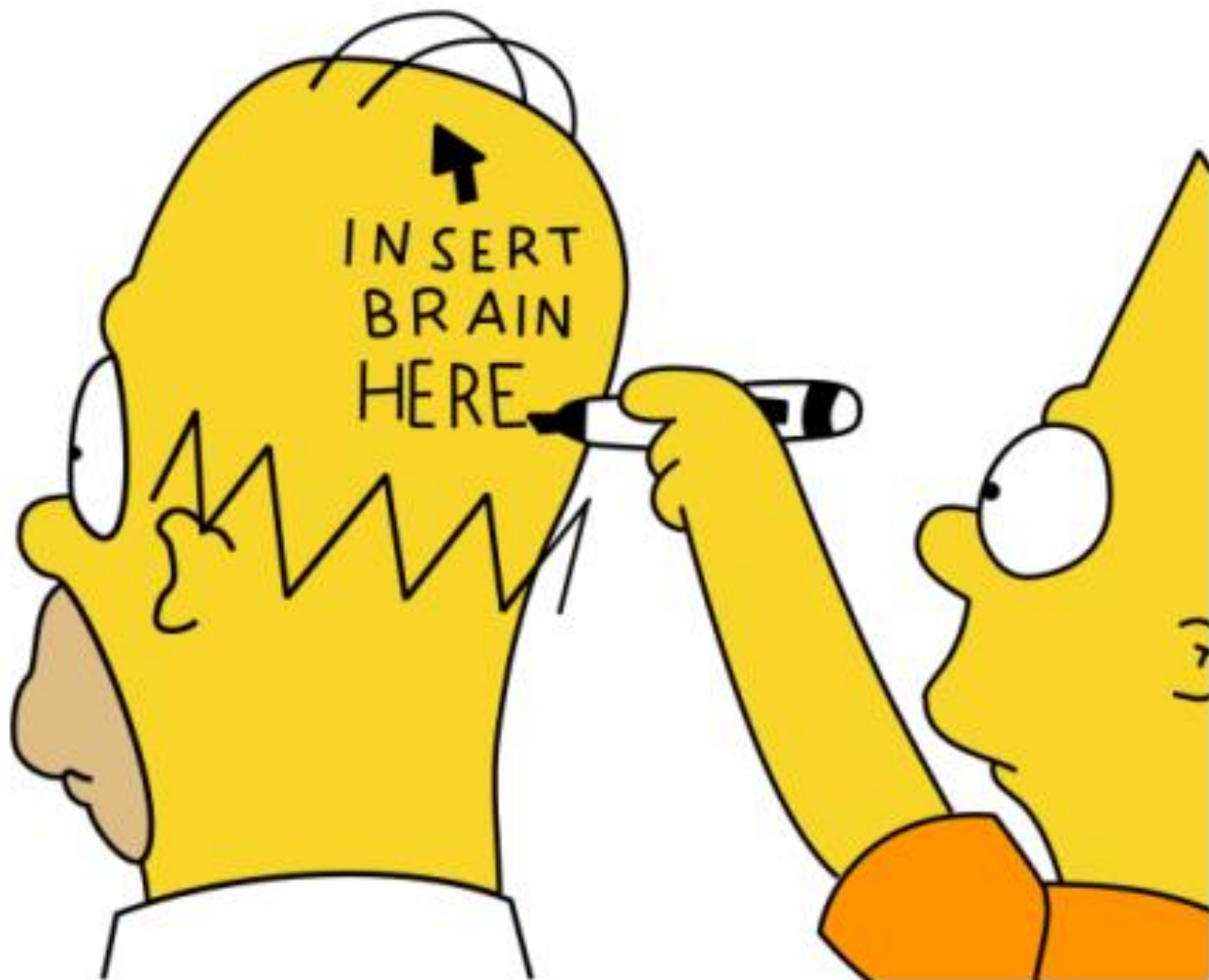




Cognition and the Brain

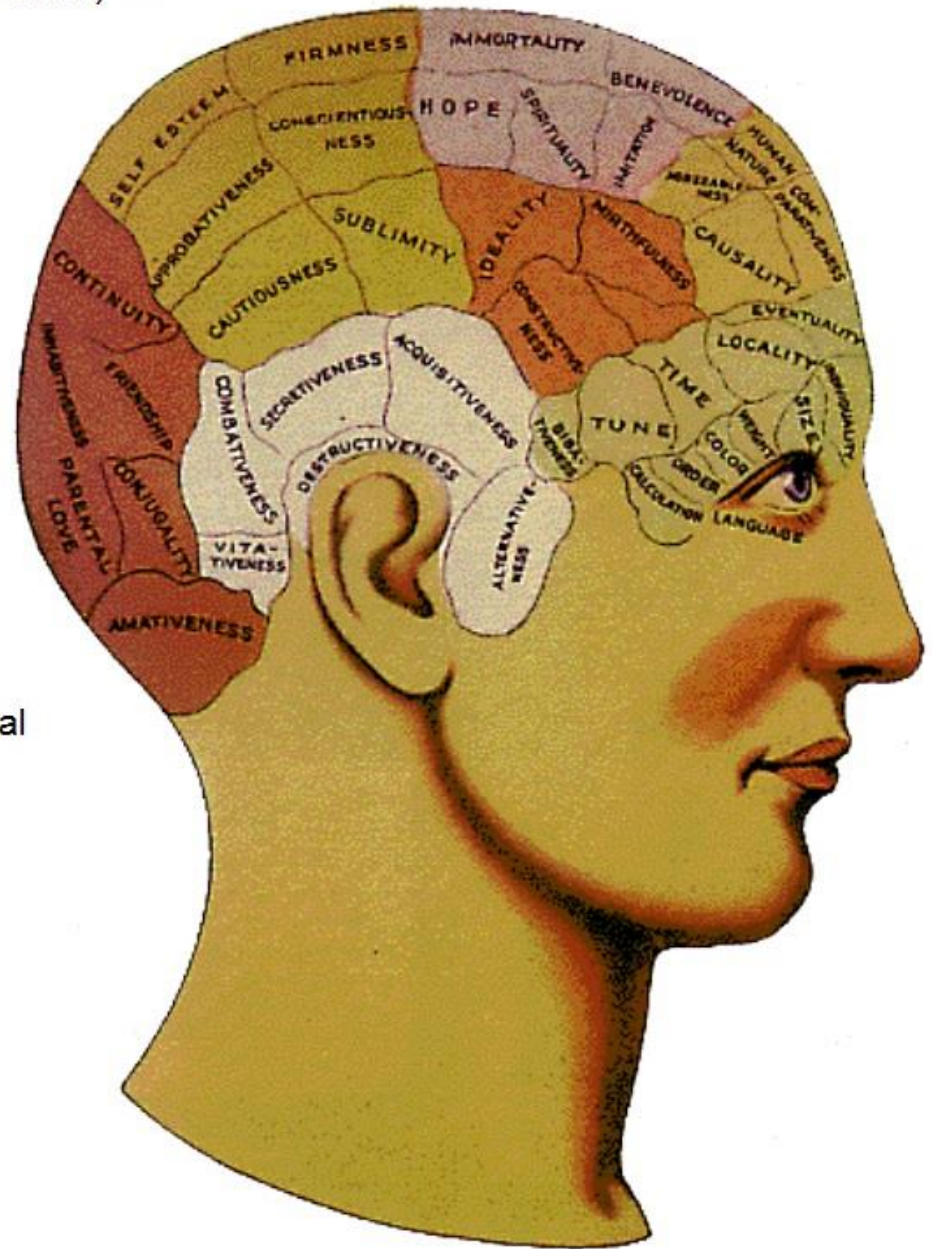


Phrenology and Localization

Franz Joseph Gall (1758-1828)

Gall's method: Correlating variations in character variations in craniological signs.

Moral and intellectual faculties depend on the physical structure of an individual brain.



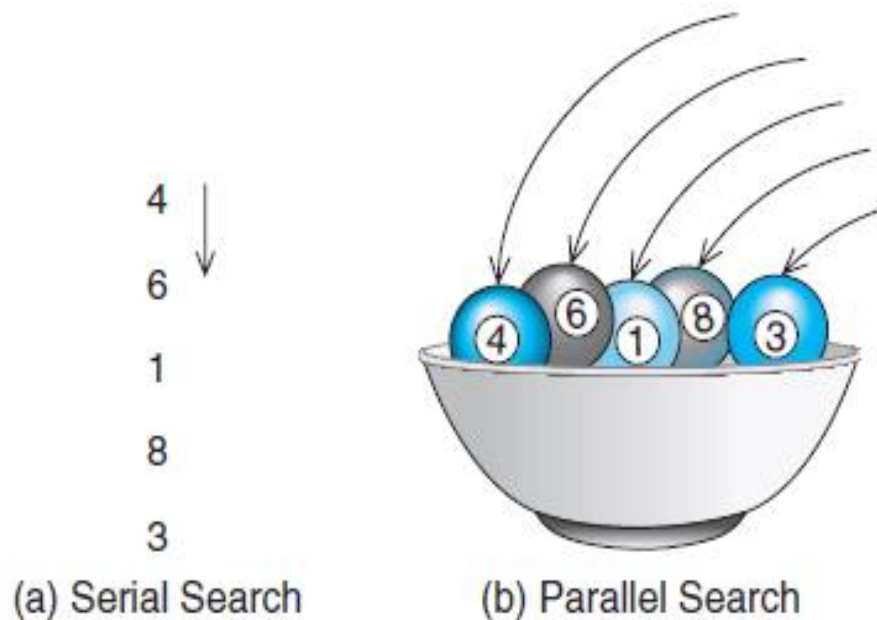


FIGURE 1–5 Two theories of memory scanning

- (a) A set of digits can be ordered into a list and scanned serially, one digit at a time.
- (b) Alternatively, the representation can be changed, creating an unordered collection, and the process can then be changed to compensate for the change in representation—with all digits examined in parallel.

The Brain

- Empirical evidence for brain localization
 - Phineas Gage (1848)



Man has nail driven into his skull

ASSOCIATED PRESS

EAU CLAIRE, Wis. — Construction worker Travis Bogumill was shot with a nail gun that drove a 3¼-inch nail all the way into his skull, and the only difference he can see is that he's not quite the math whiz he used to be.

Bogumill, 21, walked out of a hospital Thursday after surgeons removed the nail.

