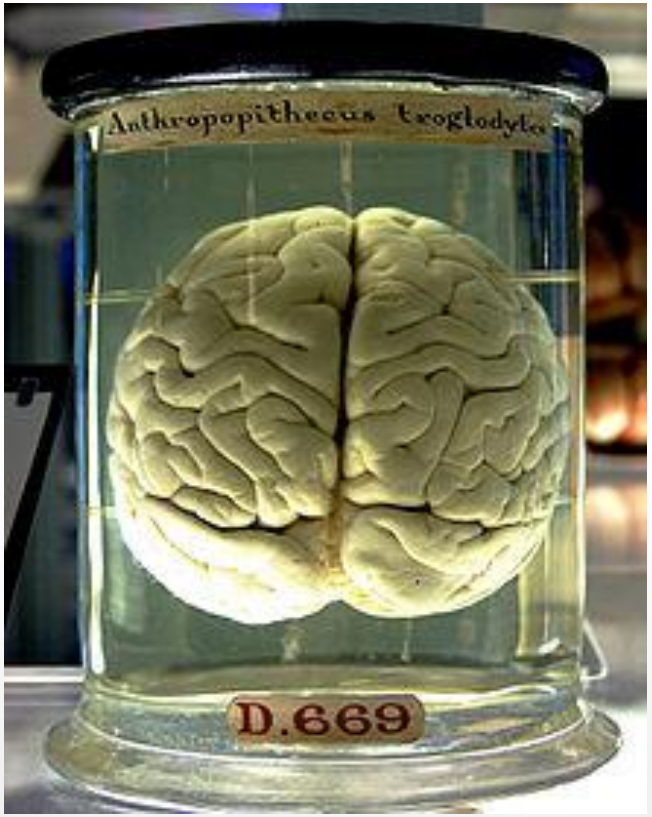
# Emotions and The Brain



# Why study the brain?

Given the proliferation of other methods to study emotion, why look at the brain?

- Brain seems to be necessary for emotions and their expressions!
- With the right methods, could give us "objective" measures of certain things implicated in emotion
  - Circulating brain hormones
  - Neural activation
  - Online temporal responses

# How do we look at what is happening in the brain?

- Animal models
  - Lesion studies
  - Genetic engineering
- Human patients with convenient damage
  - Phineas Gage (Frontal lobe)
  - HM (Hippocampus, amygdala, Para-h gyr)
  - Awake brain surgery
    - Deep brain stimulation for depression
    - Epileptic patients
    - Brain tumors
- Non-invasive procedures
  - fMRI
  - EEG

# Animal Models

- Mostly Rodents, Primates
- Can use genetic engineering to create "models" of disorders like Schizophrenia, Autism, Depression
  - Use behavioral tasks to compare functioning to "normal" animals
  - Apply drug therapies or other treatments to test efficacy in animals before human research is done
  - Neurohistology to examine structure and function of brain during development or in response to experimental manipulation
- Lesion Studies
  - Surgically create brain injuries
  - Look at behavioral effects

# Human Neuroscience

Studying humans gives us the best information about human functioning.

BUT, cannot mimic the same experiments in animal models (no experimental manipulation), so the scope of conclusions are limited.

Interviewing/experimenting on conveniently damaged patients is great, but can only have postmortem confirmation of actual damage location, and some injuries can obscure effects due to difficulty with speech, motor skills or understanding of questions.

PET scans (positron emission tomography)

Inject patient with radioactive material and trace blood flow via photon emission

- Pros
  - Good spatial resolution
- Cons
  - RADIOACTIVE!
  - Poor temporal resolution

TMS (transcranial magnetic stimulation)

