ASHI 712

The Neuroscience of Human Memory

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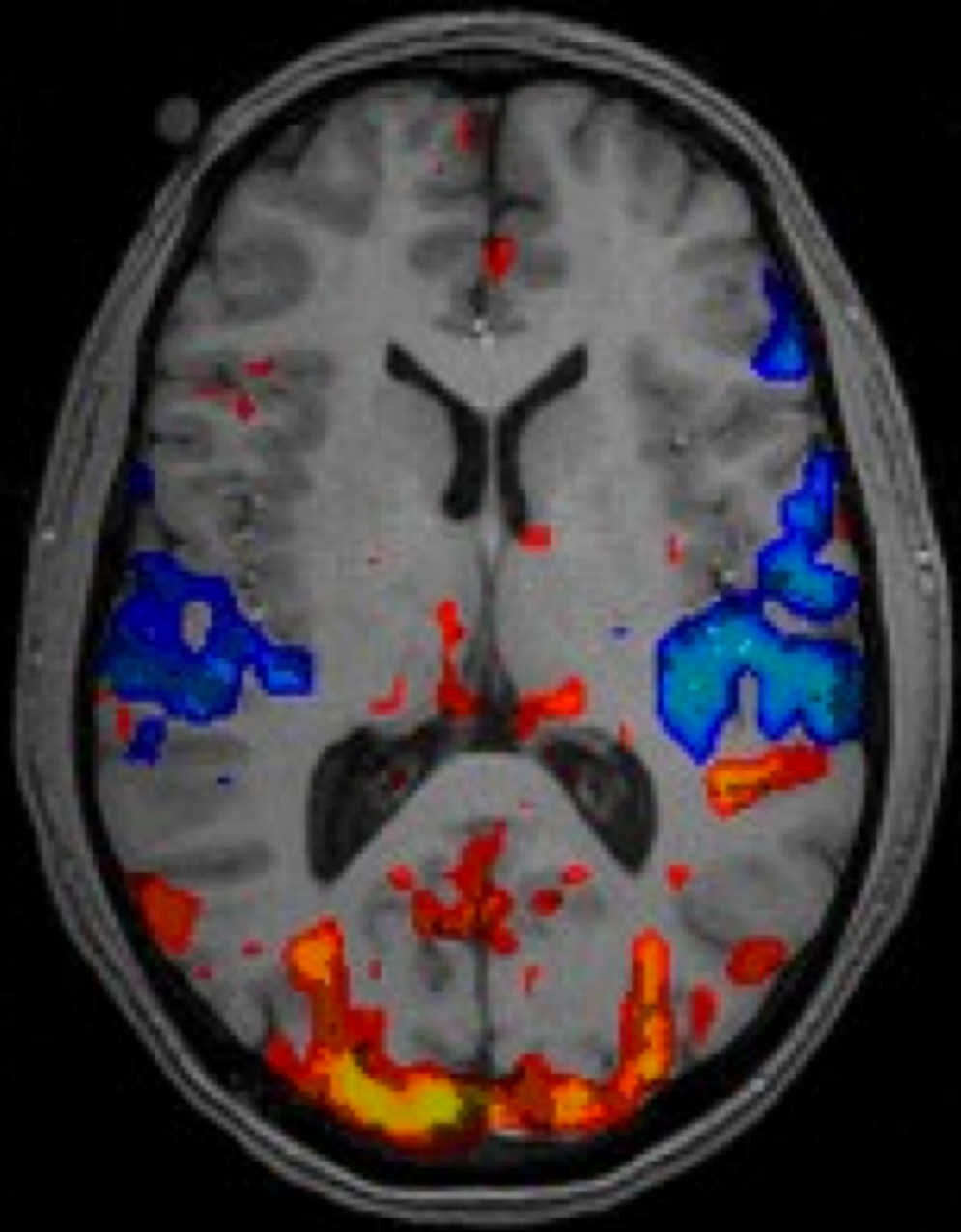
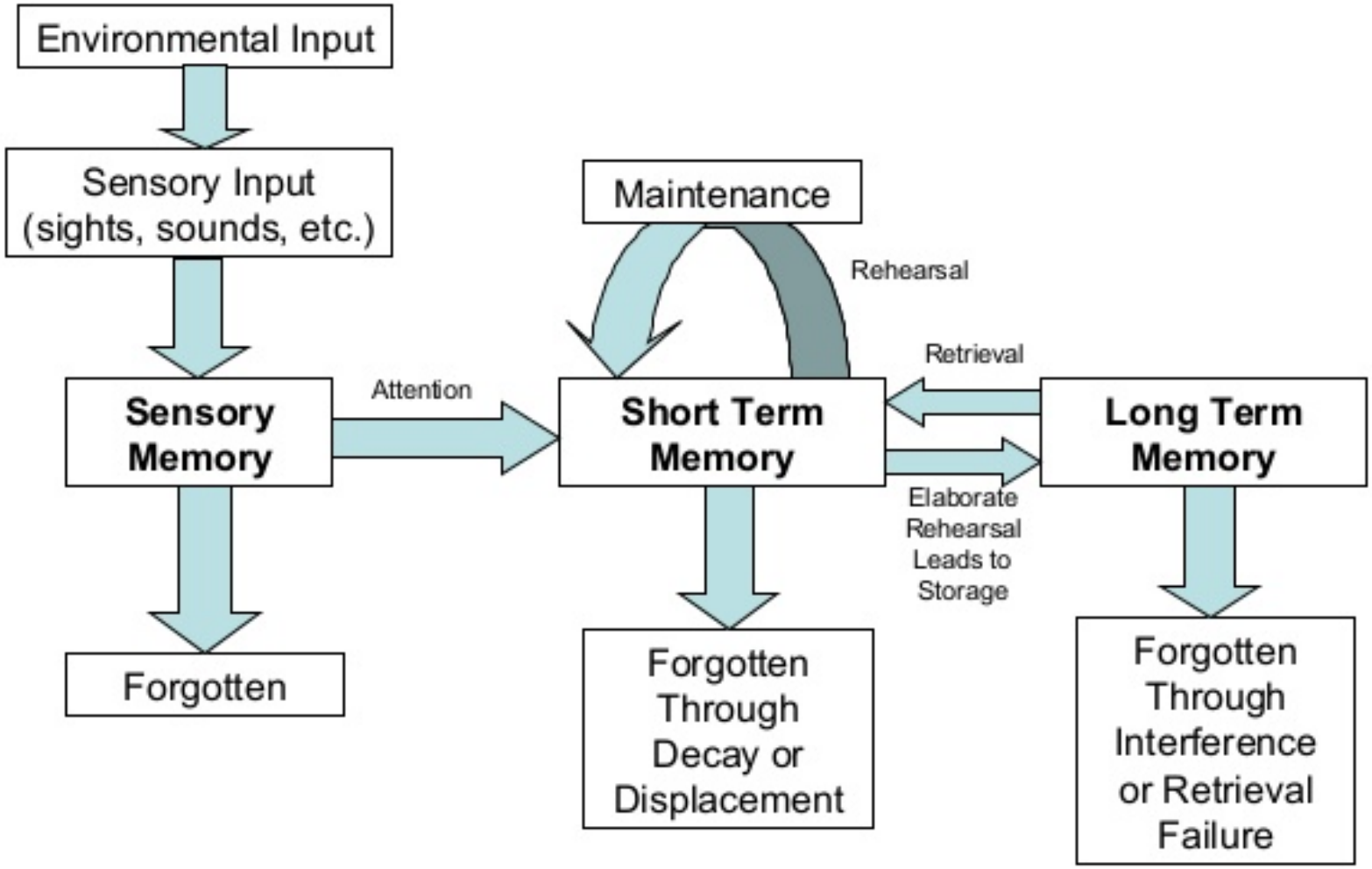
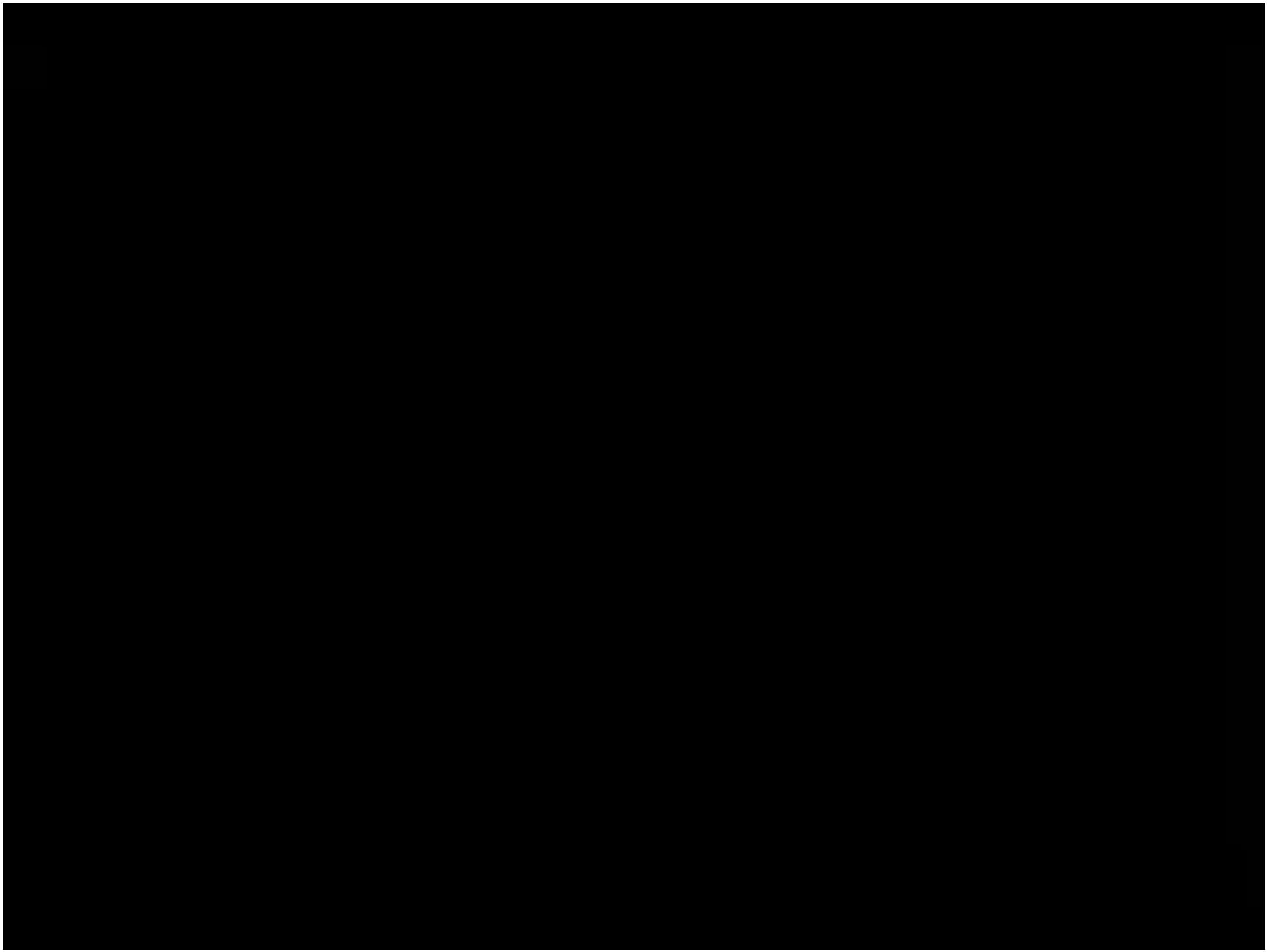
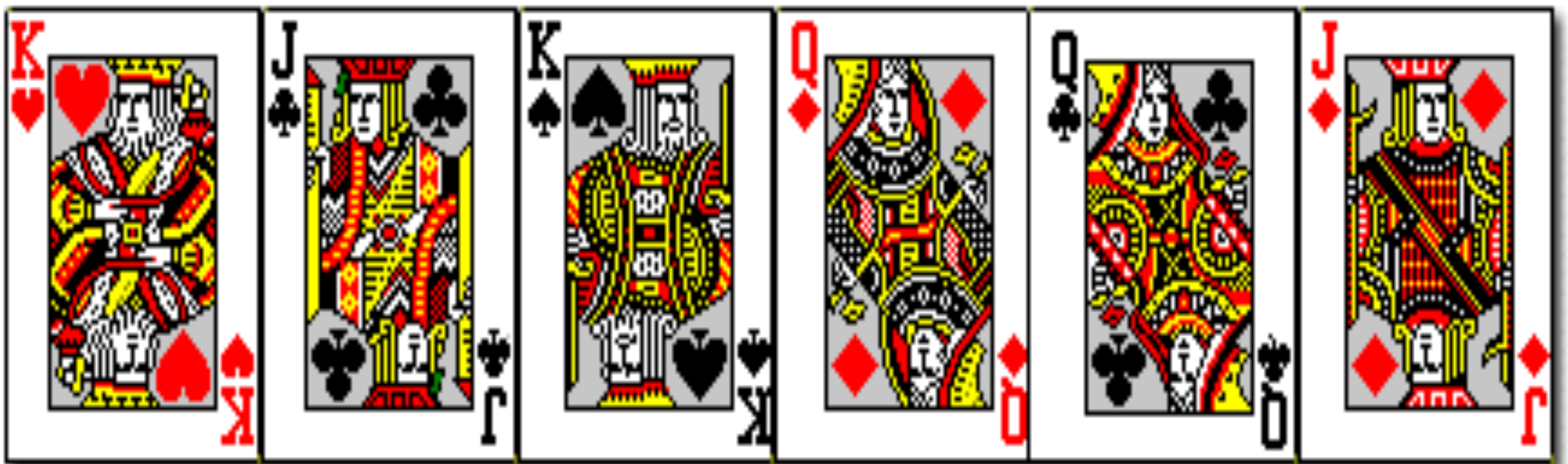
LECTURE 4:
Problems with Memory and Eidetic Memory

