

Consciousness

MEDS 470 / NRSC 500B

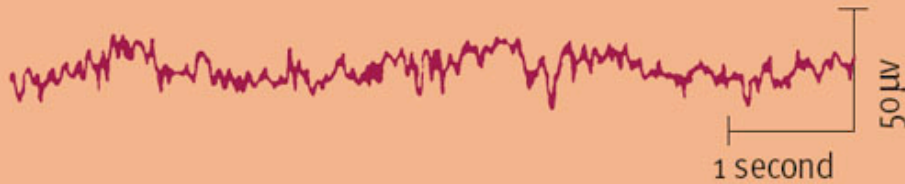
Dr. Olav E. Krigolson

What is consciousness?

Consciousness is subjective experience, the “what it is like” to perceive a scene, recognize a face, hear a sound, or reflect on the experience itself (Tononi et al., 2016a)

Although consciousness is difficult to define (Zeman, 2005), we take the base concept to be the presence of phenomenal content for an agent, and we emphasize a distinction between conscious level (i.e., a position on a scale from total unconsciousness as in coma to vivid and alert wakefulness) and conscious content (i.e., the components of any given conscious scene – the qualia; Seth et al., 2008).

Being Awake



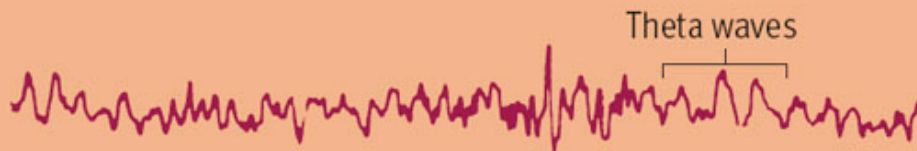
Awake

Low-voltage, high-frequency beta waves



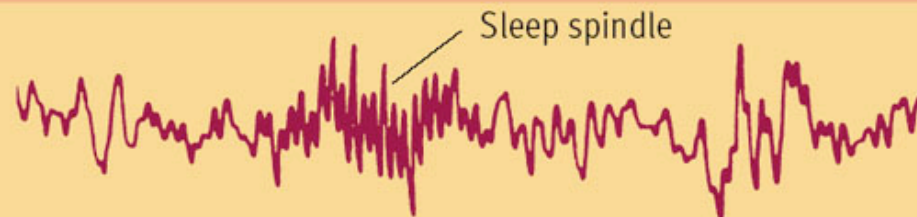
Drowsy

Alpha waves prominent



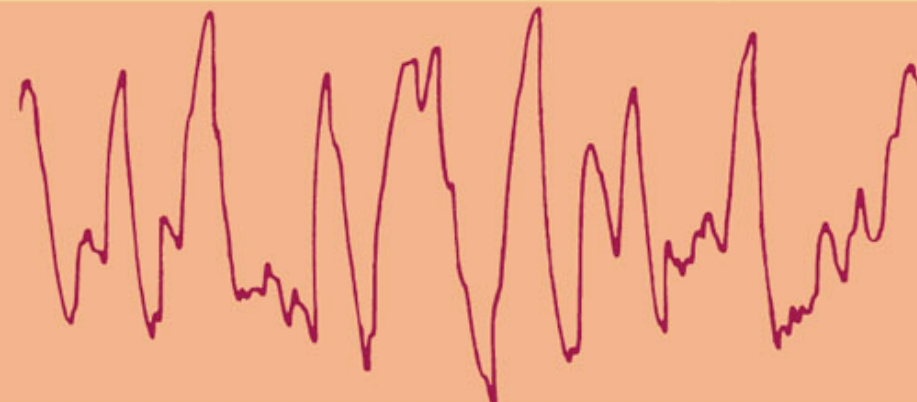
Stage 1 sleep

Theta waves prominent



Stage 2 sleep

Sleep spindles and mixed EEG activity



Slow-wave sleep

(stage 3 and stage 4 sleep)

Progressively more delta waves (stage 4 shown)



REM sleep

Low-voltage, high-frequency waves

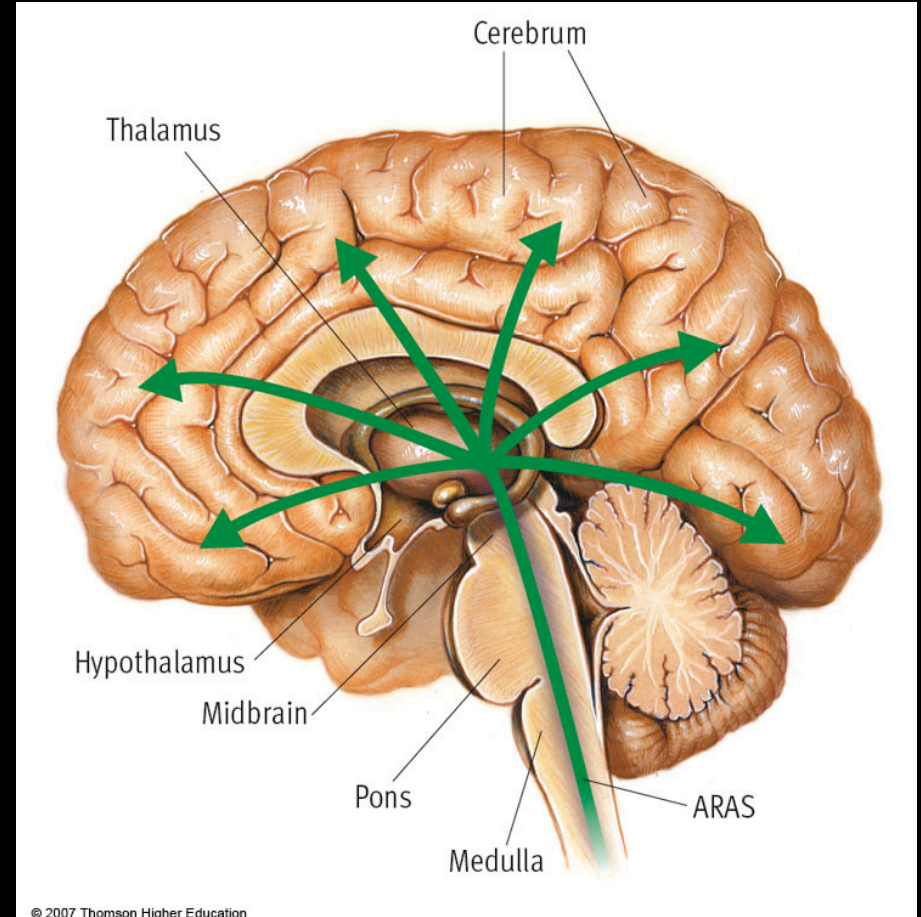
The Neural Basis of Sleep

Brain Structures:

- Ascending reticular activating system
- Pons, medulla, thalamus, hypothalamus, limbic system

Neurotransmitters:

- Acetylcholine and serotonin
- Also norepinephrine, dopamine, and GABA



Why Do We Sleep?

Hypothesis 1:

- Sleep evolved to conserve organisms' energy

Hypothesis 2:

- Immobilization during sleep is adaptive because it reduces danger

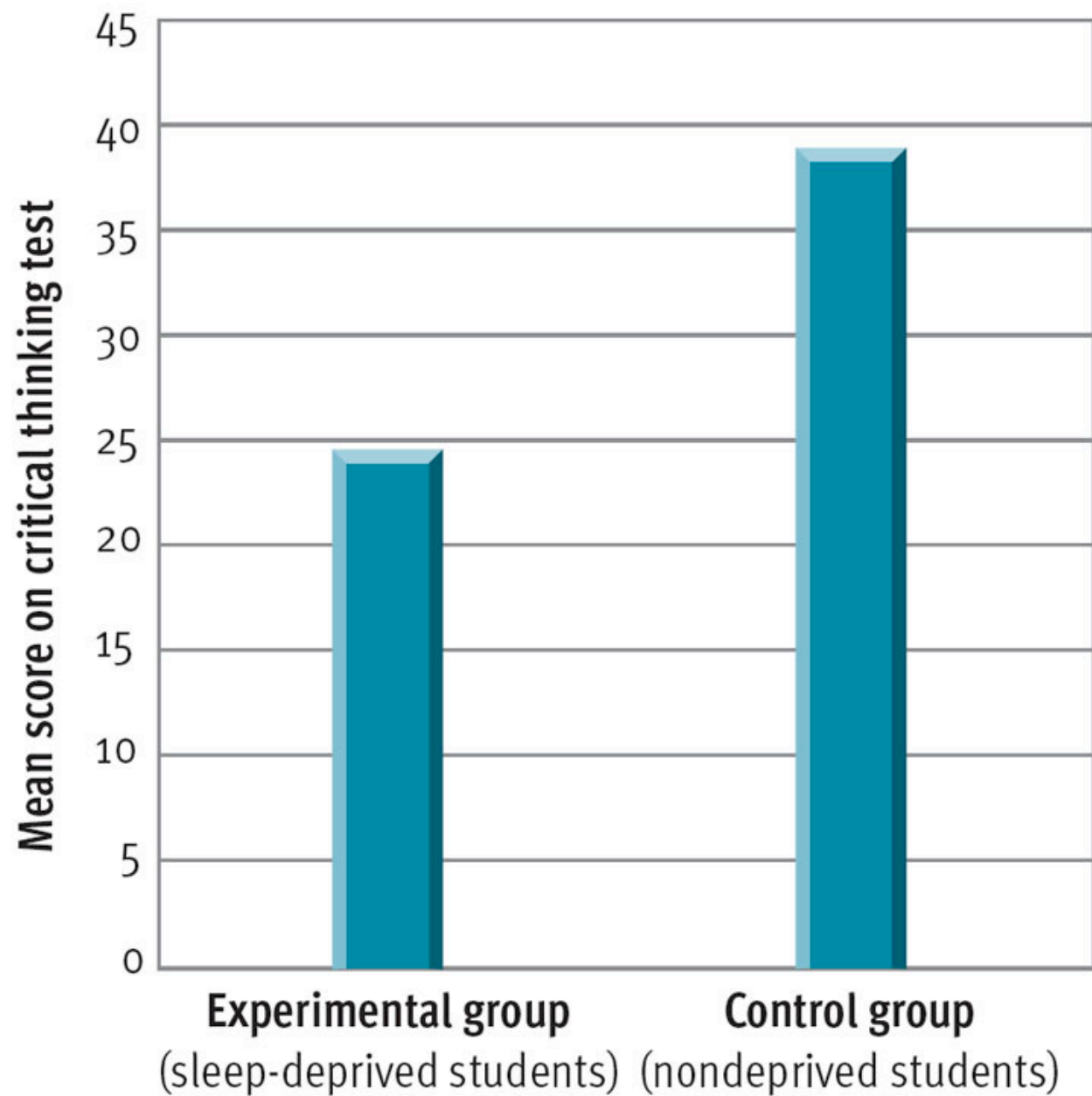
Hypothesis 3:

- Sleep helps animals to restore energy and other bodily resources

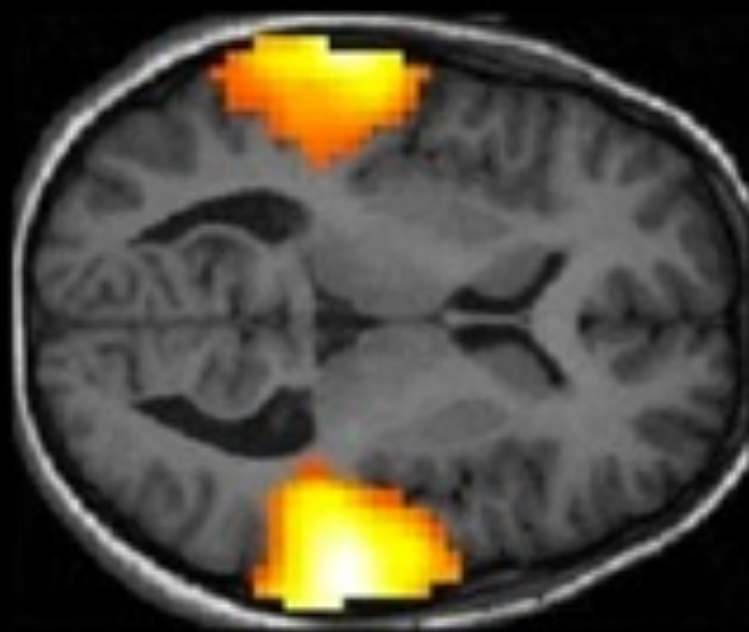
Variations in Consciousness

Levels of AWARENESS: Consciousness is Not All-or-None

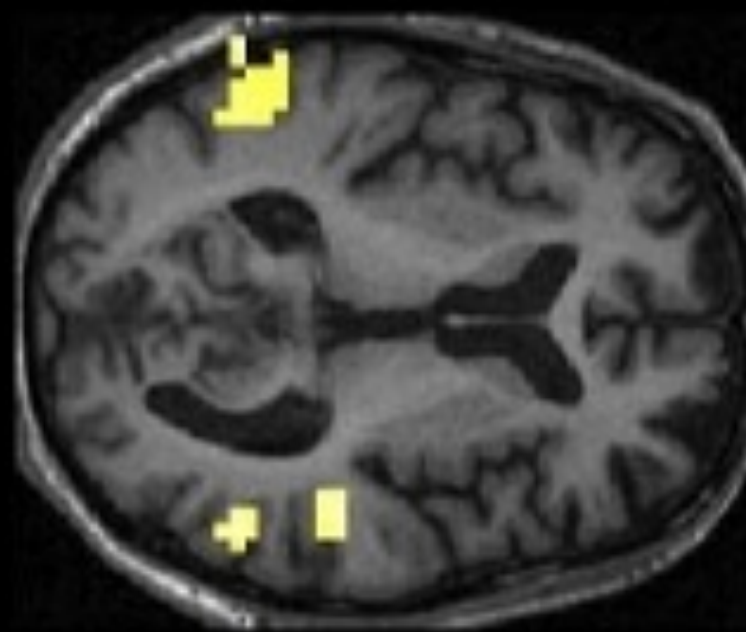
- Awake
- Sleep
- Anesthesia
- Coma
- Persistent Vegetative State
- Death



Healthy Brain



Vegetative State



The Nature of Consciousness

What is consciousness?