Uses magnets to stimulate brain areas

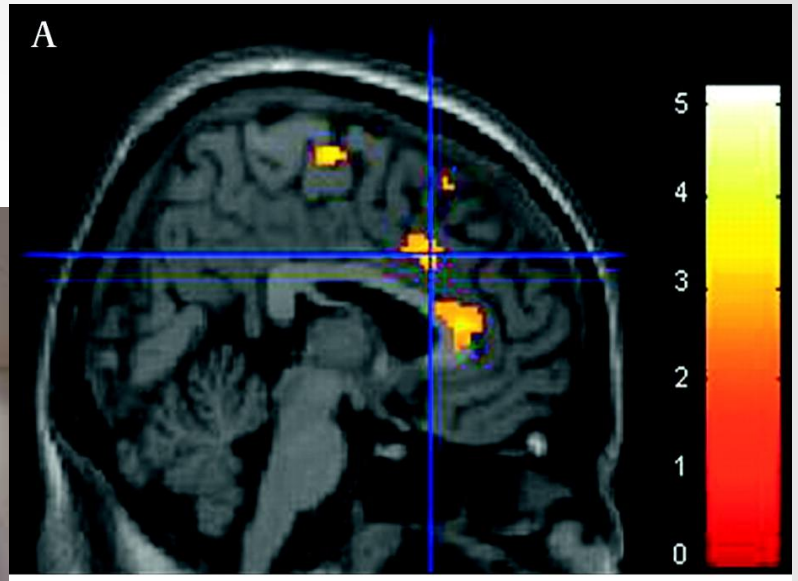
- Pros
  - Experimental manipulation (can CAUSE activation)
- Cons

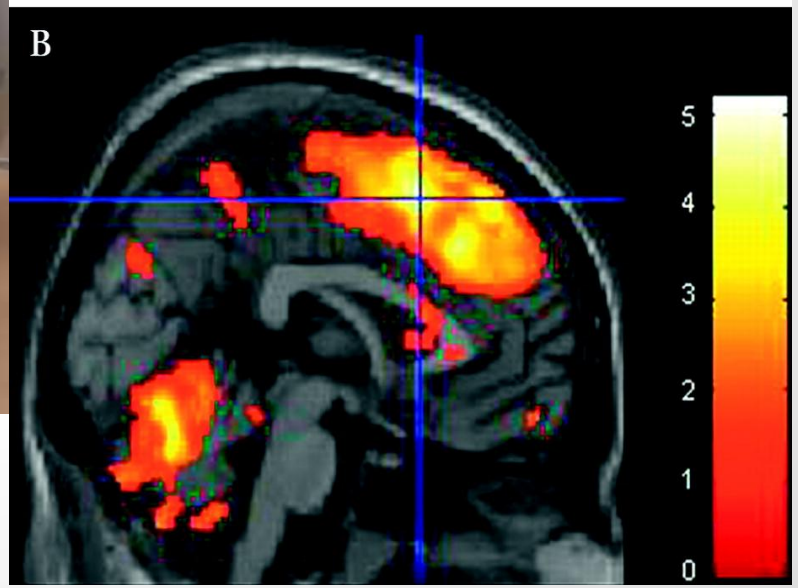
# More common procedures

Obviously, none of these are DIRECT measures of activity, so results are only a proxy of activation - but they are as close as we can get!

fMRI (functional magnetic resolution imaging)

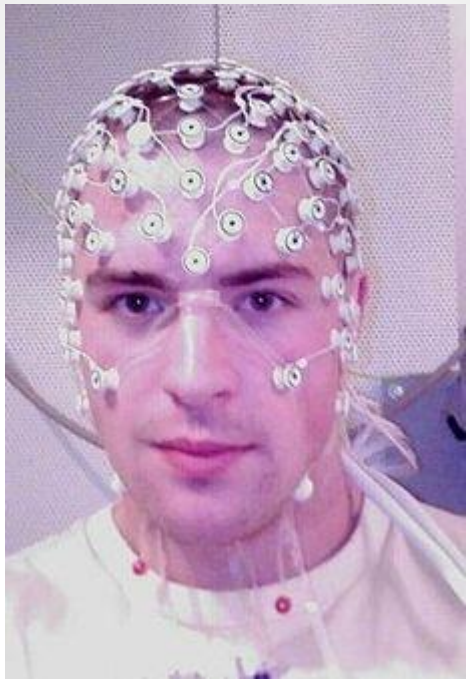
- Pros
  - Becoming increasingly popular
  - Very good spatial resolution
  - Very controlled environment
- Cons
  - Not as good temporal resolution
  - Procedure takes a long time