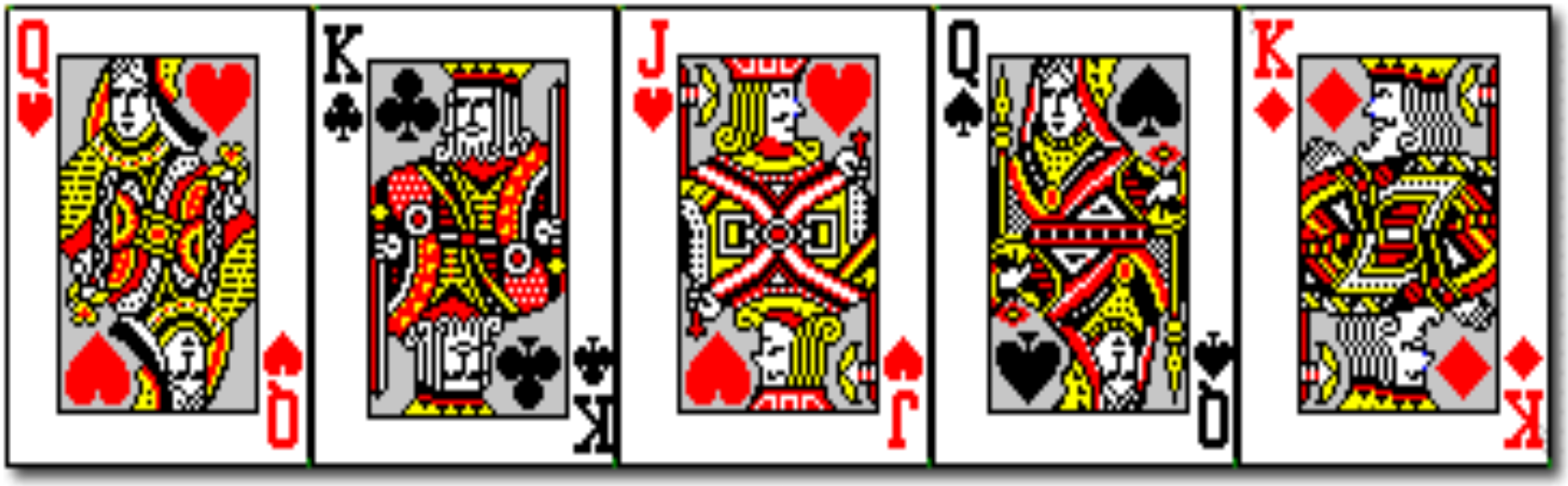


Multi Store Model - Atkinson & Shiffrin



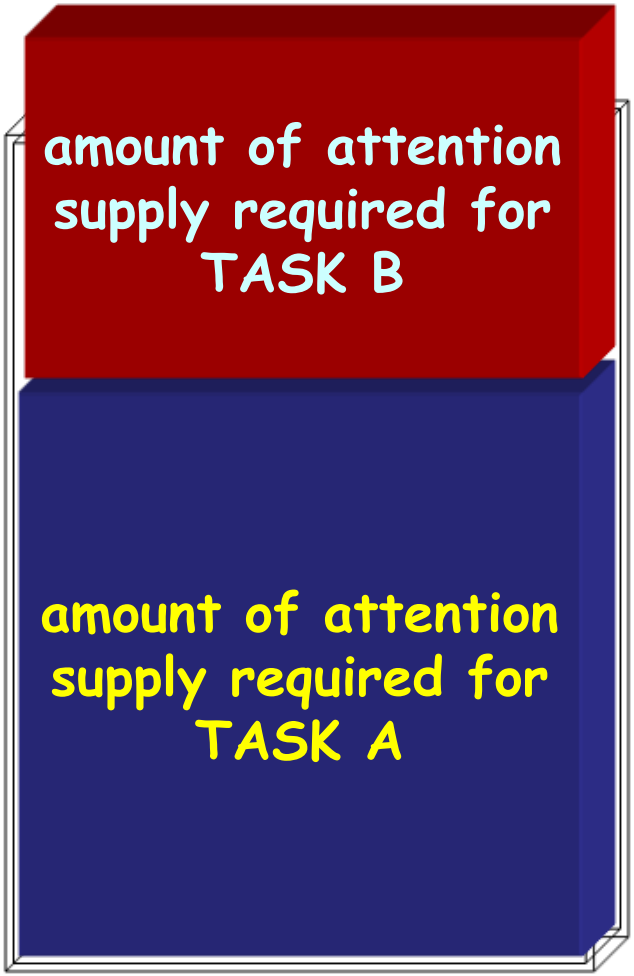




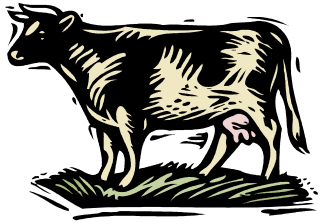


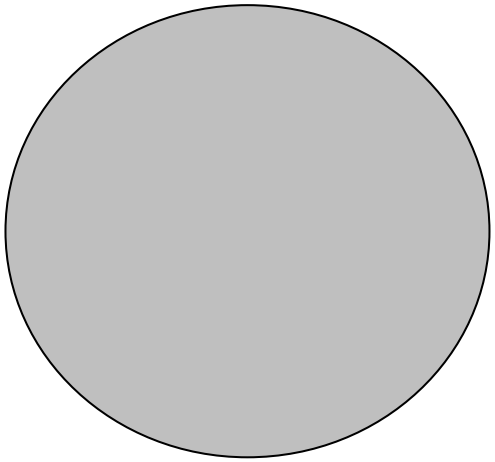
Attention as a resource

Attention as a resource

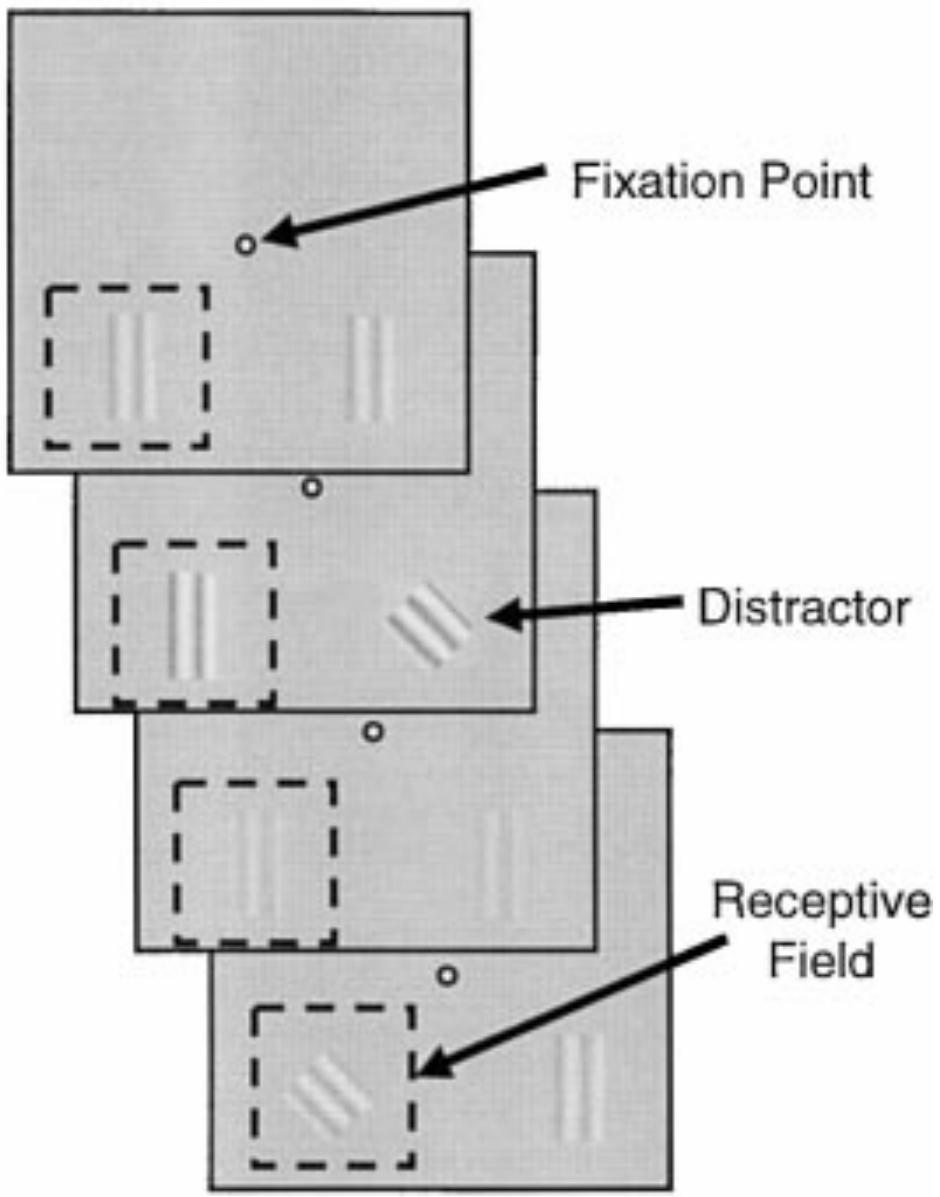


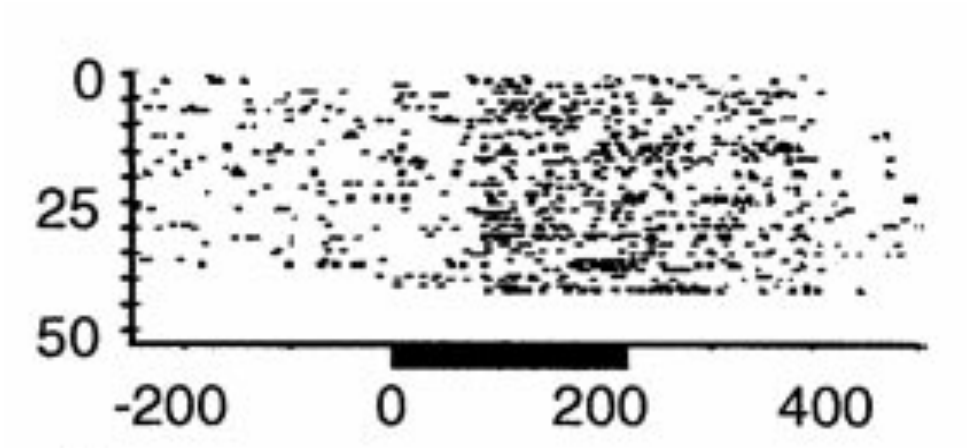
Attention as a spotlight

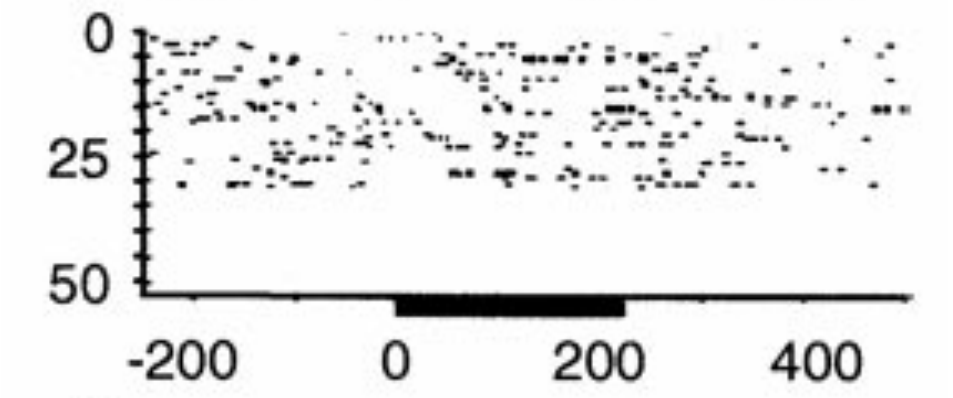


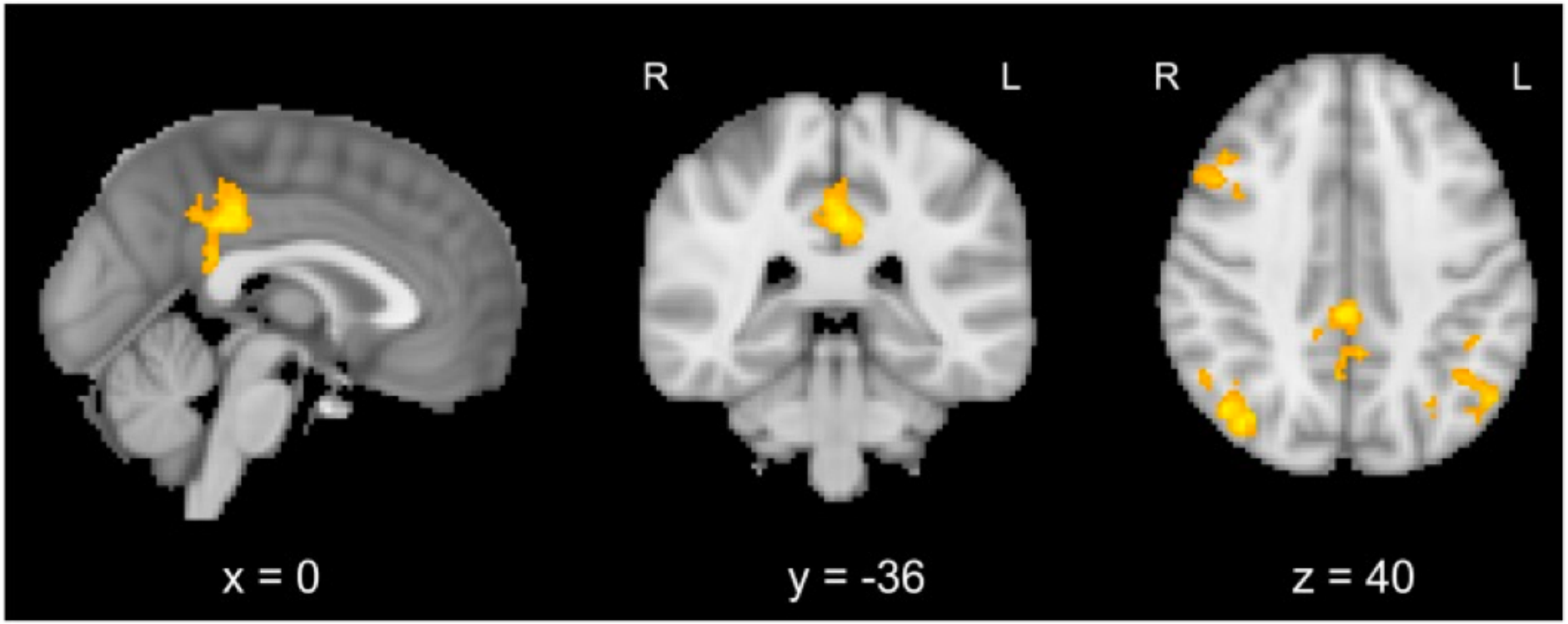


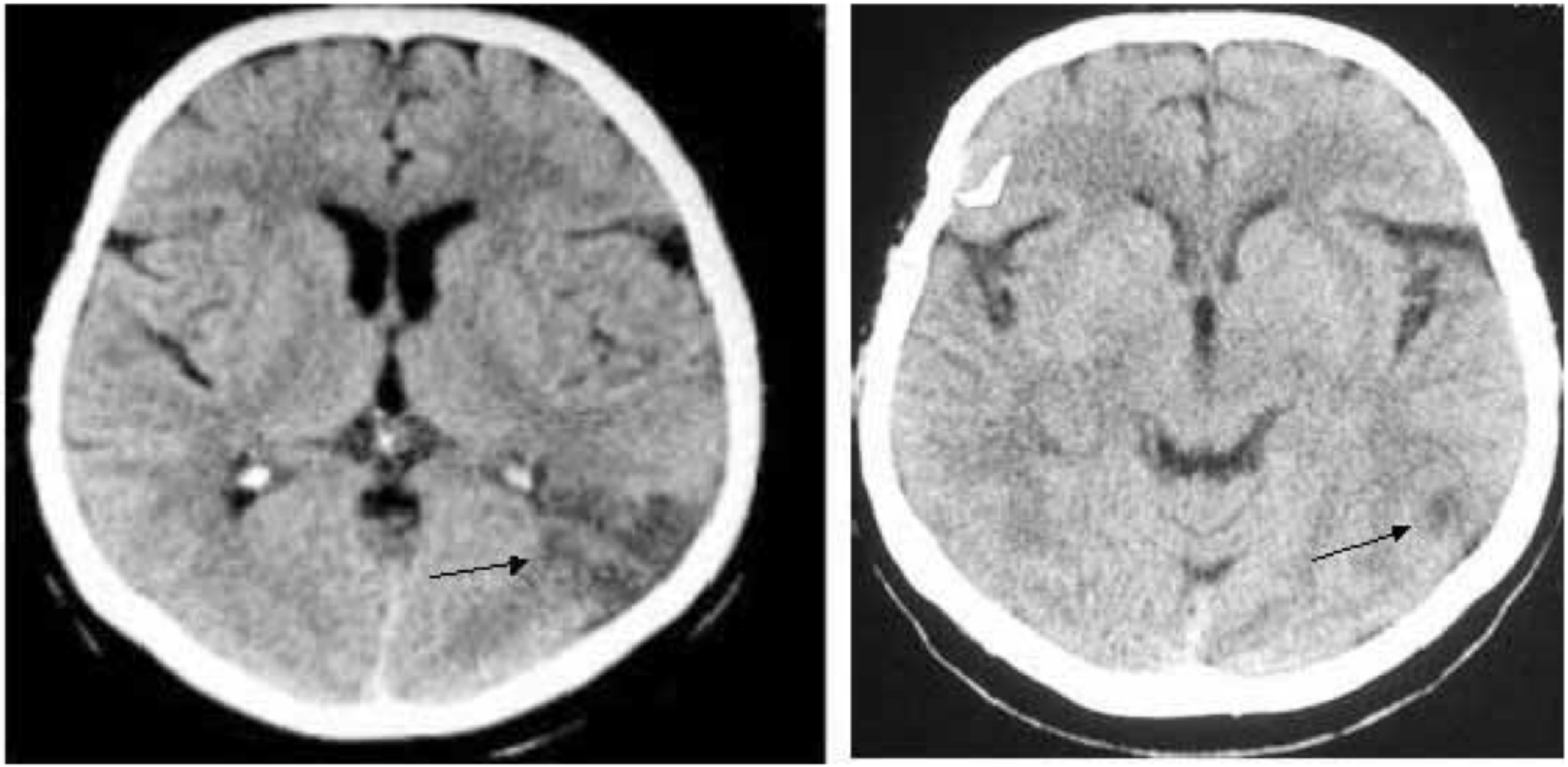
Test Trials




0
25
50
-200
0
200
400

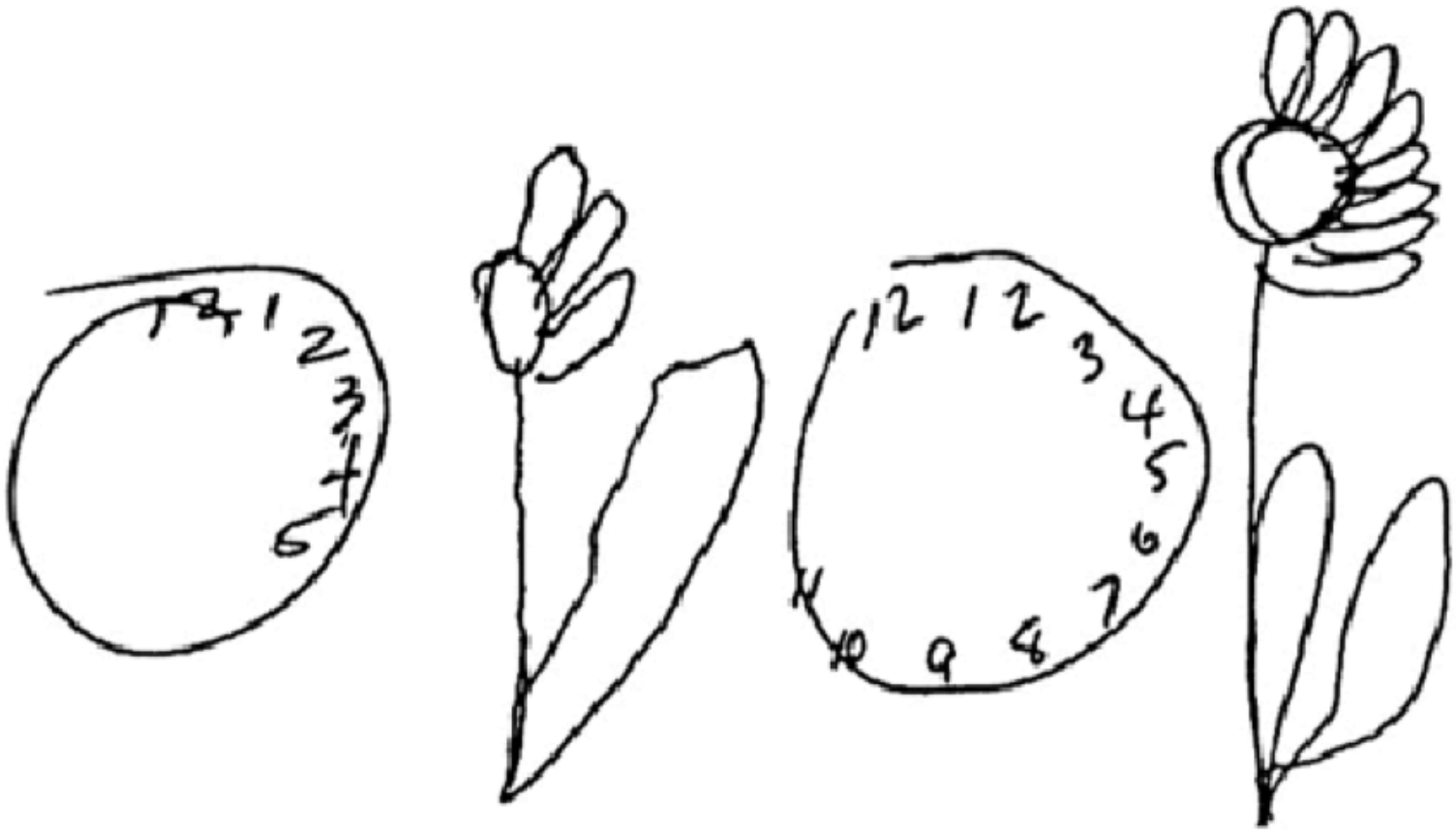

