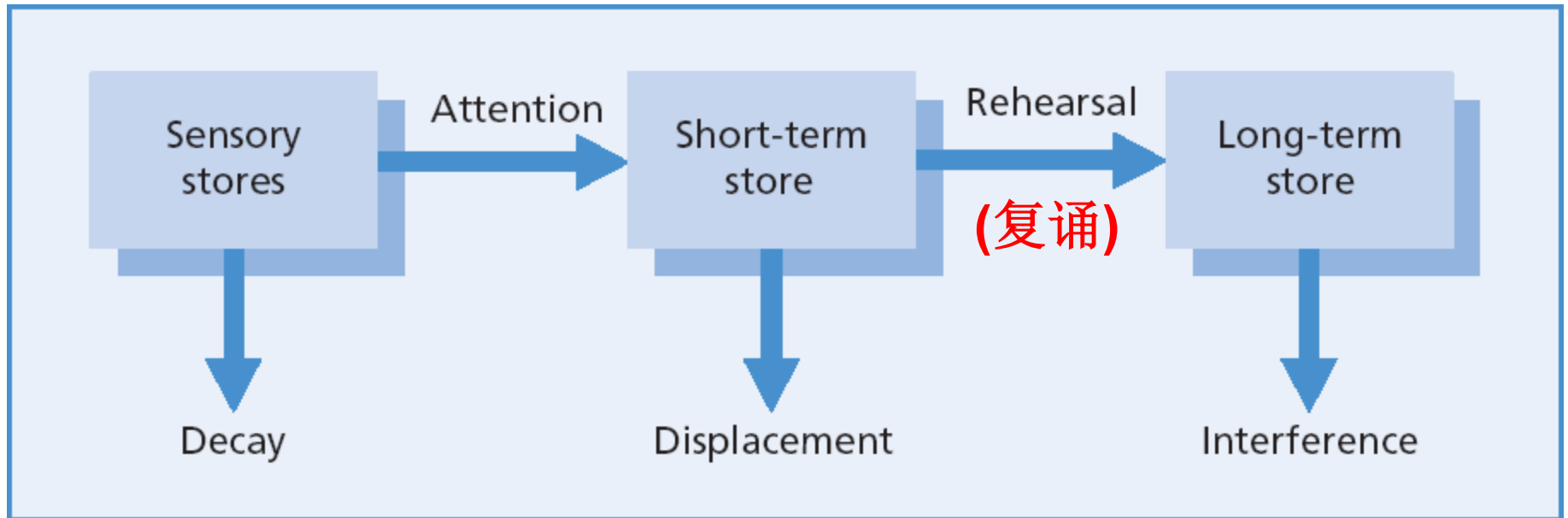


Memory III

Working Memory & Brain

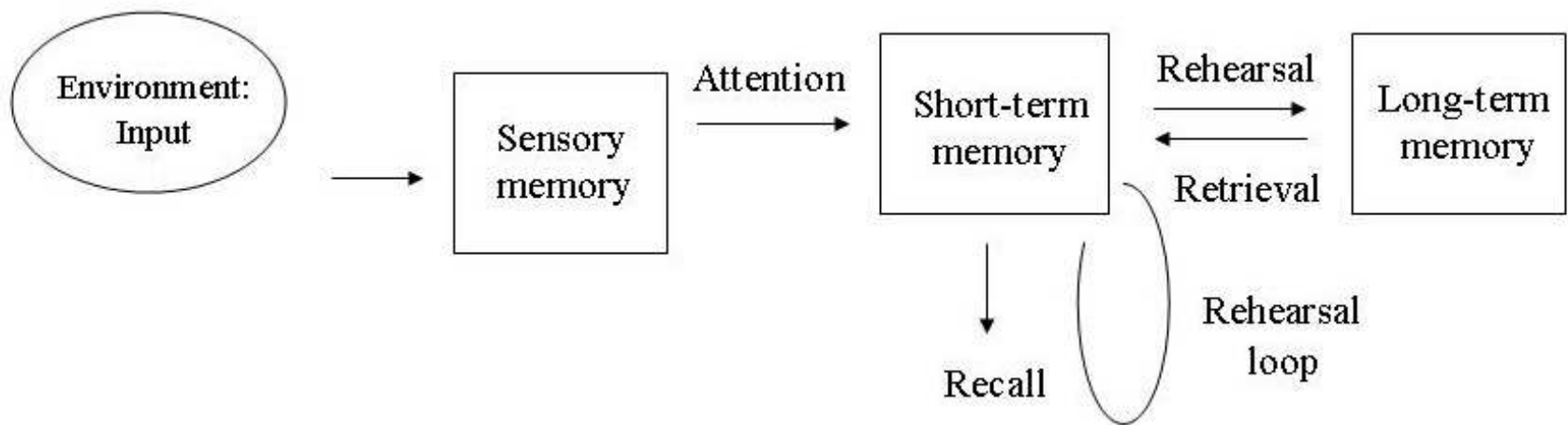


Atkinson & Shiffrin (1968) Model of Memory



Atkinson & Shiffrin (1968) Model of Memory

- **Multi Store Model (Atkinson and Shiffrin, 1968)**
- **The multi store model** is a classic model of memory. It is sometimes called the **modal model** or the **dual process model**
- **Atkinson and Shiffrin (1968)** suggest that memory is made up of a series of stores (see below)