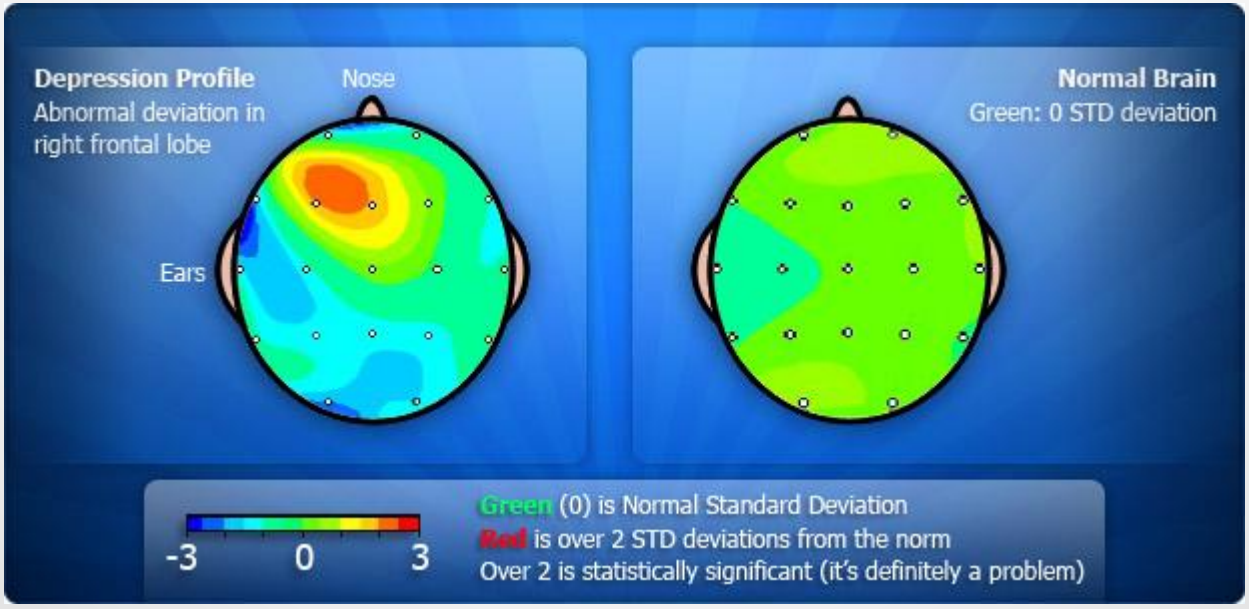

A
5
4
3
2
1
0


B
5
4
3
2
1
0

# EEG (electroencephalograph)

- Pros
  - Cheaper than fMRI
  - Less equipment
  - More portable/ patients can move around
  - Usable on claustrophobic and otherwise difficult patients (kids, for example)
- Cons
  - Poorer spatial resolution
  - Can take a long time to set up
  - May be uncomfortable




Depression Profile
Abnormal deviation in right frontal lobe
Nose
Ears
Normal Brain
Green: 0 STD deviation
-3
0
3
Green (0) is Normal Standard Deviation
Red is over 2 STD deviations from the norm
Over 2 is statistically significant (it's definitely a problem)