0
25
50
-200
0
200
400


R
L
R
L
x = 0
y = -36
z = 40

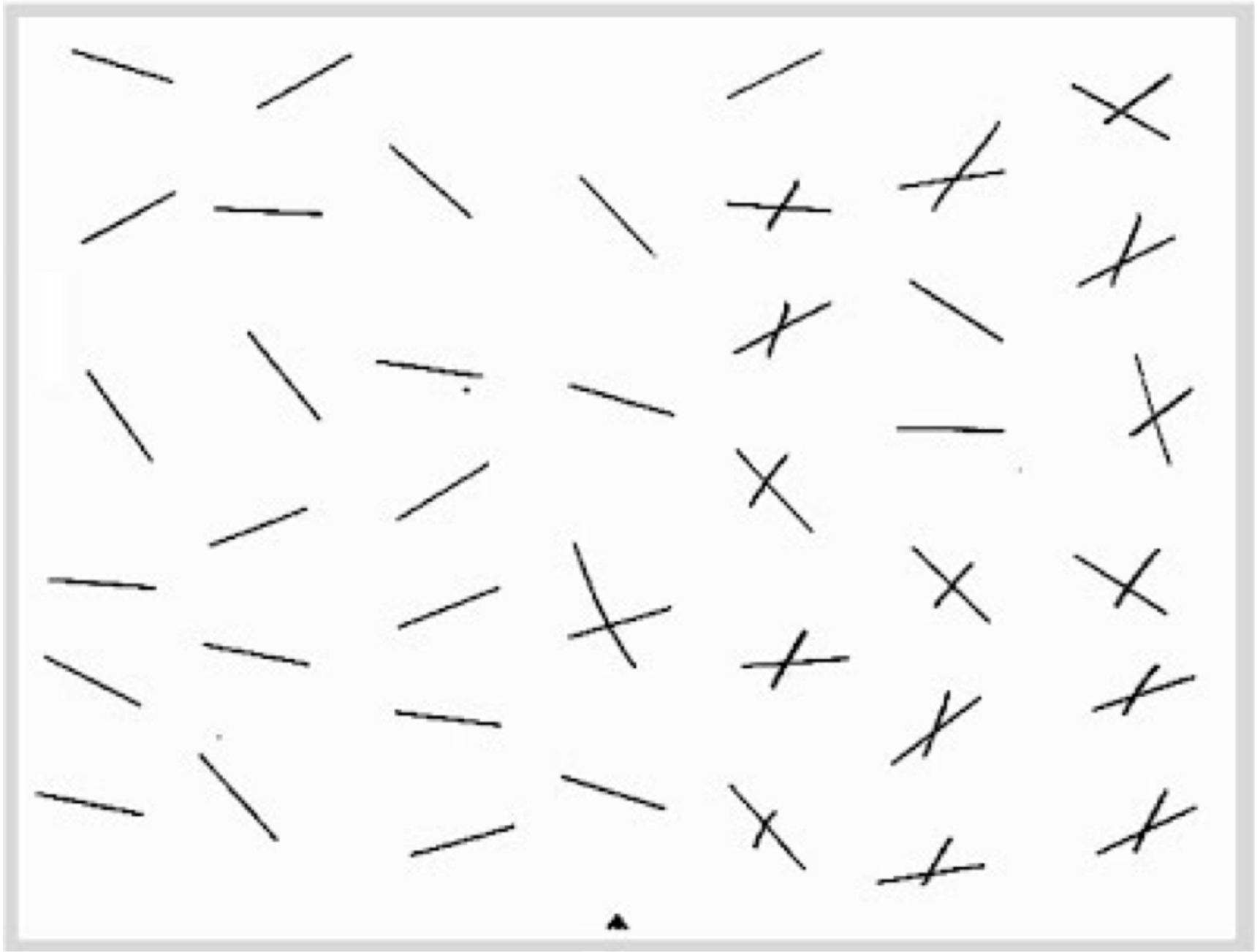


Patient A

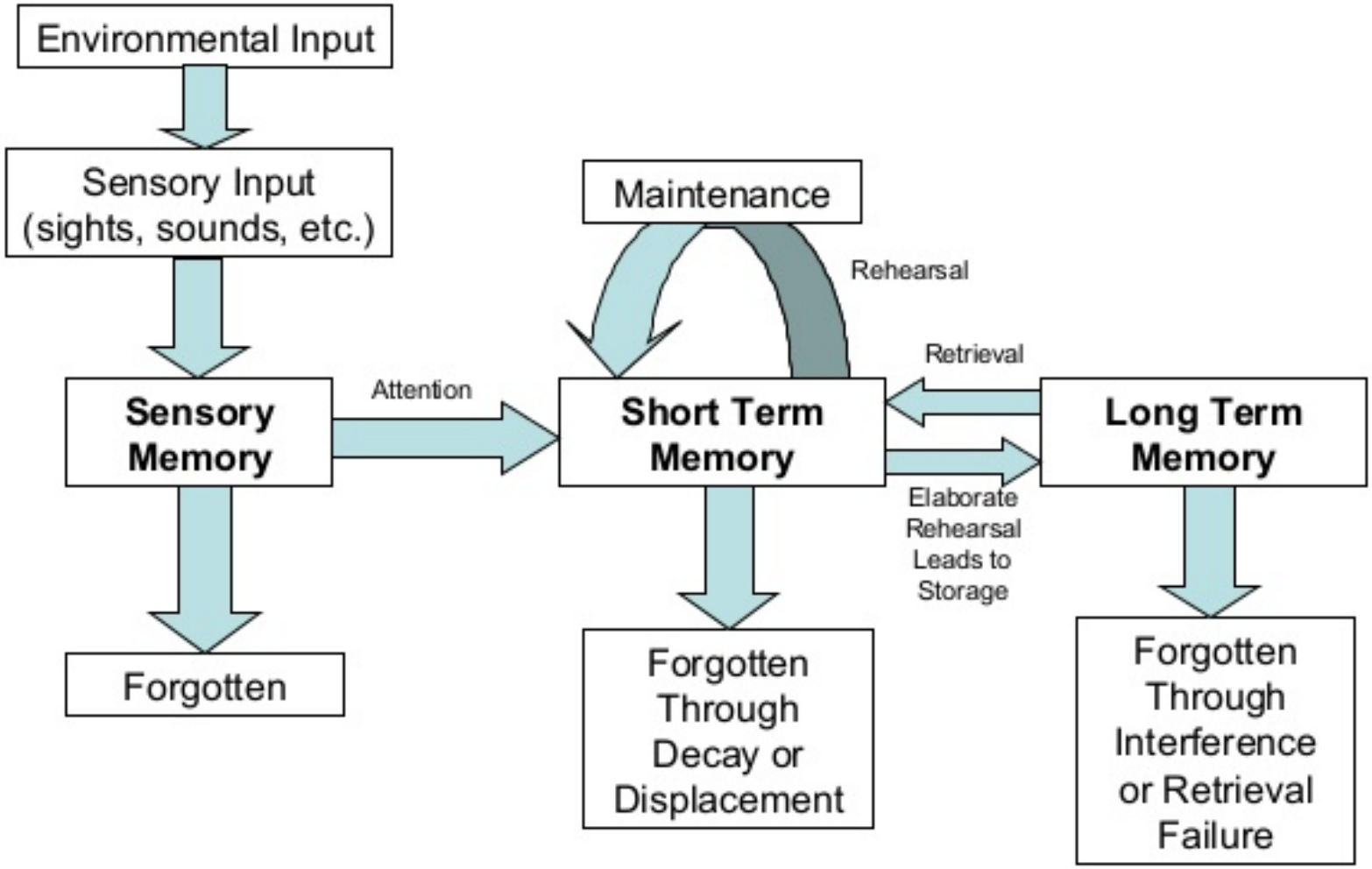
Patient B



Copies of a clock and a daisy



Multi Store Model - Atkinson & Shiffrin



Forgetting

- **Forgetting** refers to the inability to retrieve previously stored information.
- When you forget something, it means that it is unavailable to you at the time you are trying to remember it.
- The information may still be stored in in your memory, but for some reason you cannot retrieve it when you want to.