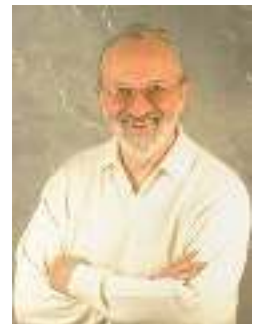


Visual Sensory Store

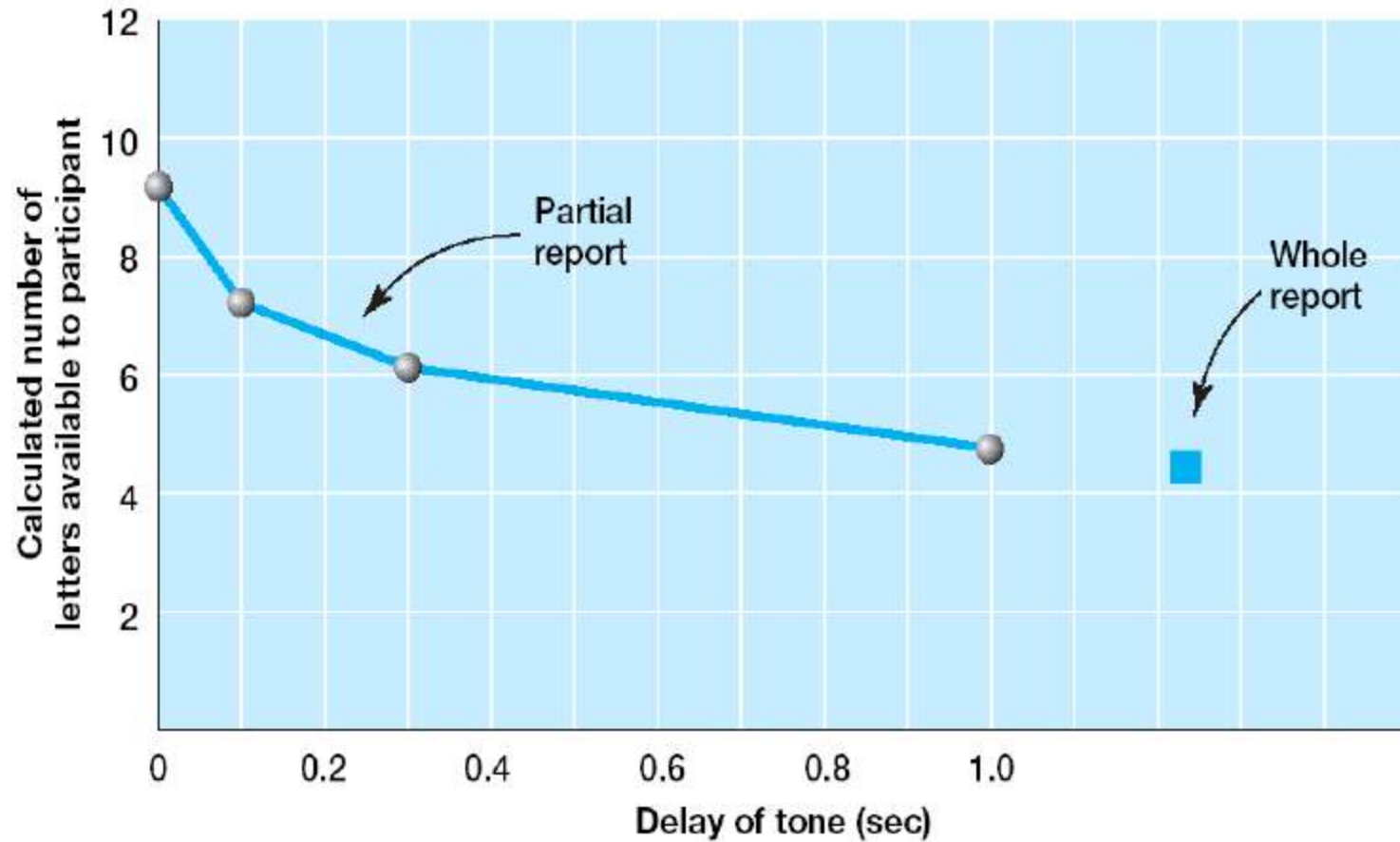
- It appears that our visual system is able to hold a great deal of information but that if we do not attend to this information it will be rapidly lost.

X	M	R	J
C	N	K	P
V	F	L	B

- Sperling (1960)
 - Presented array consisting of three rows of four letters
 - Subjects were cued to report part of or whole display



Visual Sensory Memory



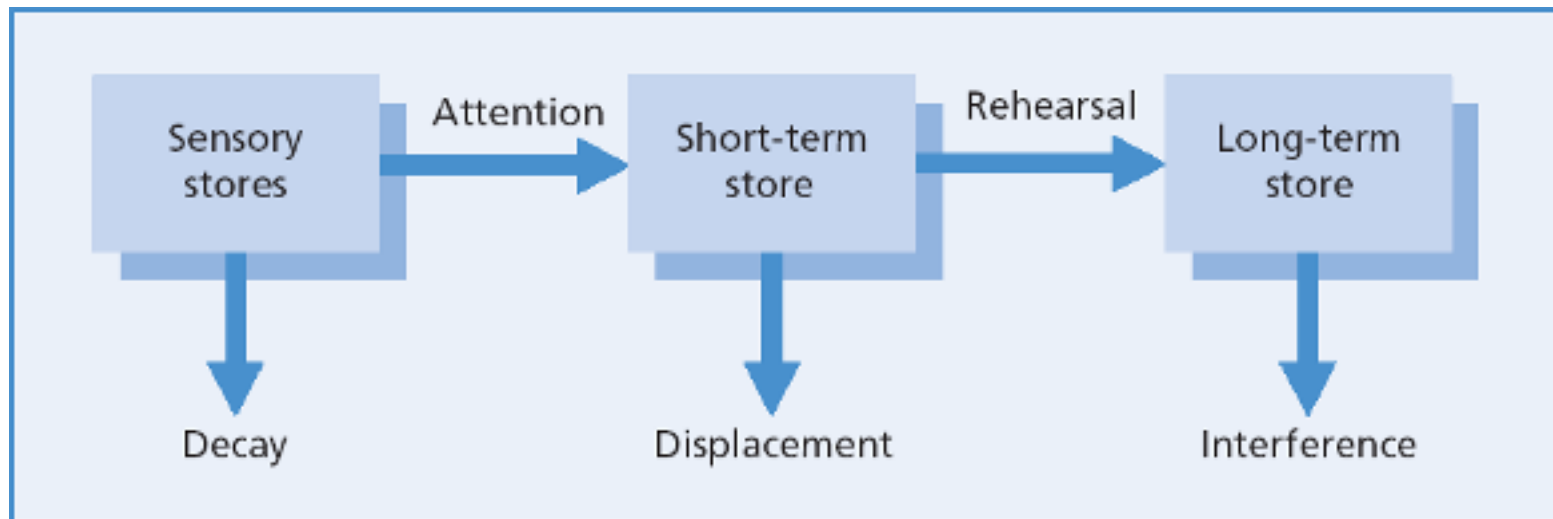
Iconic memory → high capacity, rapid decay

Iconic Memory

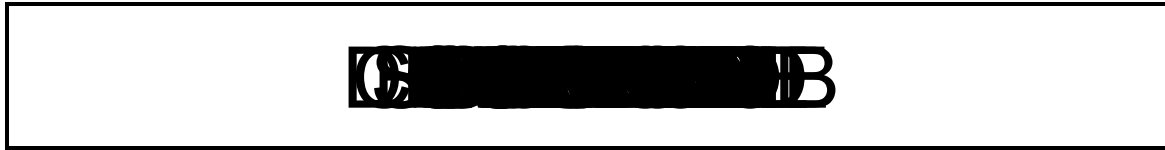
- Sperling's experiments indicate the existence of a brief visual sensory memory -- known as **iconic memory** or **iconic store**
- Information decays rapidly (after a few hundred milliseconds) unless attention transfers items to short-term memory
- Analogous auditory store: **echoic store**

Atkinson & Shiffrin (1968) Model of Memory

- **Short-term memory** (STM) is a **limited capacity** store for information -- place to rehearse new information from sensory buffers
- Items need to be **rehearsed** in short-term memory before entering long-term memory (LTM)
- Probability of encoding in LTM directly related to **time** in STM



a memory test...