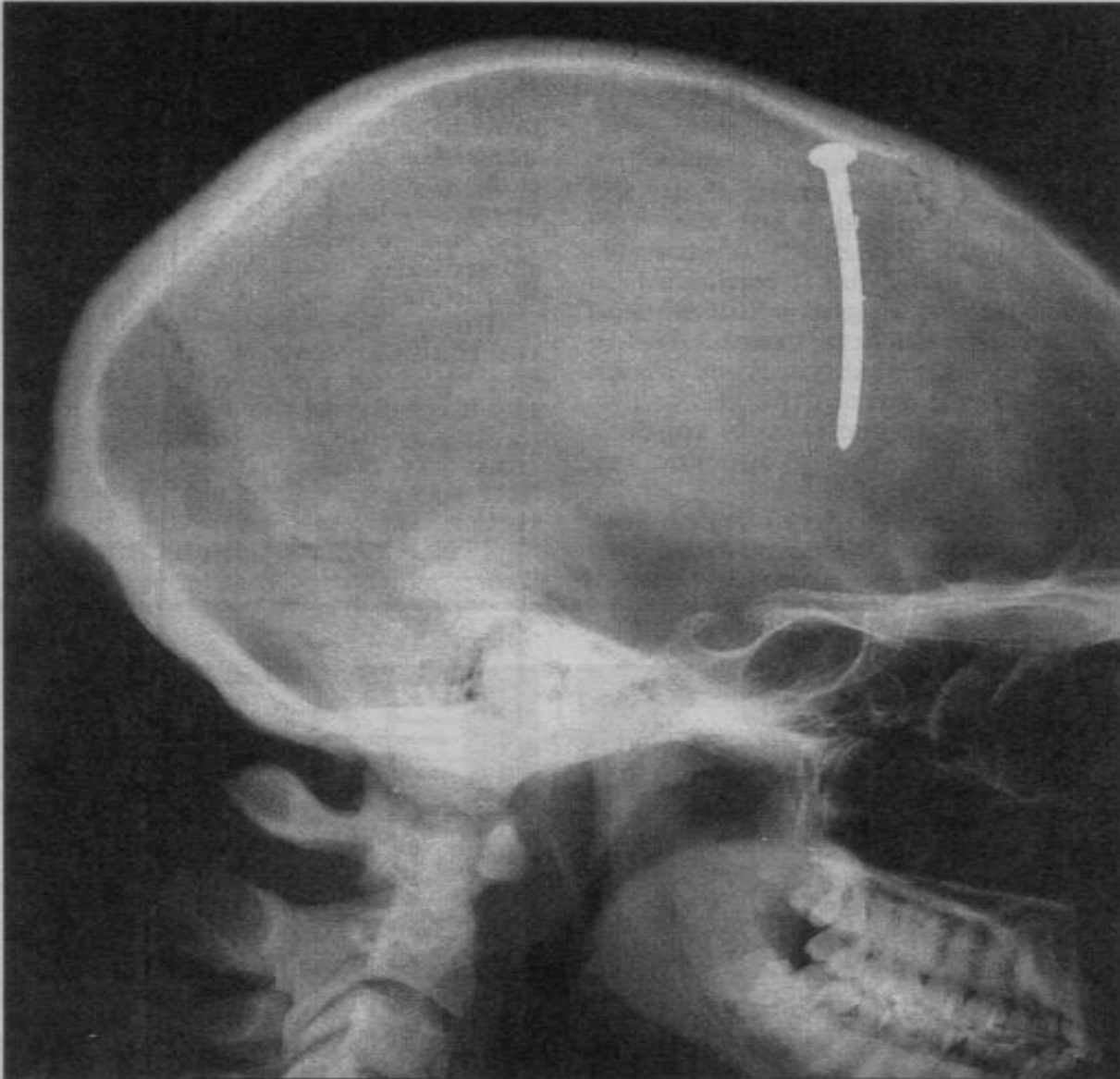
A co-worker at a construction site accidentally bumped his head with the nail gun six days earlier, and the nail went in so deep that the only thing visible was a small hole in Bogumill's scalp.

He remained conscious, turned to his co-worker and said, "You just nailed me in the head," Bogumill recalled.

An X-ray showed the nail had lodged in the right side of Bogumill's brain, halfway between his ear and the top of his head. Bogumill said it "felt like somebody was smacking my head repeatedly with a hammer."

Doctors told Bogumill, a civil engineering student at Chippewa Valley Technical College, that he shouldn't have been able to walk or talk after the accident and that they're baffled why he wasn't knocked unconscious.

Dr. John Lamoureux said the nail lodged in an area of the brain typically involved in processing math, which could explain the problems Bogumill said he is now having.



ASSOCIATED PRESS

An X-ray of Travis Bogumill's head shows the 3¼-inch penny nail that lodged in his brain after a co-worker shot him with a nail gun. Surgeons removed the nail Thursday. Bogumill is fine, but he's lost some of his math skills.

The Brain

- Myth: *“Humans only use 10% of their brain.”*
 - “Lucy” (2014)
 - Scarlett Johansson uses her entire brain...and so do you





