
  - Understanding of meaning, including context and non-literal meanings

Not all languages are spoken!

- https://www.youtube.com/watch?v=wa0nxppMJ-Q
- https://www.youtube.com/watch?v=85eWiWft0gs

- MORE: https://www.npr.org/2017/01/21/508353362/gallaudet-president-navigates-from-world-of-hearing-to-sound-leadership-of-the-d

- https://www.ling.upenn.edu/~beatrice/247/notes-phonemes.html#:~:text=In%20the%20same%20way%2C%20we,%2C%20as%20in%20(4).&text=For%20expository%20convenience%2C%20we'll,call%20it%20a%20sign%20morpheme.

Studying language

- EEG/ERPs
- https://www.mcgill.ca/neurocoglab/files/neurocoglab/2008_steinhauer_connolly_stemmer_chap_9.pdf
- Phonological and semantic processing
- Phonological mismatch negativity (PMN) and N400

(1a) Father carved the turkey with a knife (expected word: knife)
(1b) The pigs wallowed in the pen (mud)
(1c) The gambler had a streak of bad luggage (luck)
(1d) The winter was harsh this allowance (year)

Studying language

- Lesion studies
  - Stroke
  - Wada test
- fMRI

Lesion studies: Stroke

- MCA is the most commonly impacted artery in acute stroke

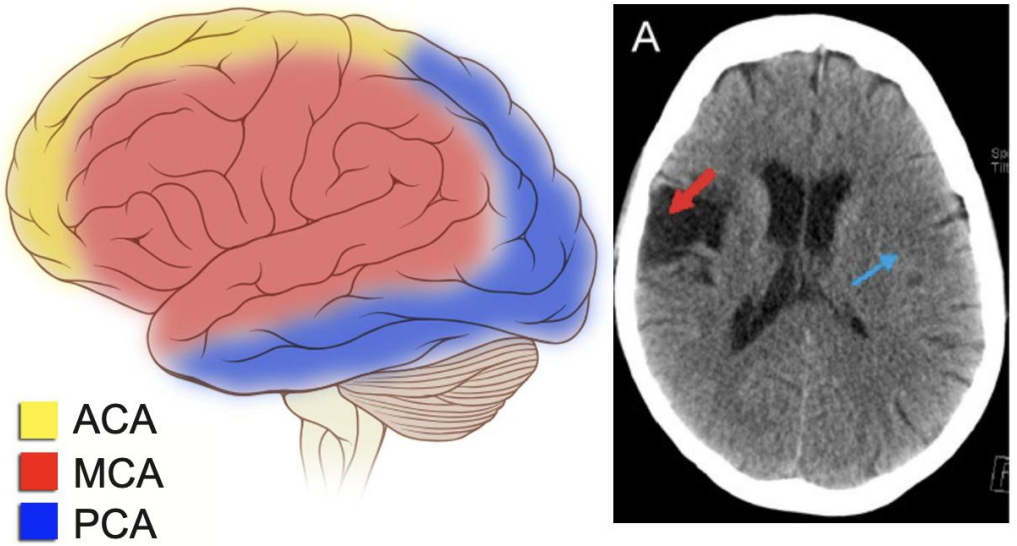


Figure 14.5 Areas of the cortex that receive blood flow from specific arteries (left). The middle cerebral artery (MCA) provides perfusion to frontal, parietal, and temporal areas that are important for language. CT scan of a patient after a stroke of the MCA, showing loss of brain tissue (red arrow, right).

Lesion studies: Wada test

- https://www.youtube.com/watch?v=SBKc_ncPzOo
- Sodium amytal: a GABA receptor positive allosteric modulator that acts as an anesthetic
- Question: Does sodium amytal increase or decrease GABA function? How do you know?
- Shortage

fMRI

- Presurgical mapping is the ONLY clinical application of fMRI (after 30 years of development)
- https://onlinelibrary.wiley.com/doi/10.1002/hbm.23661 Figure 3