Awareness of external events

Awareness of internal sensations

Awareness of yourself as a unique being having experiences

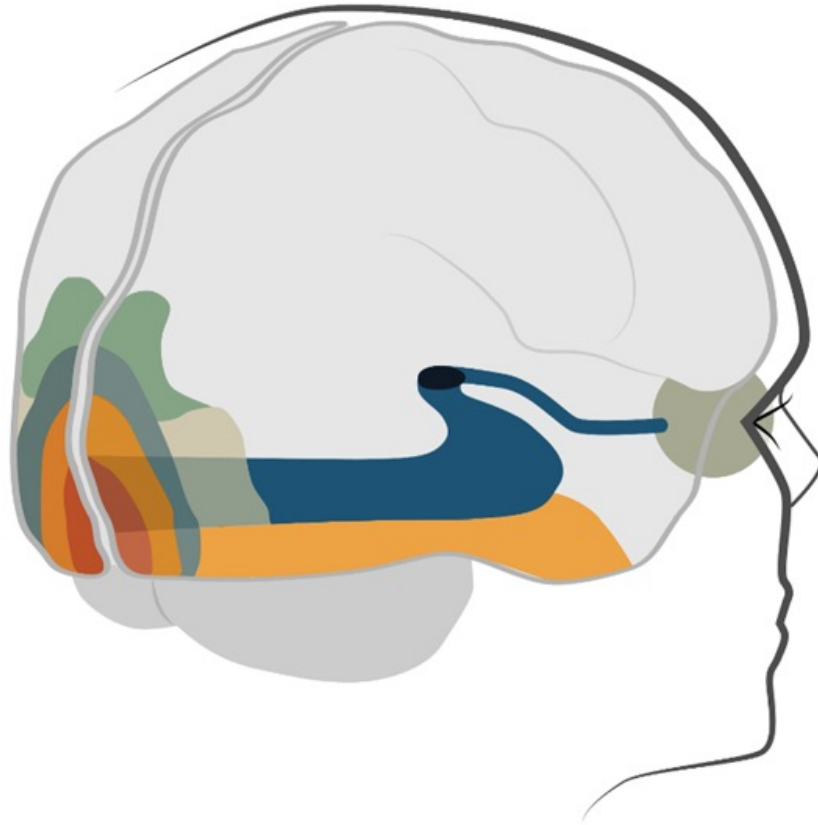
Awareness of your thoughts about these experiences

The critical element in consciousness is *awareness*.

The Nature of Consciousness

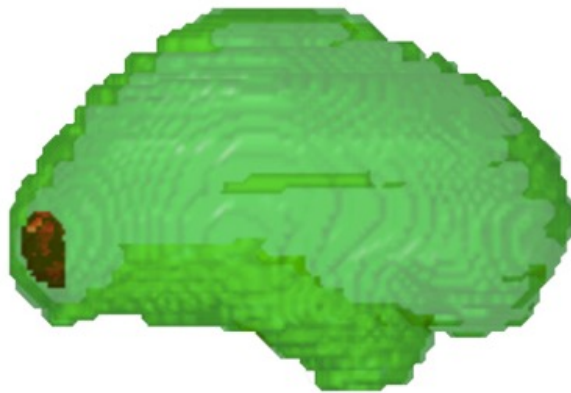
What is consciousness?

Awareness of external events (perception)

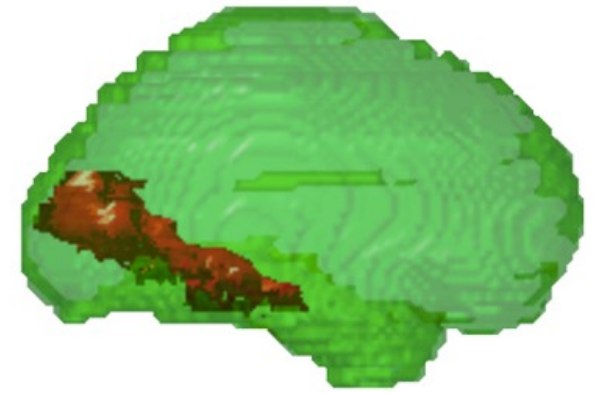
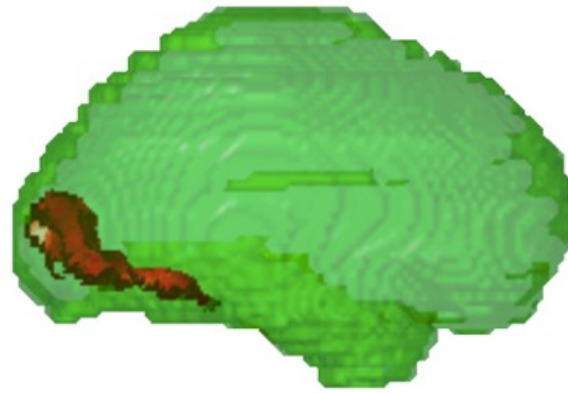


60 msec

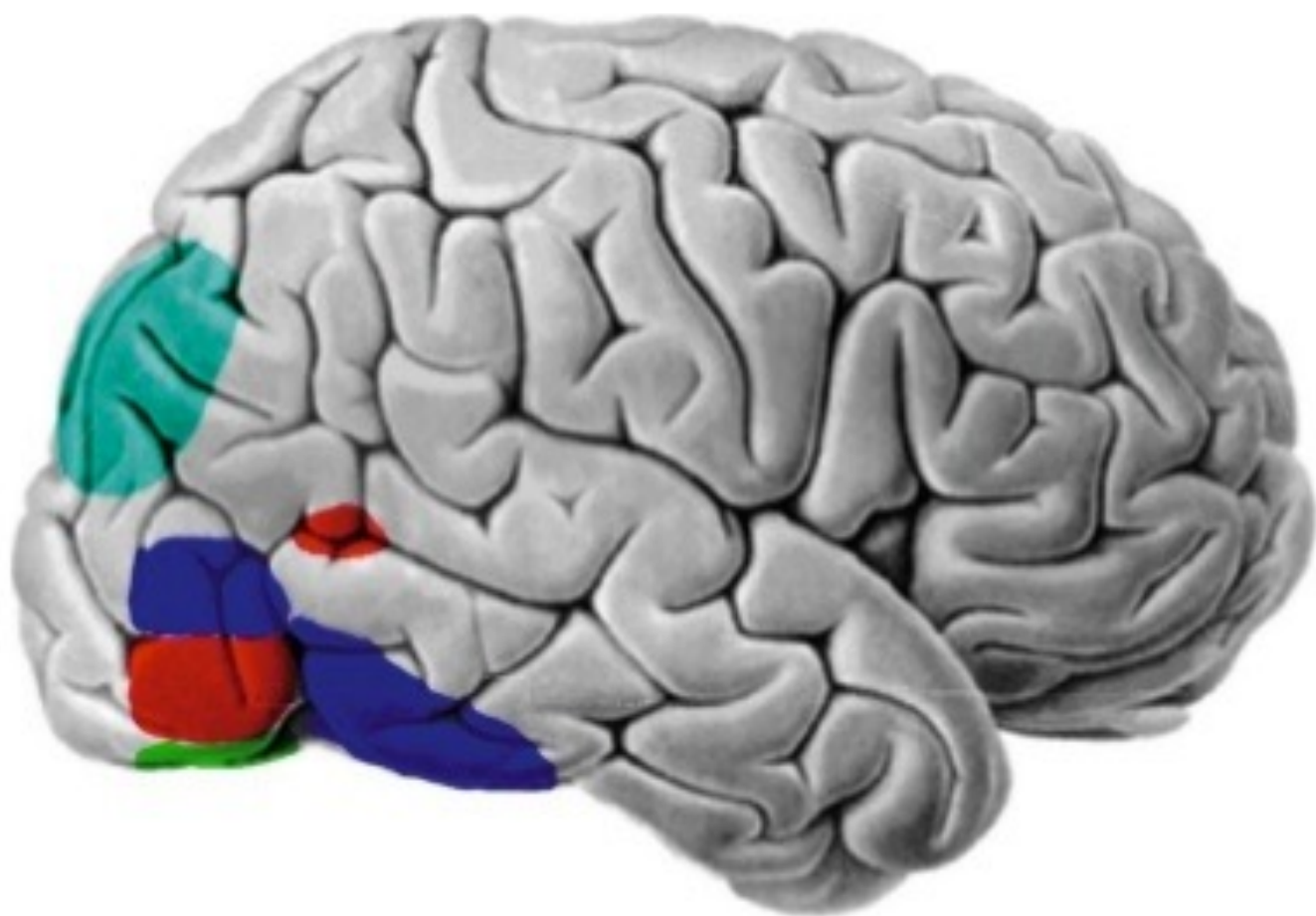
130 msec



Early visual cortex



Inferior temporal cortex



Faces



Houses

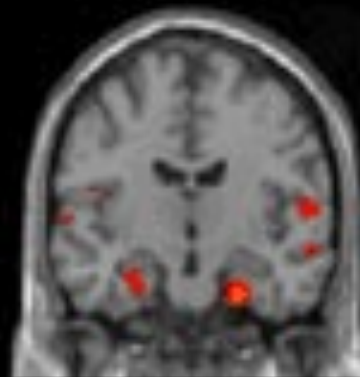
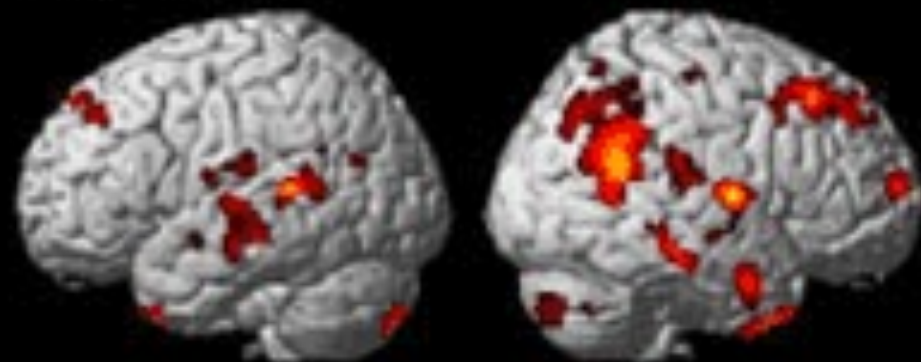


Chairs

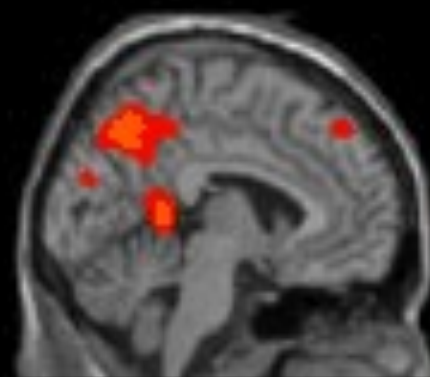


**Houses and
Chairs**

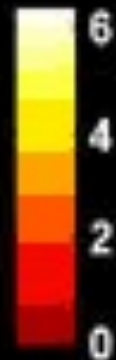
Maternal



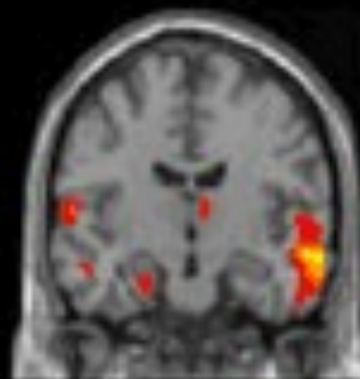
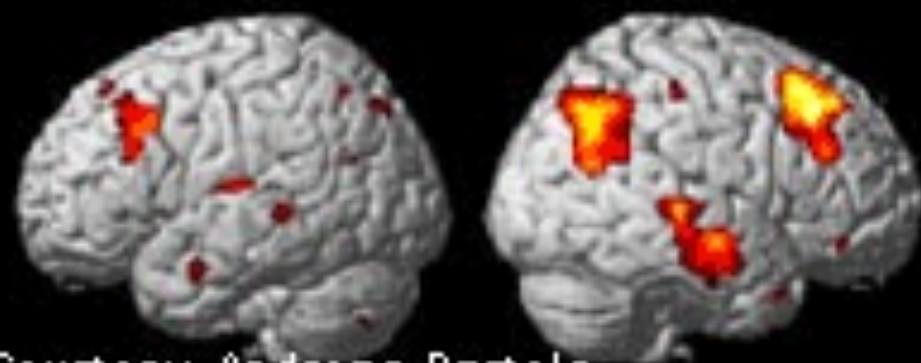
y=12