# Areas of Brain Activation for Specific Emotions

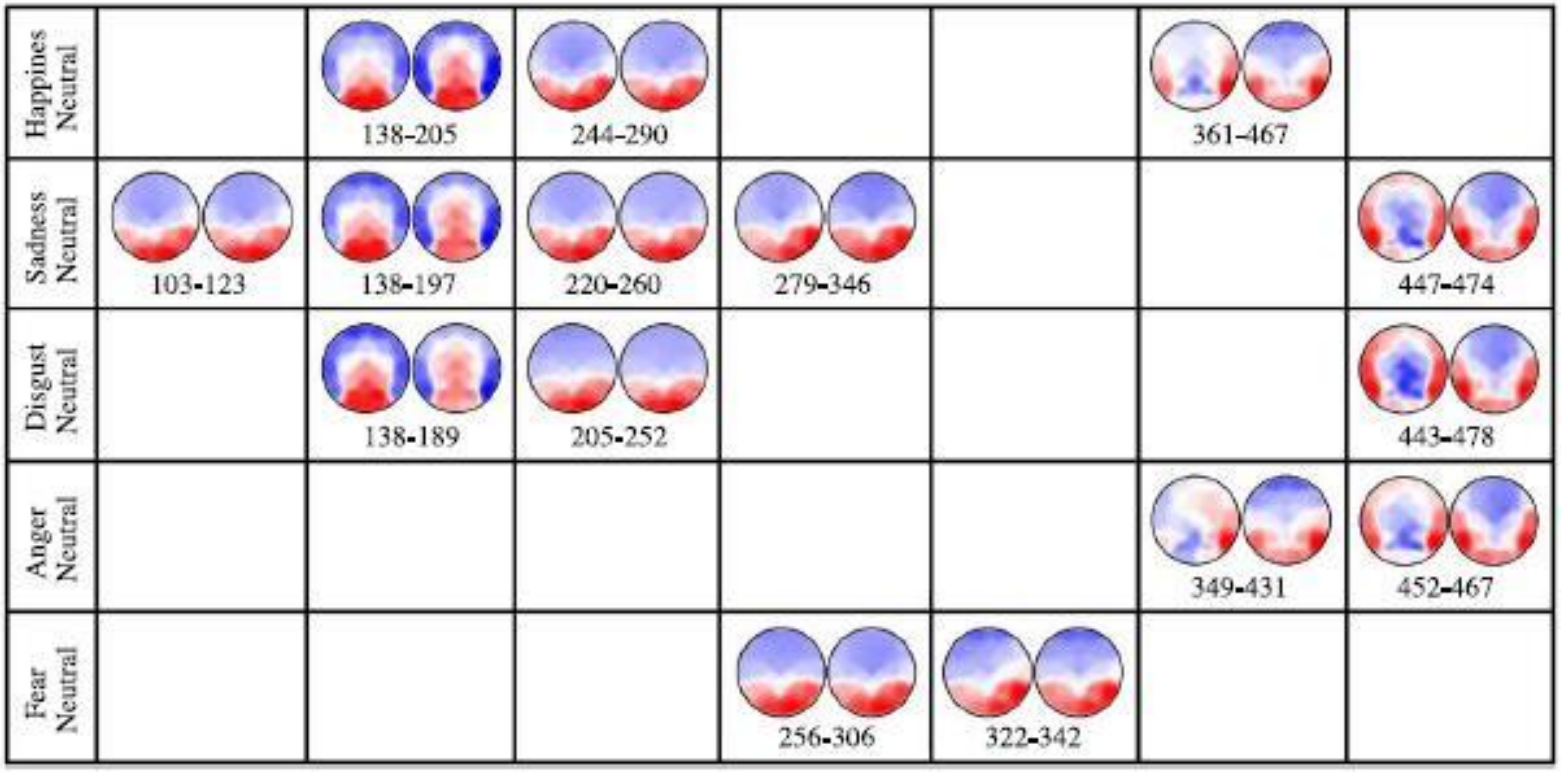



Fig. 4. Average reference, grand average topographic maps of scalp electric potential differences for each emotion condition and for the neutral condition across the 17 subjects. Each pair of maps within a box corresponds to a time segment of significant difference between the emotion condition (left map) and the neutral condition (right map). The time arrangement of these boxes is schematic, roughly following the exact display of the segments in Fig. 3; the numbers indicate exact time segment borders in milliseconds. Head seen from above, left ear left; red = positive, blue = negative potential. All maps are scaled with respect to their maximum and minimum.

