

# Notes: Cognition 1

---

Version:

11/14/12 - original version

## Research Methods

---

Cognition - some of the most interesting topics, but some of the most difficult to define

\_\_\_\_\_ a concept

To decide on a strict definition for study, which may or may not satisfy other people's concepts

Research may or may not investigate the \_\_\_\_\_ basis of behavior

Fields that typically include neuro: neuroscience, neuropsychology, cognitive neuroscience, neurology

Fields that less typically include neuro: psychology, cognitive science, psychophysics

\_\_\_\_\_ / \_\_\_\_\_ - describe but can not explain

Neuroimaging - measuring activity in areas of the brain (e.g. fMRI, EEG, PET)

Electrophysiology - measuring activity from one or more neurons

Lesions - comparing differences in behavior caused by existing lesions

Can be applied for both humans & animals subjects

\_\_\_\_\_ / \_\_\_\_\_ - can attribute results to a cause

Stimulation - increasing/decreasing activity in the brain

Lesions - destroying specific areas of the brain and comparing to controls

Drug studies - administering chemicals to affect activity and comparing to controls

Genetic knock-outs/ins - modifying the genetic make-up of an organism

Typically limited to animal subjects

## Executive Function

---

"forming and maintaining a task plan" (Duncan et al)

"regulate, control, and manage other cognitive processes" (Elliott 2003)

## Concepts

- Working memory
- Conflict resolution & error detection
- Impulse control & delayed reward
- Rules
- Prediction
- Information manipulation

## Prefrontal Cortex (PFC) Anatomy

PFC reaches largest relative size in \_\_\_\_\_

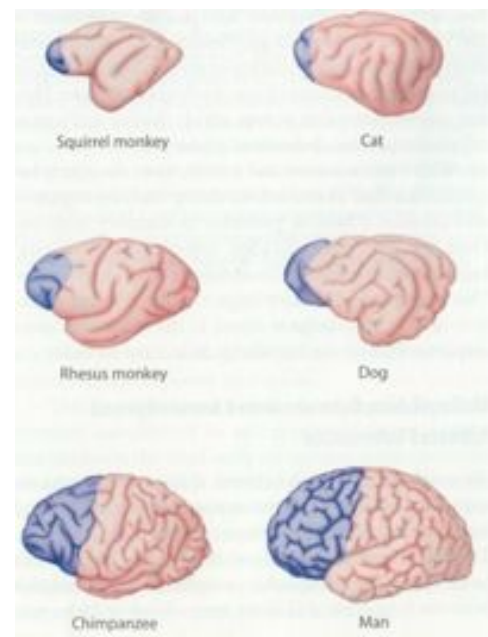
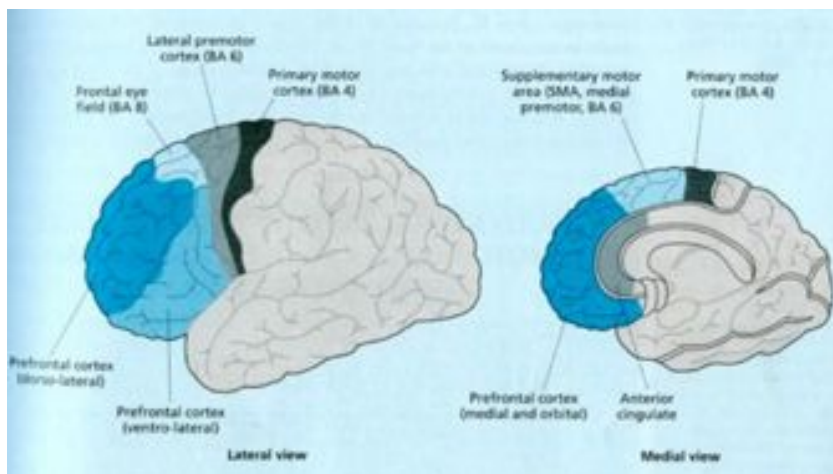
Comprises \_\_\_\_ of the surface area of the human cortex

Key areas for this lecture

Dorsolateral prefrontal cortex (DLPFC)

Dorsomedial prefrontal cortex and anterior cingulate cortex (ACC)

Ventrolateral prefrontal cortex, specifically the right inferior frontal gyrus (rIFG)

