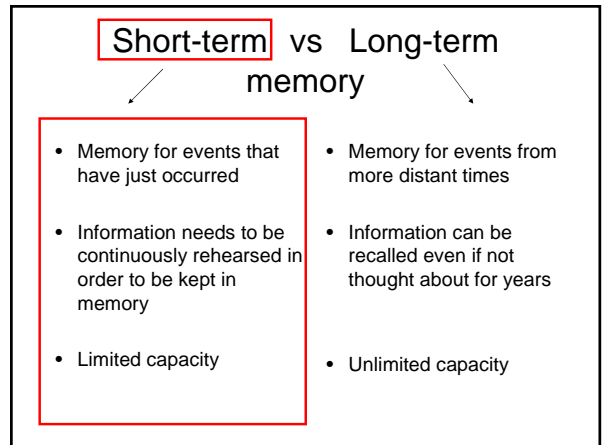


### Clive

- Profound memory impairment
  - Long-term memory  
"robbed of knowledge of his own life"
  - Short-term (working) memory  
"moment to moment consciousness", "time vacuum"  
"relate yourself to the past and project yourself into the future"
- Certain aspects of mental life preserved
  - Procedural memory (skills)
  - Emotions



### Short-term and Working memory

- Short-term memory
  - originally seen as the temporary station on the way to long-term memory
  - later on, shown to have a more complex role
- Working memory
  - temporary holding and manipulating of info
  - used during performance of a range of tasks  
e.g., comprehension, learning, reasoning

### Working memory (WM) is linked to Prefrontal Cortex (PFC)

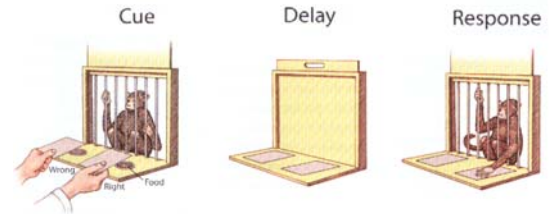
Impaired WM with PFC lesions (both humans and nonhuman primates)

PFC neurons increase their firing rates during WM delay in nonhuman primates

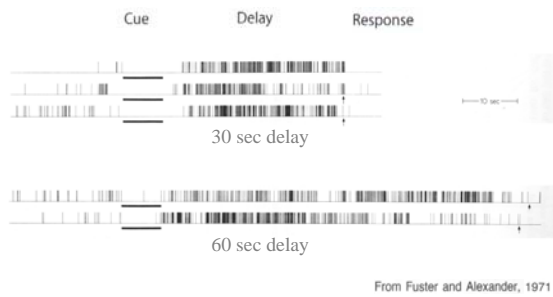
WM tasks activate PFC in humans

- Working memory as keeping something in mind during a delay

### Delayed matching-to-sample

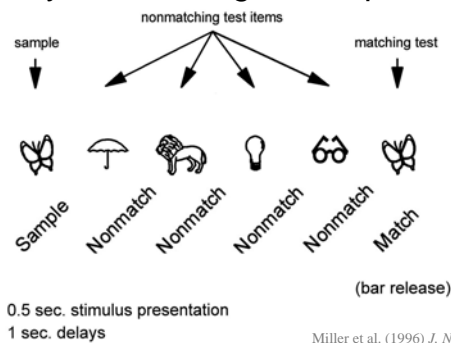


### Activity of a prefrontal unit during delayed-response trials

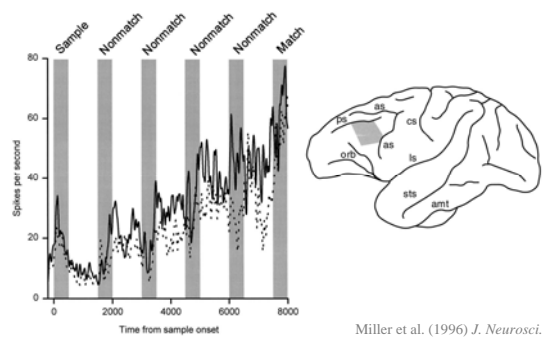


- Working memory as keeping something in mind during a delay  
**With distractors during the delay**