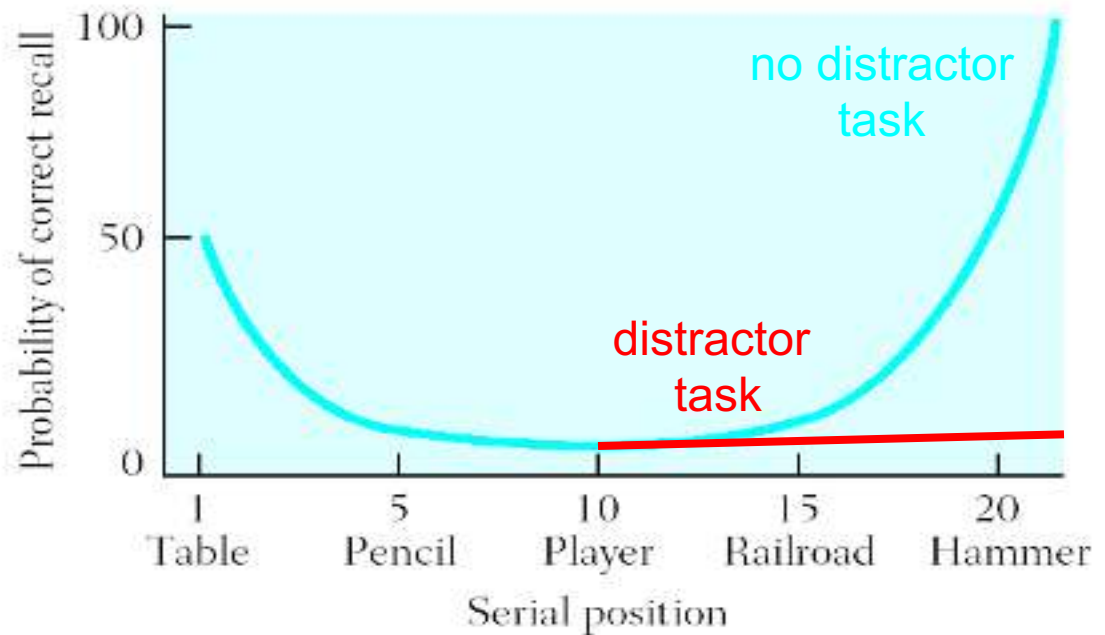


Serial Position Effects (序列位置效应)

- In free recall, more items are recalled from start of list (primacy effect) (首因效应) and end of the list (recency effect) (近因效应)
- Distractor task (e.g. counting) after last item removes recency effect

1 Table	11 Kitten
2 Candle	12 Doorknob
3 Maple	13 Folder
4 Subway	14 Concrete
5 Pencil	15 Railroad
6 Coffee	16 Doctor
7 Towel	17 Sunshine
8 Softball	18 Letter
9 Curtain	19 Turkey
10 Player	20 Hammer

(A)



(B)

Serial Position Effects

- Explanation from Atkinson and Shiffrin (1968) model:
 - Early items can be rehearsed more often
 - more likely to be transferred to long-term memory
 - Last items of list are still in short-term memory (with no distractor task)
 - they can be read out easily from short-term memory

Atkinson & Shiffrin (1968) Model of Memory

Atkinson-Shiffrin's multi-store model of memory



Evaluating Modal Memory Model

- Pro

- provides good quantitative accounts of many findings

- Contra

- assumption that all information must go through STM is probably wrong
- Model proposes one kind of STM but evidence suggests we have multiple kinds of STM stores

Baddeley's working memory model

- Baddeley proposed replacing unitary short-term store with working memory model with multiple components:



- Key components:
- Central Executive; other two systems are slave systems.
- Phonological Loop holds information in phonological or speech-based form.
- Visuospatial sketchpad specialized for spatial and/or visual coding.



Allen Baddeley

Phonological Loop

(a.k.a. articulatory loop)

- Stores a limited number of sounds – number of words is limited by **pronunciation time**, not number of items

- Experiment:

LIST 1:

Burma

Greece

Tibet

Iceland

Malta

Laos

LIST 2:

Switzerland

Nicaragua

Afghanistan

Venezuela

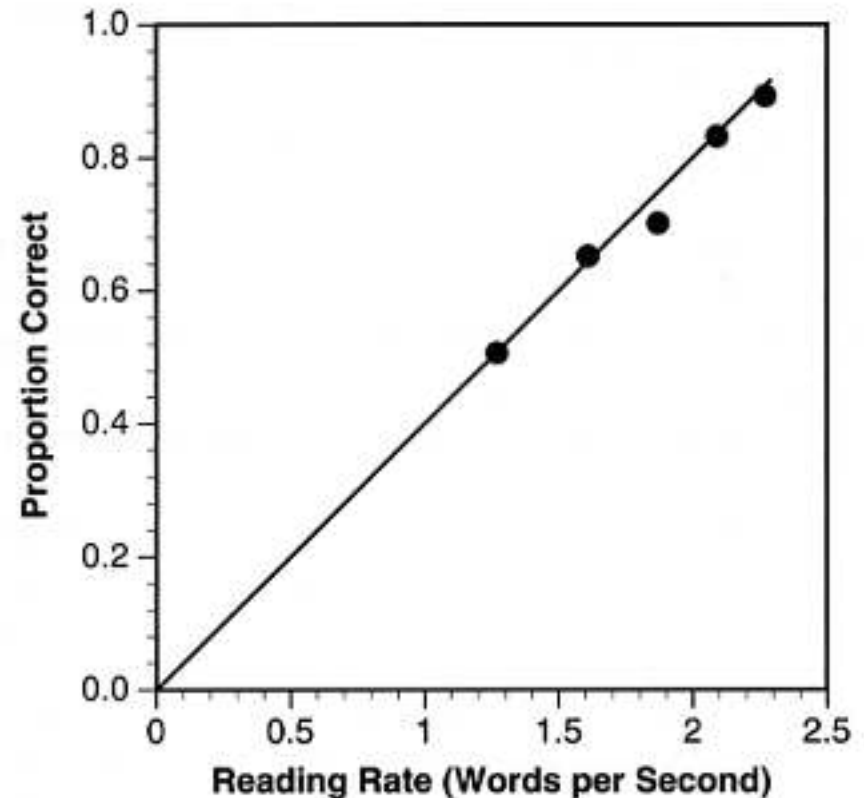
Philippines

Madagascar

- **Word length effect** -- mean number of words recalled in order (list 1 → 4.2 words; list 2 → 2.8 words)