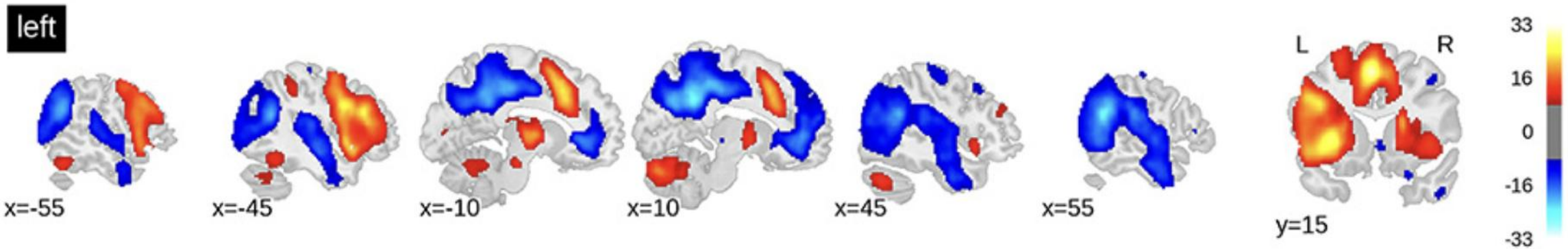


Figure 14.6 Non-invasive fMRI scans demonstrate that left hemisphere (negative x) brain areas increase in blood flow compared to right hemisphere (positive x) during the performance of language tasks. Warmer colors indicate increases in blood flow, while cooler colors represent decreases.

Challenges for studying language with fMRI?

Aphasia

- Expressive/non-fluent/Broca’s
- Receptive/fluent/Wernicke’s
- Conduction aphasia
- Global aphasia

Broca’s aphasia

- Louis Victor Lebourgne
- Brain examined on autopsy by Paul Broca
- No comprehension impairments
- Profoundly aware of production impairments
- Modality independent

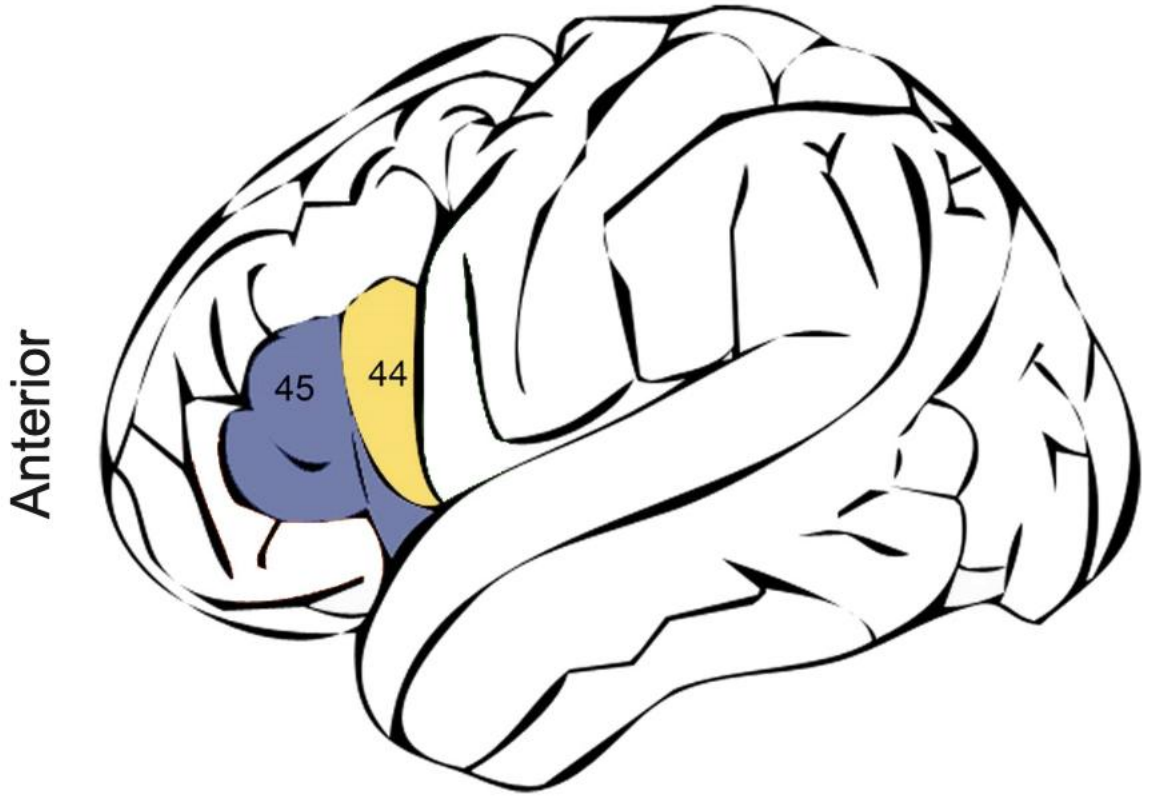


Figure 14.7 The posterior IFG, or Broca’s area (labeled as 45 and 44; purple and yellow) contribute to language production.