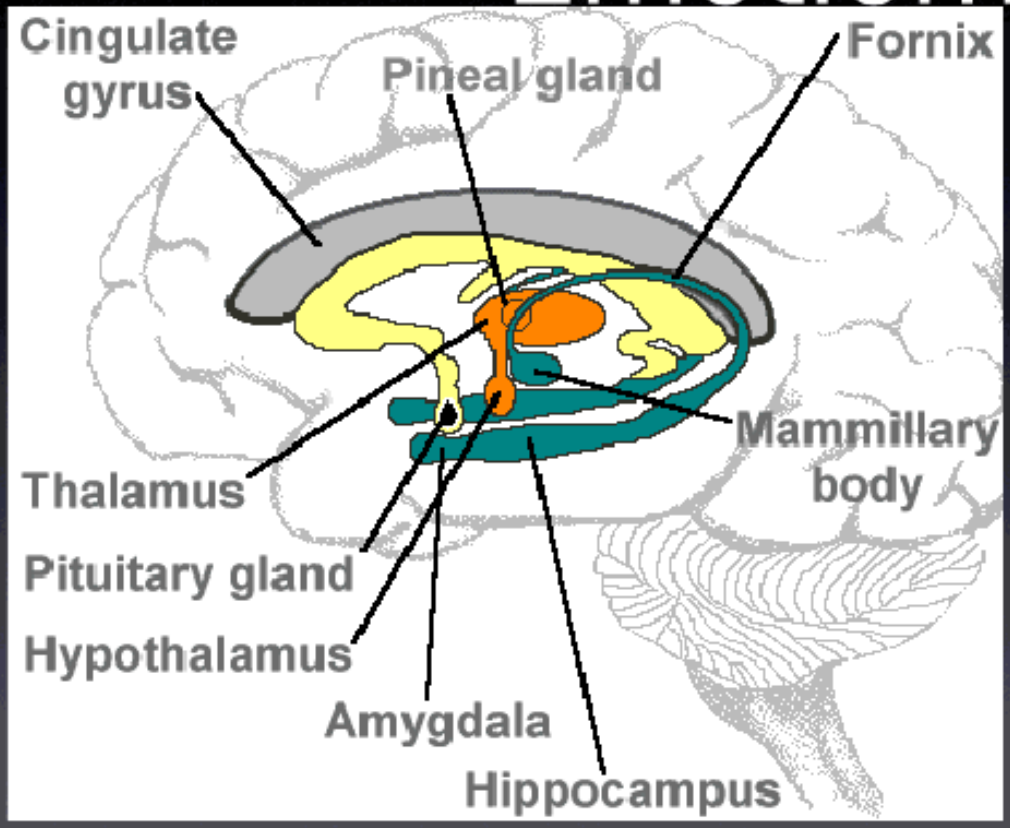
# So where ARE emotions in the brain?

- The triune brain
  - Paul Maclean's "3 brains"
    - The reptilian brain (primitive survival functions, 3 Fs)
    - Limbic/paleo-mammalian (most emotions)
    - Neocortex (reasoning)

Idea that the "older" parts of the brain control more basic functions, while "newer" parts are involved in processing, regulation, and expression of emotions

- Recent developmet of language centers and

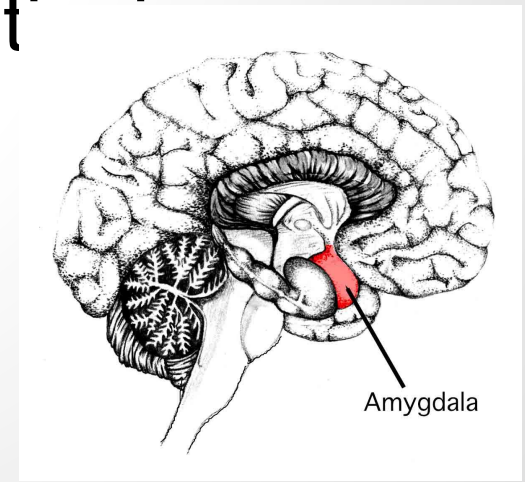
# "Limbic" System: Underpinnings of Emotion?