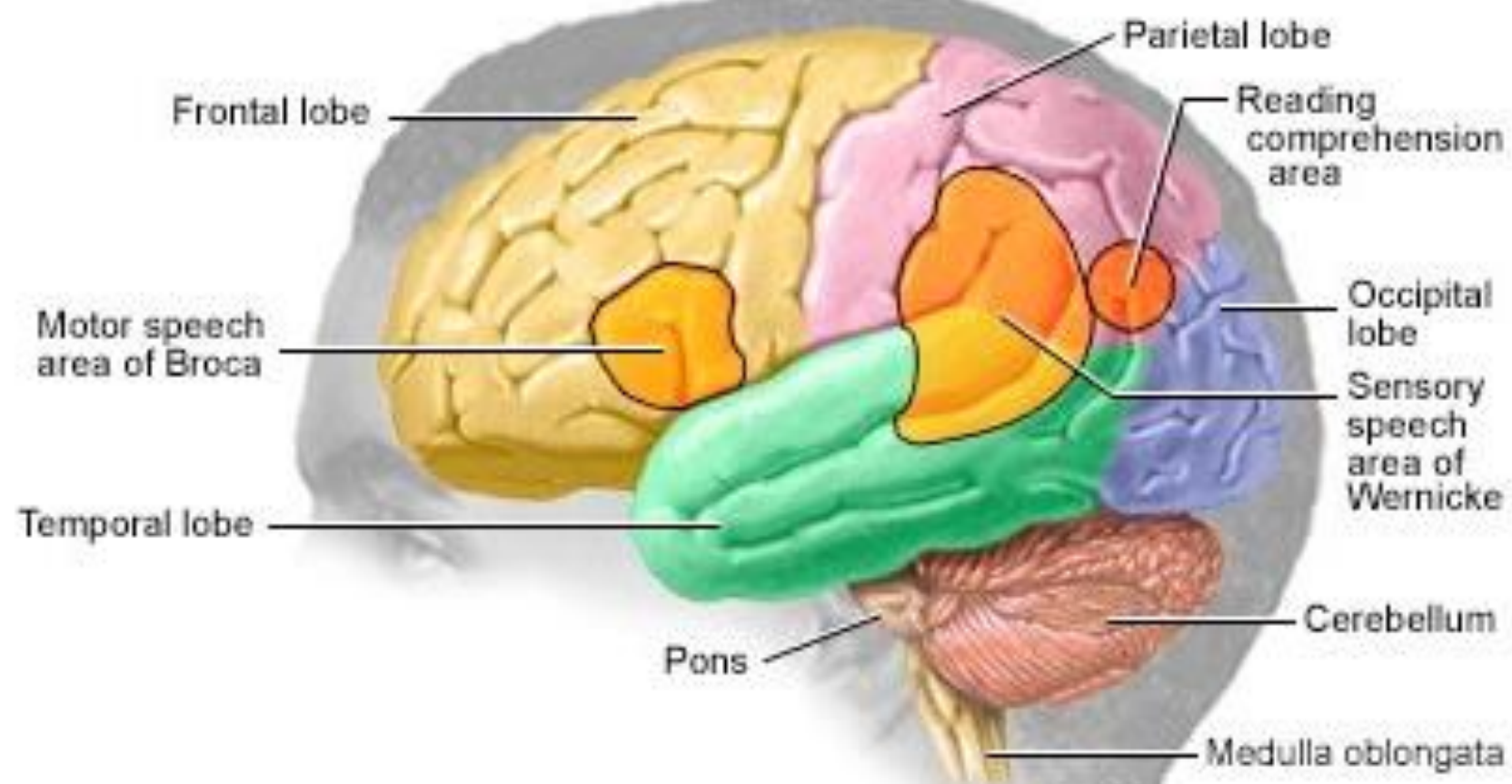
The Brain

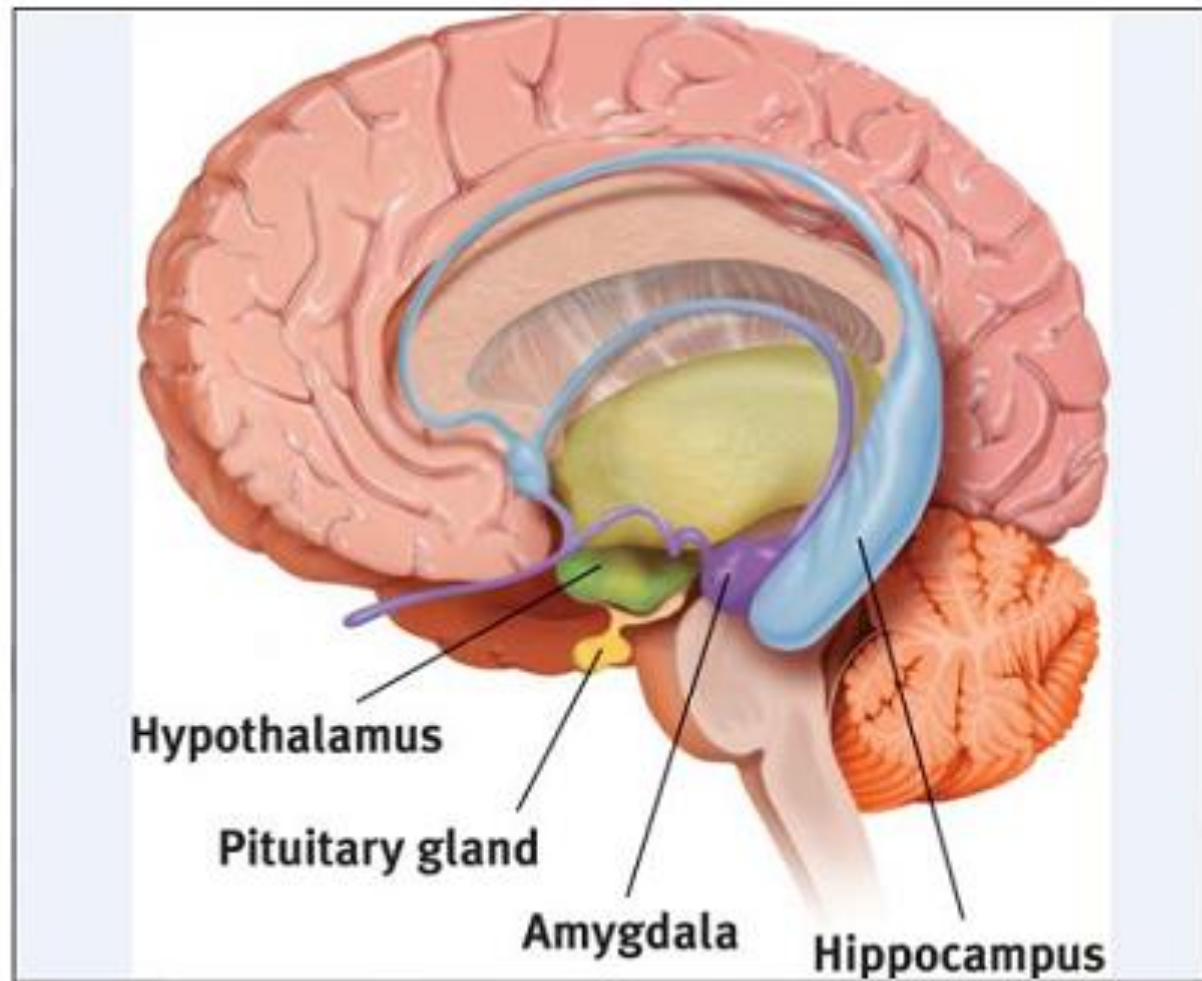
- Myth: “*Humans only use 10% of their brain.*”
 - Misconception began with author **Lowell Thomas** misquoting **William James** in *The Energies of Man*
 - Thomas: “We develop only 10% of mental ability...”
(*How to Win Friends and Influence People*, 1936)