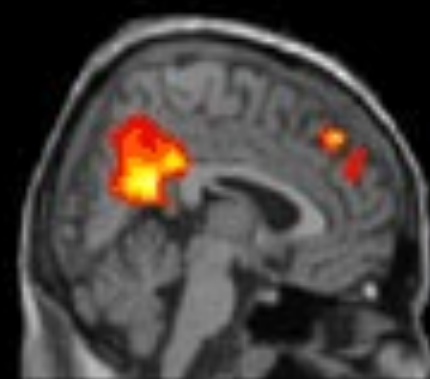
x=4



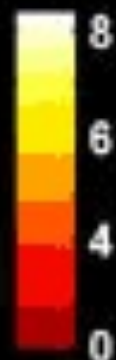
Romantic



y=-12

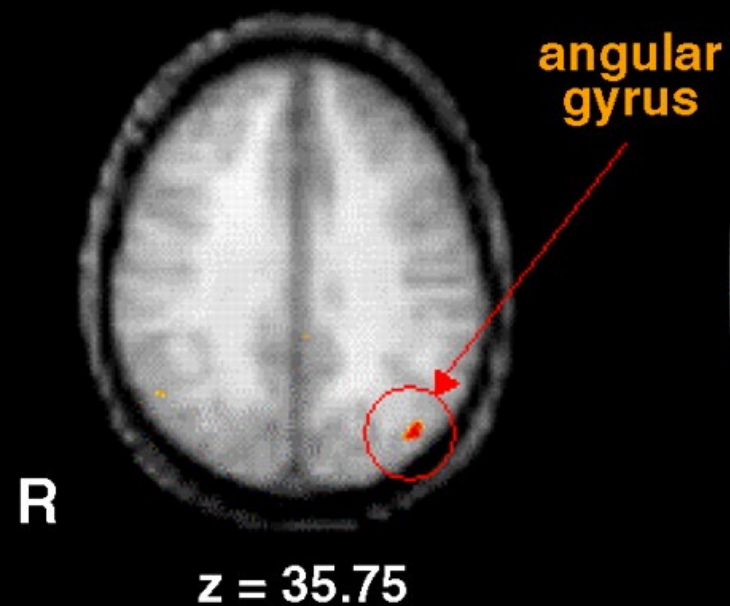


x=4

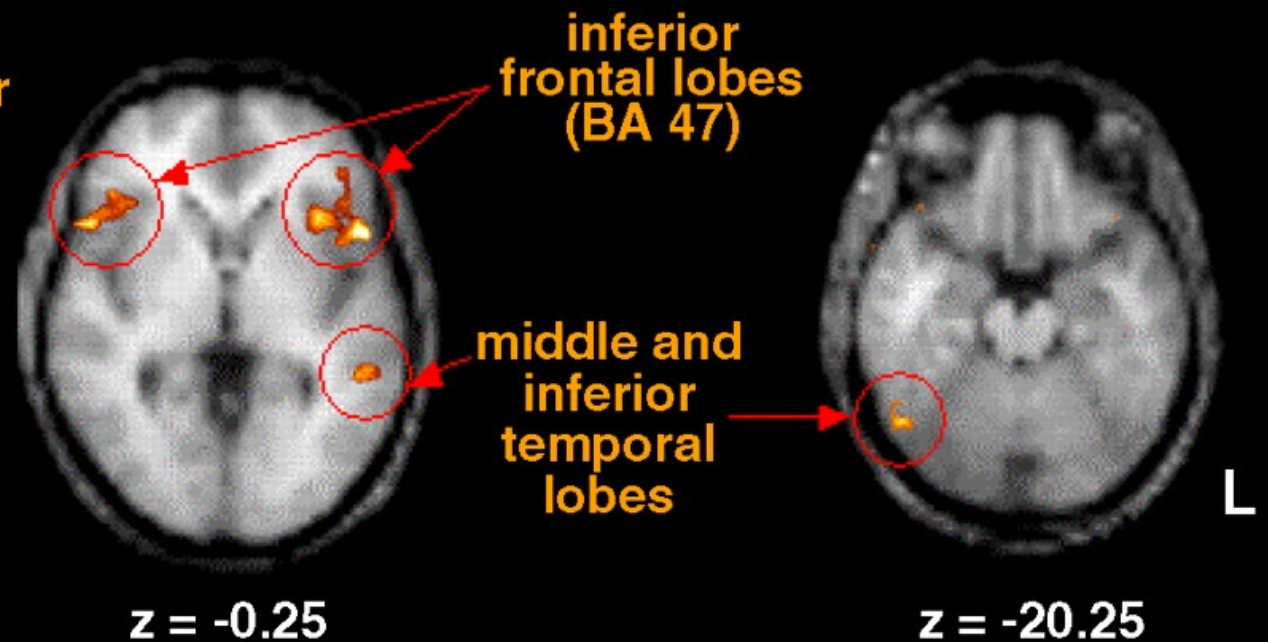


Courtesy Andreas Bartels

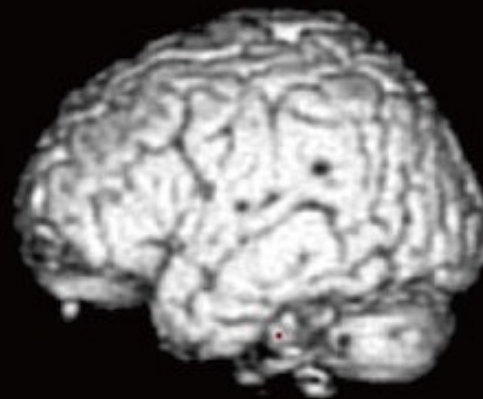
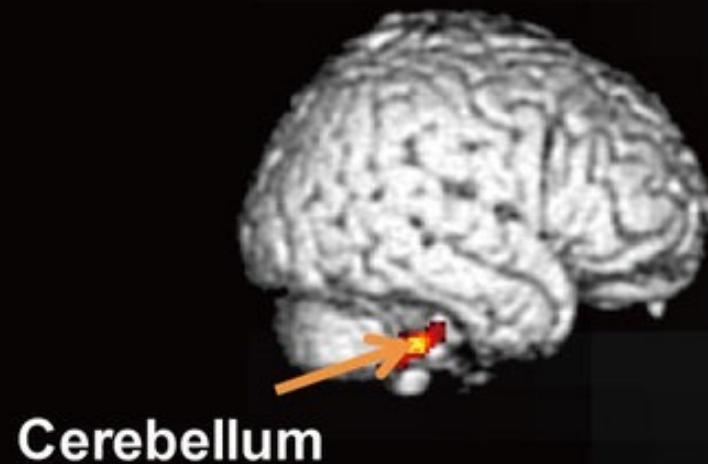
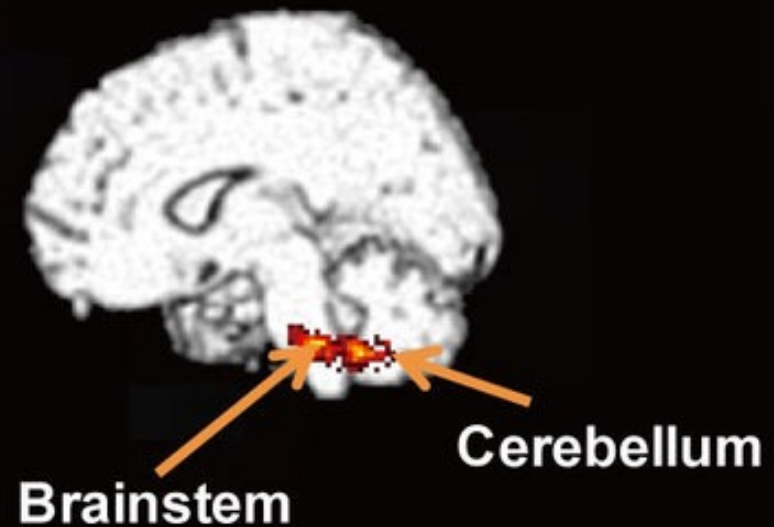
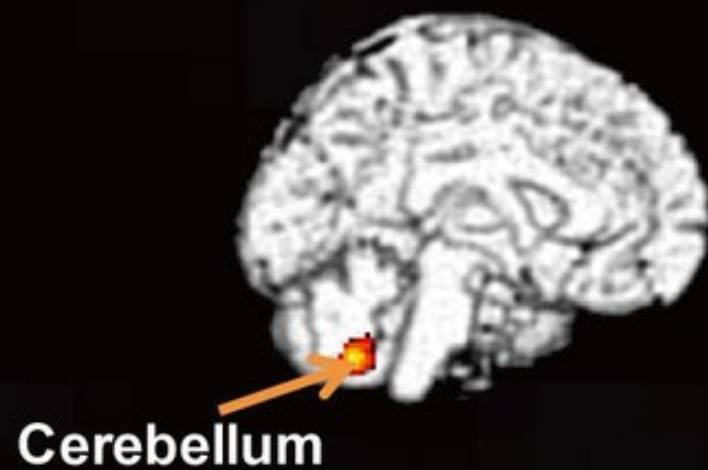
A Lexical processing



B Semantic processing

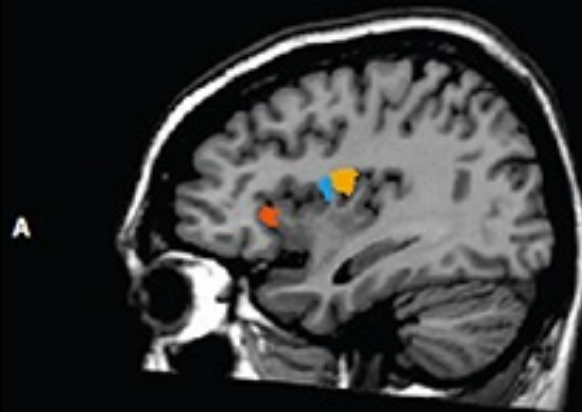


Frame4: Funny – Non-funny



x = -36





SAG



y = 19

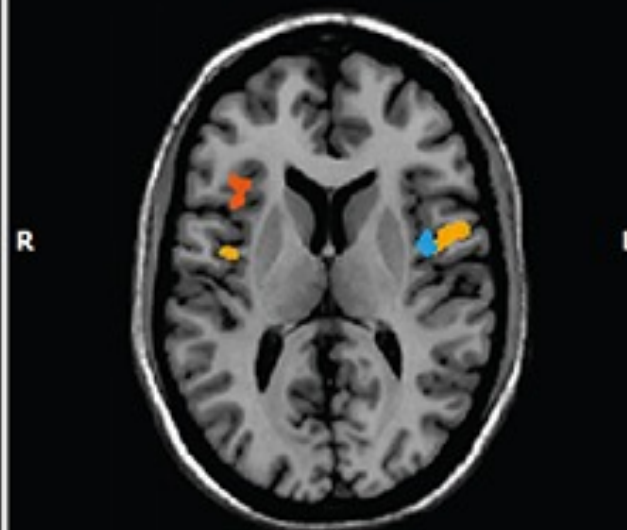
COR



-  Experts - Taste
-  Experts - After taste
-  Controls - Taste
-  Controls - After Taste