- Some structures not involved at all in emotion
- Some not specific to emotion

# Amygdala

- Fear responses
  - Evaluation of input from all sensory modalities
  - Output to the brainstem as well as "slower" areas
- Memory consolidation via LTP
  - Not storage, but imperative in transferring info into long-term memories
- Appetitive and aversive conditi
  - Emotional learning
  - Pavlovian conditioning
- Social interaction
  - Autism
  - Depression, anxiety, phobias
  - Larger social networks = larger amygdala

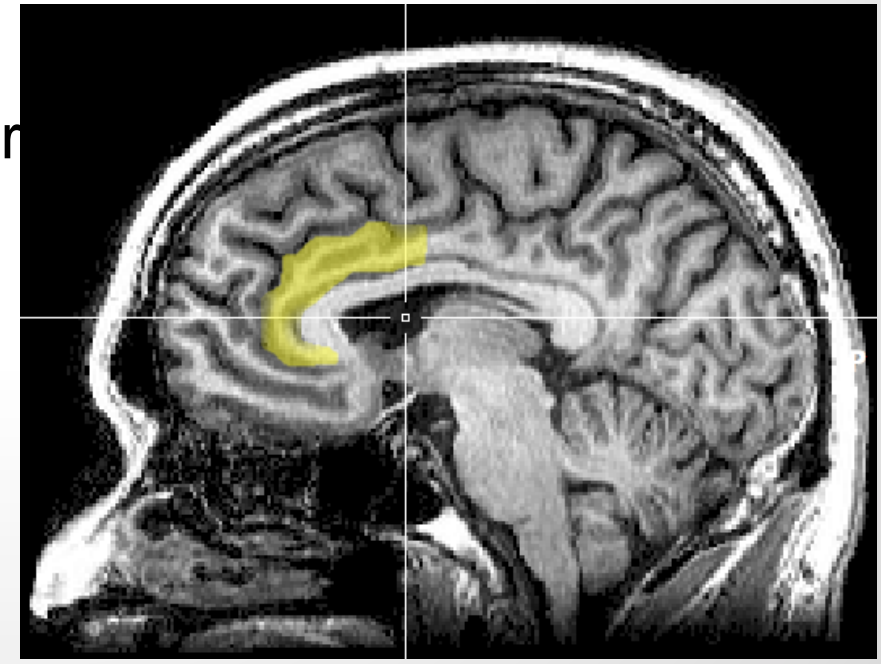


# Kluver-Bucy Syndrome

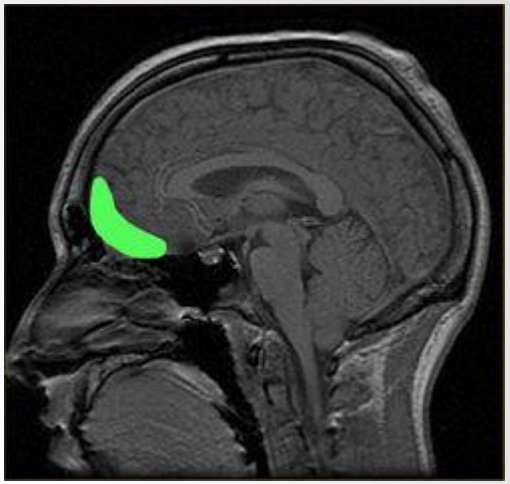
- Originally seen in monkeys with amygdala damage
  - Tameness and lack of fear
  - Indiscriminate eating
  - Increased and inappropriate sexual behavior
  - Tendency to attend and react to visual stimuli
  - Oral examination of objects
- Amygdala and stereotyping
  - Can we realte amygdala activity to prejudice?
    - Fear, but not disgust, increases amygdala activation
- Two studies about amygdala and prejucice
  - Results showed increased amygdala activation in those with more unconcsious prejucide, but is this

# Anterior Cingulate Cortex

- Associated with empathy, consciousness, emotional awareness
  - Schizophrenics shown to have lower ACC function and difficulty in dealing with conflicting spatial locations
  - ADHD
  - OCD
  - Social Anxiety Disorder