Wernicke’s aphasia

- Dramatic impairments in comprehension
- Fluent speech with no semantic content
- https://www.youtube.com/watch?v=3oef68YabD0
- Can also happen at the level of the phoneme or morpheme, such as in nonwords such as “emchurch” or “plehzd”
- Circumlocution (“red, it’s green, and yellow means be cautious, to keep people safe” instead of “traffic light”)

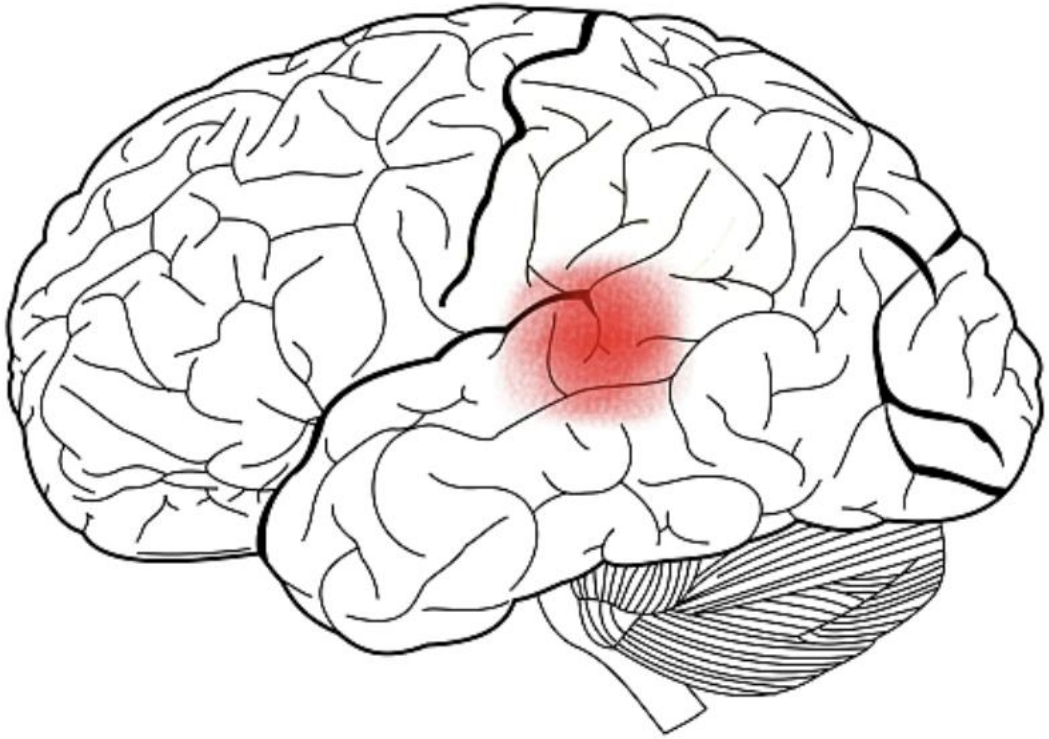


Figure 14.8 The superior temporal gyrus, or Wernicke’s area (red), contributes to language comprehension.

Conduction aphasia

- Damage to the arcuate fasciculus (white matter that connects the inferior frontal gyrus and the superior temporal gyrus)
- No significant issues with production or comprehension
- Paraphasias when asked to repeat multisyllabic words, often switching phonemes around in a single word (e.g., pasghetti)