z = 11

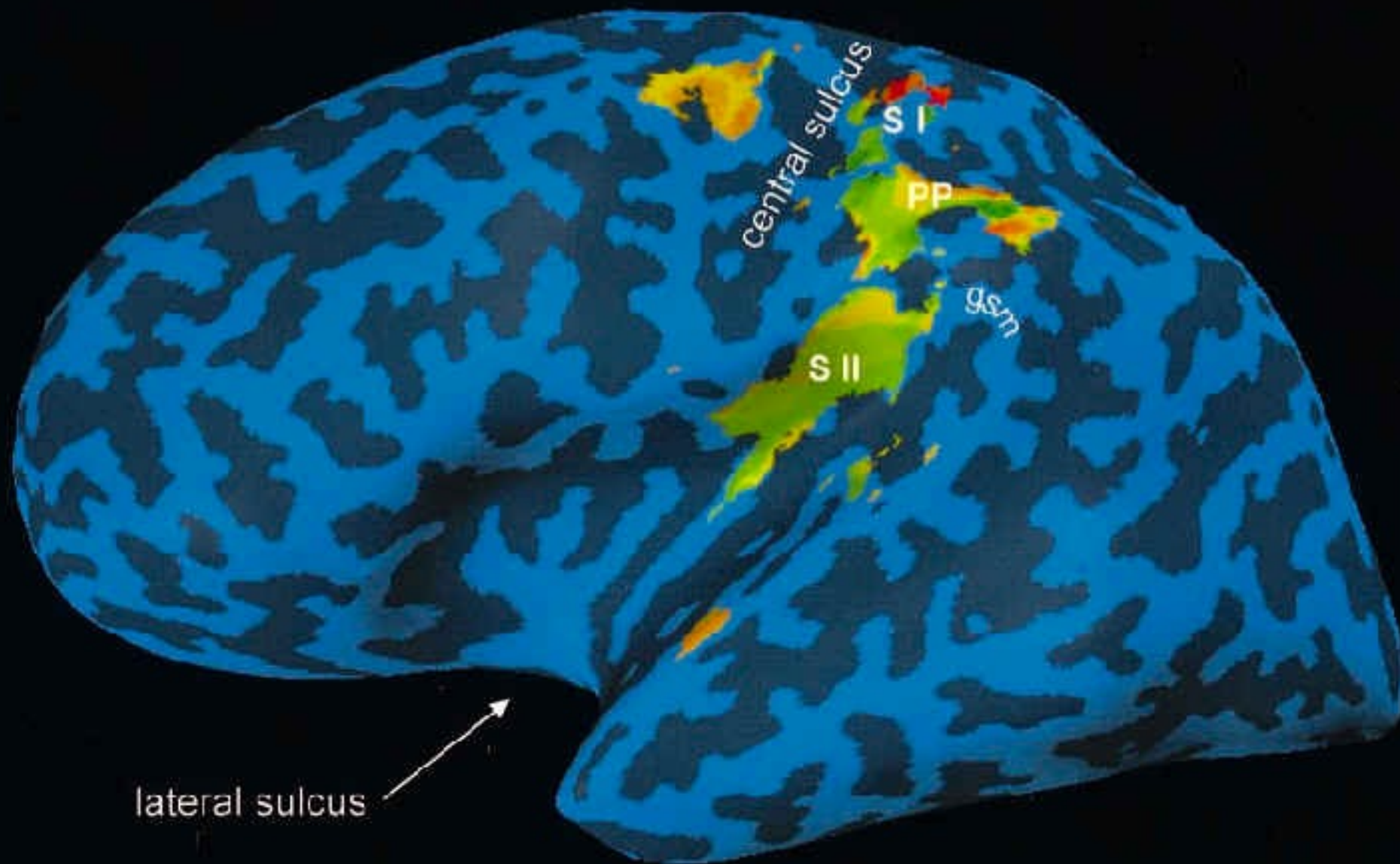
TRA

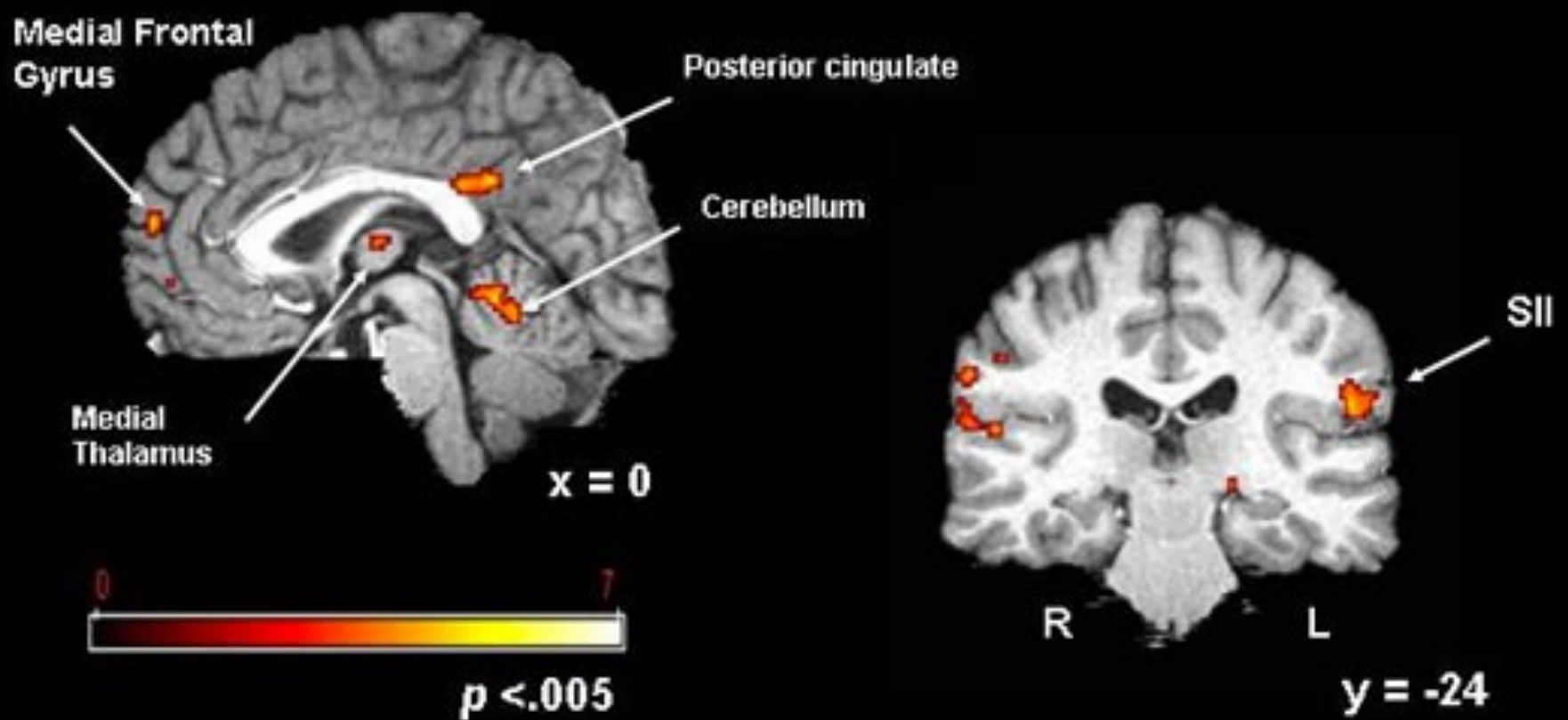


The Nature of Consciousness

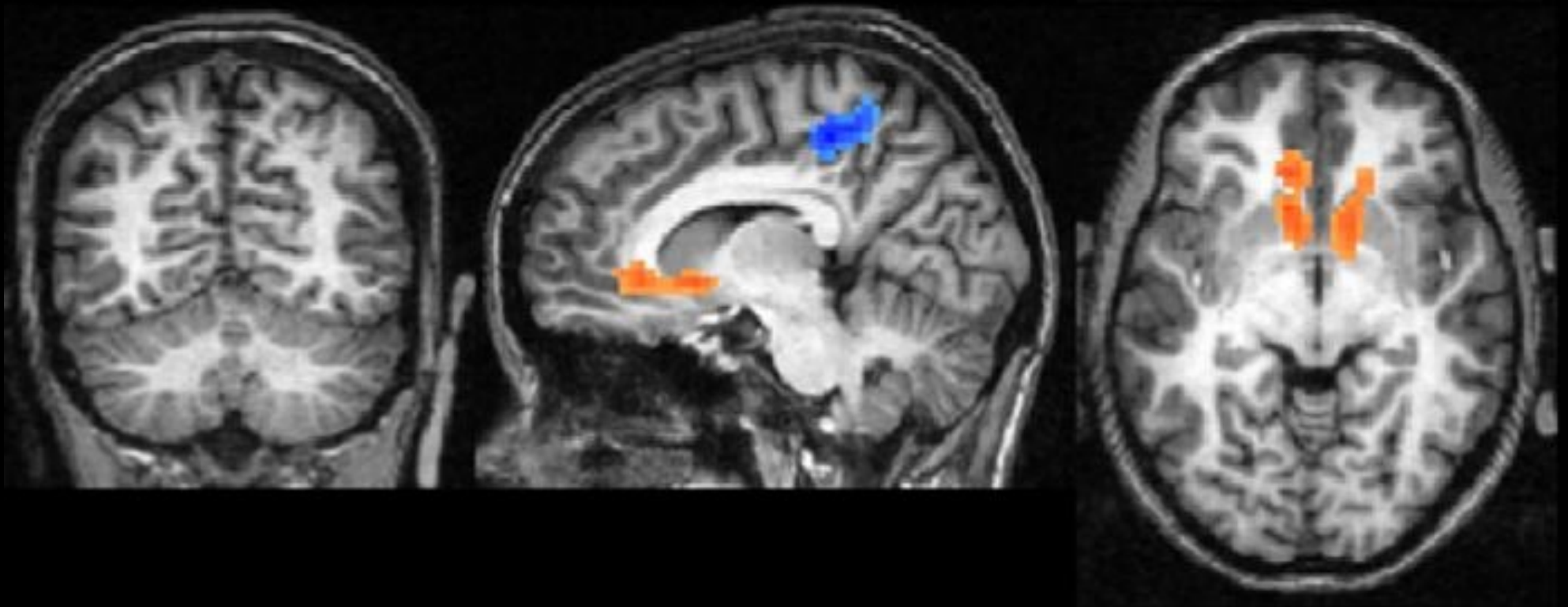
What is consciousness?

Awareness of internal sensations (sensory, emotion)



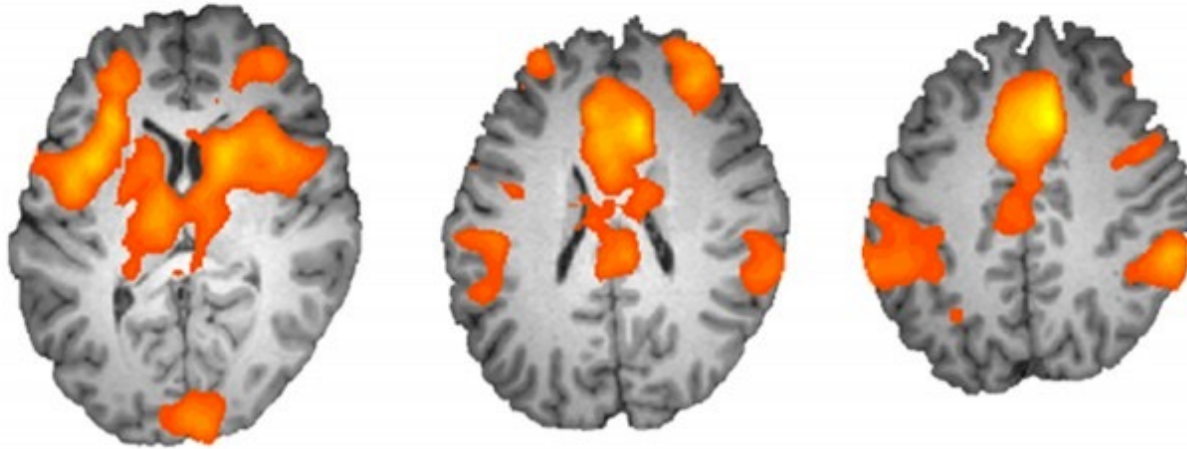


fMRI activations during painful stimulus.