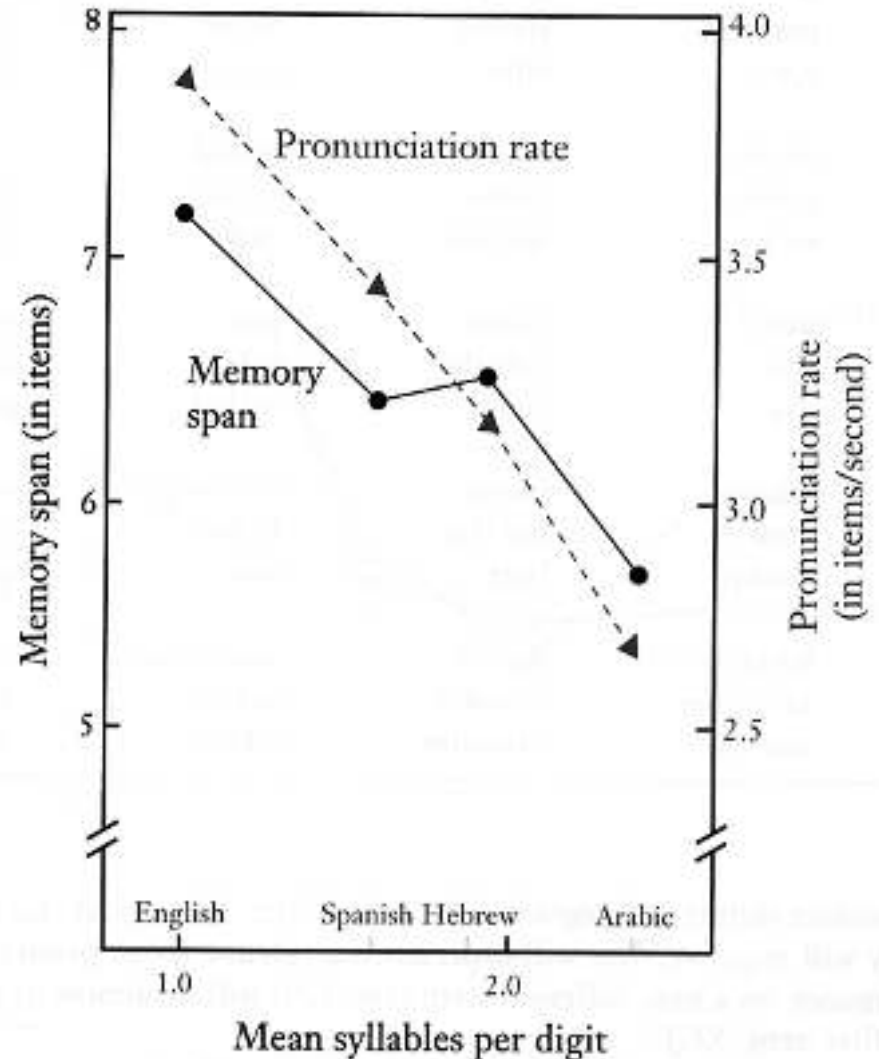
Reading rate determines serial recall

- Reading rate seems to determine recall performance
- Phonological loop stores 1.5 - 2 seconds worth of words



Working memory and Language Differences

- Different languages have different #syllables (音节) per digit
- Therefore, recall for numbers should be different across languages
- E.g. memory for English number sequences is better than Spanish or Arabic sequences



The working memory model



Features of the Phonological Loop

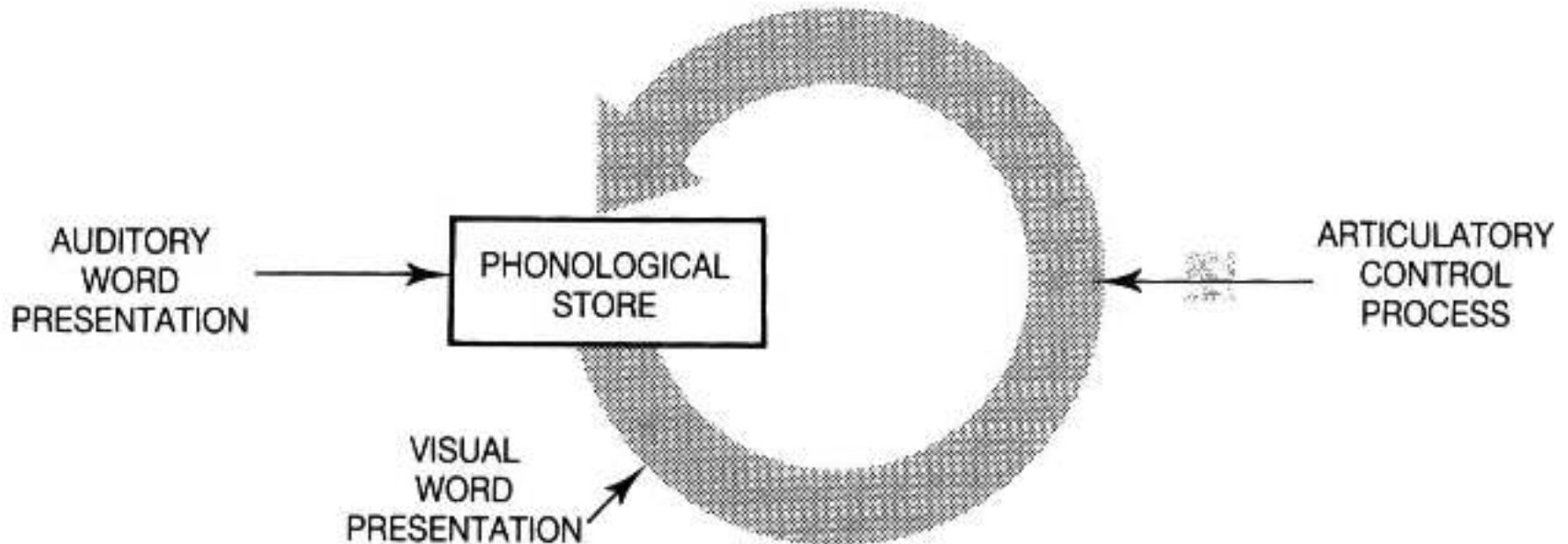
- **Phonological store**

- Auditory presentation of words has direct access
- Visual presentation only has indirect access
- Affected by **phonological similarity**