The Brain

- Myth: *“Humans only use 10% of their brain.”*
 - 2/3 of the general public believe this is to be true
 - Brain consumes nearly 20% of body's total daily energy despite only being 2% of total body weight
 - Equally important to the duration of mental exertion is one's attitude toward it





THE NERVOUS SYSTEM

```
graph TD; A[THE NERVOUS SYSTEM] --> B[Peripheral Nervous System (PNS)]; A --> C[Central Nervous System (CNS)]; B --> D[Somatic Nervous System]; B --> E[Autonomic Nervous System]; C --> F[Spinal Cord]; C --> G[Brain]; E --> H[Sympathetic Nervous System]; E --> I[Parasympathetic Nervous System];
```

Peripheral Nervous System (PNS)

Carries information to and from the central nervous system

Somatic Nervous System

Transmits sensory information to the CNS and carries out its motor commands

Autonomic Nervous System

Serves basic life functions such as beating of the heart and responses to stress

Sympathetic Nervous System

Readies the body in response to threat and/or stress; activates the organism to "fight or flight"

Parasympathetic Nervous System

Maintains routine bodily functions and tasks; calms the body down after threat or stress has passed

Central Nervous System (CNS)

Directs psychological and basic life processes; responds to stimuli

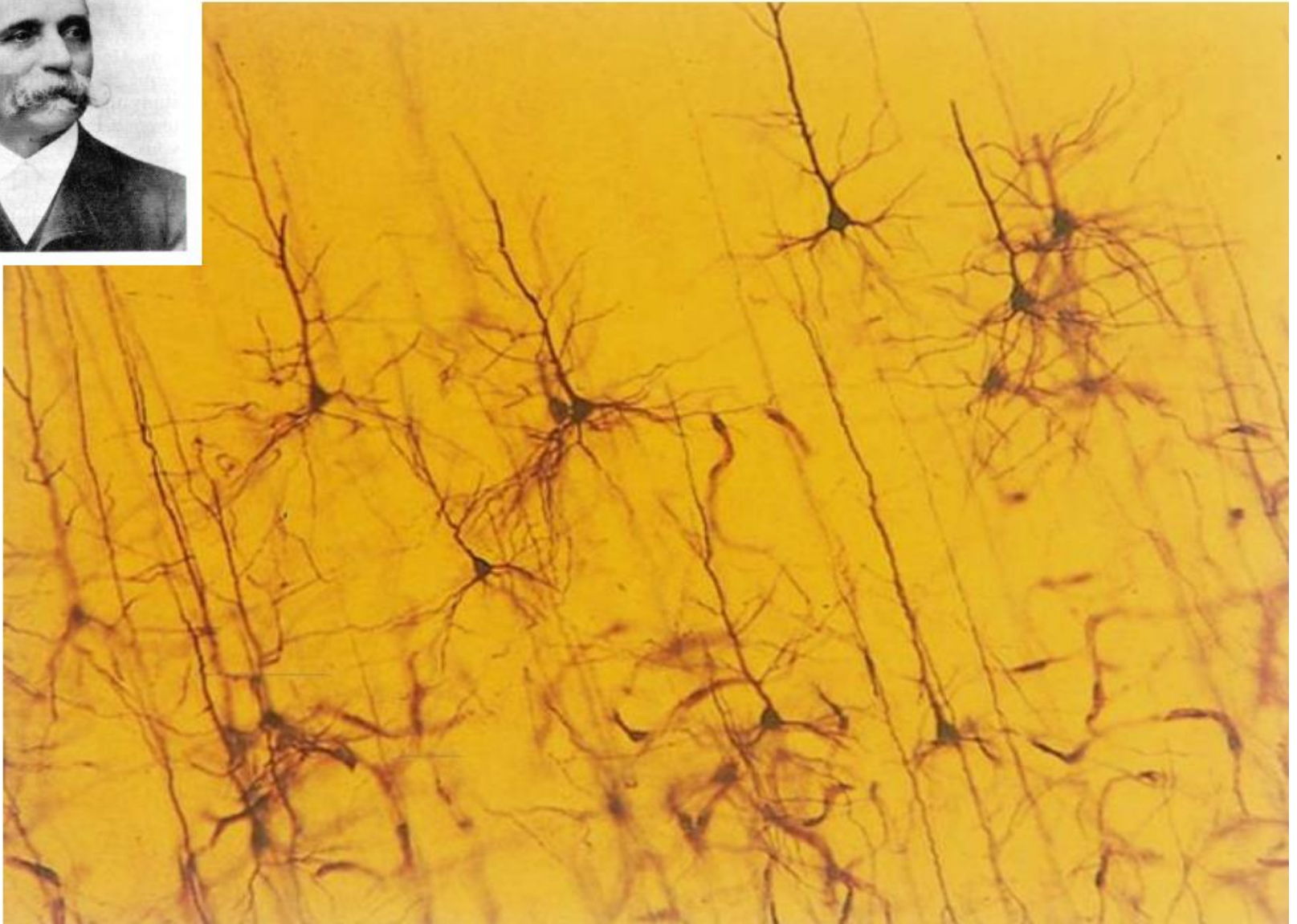
Spinal Cord

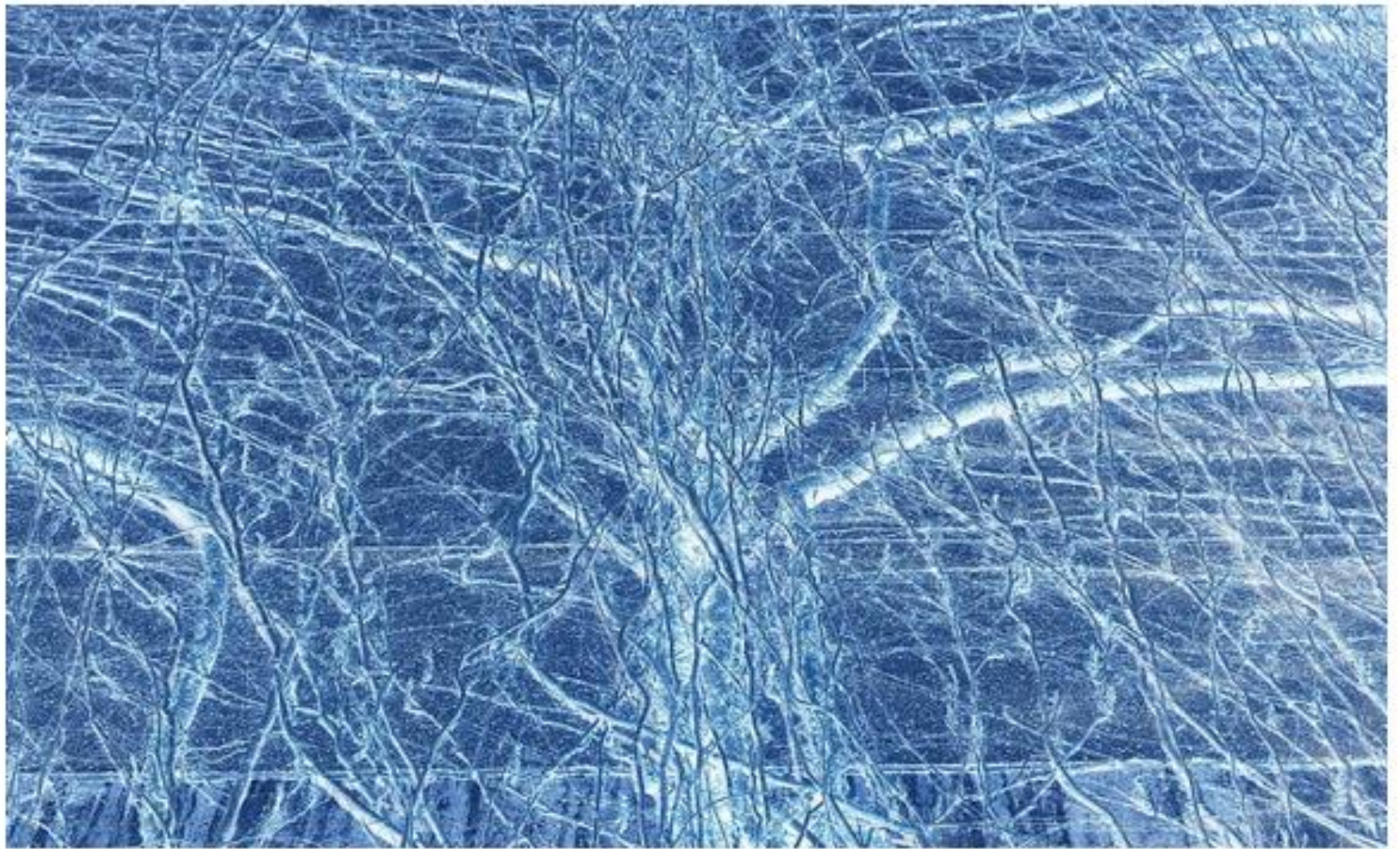
Receives sensory input, sends info to the brain, responds with motor output

Brain

Directs activity, processes info, maintains life support

The Golgi Stain







Observing the Brain

- Behavioral methods

- **Accuracy of task completion**

- Pro: Objective and non-invasive; also includes unconscious processing

- Con: “Ceiling effects” and “floor effects”



Observing the Brain

- Behavioral methods

- **Task response time**

- Pro: Objective and non-invasive; also includes unconscious processing

- Con: Expectancy effects



Observing the Brain

- Behavioral methods

- **Judgments/ratings**

- Pro: Measures subjective reactions/responses;
easy to administer, and to collect data

- Con: Instrumentation issues; attitude accessibility?