Forgetting Curve

- The **forgetting curve** shows the pattern (*rate* and *amount*) of forgetting that occurs over time.
- Generally, the graph shows that forgetting is rapid soon after original learning, then the rate of memory loss gradually declines, followed by stability in the memories that remain.

Ebbinghaus Curve

- **Rate**: rapid loss, gradual then stable
- **Amount**: 50% loss within 1 hour

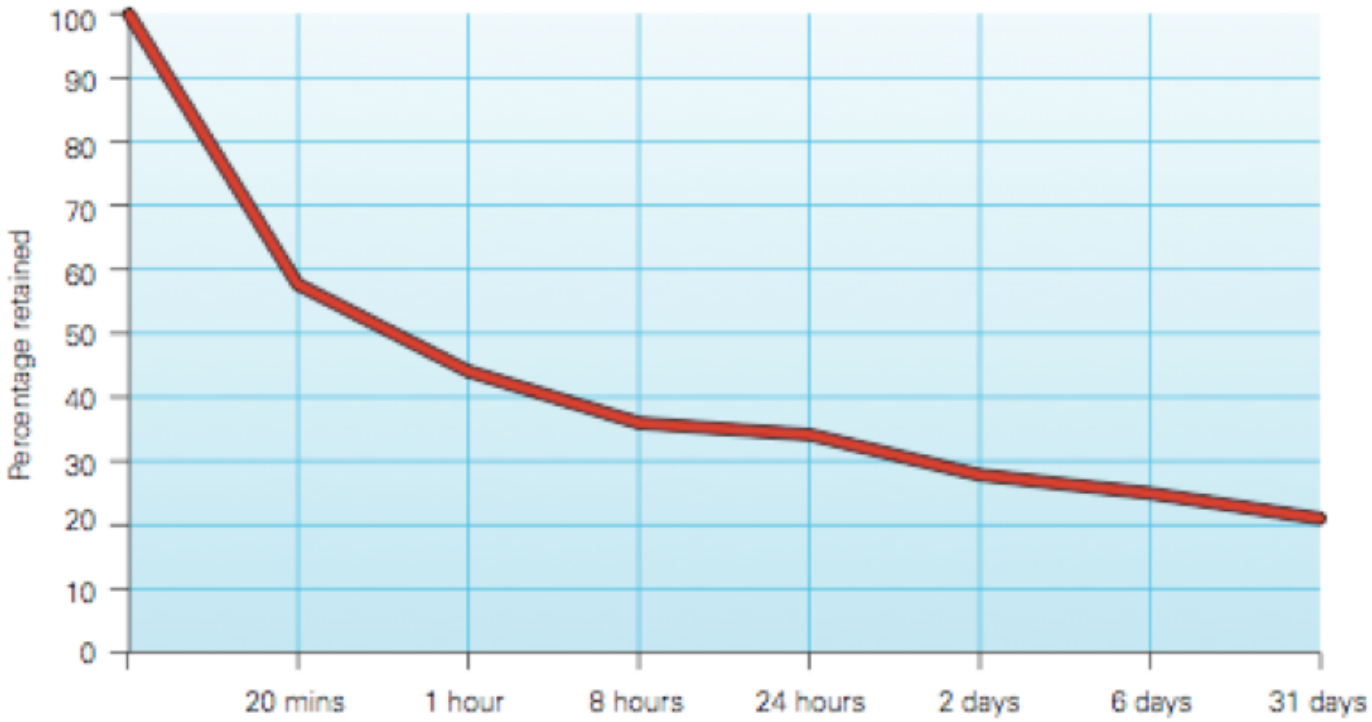
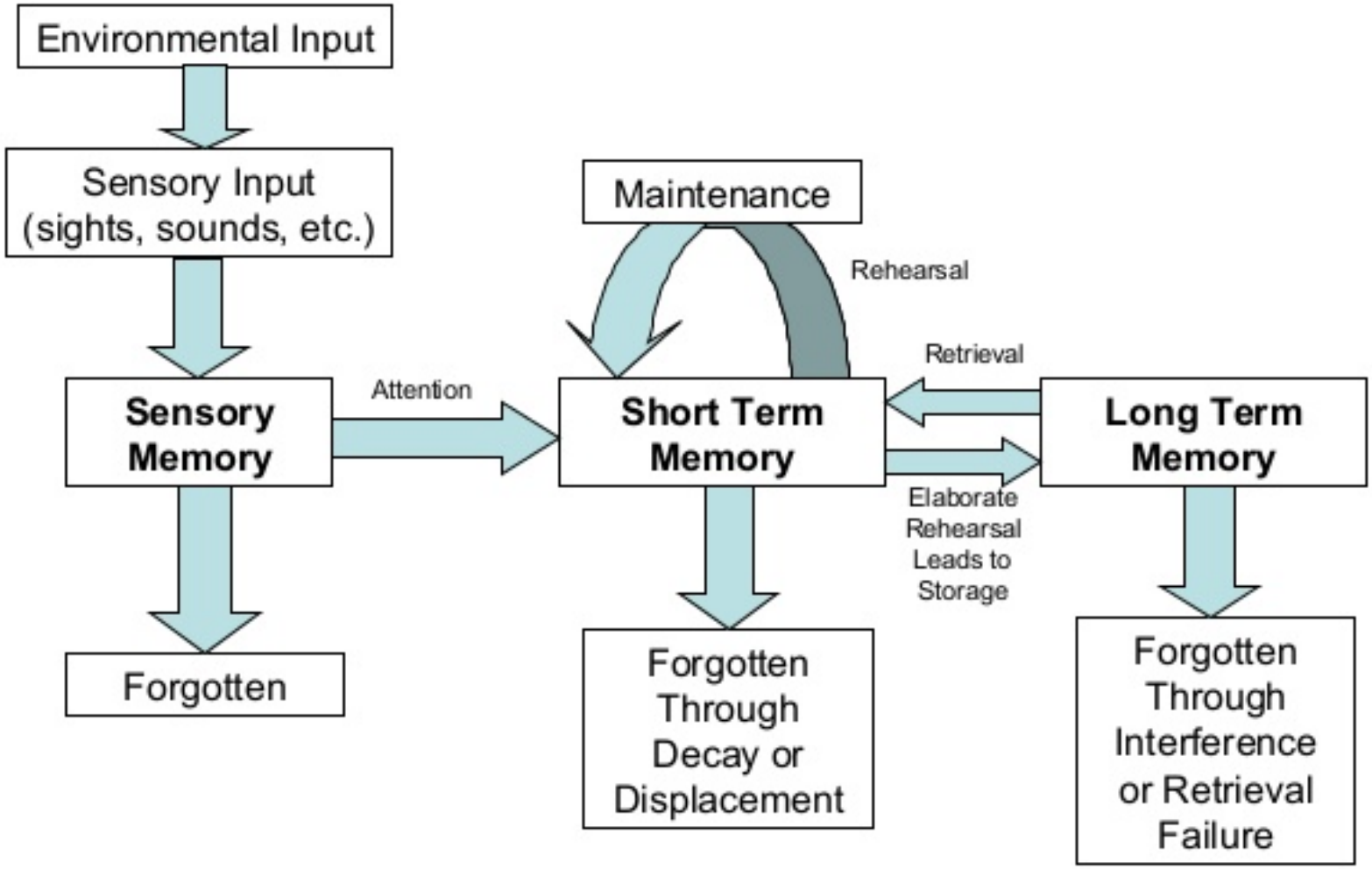


Figure 10.2
A forgetting curve shows the rate and amount of forgetting that occurs over time. Note that more than half of the learned information is forgotten in the first hour.

Forgetting Curve

- More than half the memory loss occurs within the first hour after learning.
- Virtually all the material that will be forgotten is lost in the first eight hours (about 65%).
- In addition, information that is not quickly forgotten seems to be retained in memory over a long period of time.

Multi Store Model - Atkinson & Shiffrin

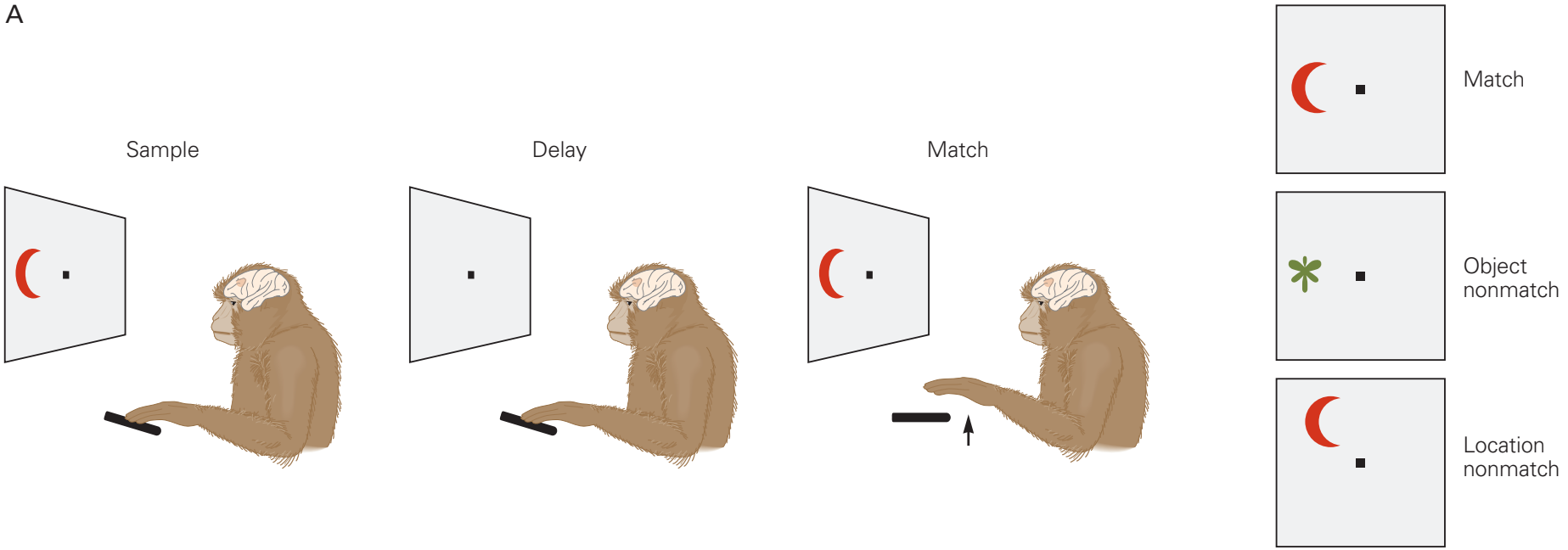


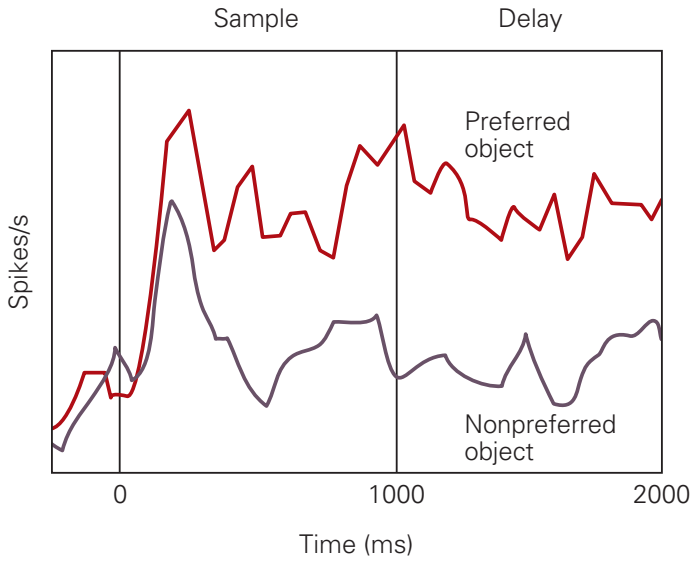
Trace Decay

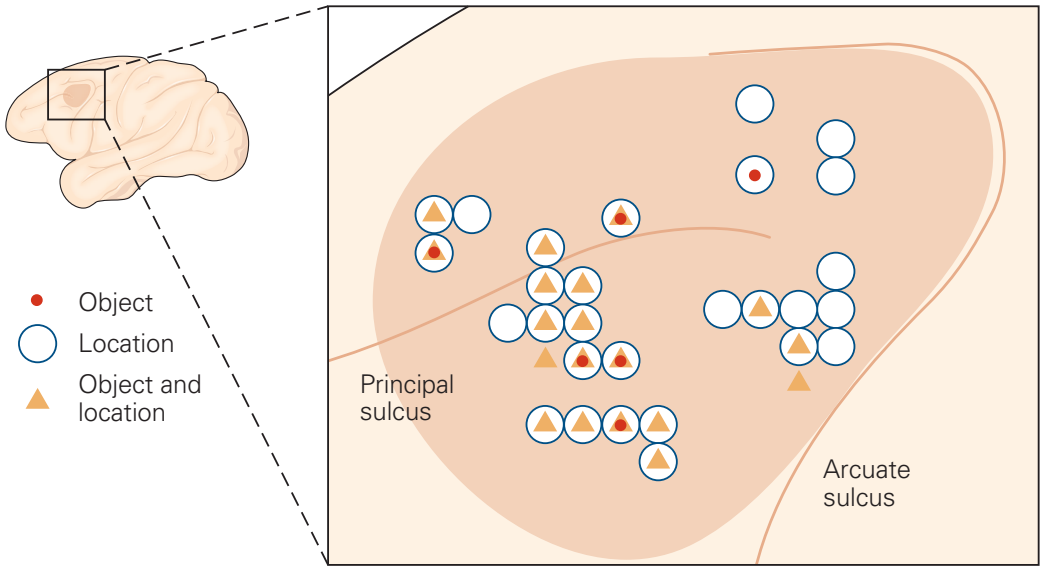
Memory “Traces”