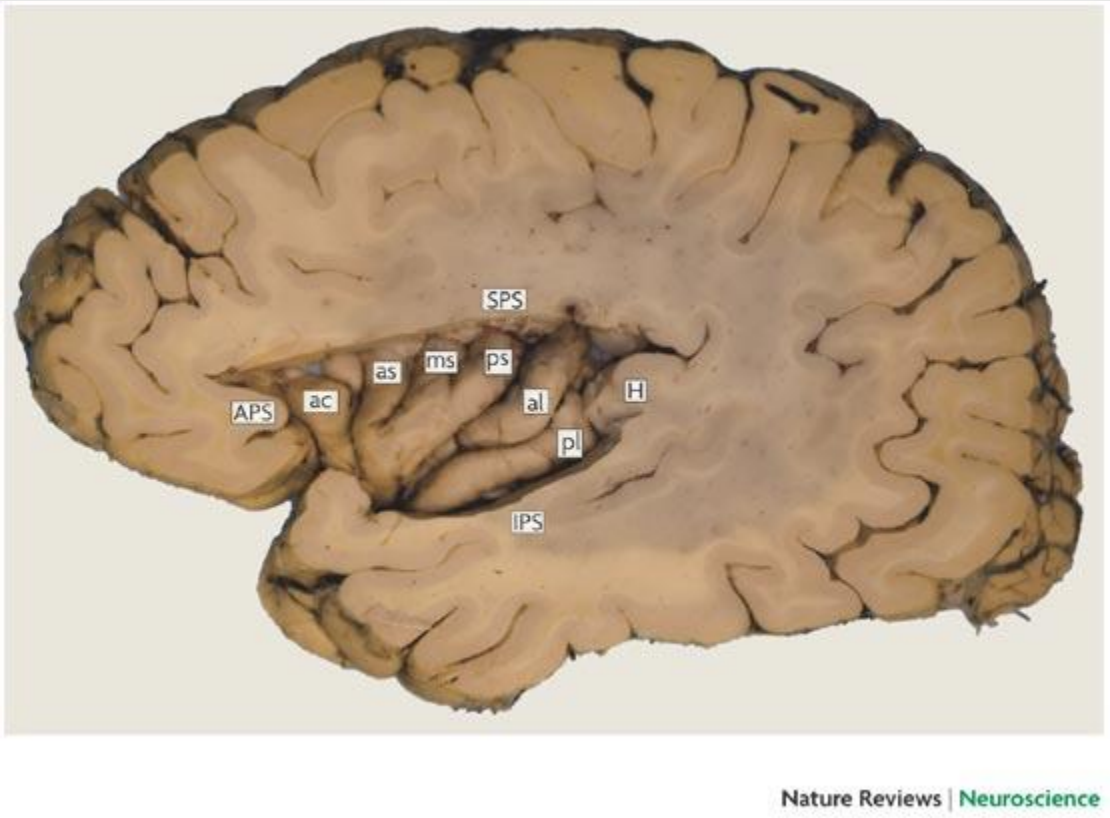
# Orbitofrontal Cortex



- Involved in reward and reinforcement
  - Implicated in addiction and reward expectation
  - Seems to not only be the target of addictive drugs, but also be responsible for conveying rewarding input to the rest of the body
  - Patients with damage have disinhibition - difficulty in controlling "gut reactions"
  - Also shown to have difficulty knowing when something socially awkward has occurred
- Very close to the olfactory bulb, receives input from many sensory modalities

# Insular Cortex

- Fusiform Facial Area
  - Recognizes facial expressions
  - Creates emotional associations between faces and events or places
  - Abstract represesntation of identity/recognition
- Bodies and body language
  - Fusiform Body Area
  - Extrastriate body area
    - Body Postures, particularly emotional ones
    - Movement
    - Context/map, what is happening in the body?
- Soft touch and social bonding
  - CT fibers
    - Repsond only to soft touch of right speed
    - Forearms, legs, back of neck, naughty bits




- Probably most recently evolved brain area
- Much larger in humans than non-human primates
- Distinct lobe

# Awesome study!

Induction of Empathy by the Smell of Anxiety
Prehn-Kristensen A, Wiesner C, Bergmann TO, Wolff S, Jansen O, et al. (2009)

- fMRI study of brain area activation
- Sweat collected from donors for 1 hour before a difficult oral exam (anxious condition) or during an exercise bike session (control)
- Ss smell sweat through an oxygen mask-like device in the fMRI
- Can detect odor only 50% of the time, and can't identify what it is