- **Articulatory process**

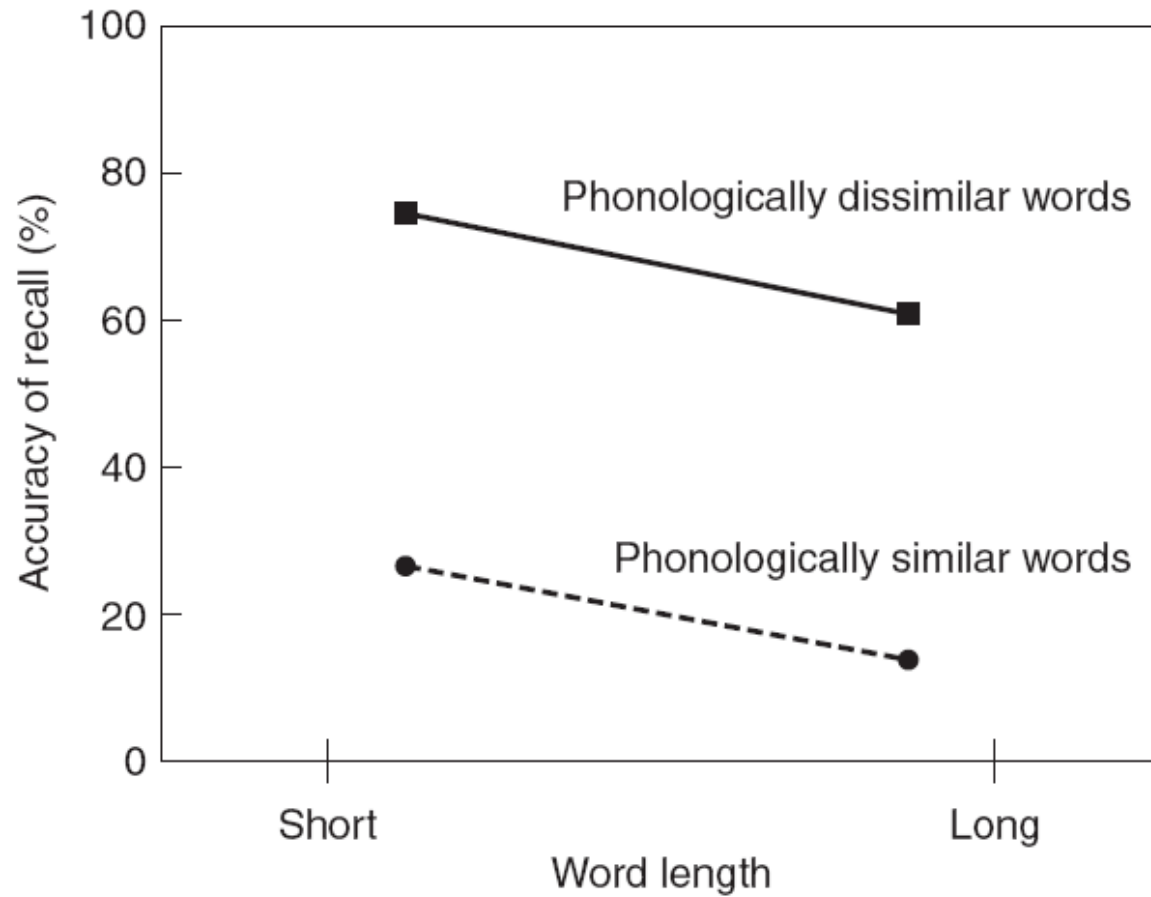
- Converts visually presented words into inner speech that can be stored in phonological store
- Affected by **word length**

Articulatory Suppression



By **auditory rehearsal**, a representation in the phonological store can be maintained