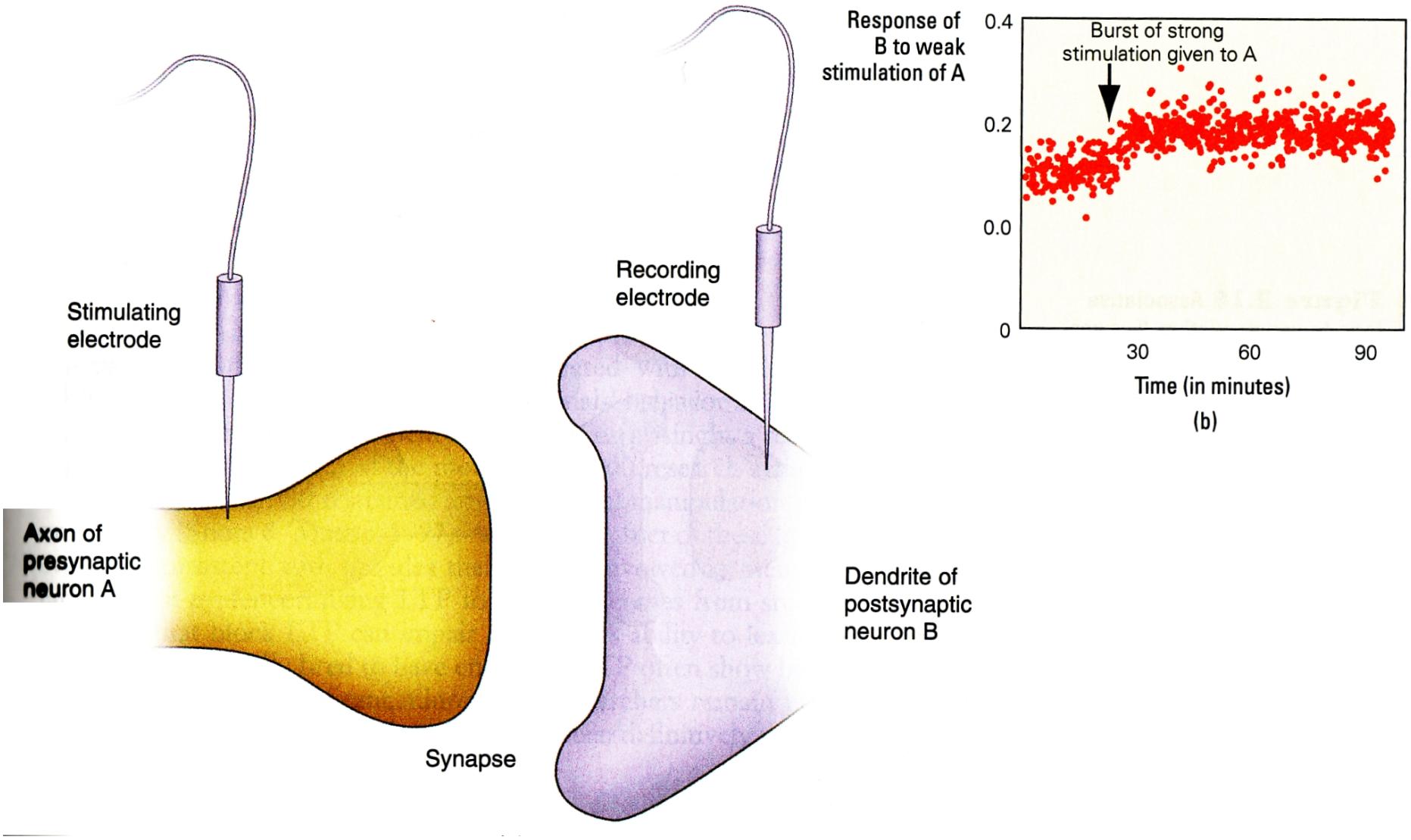
- Short term memories are held as a pattern of neural activity

A

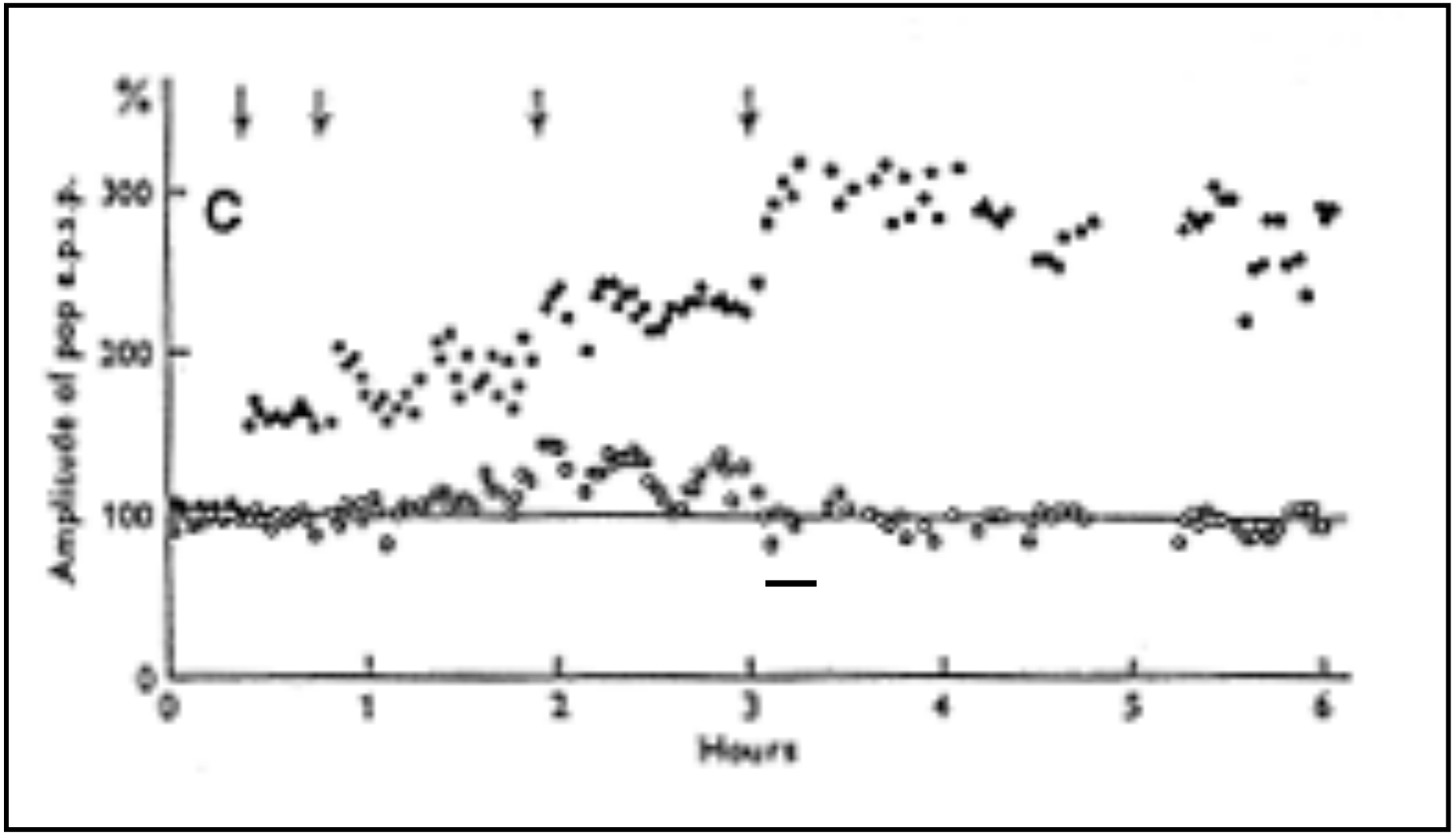

Sample
Delay
Match
Match
Object nonmatch
Location nonmatch

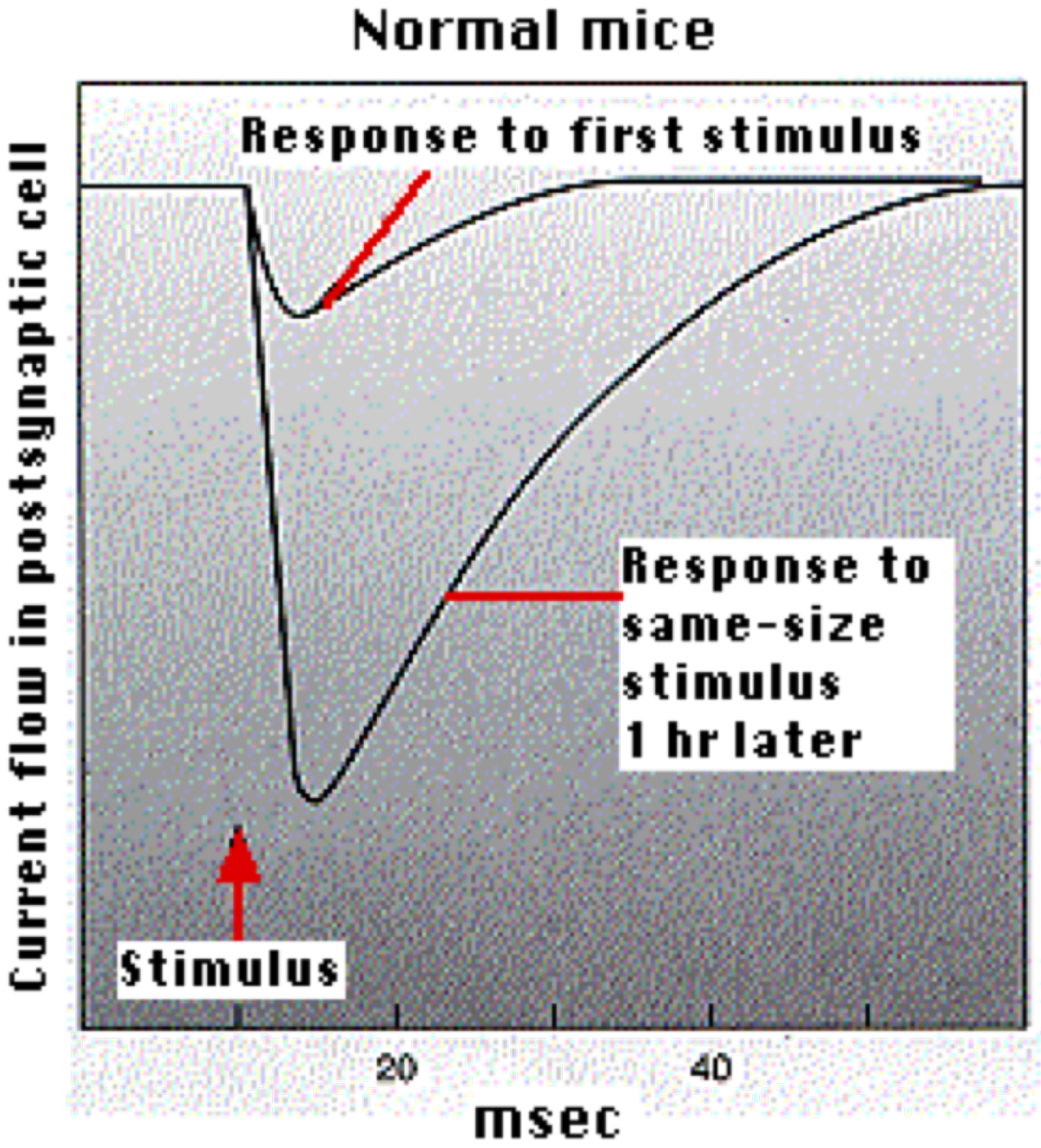

Sample
Delay
Preferred object
Nonpreferred object
Spikes/s
0
1000
2000
Time (ms)

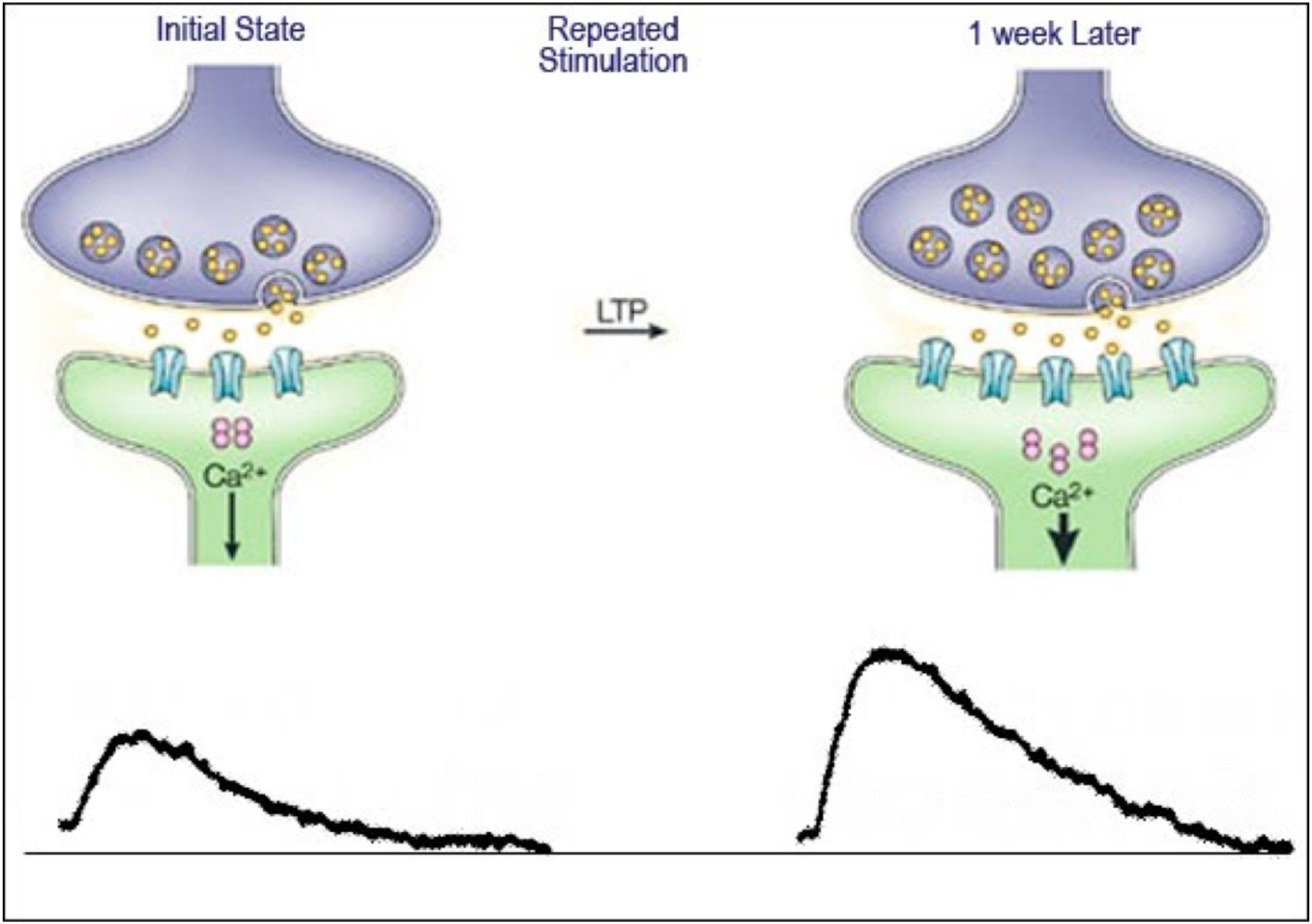

Object
Location
Object and location
Principal sulcus
Arcuate sulcus


Stimulating electrode
Recording electrode
Axon of presynaptic neuron A
Synapse
Dendrite of postsynaptic neuron B
Response of B to weak stimulation of A
Burst of strong stimulation given to A
0.4
0.2
0.0
0
30
60
90
Time (in minutes)
(b)

Bliss and Lomo's First Published LTP Experiment




Normal mice
Response to first stimulus
Response to same-size stimulus 1 hr later
Stimulus
Current flow in postsynaptic cell
20
40
msec

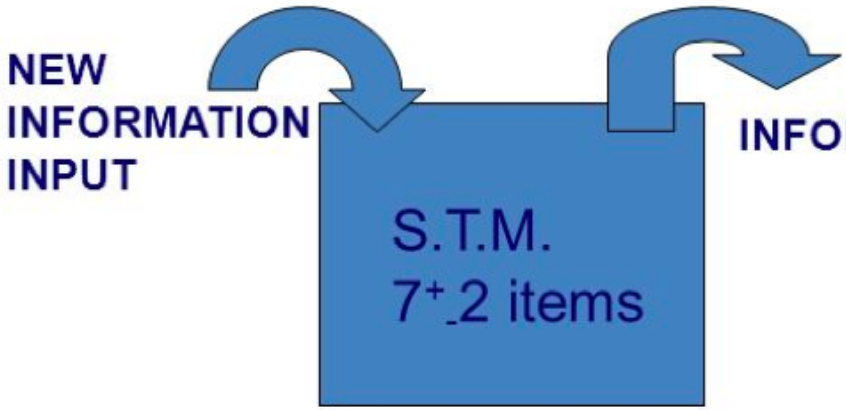

Initial State
Repeated Stimulation
1 week Later
LTP
Ca2+
Ca2+

Displacement

DISPLACEMENT

Is the simple idea that new memories will replace old ones

This theory assumes that a memory store has a limited capacity, so which types of memory will it apply to?