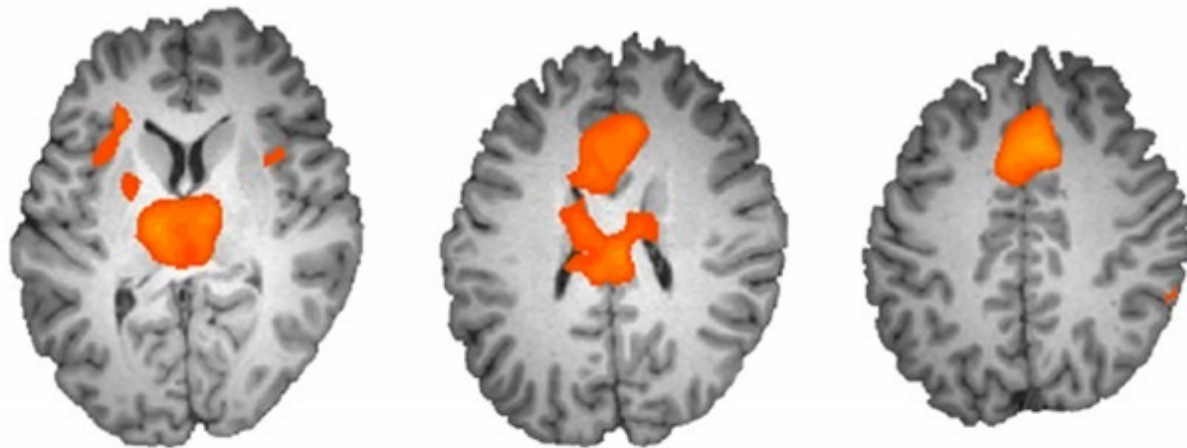


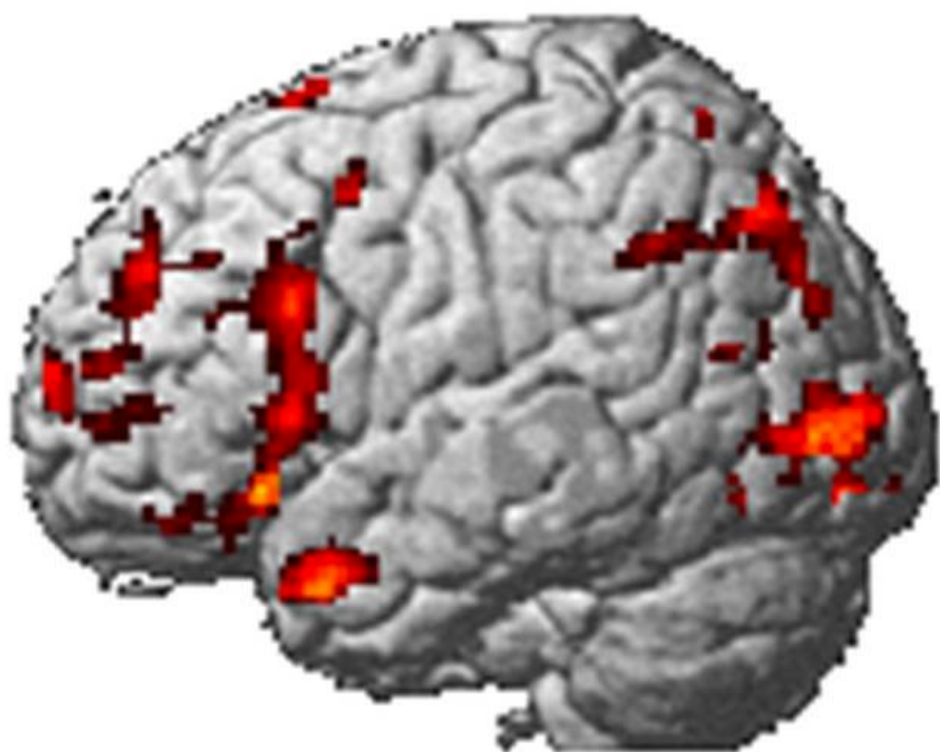
Hunger

Rested

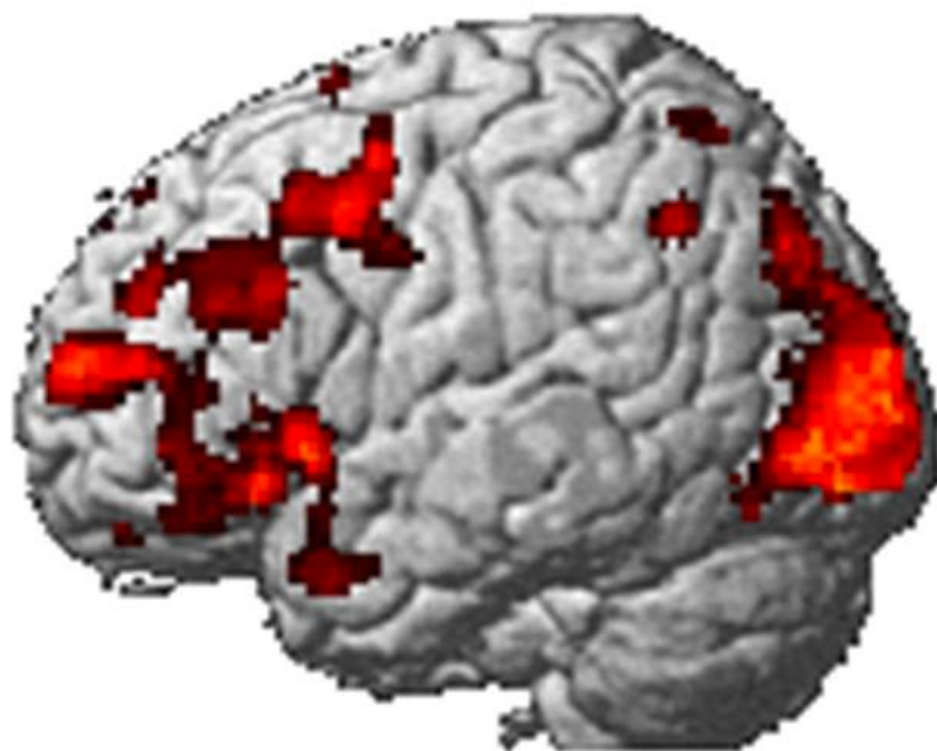


Tired





HAPPY

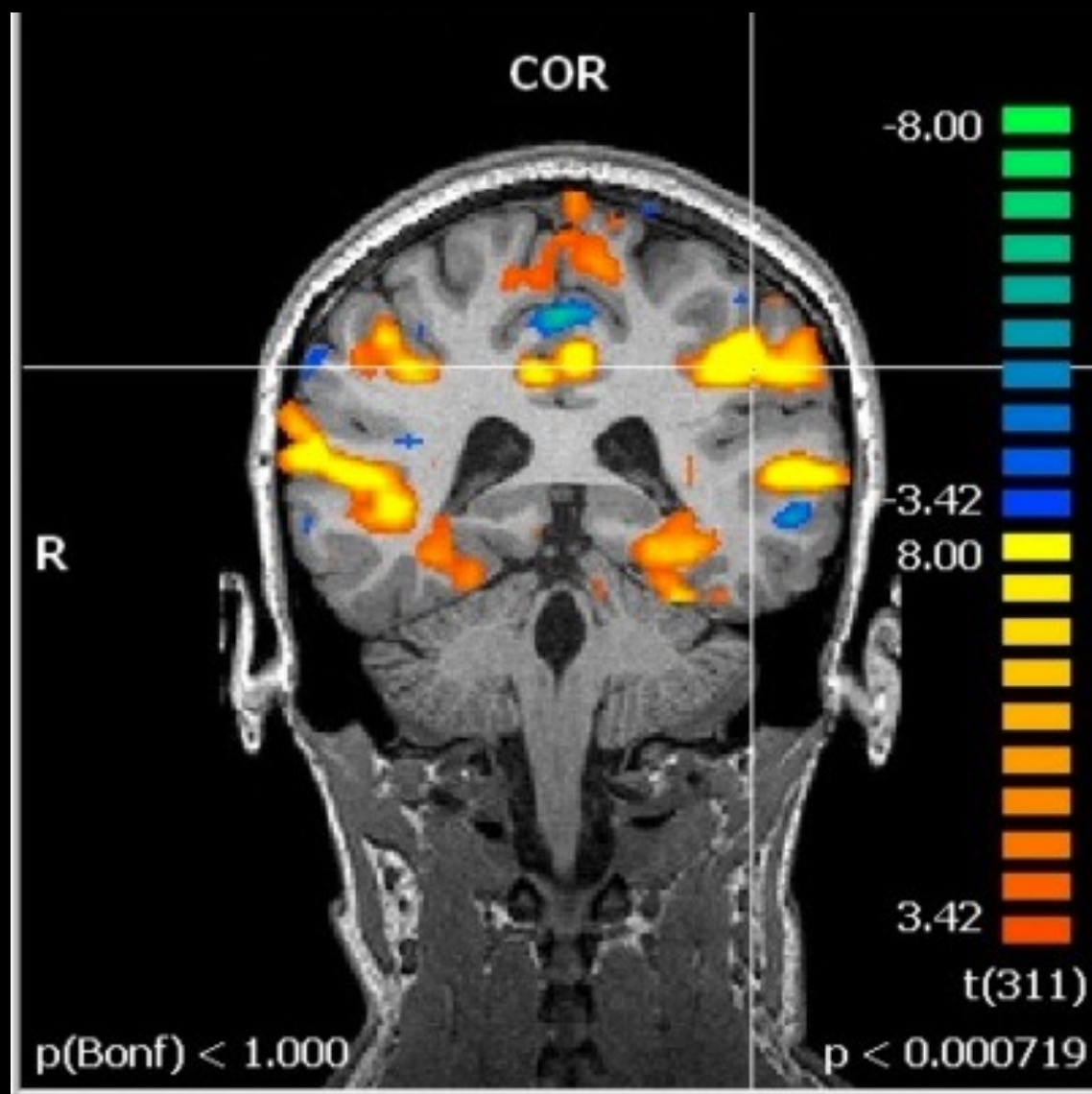


SAD

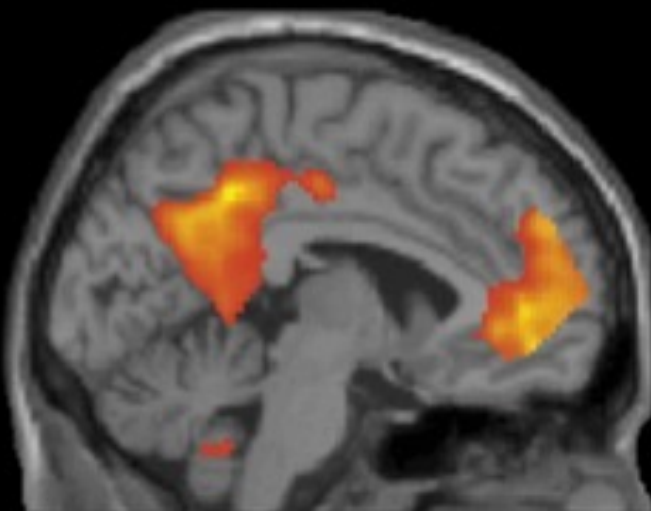
The Nature of Consciousness

What is consciousness?

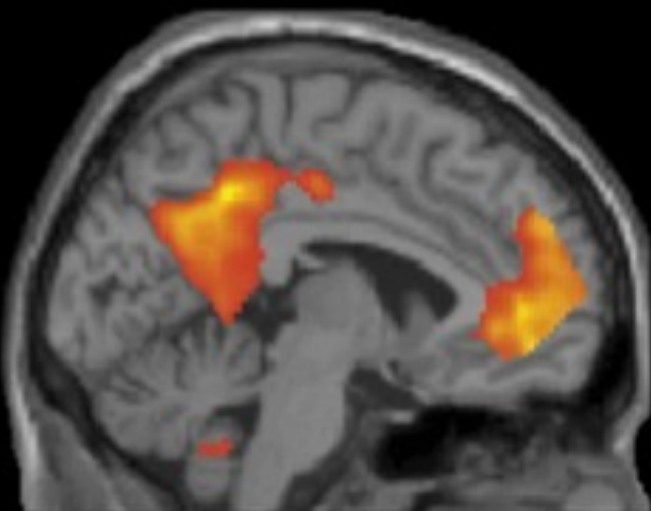
Awareness of yourself as a unique being having experiences (memory)