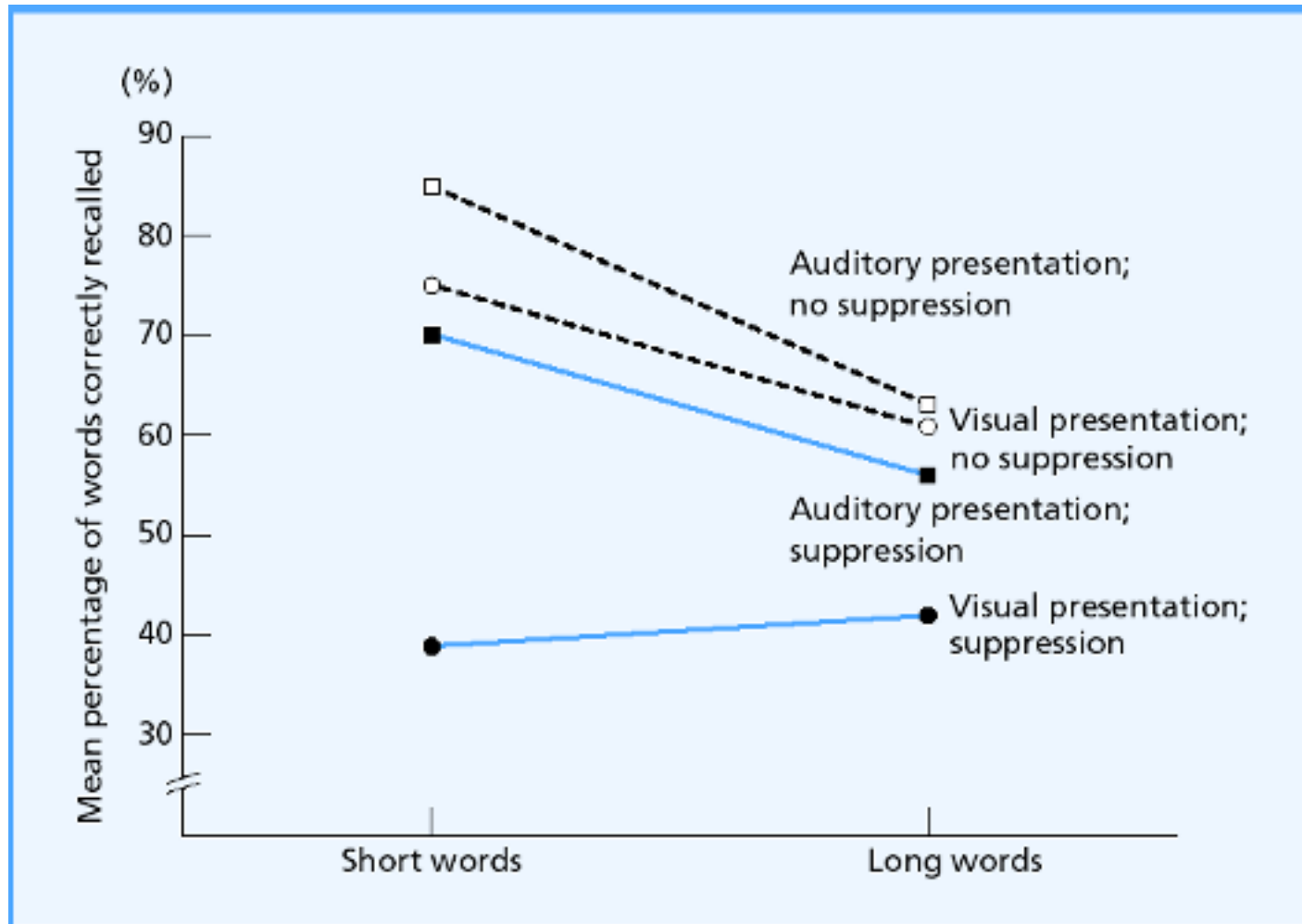
Articulatory Suppression



Articulatory Suppression

- Saying “the” all the time leads to **articulatory suppression**
- Disrupts phonological loop → worse performance
- With visual presentation, articulatory suppression leads to bad performance but there is no word length effect
→ visuospatial sketchpad takes over

Articulatory Suppression



Immediate word recall as a function of modality of presentation (visual vs. auditory), presence vs. absence of articulatory suppression, and word length.

Neural Network Models of Memory

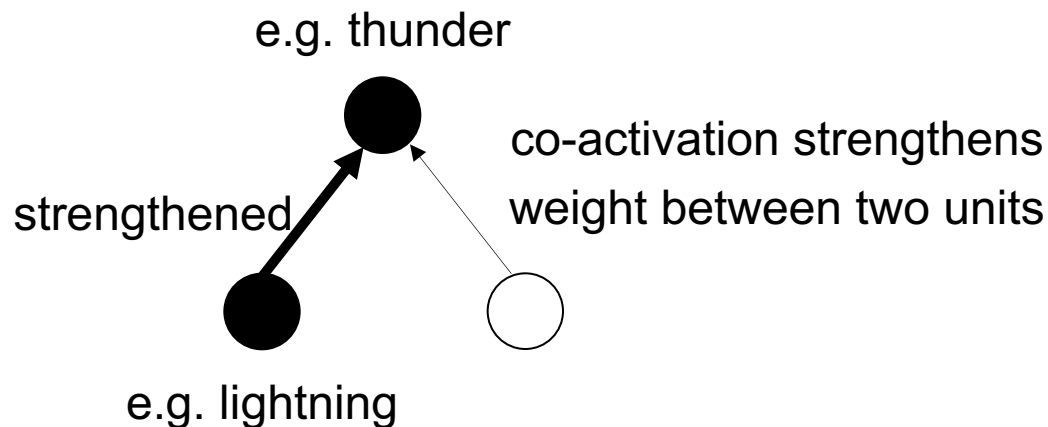
Neural Network Models of Memory

- Long-term memory:
 - **weight-based memory**
 - the memory representation takes its form in the strength or weight of neural connections

- Short-term memory:
 - **activity-based memory**
 - in which information is retained as a temporary (短暂的) pattern of activity in specific neural populations

Long-term memory

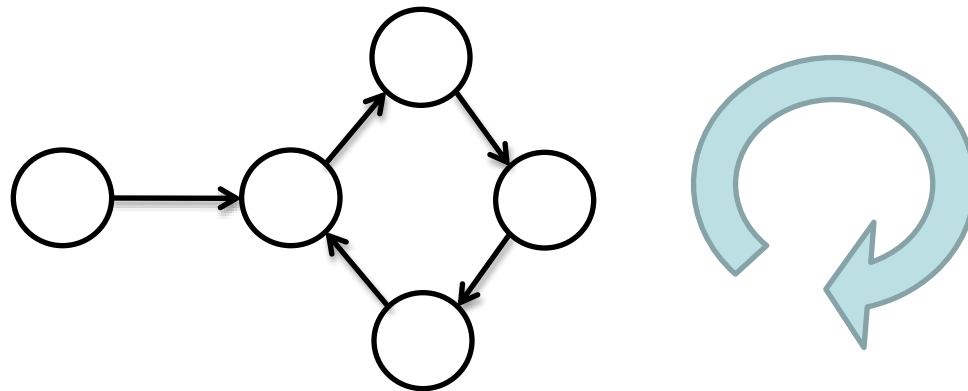
- Long-term associative memories can be formed by **Hebbian learning**: changes in synaptic (突触) weights between neurons
 - structural change
 - relatively permanent
- Long Term Potentiation (LTP) is the biological basis of Hebb's learning rule