# Empathy-related Brain Areas

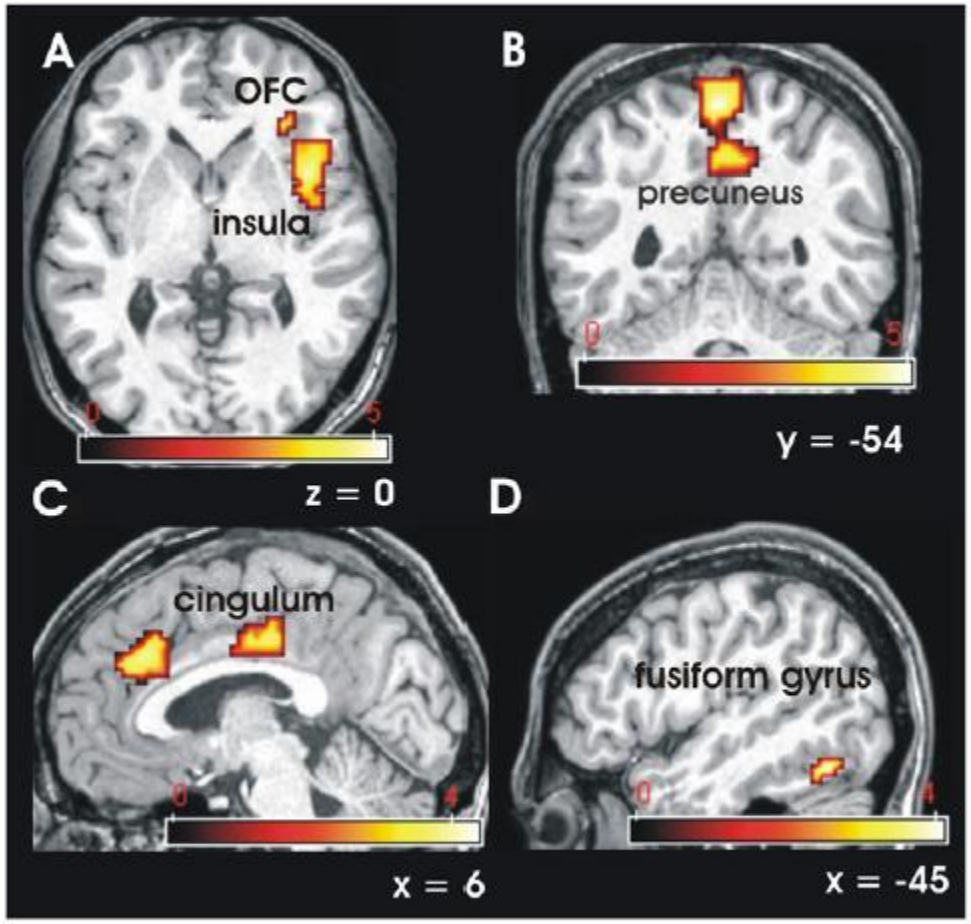



**Figure 3. Brain activations of the contrast Anxiety minus Sport in 28 participants (threshold, $p<0.001$).** A: Insula and OFC. B: Precuneus. C: Cingulate gyrus. D: Fusiform gyurs. OFC = orbitofrontal cortex.
doi:10.1371/journal.pone.0005987.g003

# Further Research in Pause Lab

- Smelling sweat collected from first-time skydivers (fear) activates the amygdala
  - Amygdala associated with fear and stress processing, initiates "fight or flight" responses
- Smelling sweat of high-stress people increases startle response to loud noises
  - Startle response refers to a sudden physical withdrawal to protect the head and neck
  - Response to anxious chemosignals was augmented in Ss who scored higher on a social anxiety measure

# Fun things to do - Neuroeconomics?

Coke vs. Pepsi Study

- Subjects given "blind" taste tests of both
- Showed no difference in activation of reward centers and reported no preference
- BUT when told the brand first, Coke activated different brain areas, and 3/4 of participants reported a preference for Coke over Pepsi.

# Conclusion

Brain is necessary for processing of emotional cues, conscious awareness of emotion, and social expression of emotion.

We still don't understand all the complexities of WHICH areas are responsible for WHAT, and HOW - there is much overlap.

But advances in technology are beginning to give us the tools to see what areas of the brain are at work in relation to which emotions, which can shed some light on how emotions work in the brain.