

# Notes: Executive Function

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PDF

"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 \_\_\_\_\_

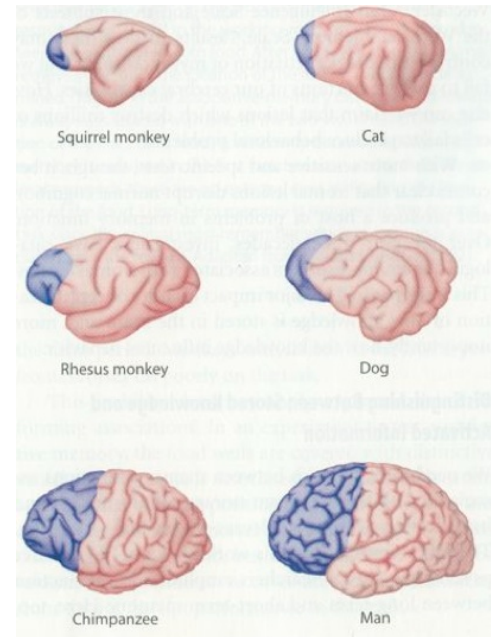
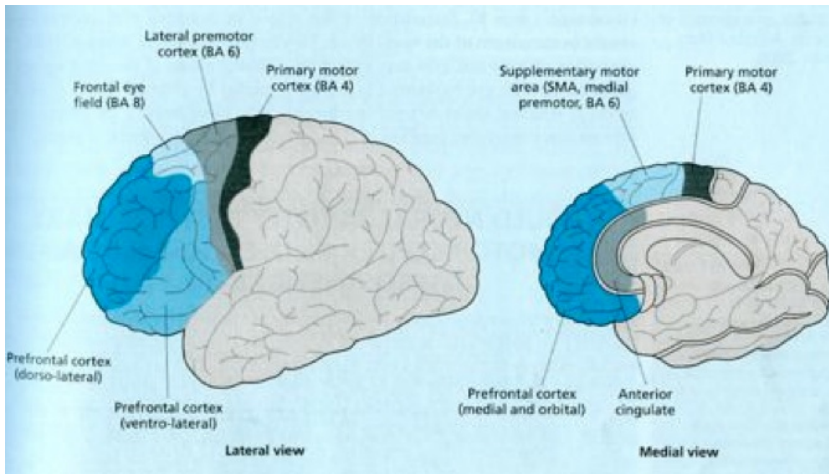
Comprises \_\_\_\_ of the surface area of the human cortex

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

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



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

### Patient A

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)

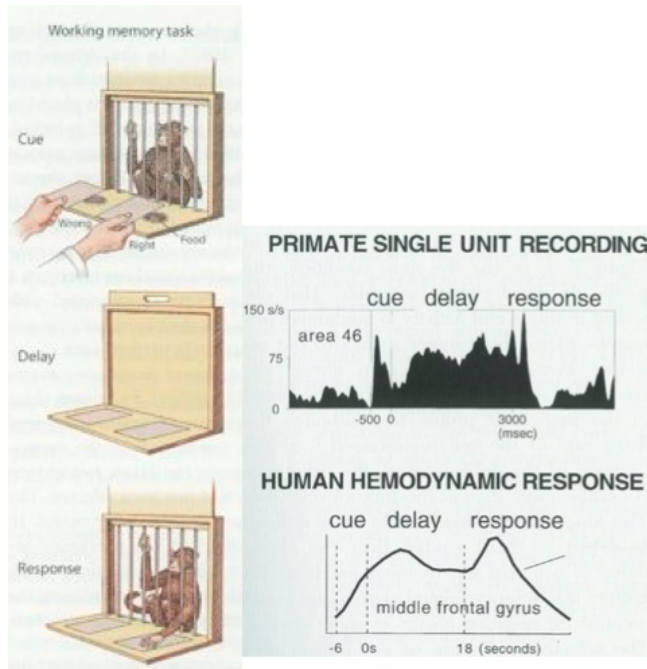
## Experimental Evidence

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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

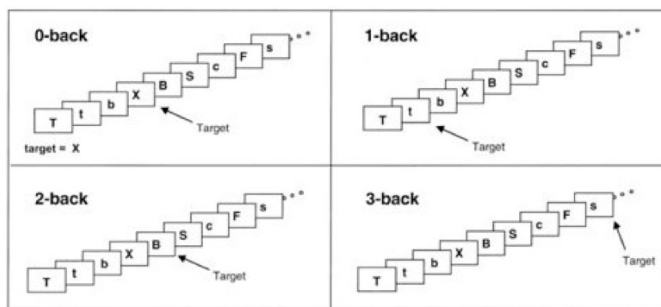
Summary

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

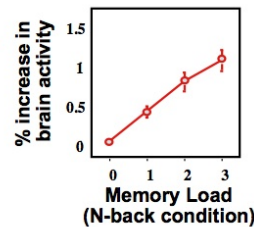
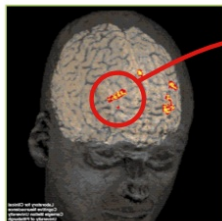
## Experiment: N-back task

Concept: \_\_working memory\_\_

[Online task](#)



Braver et al. (1997)



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)

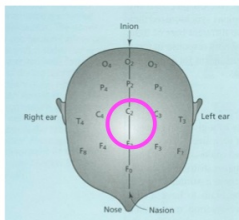
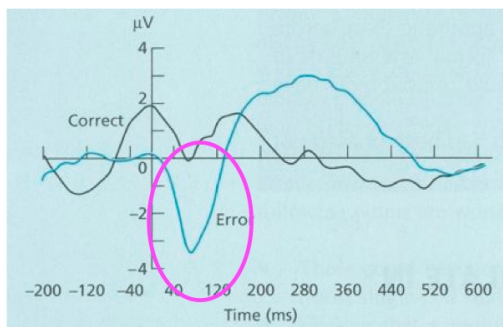
Results

People are slower to read the incongruent version

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

Summary

ACC may be involved in detecting conflicts



\_\_\_\_\_

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

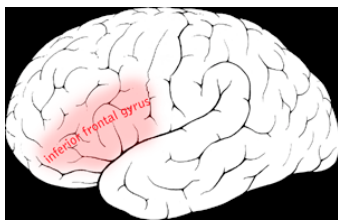
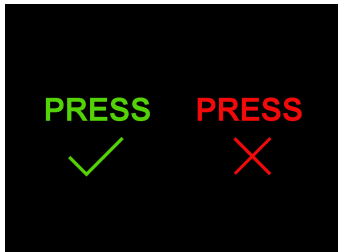
This is a hypothesis but isn't confirmed by data

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

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