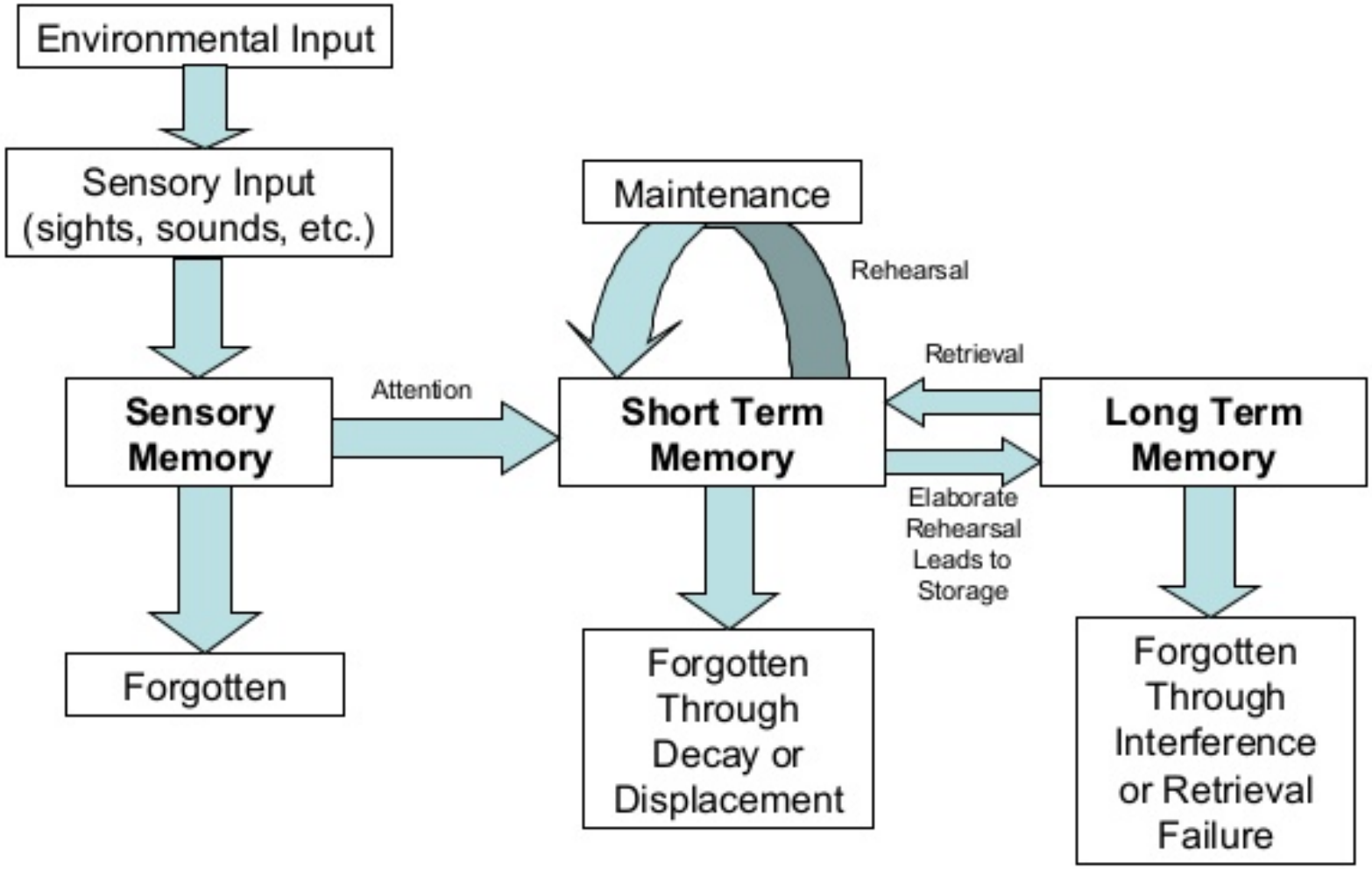
Miller (1956) found that when STM was full up (5 – 9 items) new material would push out the old.

Evidence from the digit span tests! Also Sperling (1960) found that SENSORY MEMORY also has a very limited capacity so this theory would also explain forgetting here but-

add / delete items from working memory
selecting from items
recall from long term memory
transfer to long term memory

Baddeley & Hitch, 1974

Multi Store Model - Atkinson & Shiffrin



Interference

Interference Theory

- **Interference theory** proposes that forgetting in LTM occurs because other memories interfere with the retrieval of what we are trying to recall, particularly if the other memories are similar.
- The more similar the information, the more likely it is that interference will occur.
- Furthermore, if learning of the similar information occurs close in time, interference is more likely.

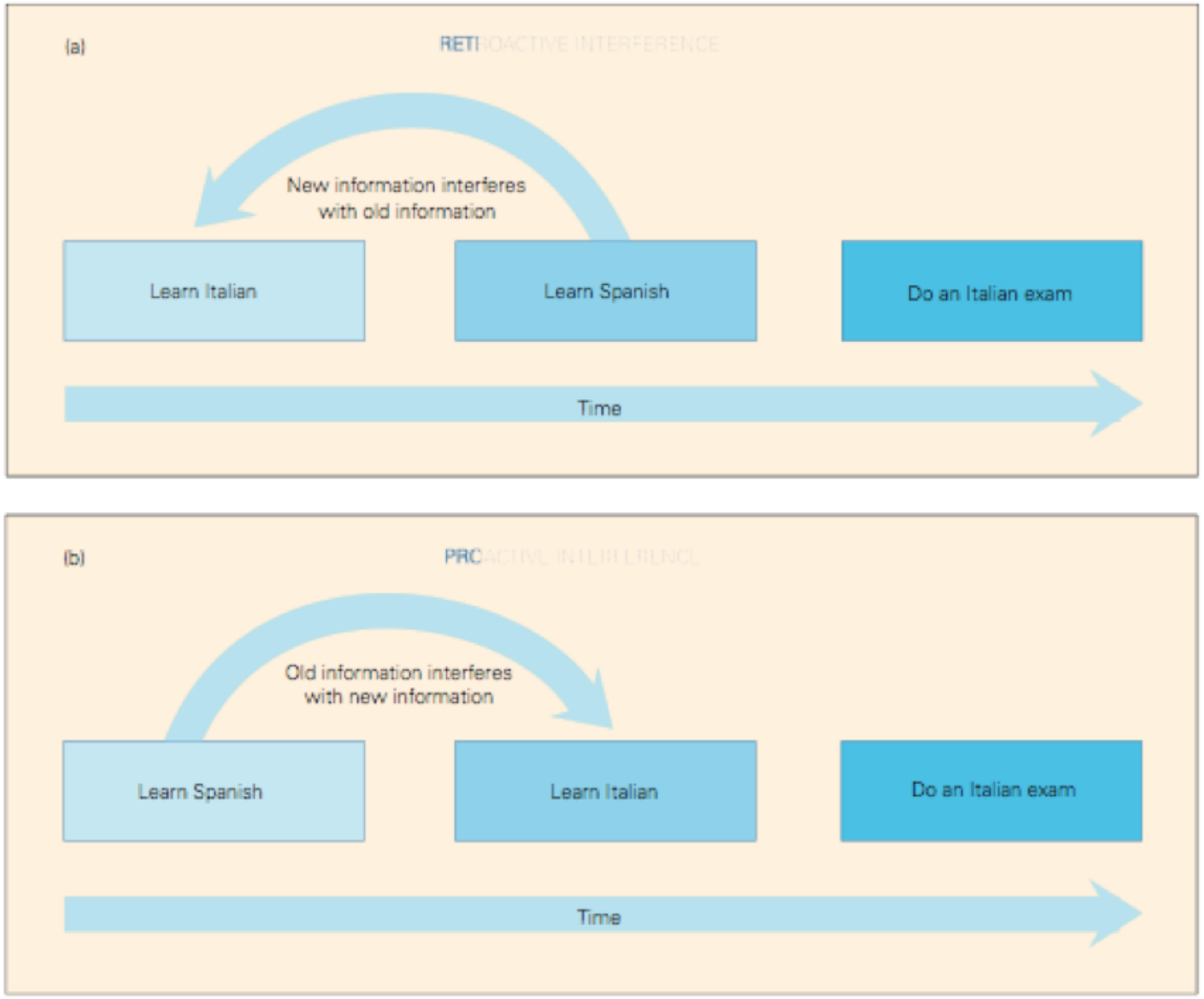


Figure 10.8
This diagram illustrates the distinction between retroactive and proactive interference. It shows how interference can play a role in forgetting information that is being learned for an exam. However, for interference to occur there must be a high degree of similarity between the information learned in Italian and Spanish.

Retroactive Interference

- When new information interferes with the ability to remember old information, psychologists refer to the interference as **retroactive interference**.

Figure 10.5
In retroactive interference, new information (Aunt Grace's address) interferes retroactively with older information (number of pennies).

Proactive Interference

- Information learned previously can interfere with our ability to remember new information. This effect is called **proactive interference**.

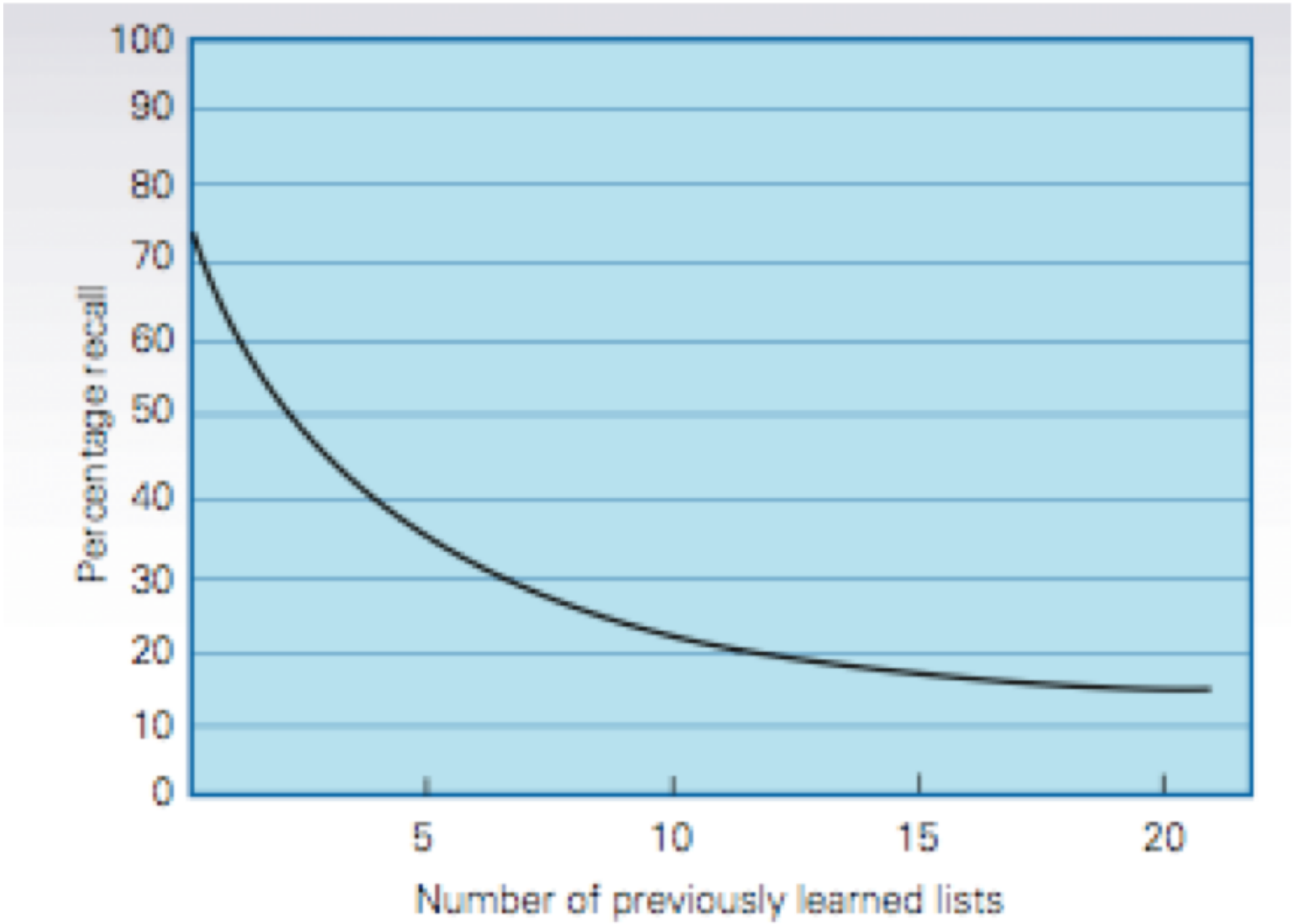


Figure 10.6
This graph shows the effect of proactive interference on previously learned lists of words. Generally, recall of the lists worsens as the number of previously learned lists increases.

Table 10.2
Experimental design for proactive interference.