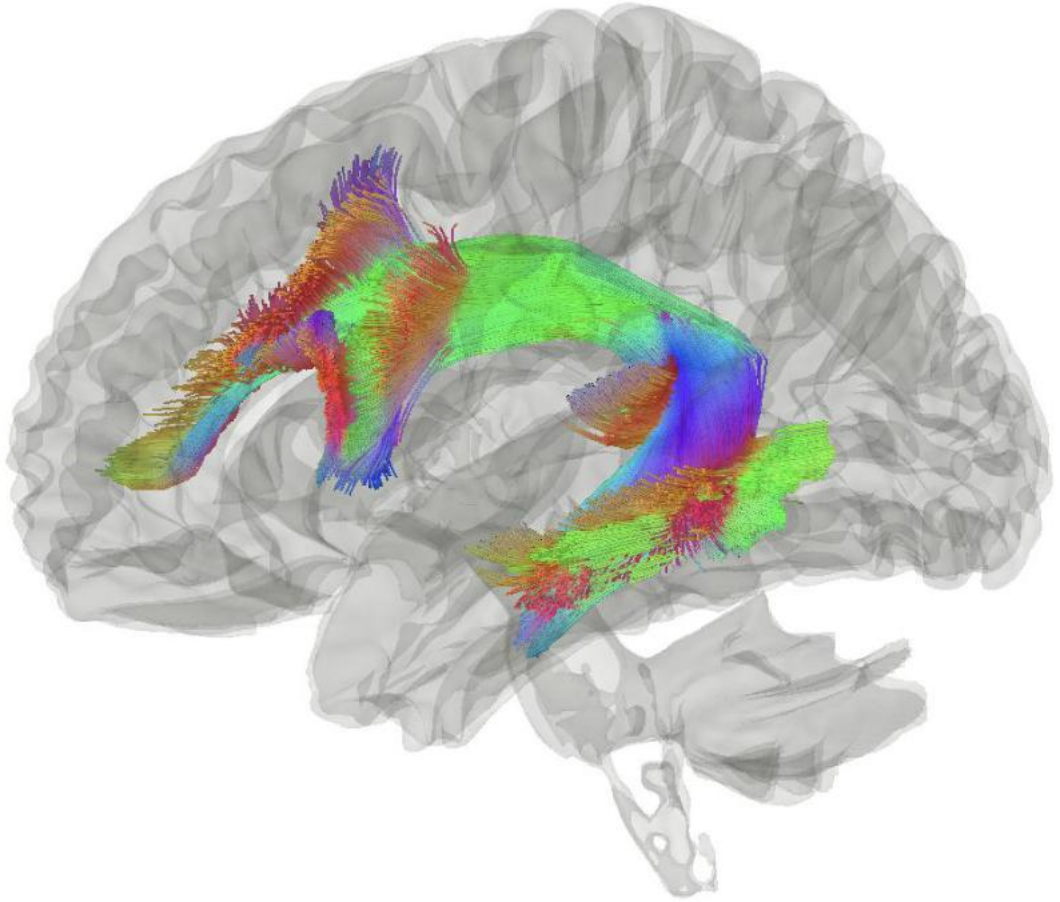
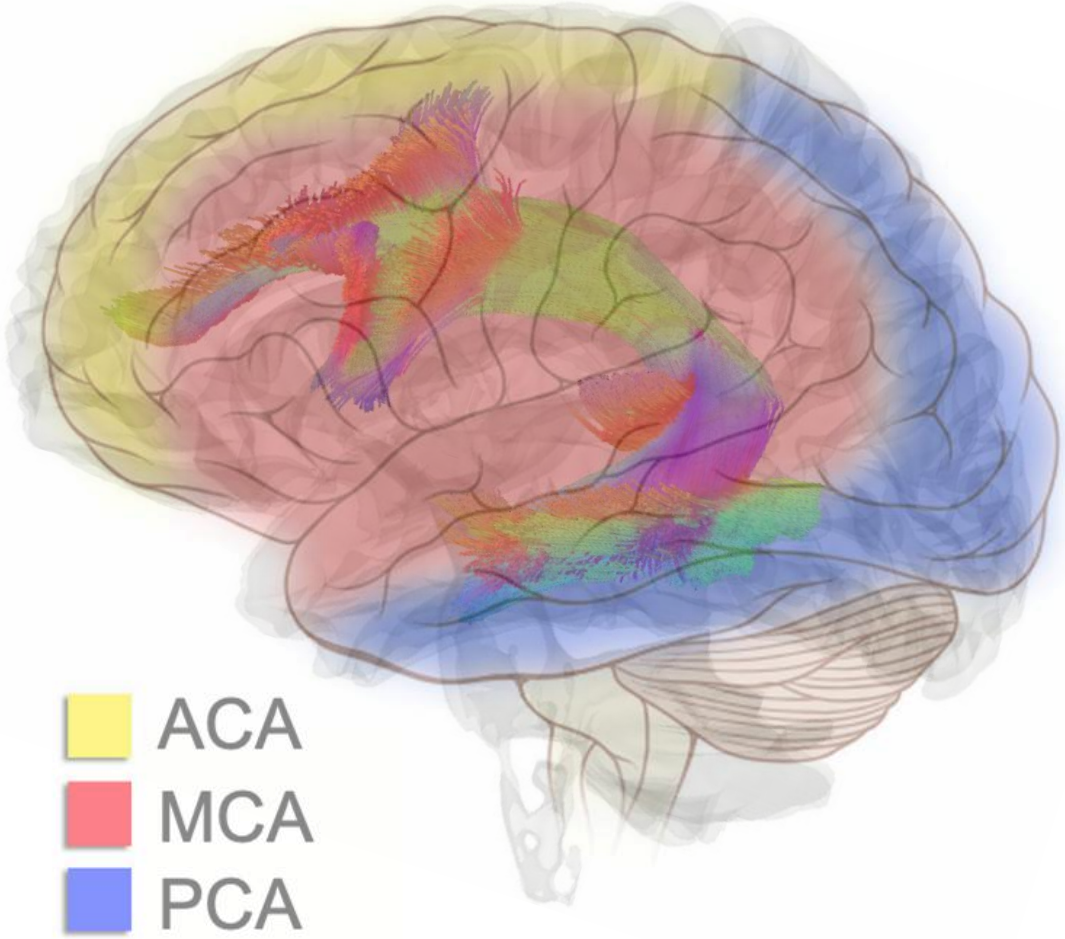