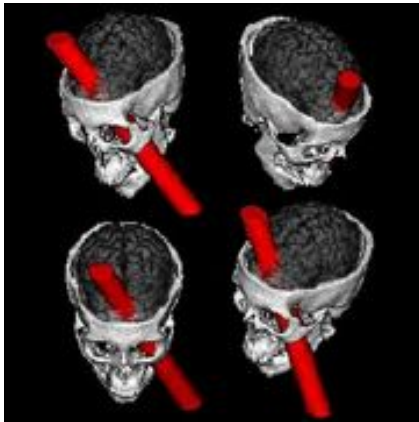


## Lesions to PFC

Phineas Gage

Patient A

Railroad worker in 1848  
metal rod passed through PFC  
became impulsive, rude,  
unreliable



Source: [boeatau.wordpress.com](http://boeatau.wordpress.com)

39 year old stock broker: restrained, modest

had large bilateral frontal lobe resection to remove a tumor

became boastful, lacked restraint, inappropriate in conversation,  
unable to plan for future, supported by family

could: learn complex procedures, play expert checkers,  
communicate, recognize his own deficits

(Source: Brickner, as cited in Neuroscience (1999), ed. by Purves, P474)

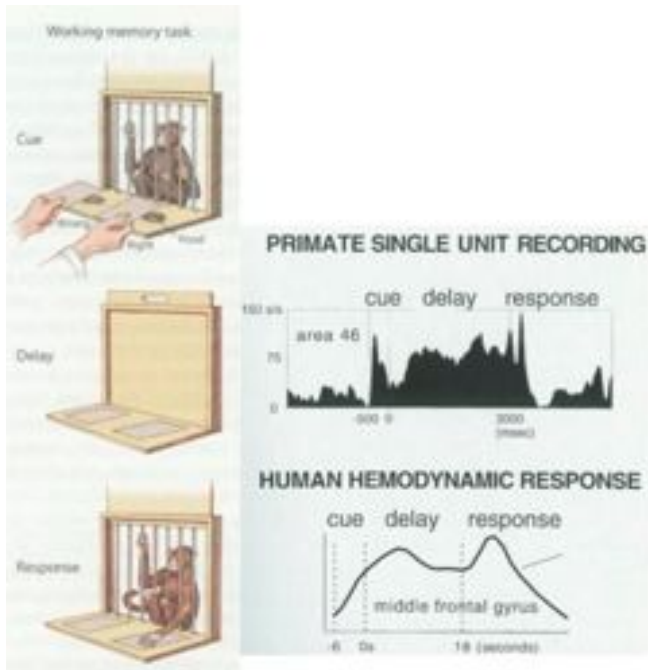
## Experimental Evidence

---

*Do you agree that the described concept (e.g. working memory, conflict) that is being tested by the task?*

### Experiment: Delayed Response

Concept: \_\_\_\_\_



**Task**

- Cue - Subject is shown a choice to remember (for monkeys, the location of food)
- Delay - Subject is shown nothing, has to remember location/choice
- Response - Subject allowed to make choice

**Results**

- Monkeys - electrodes in area \*like\* DLPFC are active throughout delay and at response
- Humans - fMRI shows increased blood flow in DLPFC throughout delay and at response

**Summary**

Prefrontal areas are active during working memory maintenance

## Experiment: Delayed Non-match to Sample

Concept: \_\_\_\_\_



Task: Recognition (above right in diagram)

- First, select any of 3 objects, move it aside, retrieve food from underneath
- Second, choose between 2 objects, select the one that you DID pick last time
- Requires: picking the object that you recognize, that feels familiar

Task: Monitoring (above left in diagram)

- (same) First, select any of 3 objects, move it aside, retrieve food from underneath
- Second, choose between 2 objects, select the one that you DIDN't pick last time
- Requires: both objects are familiar, so remember which you picked and \_\_\_\_\_

**Results**

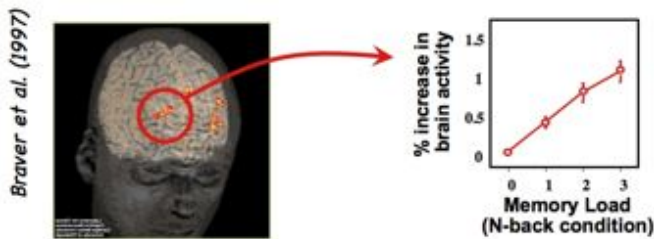
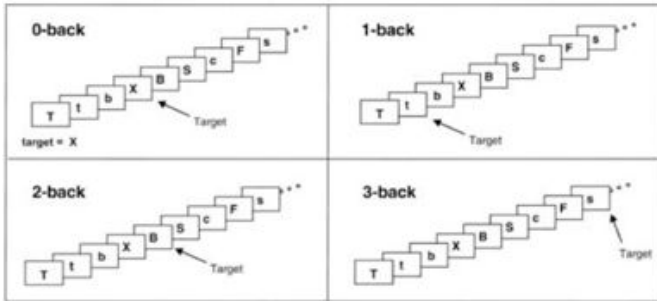
DLPFC lesions affect/don't affect recognition, affect/don't affect monitoring