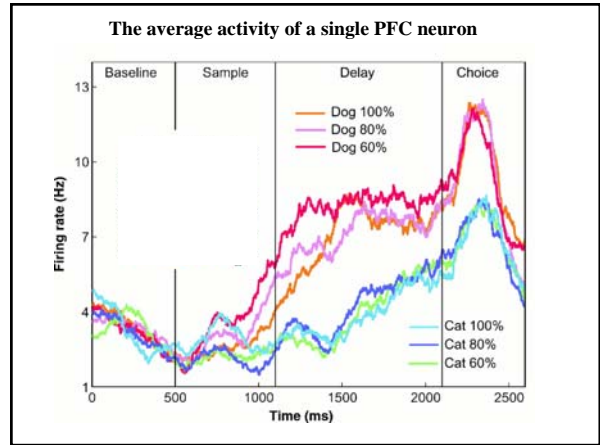
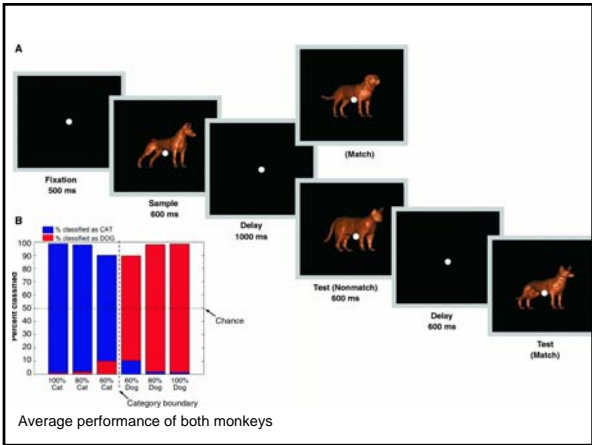
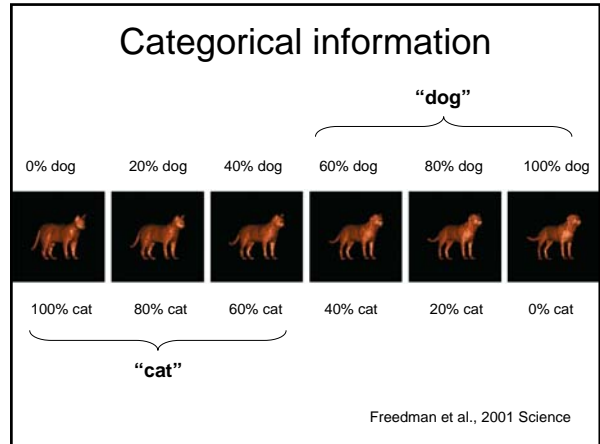
### Delayed matching to sample task



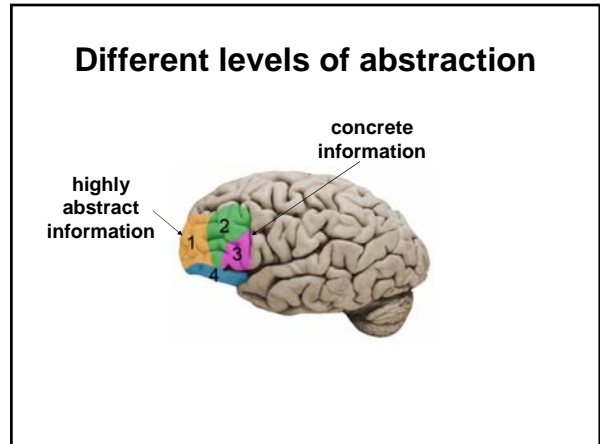
### Activity of a prefrontal neurons during a delayed matching to sample task



- Working memory as keeping something in mind during a delay  
With distractors during delay
- What kind of information can prefrontal neurons maintain?