Figure 14.9 The arcuate fasciculus (colored) is a large white matter band that connects the two major language-related cortical structures.

Global aphasia



- Most severe form
- Figure 14.9 mapped over portion of Figure 14.5

Can aphasia get better? Why or why not?

Wernicke-Geschwind model

- Think of this as a simplified model

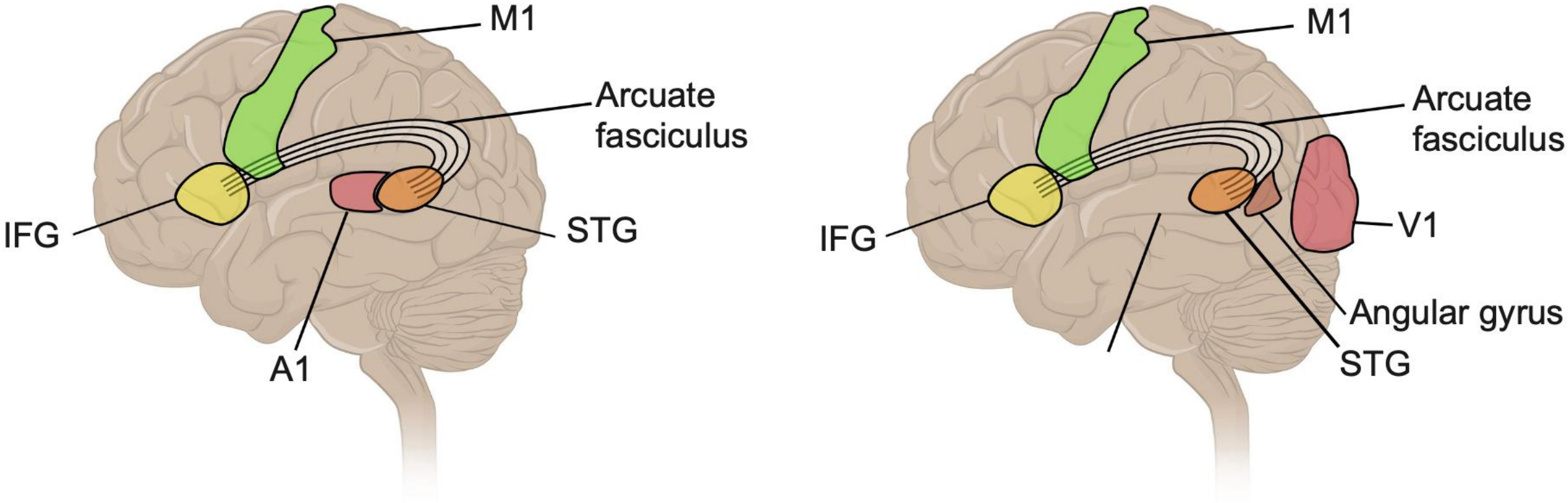


Figure 14.10 The Wernicke-Geschwind model in auditory processing and responding suggests that information signaling arrives into cortex through A1, travels through STG, IFG, then M1 (left). In a reading and responding task, the model suggests that information signaling arrives into cortex through V1, passes through circuits in the angular gyrus, then through STG, IFG, then M1 (right).

Dyslexia

- Impacts print comprehension only
- Cause unclear
- Atypical connectivity from V1 to language areas have been implicated
- Genetic component
- 7-20% of the population!