Donald O. Hebb

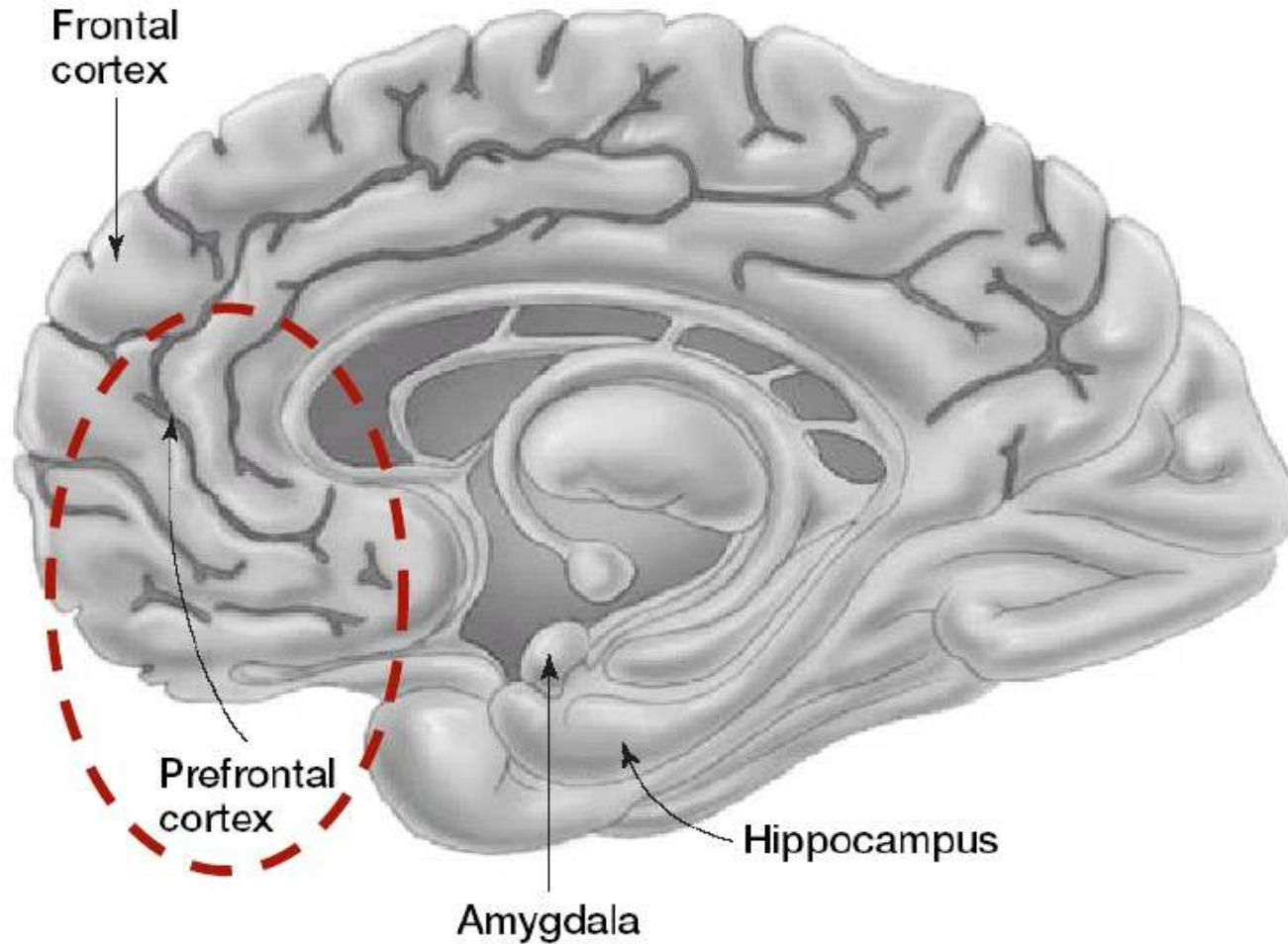
Short-term Memory

- Change in neural **activity**
 - not structural
 - temporary
- **Reverberatory loop (反射回路)** -- circuits that maintain activity for a short period

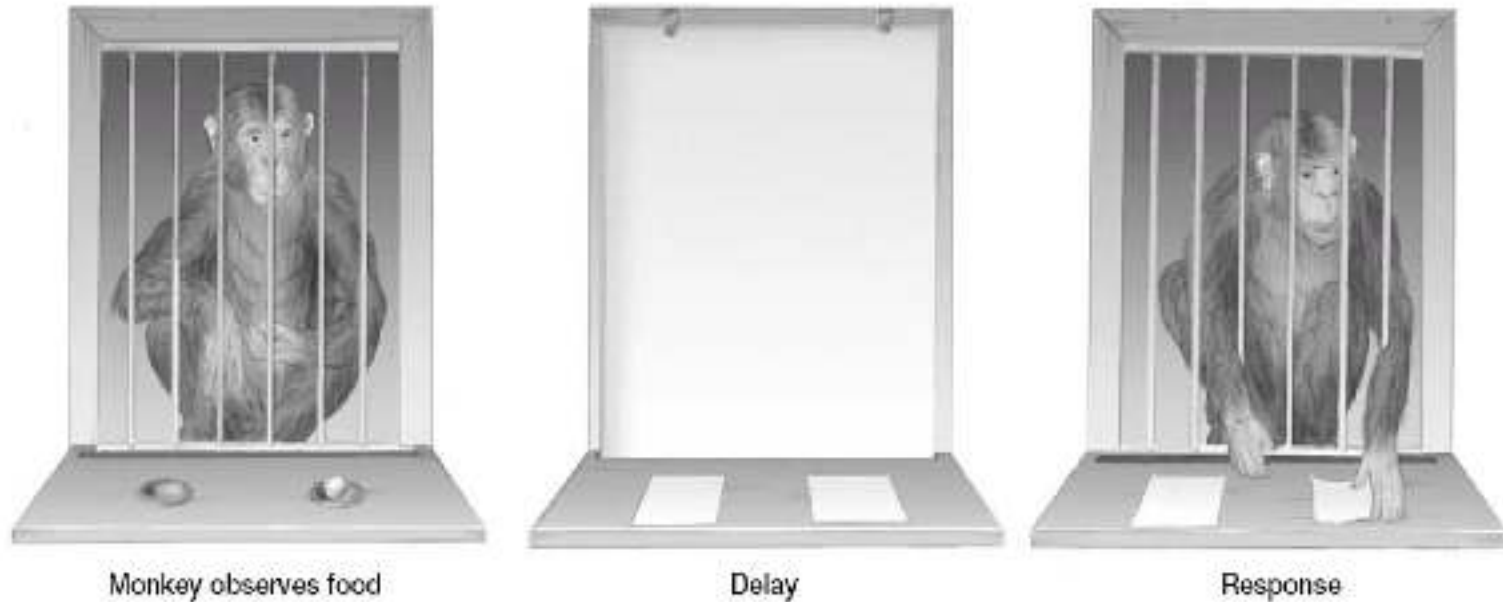


Working Memory and Prefrontal Cortex

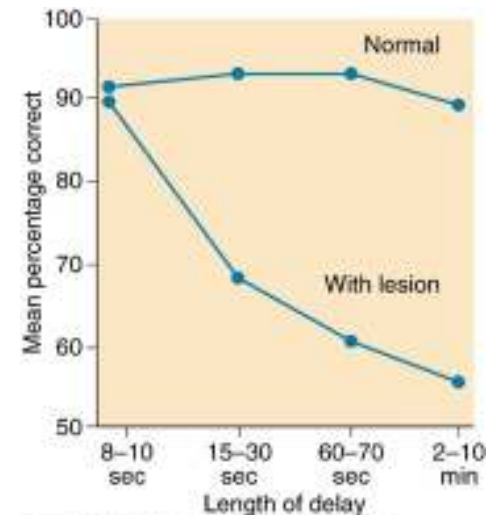
(PFC: 前额皮质)