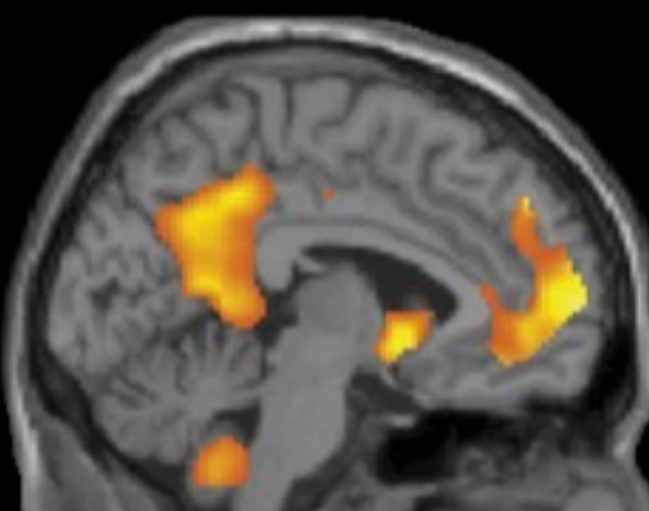
(a) REMEMBERING



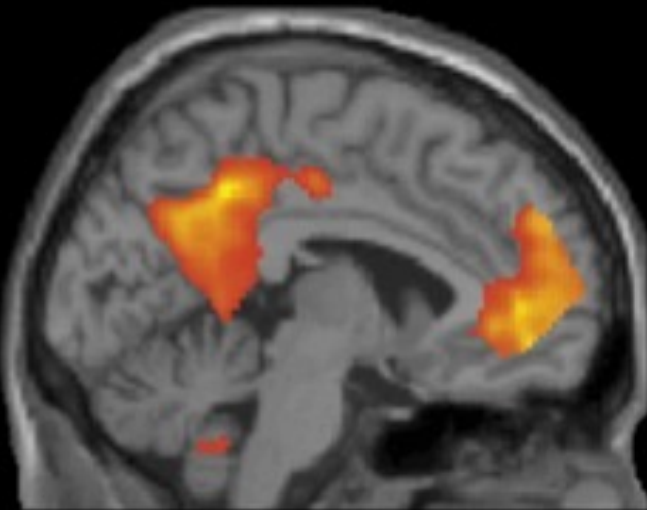
(a) REMEMBERING



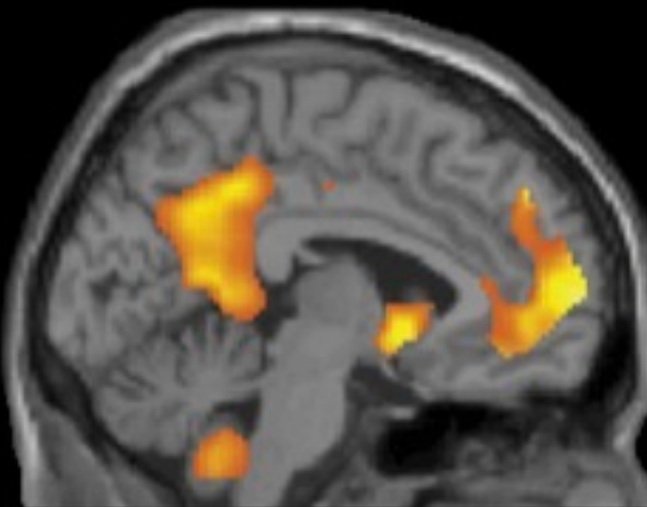
(b) PROSPECTION



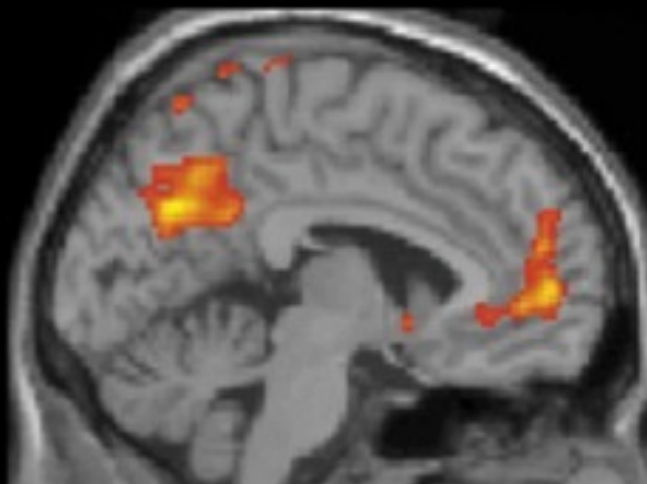
(a) REMEMBERING



(b) PROSPECTION



(c) THEORY OF MIND

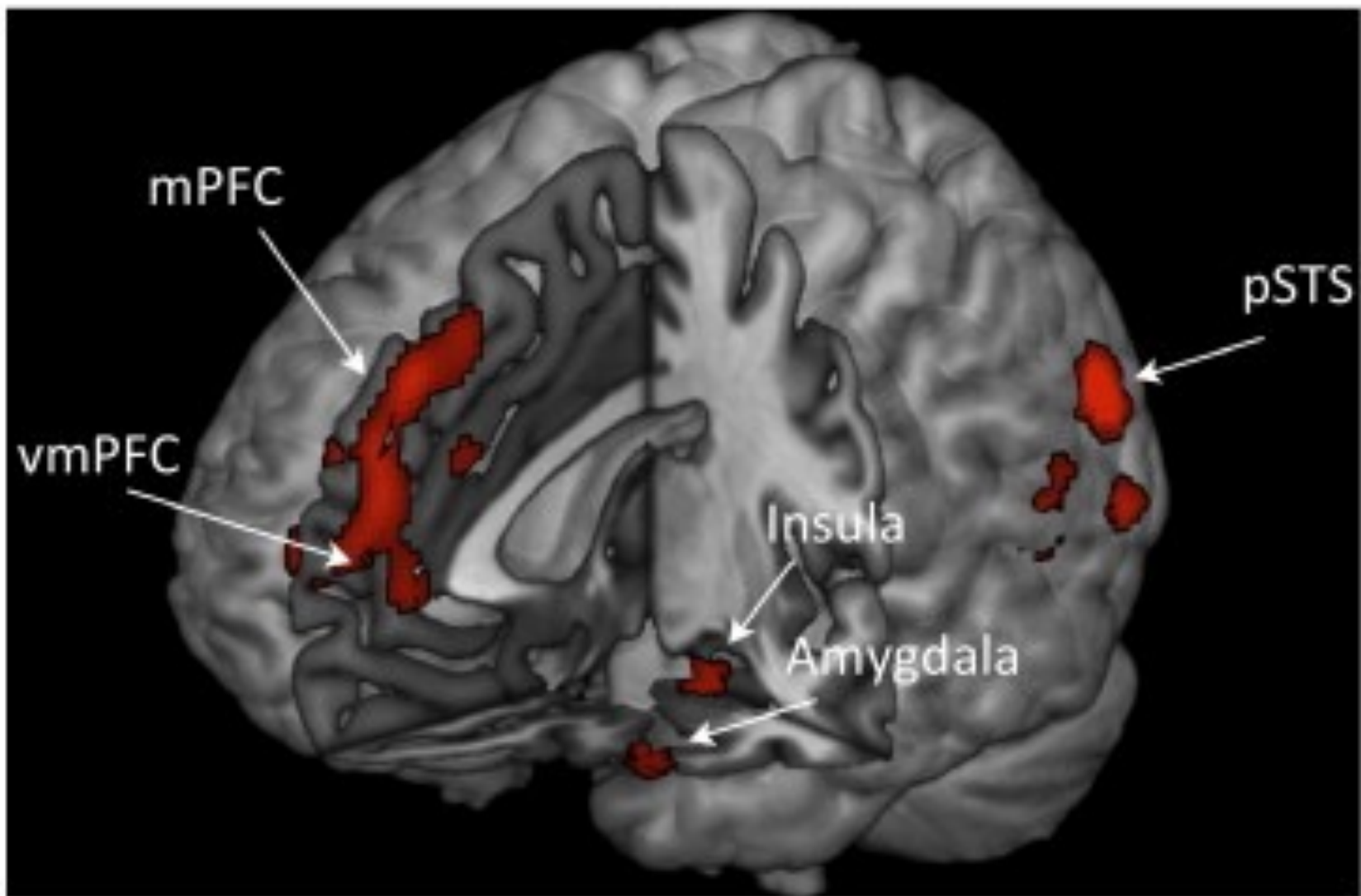


the ability to attribute mental states—beliefs, intents, desires, pretending, knowledge, etc.—to oneself and others and to understand that others have beliefs, desires, intentions, and perspectives that are different from one's own

The Nature of Consciousness

What is consciousness?

Awareness of your thoughts about these experiences



Self Reflection

You name it, there is a distinct pattern
of neural activity for it...

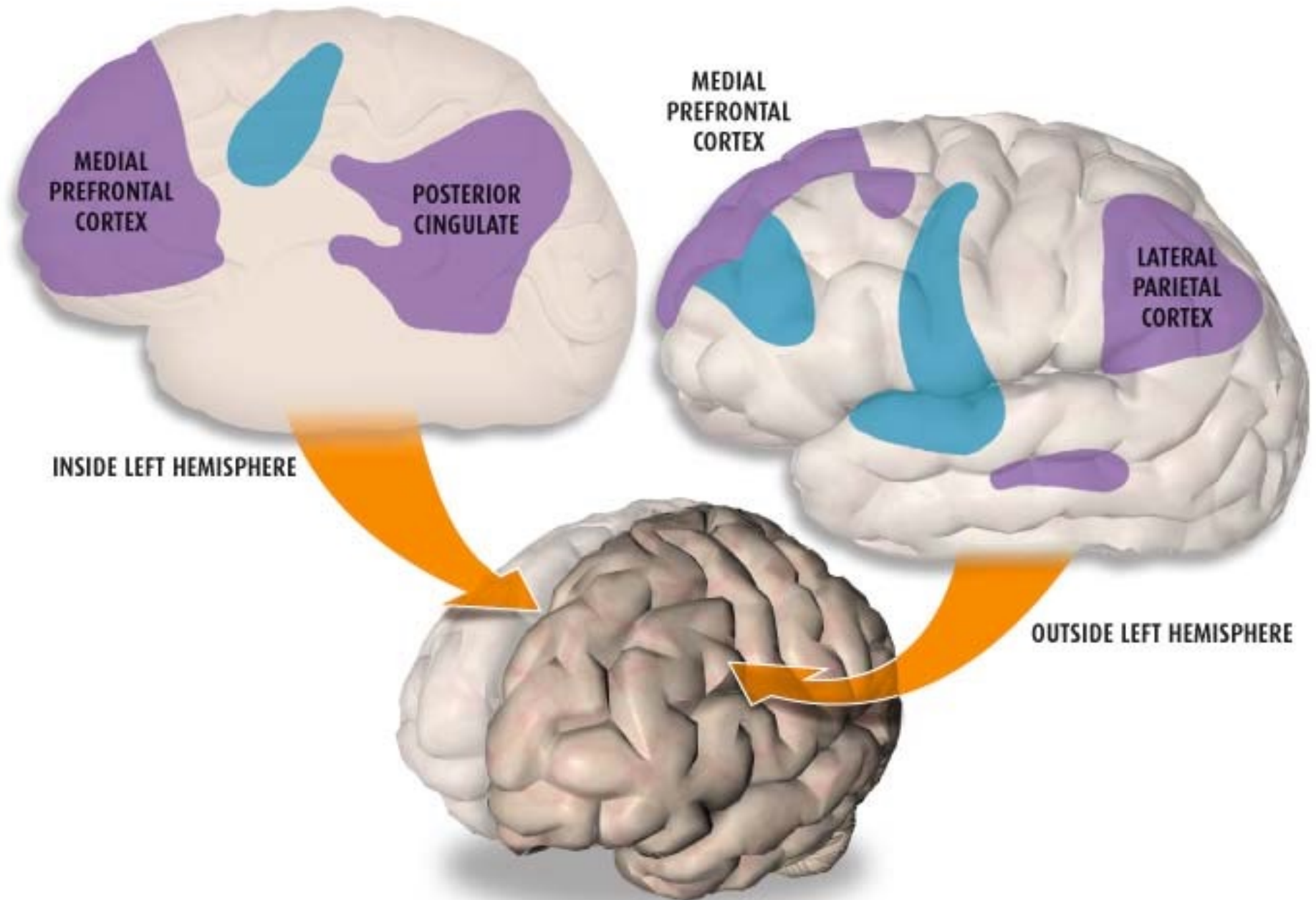
The ability to generate all of these
"unique" and "human" patterns of
activity is consciousness.

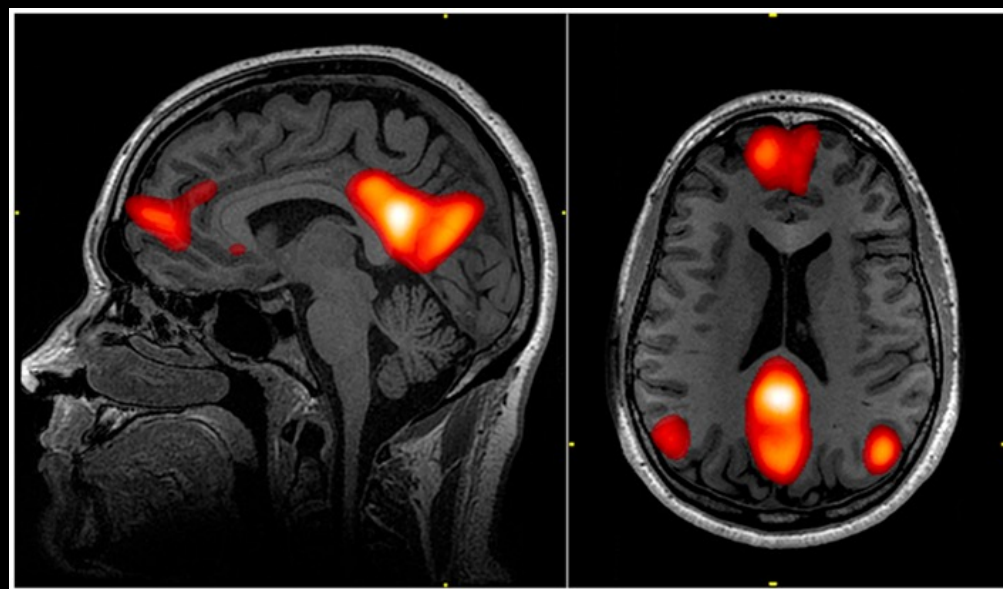
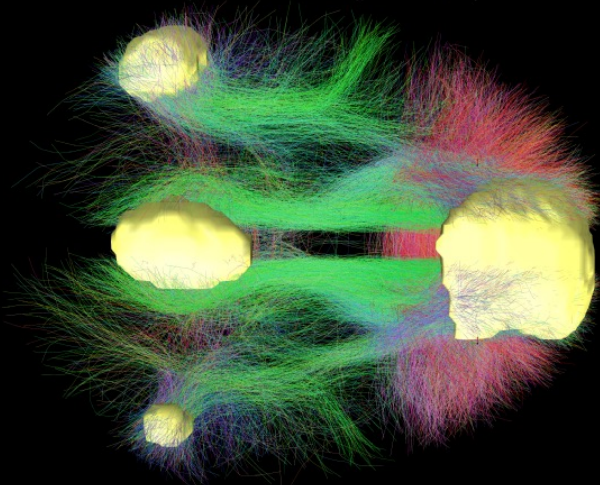
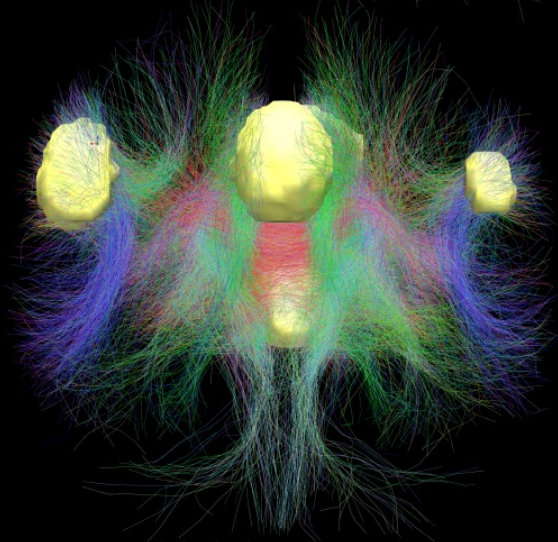
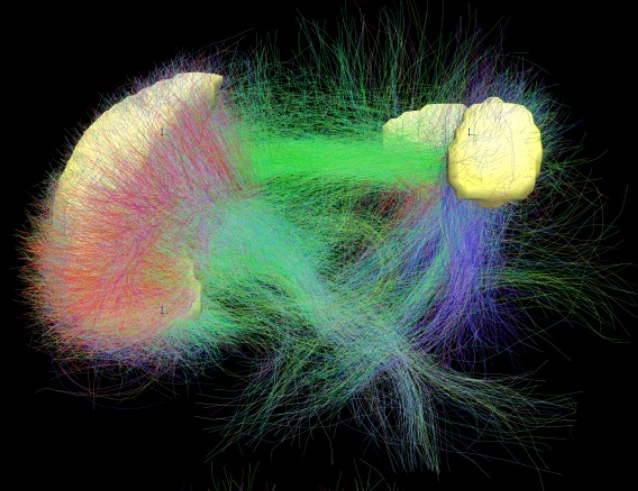
Default Mode Network

THE BRAIN IN NEUTRAL

When you switch off, a distinctive network of brain areas not involved in focused attention bursts into action

● Default network ● Areas involved in focused visual attention



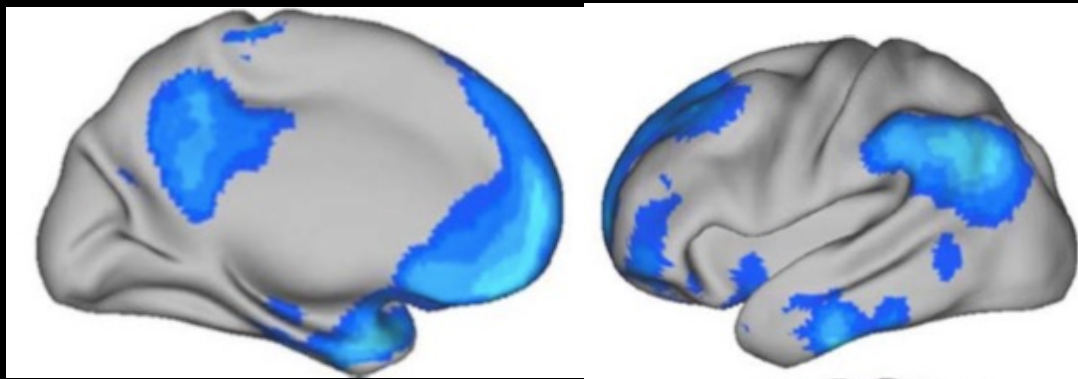


Default Mode Network

Two reliable characteristics:

- 1) shows greater BOLD activity during quiet restfulness (e.g. the resting state) than during active cognition.**