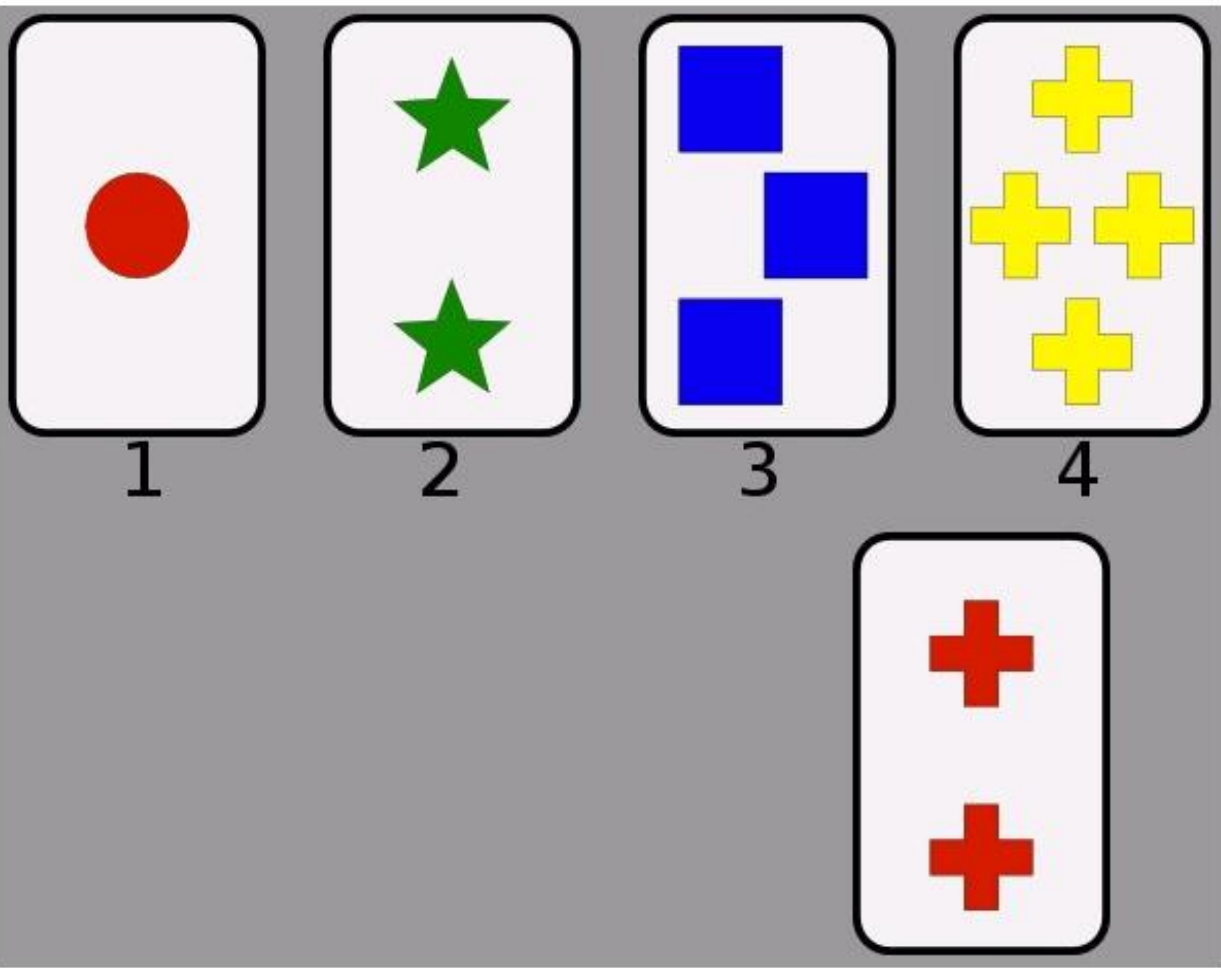
Observing the Brain

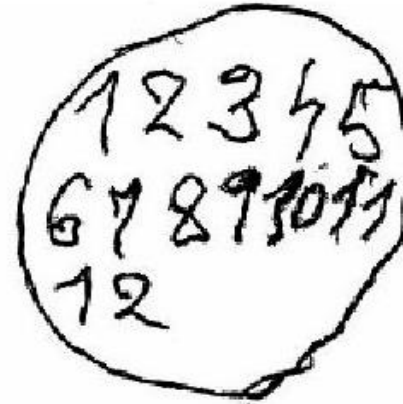
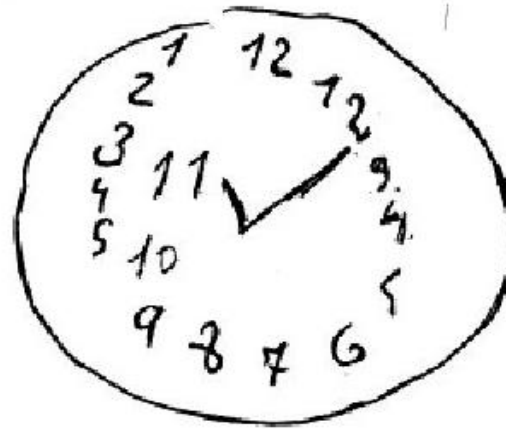
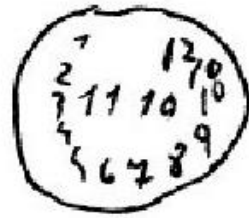
- Behavioral methods