Group	First task	Second task	Third task
Experimental	Learns A	Learns B	Test for retention of B
Control	No activity	Learns B	Test for retention of B

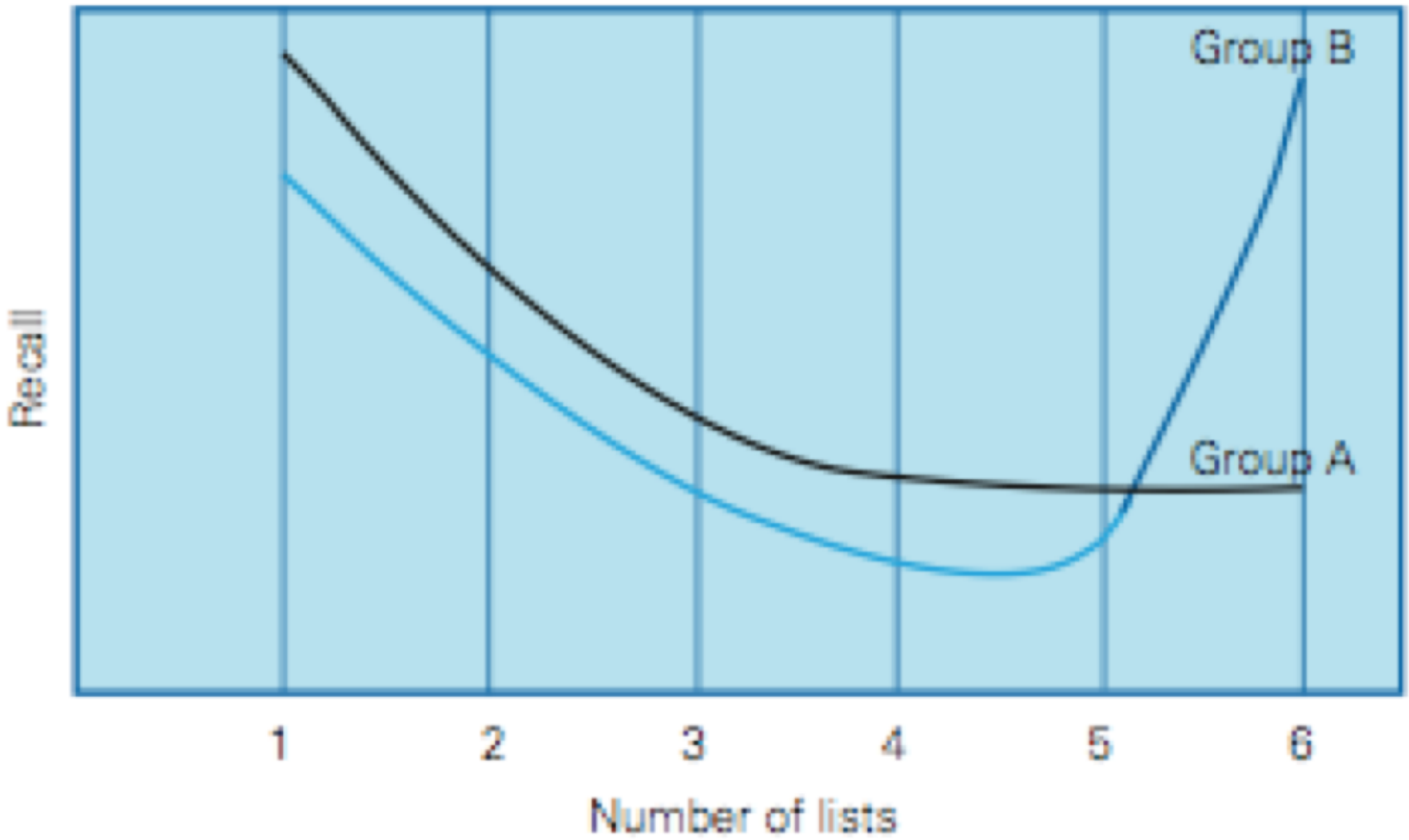


Figure 10.7
Results of an experiment on the effects of interference on retrieval of similar information.

How does interference disrupt a memory?

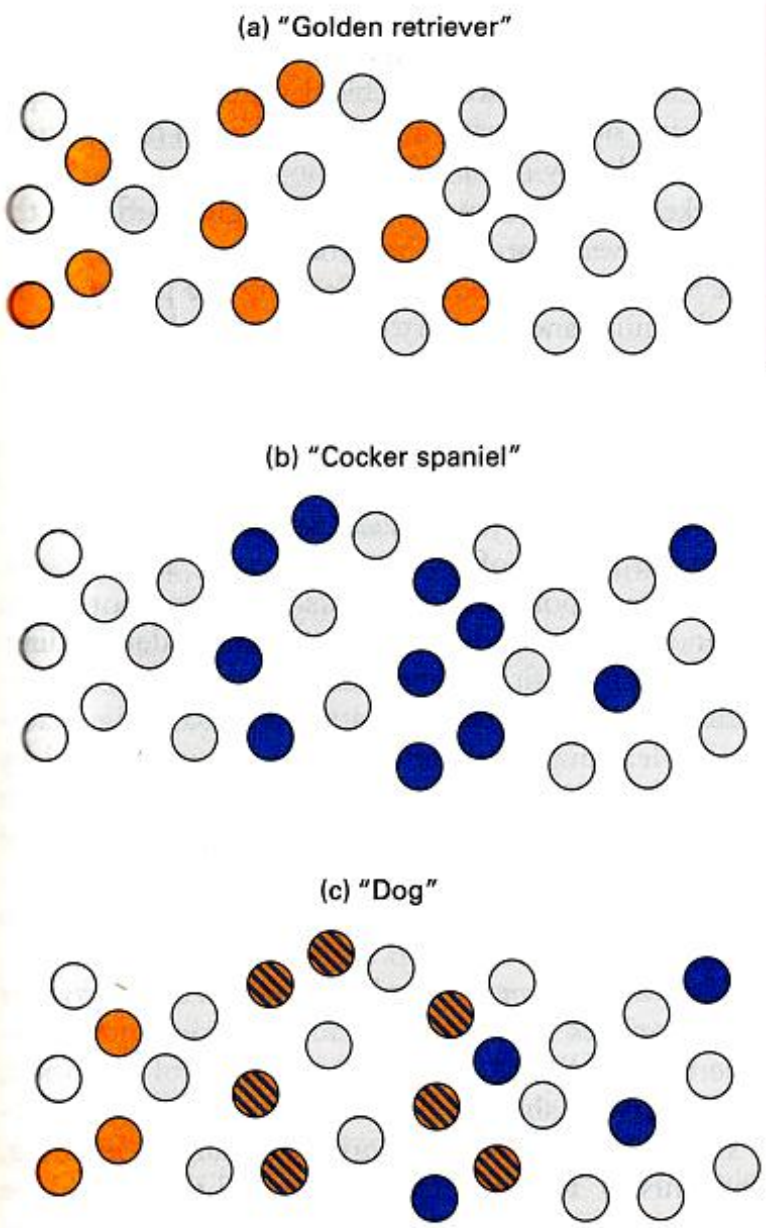
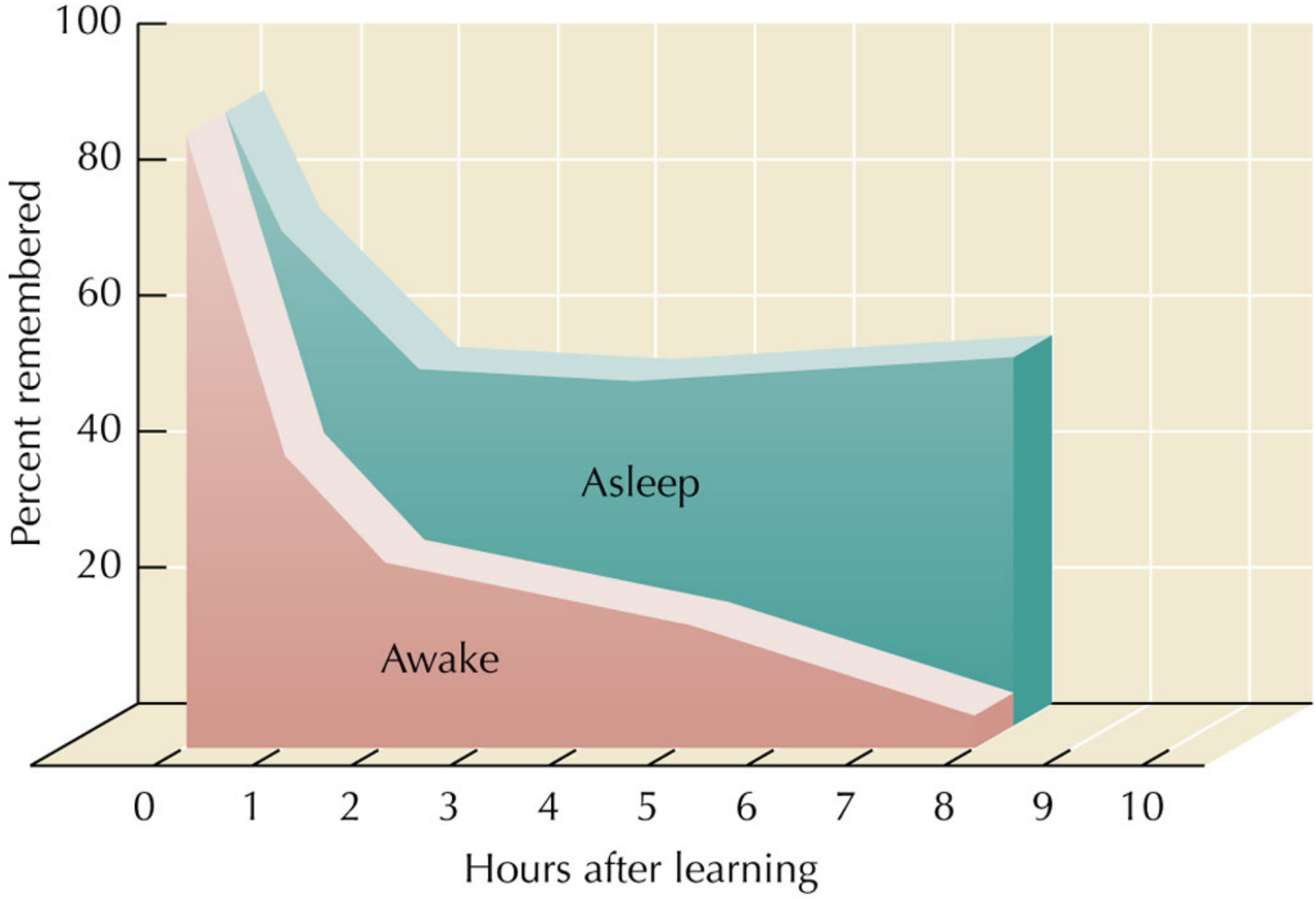


Figure 1.11 Distributed representations (a) The representation of "golden retriever" activates one subset of nodes, shown in yellow. (b) "Cocker spaniel" activates a different subset, shown in blue. (c) The similarity between them—both are dogs—emerges naturally as a function of the overlap between representations, shown by the yellow-and-blue nodes.