Internal Dialogue Hypothesis: the default network forms part of the neural substrates underlying autobiographical memory, social cognition, reflection, awareness



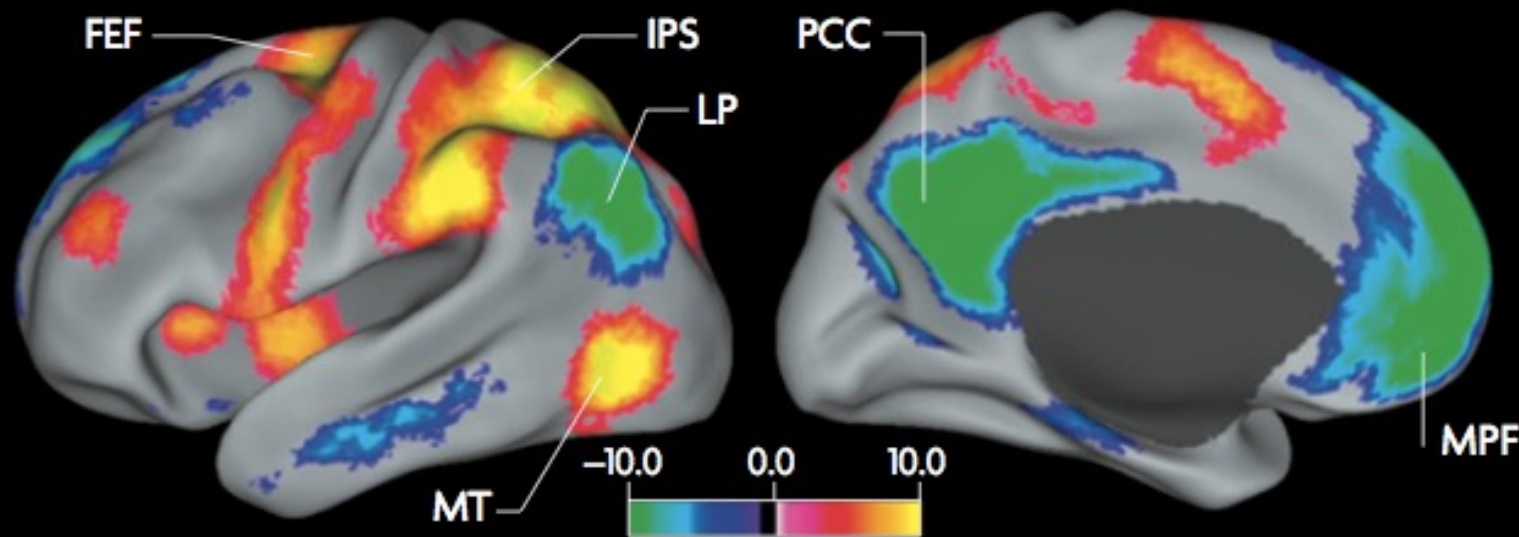
Raichle et al., 2001. **A default mode of brain function.** PNAS, 98 (2). 676-82.

Default Mode Network

Two reliable characteristics:

- 2) Activity is suppressed when individuals engage in goal-directed, task specific processing**

The default mode network is inherently anti-correlated with task positive networks



Frontal-Parietal Network

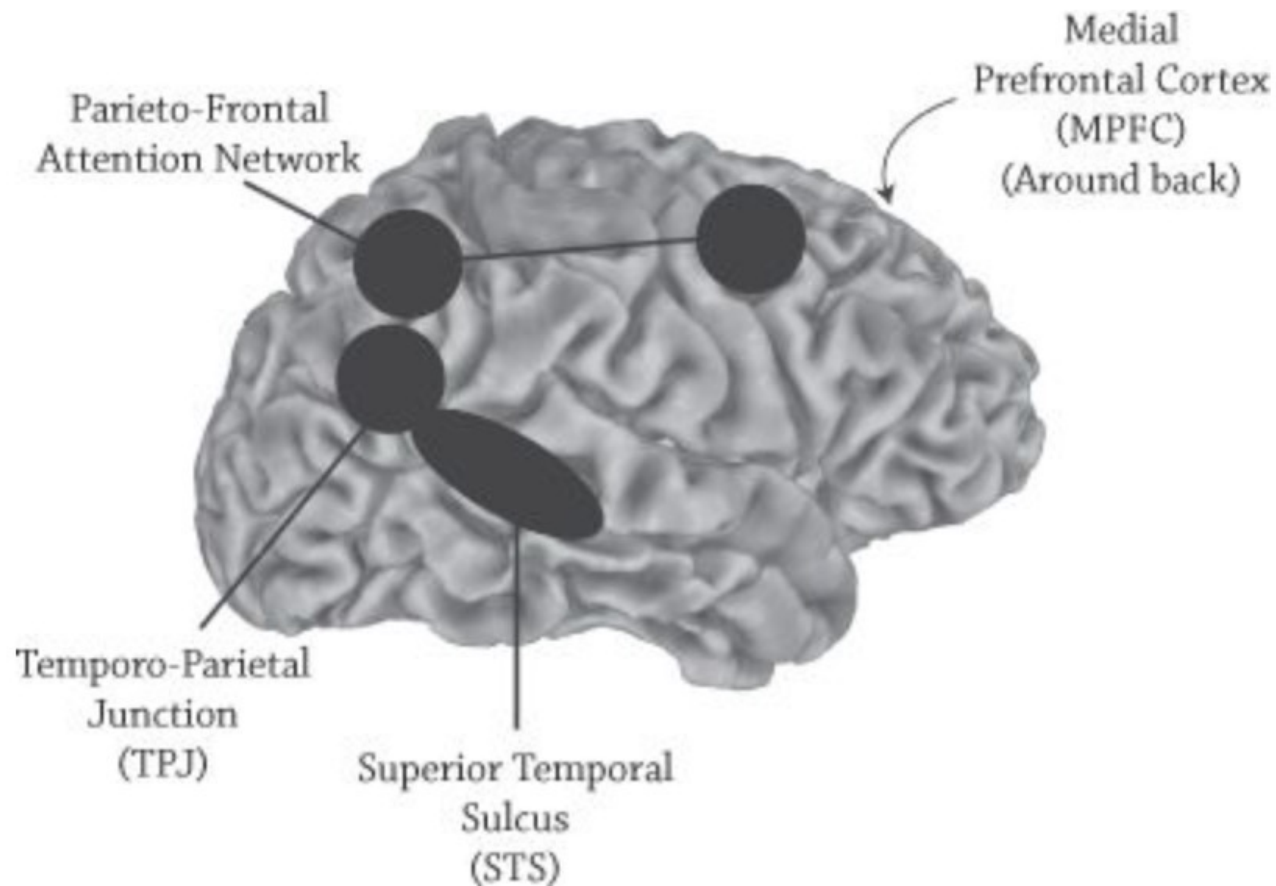


FIGURE 13.2

Some areas of the human brain relevant to social intelligence and to the control of attention.