**Summary**

DLPFC is not necessarily saving information, but managing what is \_\_\_\_\_/important (monitoring)

## Experiment: N-back task

Concept: \_\_working memory\_\_



Task:

Letters are presented in sequence (can be auditory or visual)

In the 0-back condition, subject has to react when the letter matches a target (here, when the letter is "X")

In the 1-back condition, subject has to react when any letter matches the previous letter (1 back)

In the 2-back condition, subject has to react when any letter matches the letter 2 back

Requires rotating letters in memory and constant monitoring

Results

With increasing n (the number of letters to be remembered), there was increasing blood flow in the DLPFC

Summary

A complex working memory task not only activated the DLPFC,

but a more \_\_\_\_\_ task produced \_\_\_\_\_ activations

## Experiment: Stroop Task

Concept: \_\_\_\_\_

Red  
Yellow  
Blue  
Green  
Green  
Yellow  
Blue

Blue  
Green  
Yellow  
Red  
Green  
Blue  
Red

Source: <http://scienceblogs.com/cognitivedaily/2007/07/05/the-stroop-effect-not-as-autom-2/>

Task: \_\_\_\_\_ version (easy)

Read aloud the words on the left

Task: \_\_\_\_\_ version (hard)

Read aloud the words on the right (the words, not the ink color)

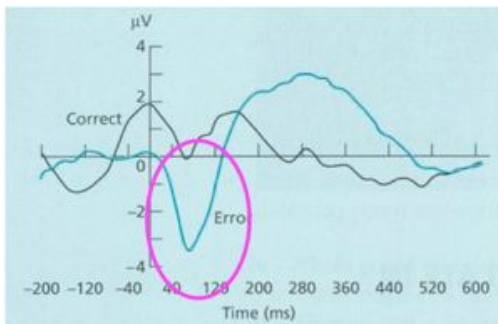
Results

People are slower to read the incongruent version

Incongruent version has greater activation in the \_\_\_\_\_

Summary

ACC may be involved in detecting conflicts



Electroencephalography (EEG)

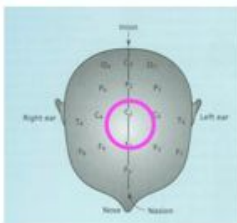
Monitor electrical signals on scalp

EEG provides precise changes across time

EEG does NOT provide precise location

Event related potential

When many similar events are averaged together, there are sometimes reliable positive/negative changes in signal



Have subjects repeat many trials, they sometimes make errors

Average all the error trials together

Within fractions of a second of making an error, there is a signal

Signal is strongest over \_\_\_\_\_ cortex

Summary

Dorsomedial PFC not only detects external \_\_\_\_\_,

but internal conflicts like \_\_\_\_\_

## Theory

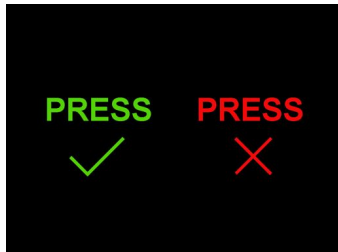
This is a hypothesis but isn't confirmed by data

ACC detects conflict, DLPFC boasts activity in brain areas responsible for the task to resolve conflict

this is called \_\_\_\_\_ control

## Experiment: Stop Signal Task

Concept: \_\_\_\_\_



### Task

On most trials, press space bar as quickly as possible after GO signal

On a few random trials, a STOP signal appears a split-second after GO signal

Subject has to try to stop the button press action they have just started

### Results

Patients with damage to right inferior frontal gyrus (rIFG) have deficits

Patients with damage to left inferior frontal gyrus do not have deficits



### Summary

rIFG may issue the command to inhibit actions / thoughts

## Review

Dorsolateral prefrontal cortex (DLPFC)

Dorsomedial prefrontal cortex and anterior cingulate cortex (ACC)

Ventrolateral prefrontal cortex, specifically the right inferior frontal gyrus (rIFG)

Copyright 2012 - Michael Claffey