Delayed Match to Sample Tasks

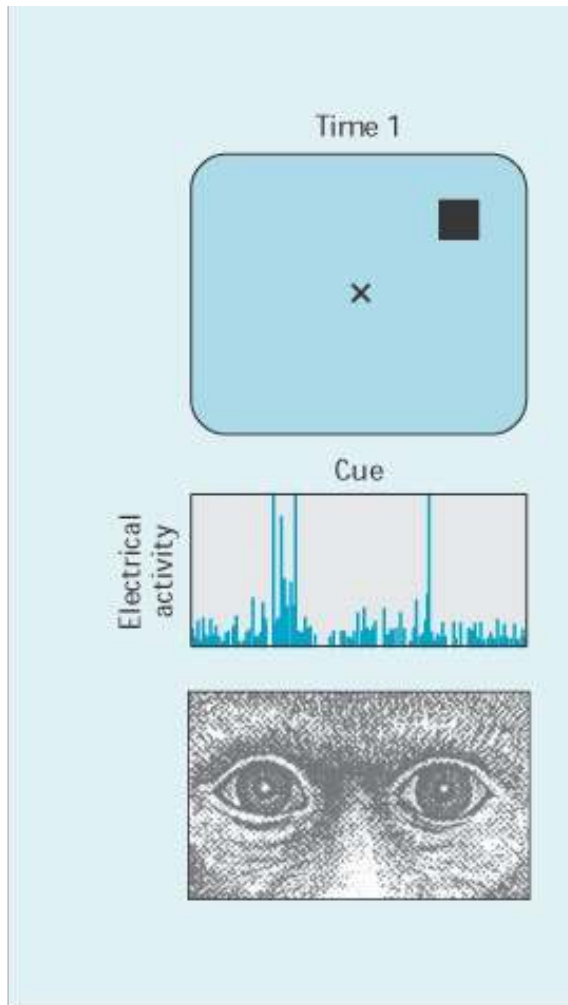


- Correct response requires keeping location of food in mind
- Monkeys and humans with lesions of PFC fail these tasks



Delayed Saccade Task

(Goldman-Rakic)



Patricia Goldman-Rakic (1937-2003)

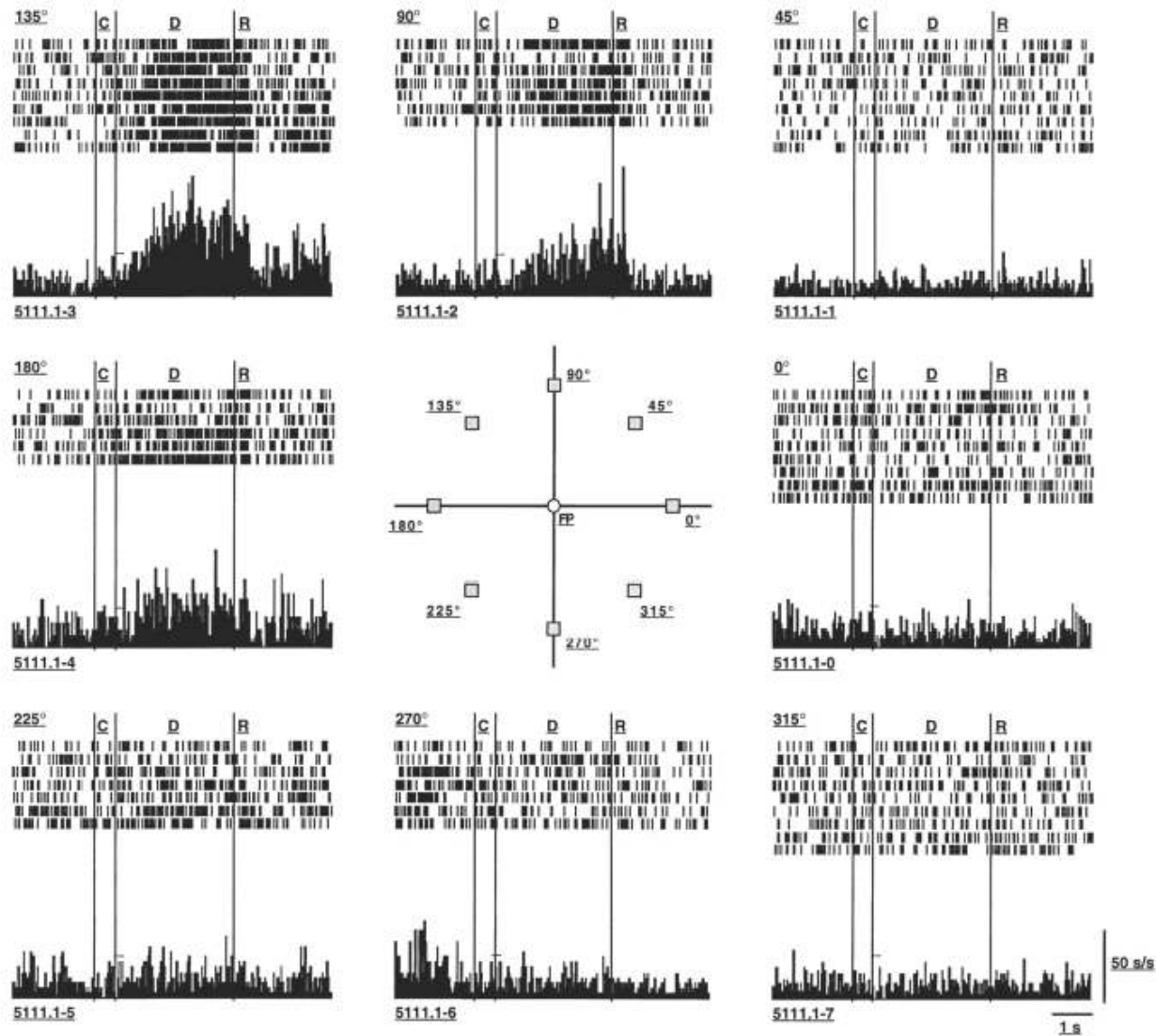


Fig. 2. Activity of a single prefrontal neuron, exemplifying persistent discharges during the execution of the oculomotor delayed-response task. Discharges are arranged as to indicate the location of the cue. The neuron is mostly active during the delay period following presentation of a stimulus in the upper left (135-degree) location. From Funahashi and others (1989) with permission.

Role of PFC in Memory Encoding

- If fMRI activity at encoding is back-sorted according to whether words are subsequently remembered or forgotten, then lower left VLPFC (and hippocampus) activation predicts later forgetting