- **Protocol collection**

- Pro: Observe systematic thinking processes

- Con: May not be a viable method for assessment
of unconscious processes






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Neuroimaging techniques

Imaging modality	Technique	Pros	Cons
 CT	Passes x-rays through the body while the detector and x-ray generator rotate around the body, generating multiple images/slices of the body in each plane	Rapid, noninvasive	Radiation exposure
 MRI	Uses magnetic field and radio waves to create images of variably aligned and misaligned hydrogen ions in the tissue	Noninvasive, precise, no radiation	Expensive, cannot use in some patients with metal biomedical implants or clips/stents or severe claustrophobia
 fMRI	Tracks blood flow and oxygen levels, which approximate neuronal activity; often superimposed on structural MRI slices for orientation; can be linked in time with EEG	Noninvasive; no radiation, injections, or ingestions required	Blood flow/oxygen levels dependent on cardiovascular response; results in temporal delay between stimulus and output
 PET	Uses radioisotope (ingested or injected); measures uptake of the radioisotope; allows in vivo monitoring of molecular changes; used in conjunction with structural imaging	Molecular changes visible in real time	Radioactive substance, minor radiation exposure
Nonvisual modality	Technique	Pros	Cons
EEG/ERP	Measures electrical brain wave activity in outer layer of brain in real time; can be used in combination with MRI; ERP: an averaging of recordings/responses to a specific stimulus	Inexpensive, noninvasive, portable	Poor spatial sensitivity, cannot measure beyond cerebral cortex
MEG	Measures magnetic fields created by brain waves	Noninvasive	Poor spatial sensitivity, cannot measure beyond cerebral cortex, expensive equipment, not widely available



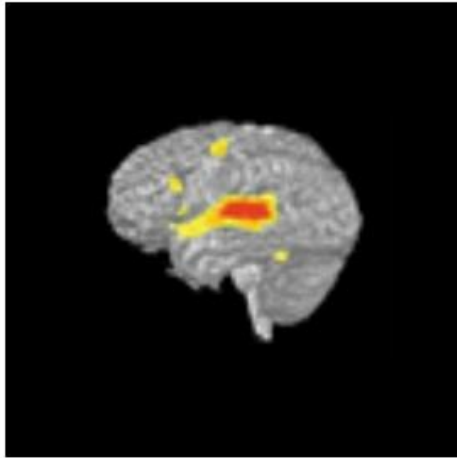
Observing the Brain

- Localization methods
 - **Spatial resolution:** localizing signal areas
 - **Temporal resolution:** track activity changes
 - **Invasiveness:** some procedures very invasive
 - **Cost:** equipment, technicians, compensation to participants

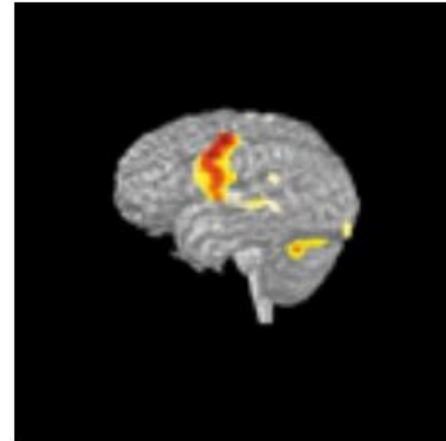




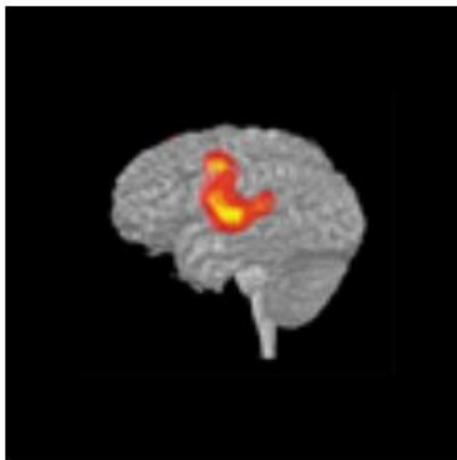
PET (Positron Emission Tomography)



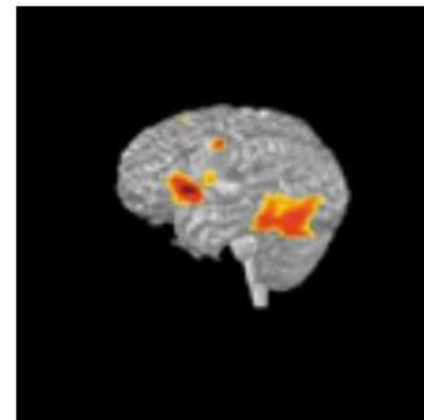
Hearing
Words



Seeing Words



Speaking
Words



Thinking
about Words



Information processing

- **Functional**
 - What is the goal/purpose of processing information?
- **Representational**
 - How is mental information represented systematically?
- **Physical**
 - How is mental processing physically realized?