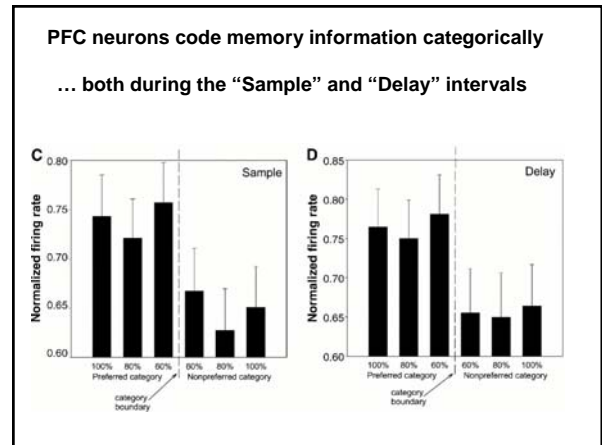
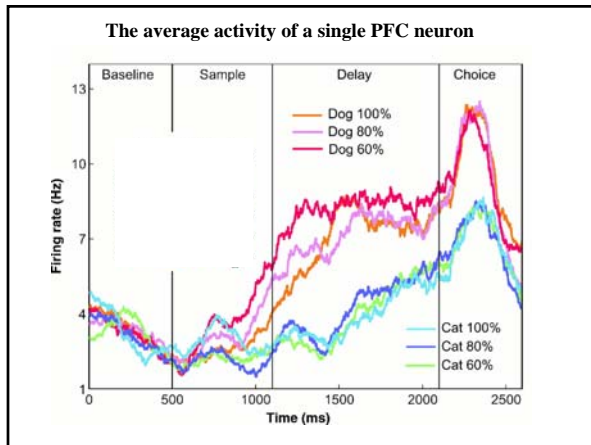
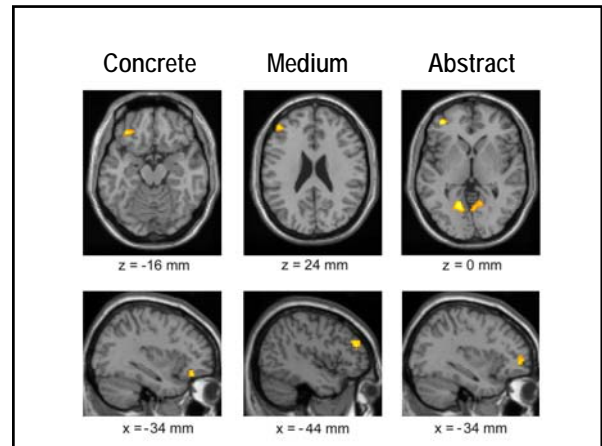
- Working memory as keeping something in mind during a delay  
With distractors during delay
- What kind of information can prefrontal neurons maintain  
**concrete (objects)**, as well as  
**abstract (categories)**



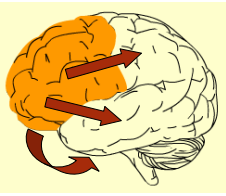
**Verbal problem solving task: anagrams**

<b>Abstract</b>	<b>Medium</b>	<b>Concrete</b>
A P e a l p	D n c a e	D k e s
H m a r	T p i r	F o d o
G a c r e	S n g o	B o l t e t

Christoff et al. (2009) Brain Research



**The prefrontal cortex (PFC)**



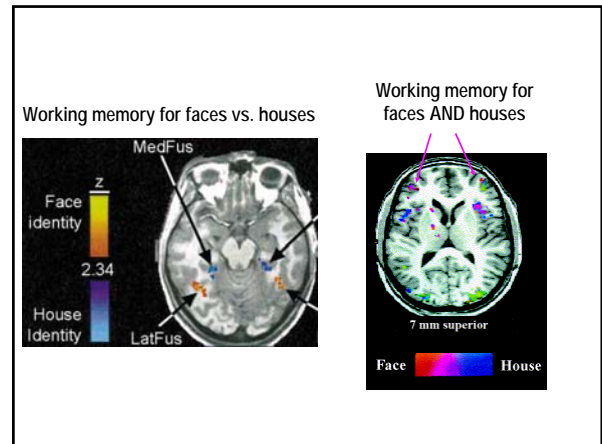
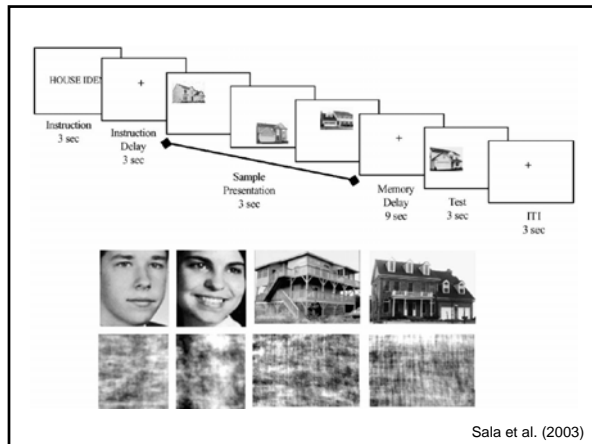
**Cognitive control**      **Perception and memory**

**PFC biases neural processes occurring in posterior brain regions**

**Cognitive control**

- Considered one of PFC's primary functions
- Helps us to engage in selective attention (e.g., looking for your friend whose wearing a red jacket)
- Implemented by increasing the gain of sensory or motor neurons that are engaged by task- or goal-relevant elements in the external environment

# Working Memory



## The prefrontal cortex serves to

- Actively maintain patterns of activity that represent goals and the means to achieve them
- Provide bias signals throughout the rest of the brain, e.g.
  - Sensory modalities
  - Memory retrieval
  - Emotional evaluation
- Guide the flow of neural activity along pathways that establish the appropriate mappings between inputs, internal states, and outputs needed to perform a given task