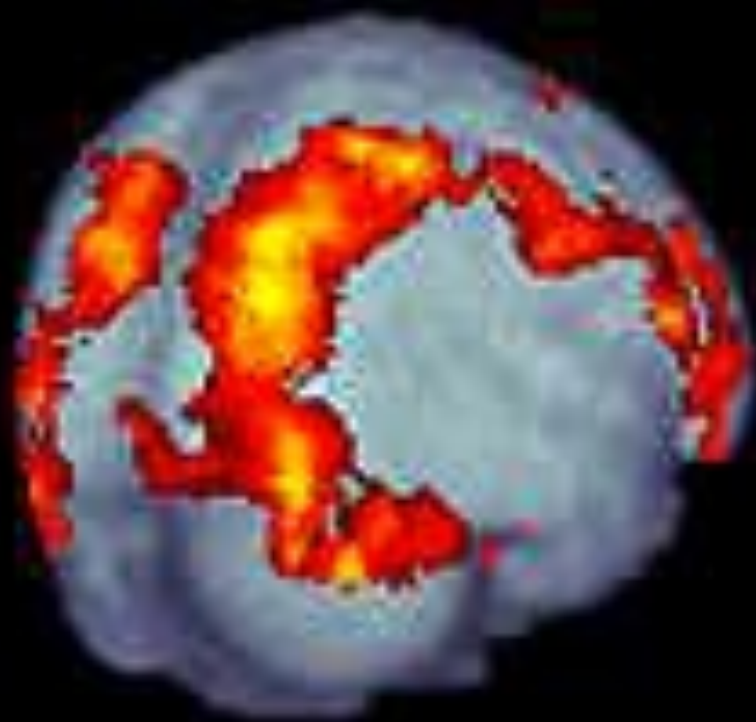
Individual Differences



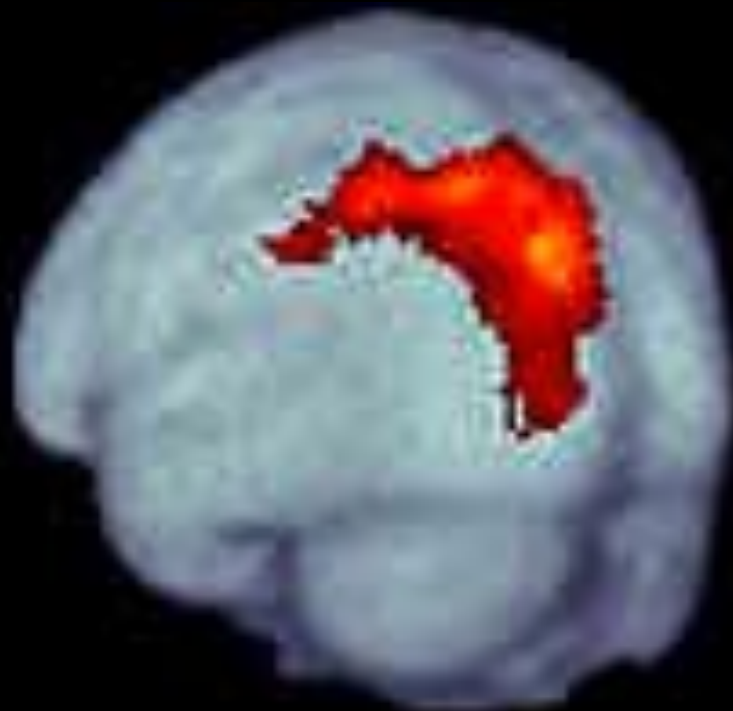
Alcoholic



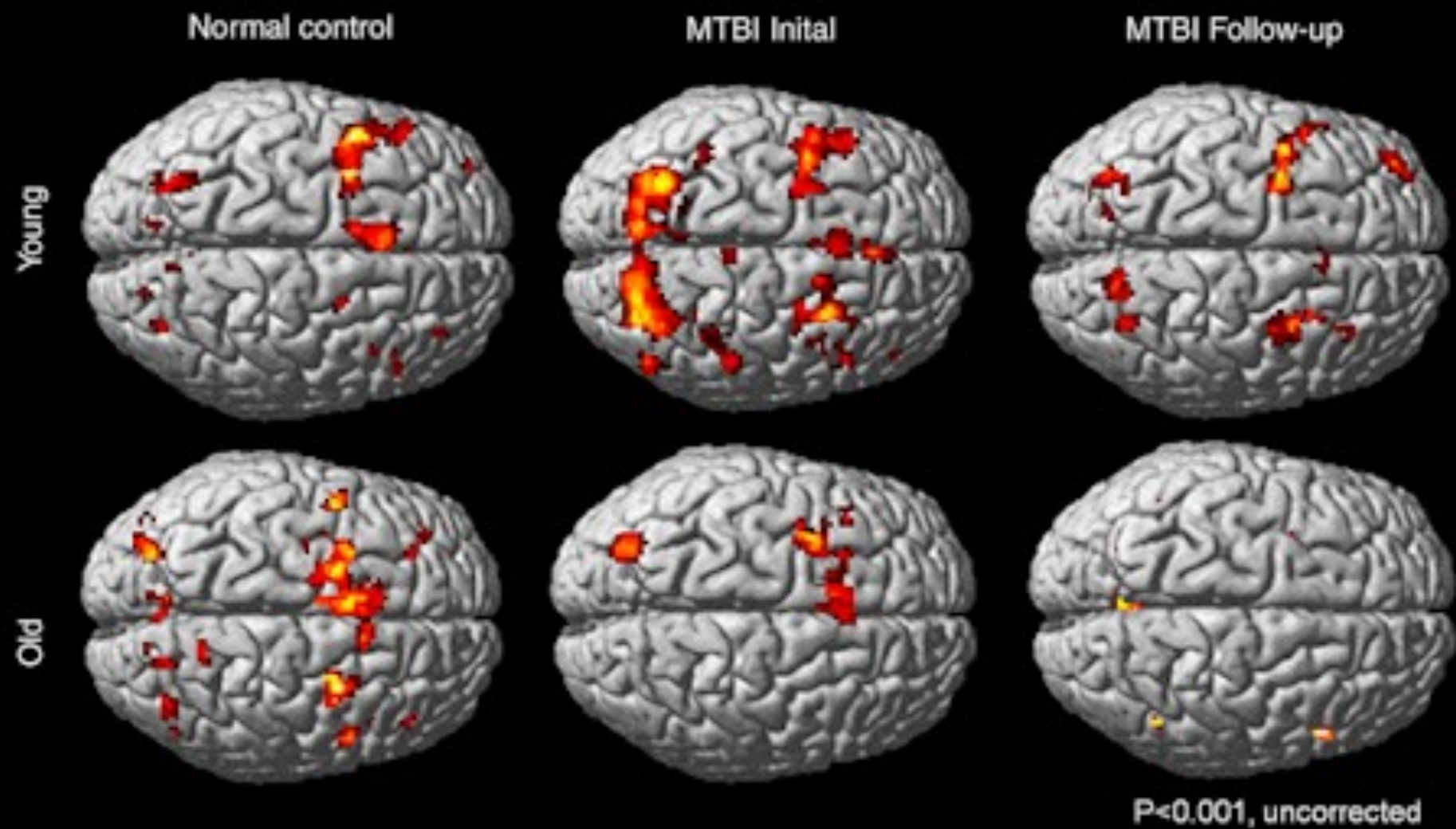
Normal
Control



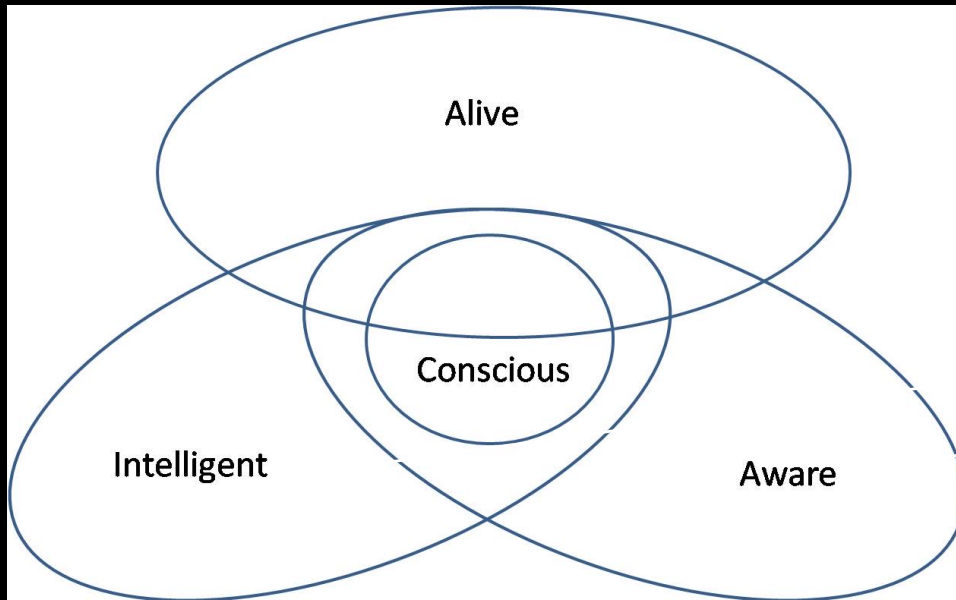
Control



ADHD



Consciousness:



- Consciousness requires
 - Intelligence (ability)
 - Awareness (state)
- Not necessary alive



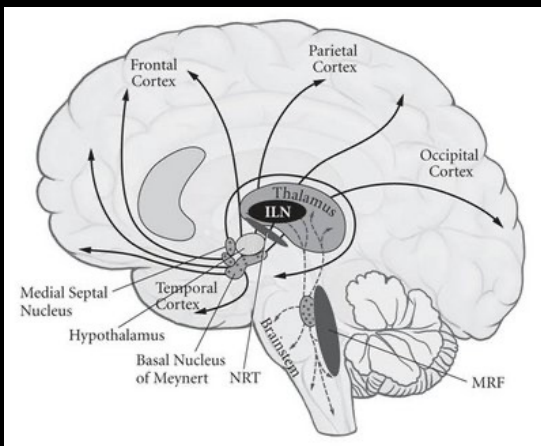
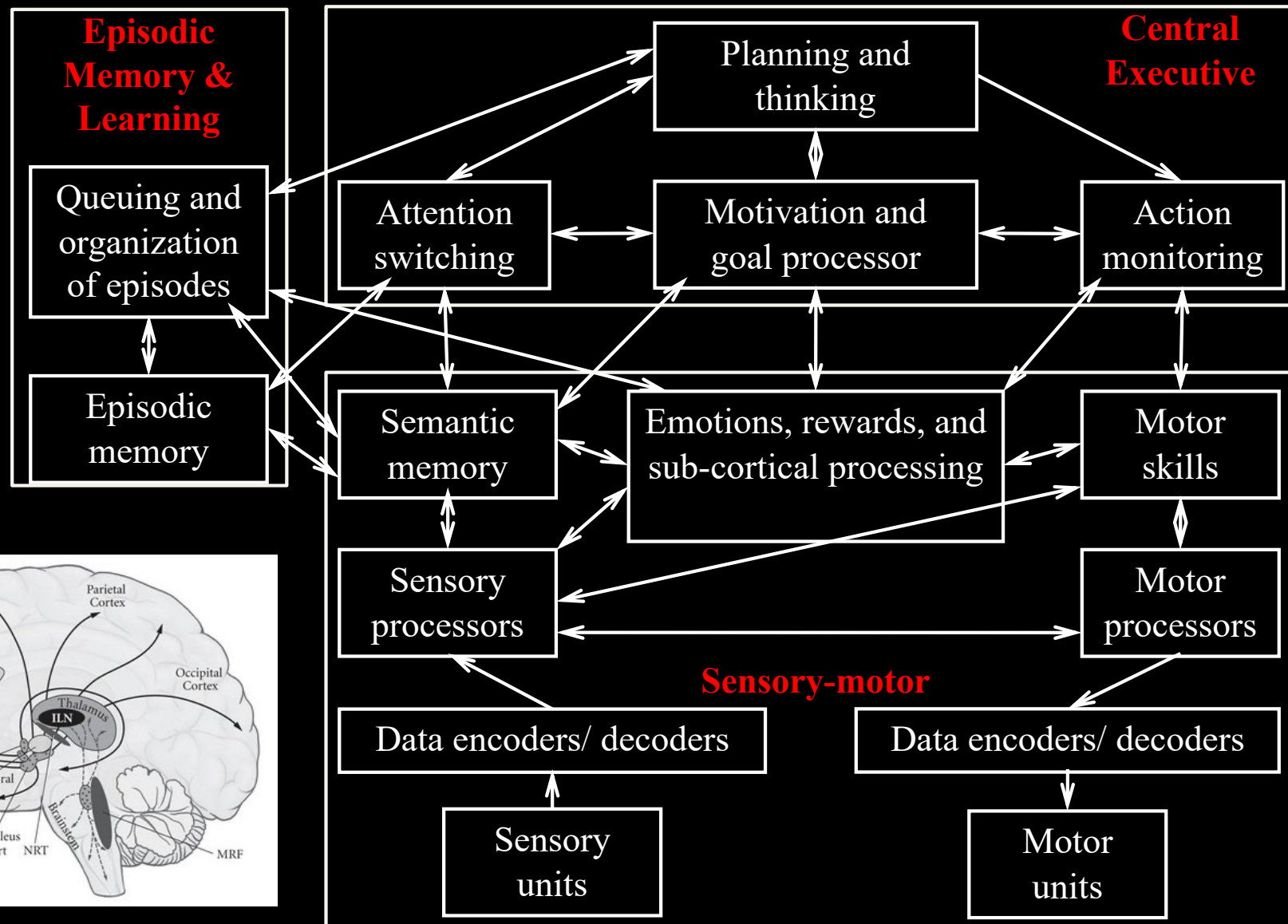




Consciousness: functional requirements

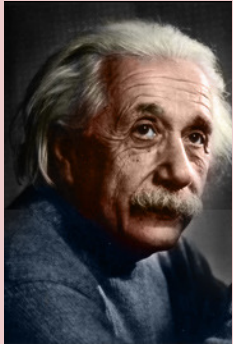


- ☐ *Intelligence (Memory)*
- ☐ *Central Executive (Badelley)*
- ☐ *Attention and Attention Switching (Badelley)*
- ☐ *Perception (Previous)*
- ☐ *Cognitive Action Control (Next)*

Consciousness



Evolution and consciousness

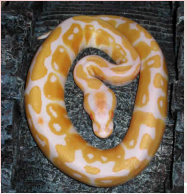



– appearance and evolution of consciousness

| Living Being | Evolutionary traits | Analogous feasibility in machines |
|---|---|-----------------------------------|
|  <p>Human Beings</p> | <ul style="list-style-type: none"> ▪ Fully developed cross-modal representation ▪ Sensory capabilities: auditory, taste, touch, vision, etc. ▪ Pre-frontal cortex: planning, thought, motivation | <p>Impossible at present</p> |
|  <p>Hedgehog (earliest mammals)</p> | <ul style="list-style-type: none"> ▪ Cross-modal representation ▪ Sensory capabilities: auditory, touch, vision (less developed), etc. ▪ Small frontal cortex | <p>Impossible at present</p> |
|  <p>Birds</p> | <ul style="list-style-type: none"> ▪ Primitive cross-modal representation ▪ Sensory capabilities: auditory, touch, vision, olfactory. ▪ Primitive associative memory | <p>Associative memories</p> |



Evolution and consciousness

– absence of consciousness

| Living Being | Evolutionary traits | Analogous feasibility in machines |
|---|--|--|
|  <p>Reptiles*</p> | <ul style="list-style-type: none"> ▪ Olfactory system ▪ Primitive vision | Computer vision (emerging) |
|  <p>Hagfish (early vertebrate)</p> | <ul style="list-style-type: none"> ▪ Primitive olfactory system ▪ Primitive nervous system | Artificial neural networks |
|   <p>Lower level animals (hydra, sponge, etc.)</p> | <ul style="list-style-type: none"> ▪ Sensory motor units ▪ Point to point nervous system | Mechanical or electronic control systems |
| * inconclusive\consciousness in transition | | |

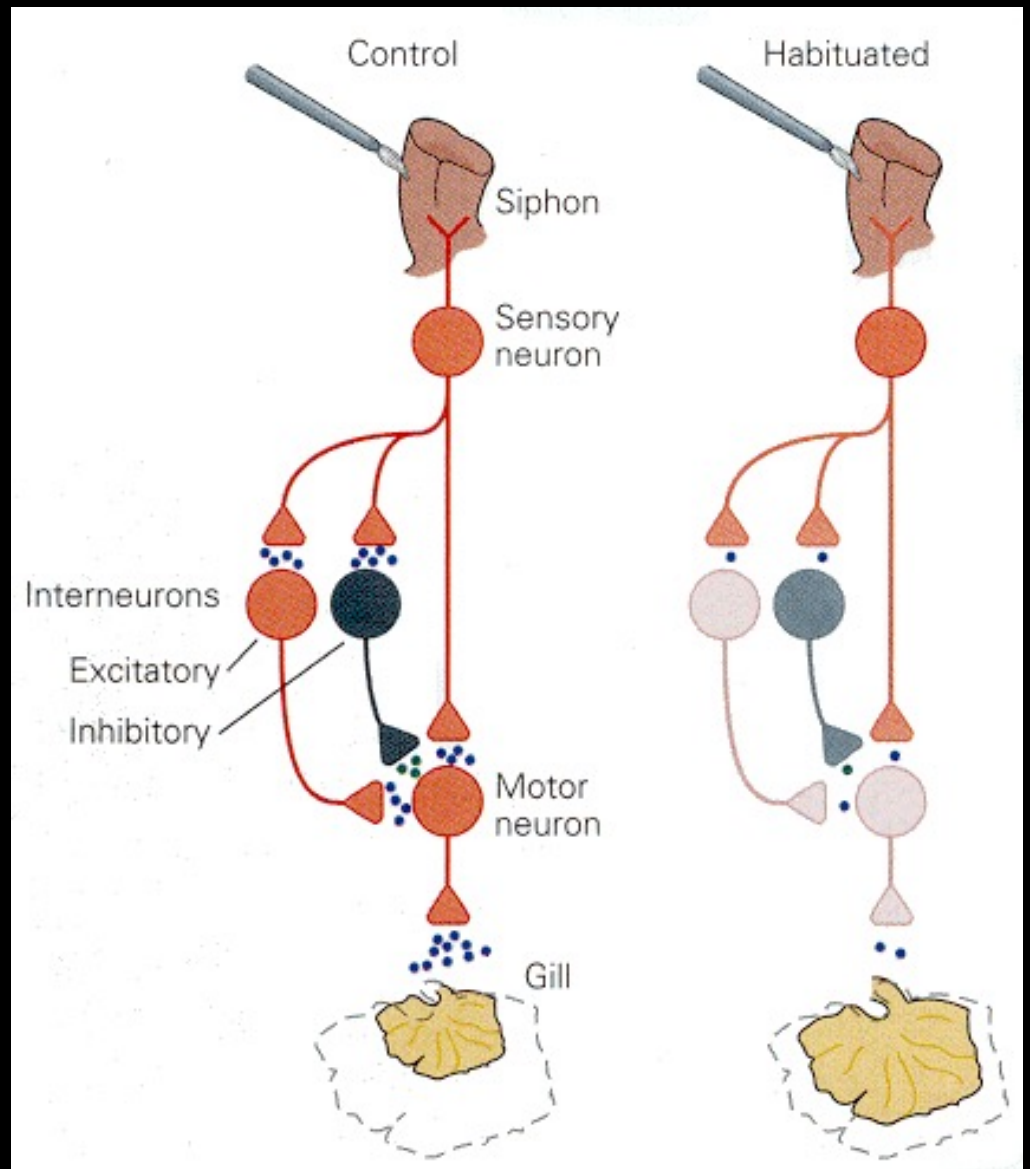
Emergence of Consciousness



| Week | Human Fetus brain development |
|------|--|
| 6 | Cortical cells come at the correct position |
| 20 | Cortical region is insulated with myelin sheath |
| 25 | Development of local connections between neurons |
| 30 | Fetus' brain generates electrical wave patterns |



Are animals conscious?





Choice and Free Will



Summary

Consciousness emerges from complex patterns of neural activity – there is no "black box" or "soul" – at least from a neuroscience perspective.

I am sorry.