Figure 7.13



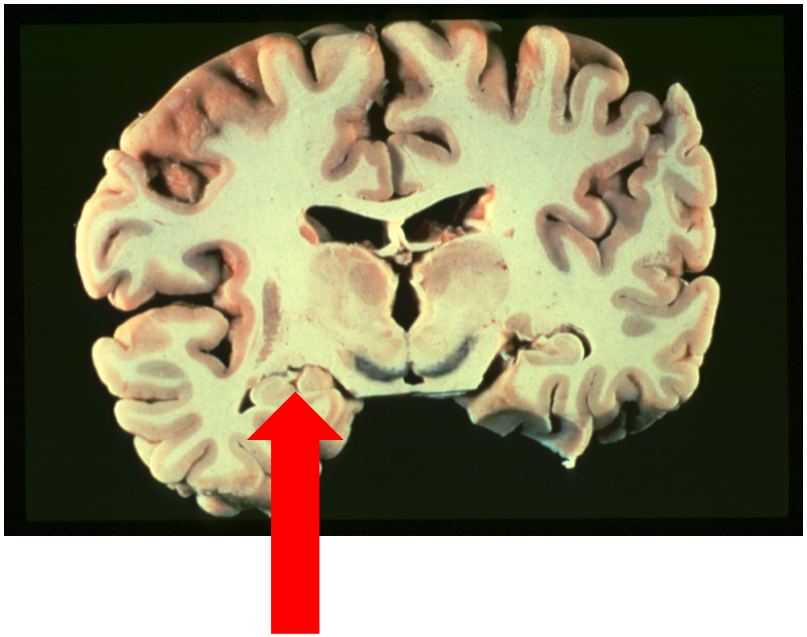
Retrieval Failure

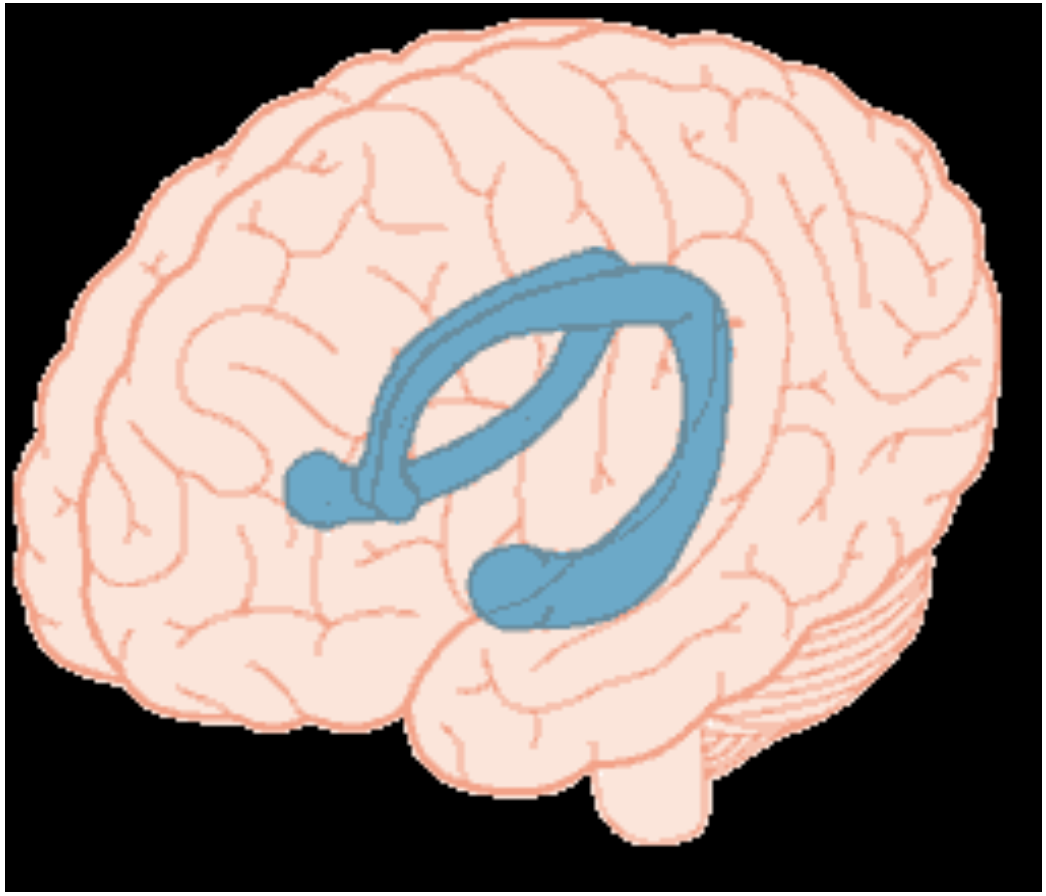
Retrieval Failure Cue

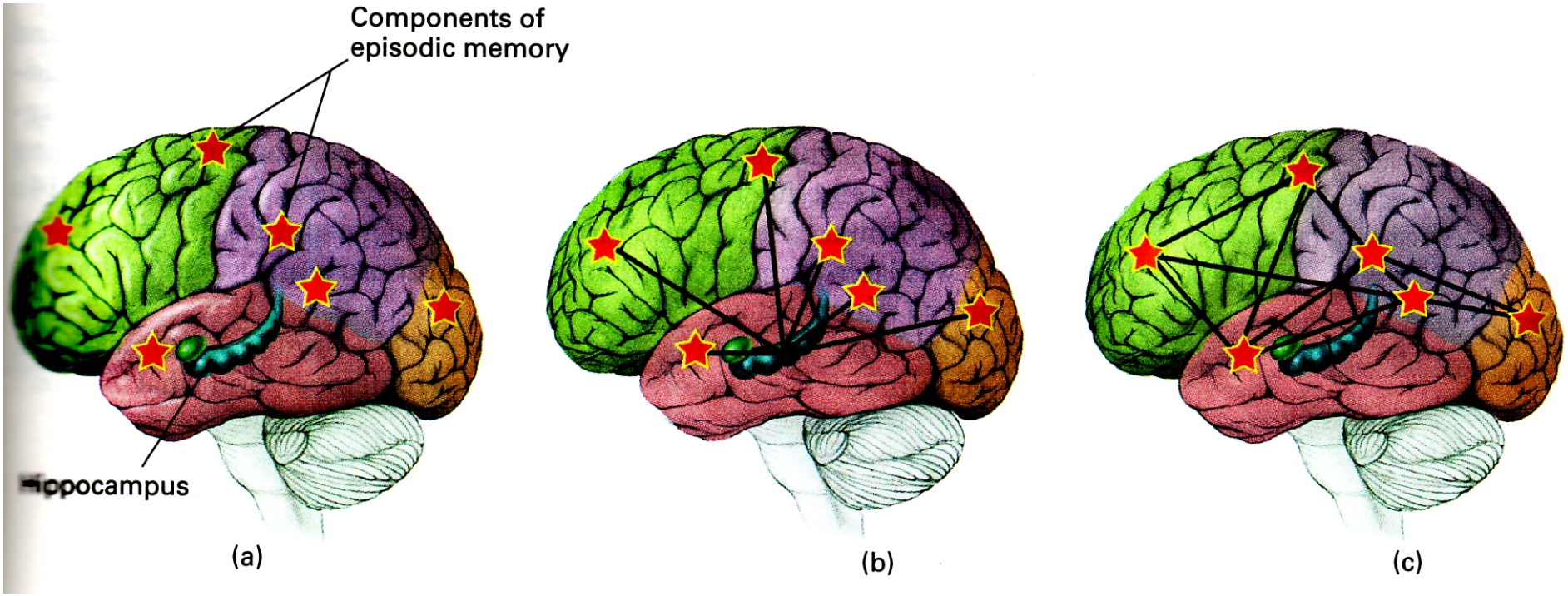
- According to **retrieval failure theory** we sometimes forget because we lack or fail to use the right cues to retrieve information stored in memory.
- This explanation of forgetting suggests that memories are not actually forgotten, but are temporarily inaccessible or unavailable because of an inappropriate or faulty cue.
- This theory is often referred to as *cue-dependent forgetting*.

Retrieval Failure Cue

- A **retrieval cue** is any stimulus that assists the process of locating and recovering information stored in memory.
- Basically a retrieval cue acts as a prompt or a hint that guides the search and recovery process within memory.






Components of
episodic memory
Hippocampus
(a)
(b)
(c)

Motivated Forgetting

Motivated Forgetting

- **Motivated forgetting** is used to describe forgetting that arises from a strong motive or desire to forget, usually because the experience is too disturbing or upsetting to remember.

Repression

- *Repression* is an **unconscious** process through which an individual blocks a memory of an event or experience from entering conscious awareness.
- This explanation is based on the observations of Austrian psychoanalyst Sigmund Freud (1856-1939) that individuals sometimes unconsciously prevent a memory from entering conscious awareness because it is too **psychological painful or unpleasant** to remember the specific information.

Suppression

- Unlike repression, *suppression* involves being motivated to forget an event or experience by making a deliberate, **conscious** effort to keep it out of conscious awareness.
- Although the person remains aware of the experience and knows that the associated event actually did occur, they consciously choose not to think about it.
  - e.g. something **embarrassing**

Memory Loss

Decay Theory

- Decay theory is based on an assumption that when something new is learned, a physical or chemical trace of the experience is formed.

- The memory trace containing stored information is formed in the brain as the information is consolidated in LTM.

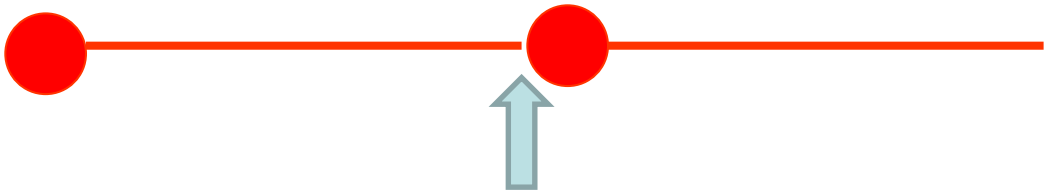
Decay Theory

- According to **decay theory**, forgetting occurs because a memory (or the memory trace) fades through disuse as time passes, unless it is reactivated by being used occasionally.

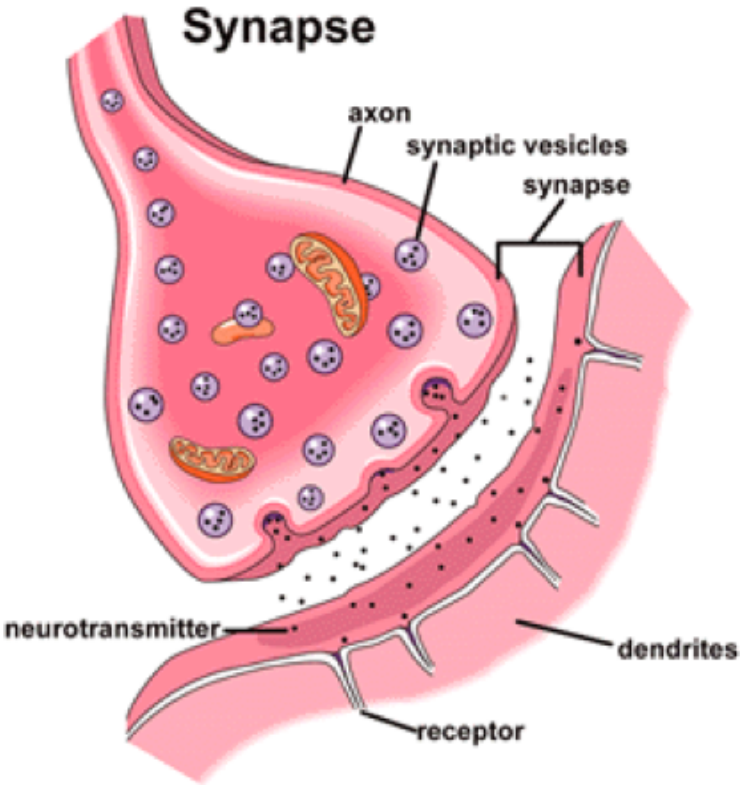
- If the memory trace simply decayed over time, it would be reasonable to assume that the presentation of retrieval cues would have no effect on the retrieval of information or events that have been held in LTM for a considerable period of time—but it does.

Decay Theory

Figure 10.13
According to decay theory, forgetting occurs due to the fading of a memory trace through disuse of the memory over time.



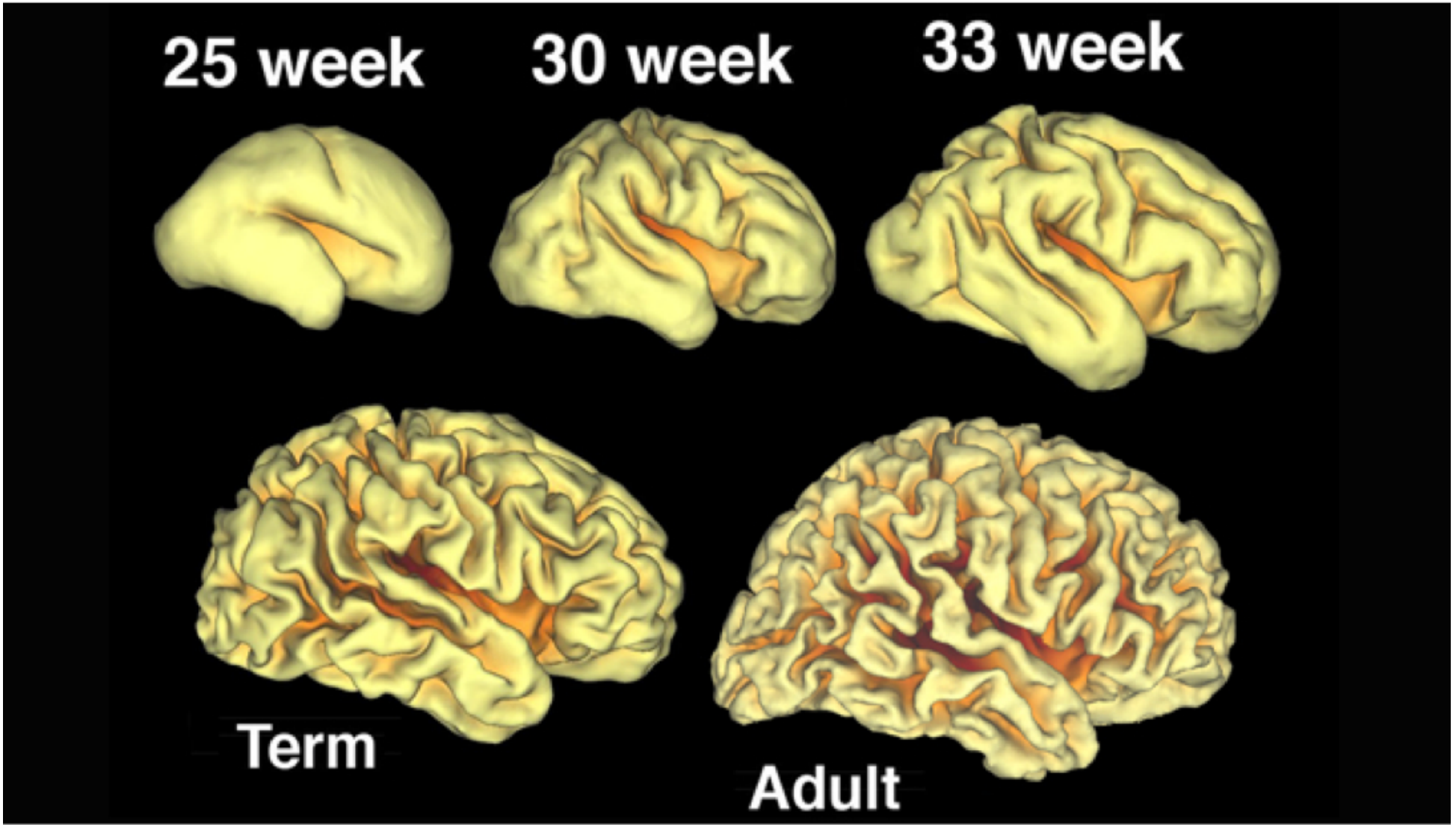
strengthen

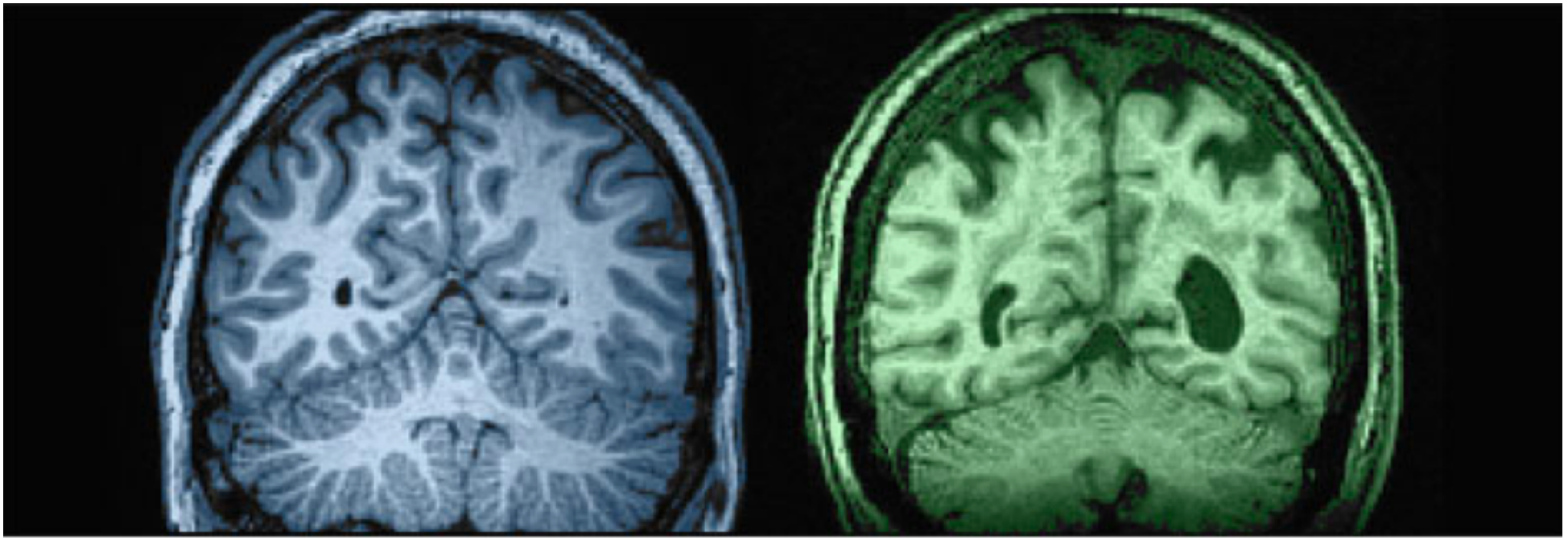


HOW?

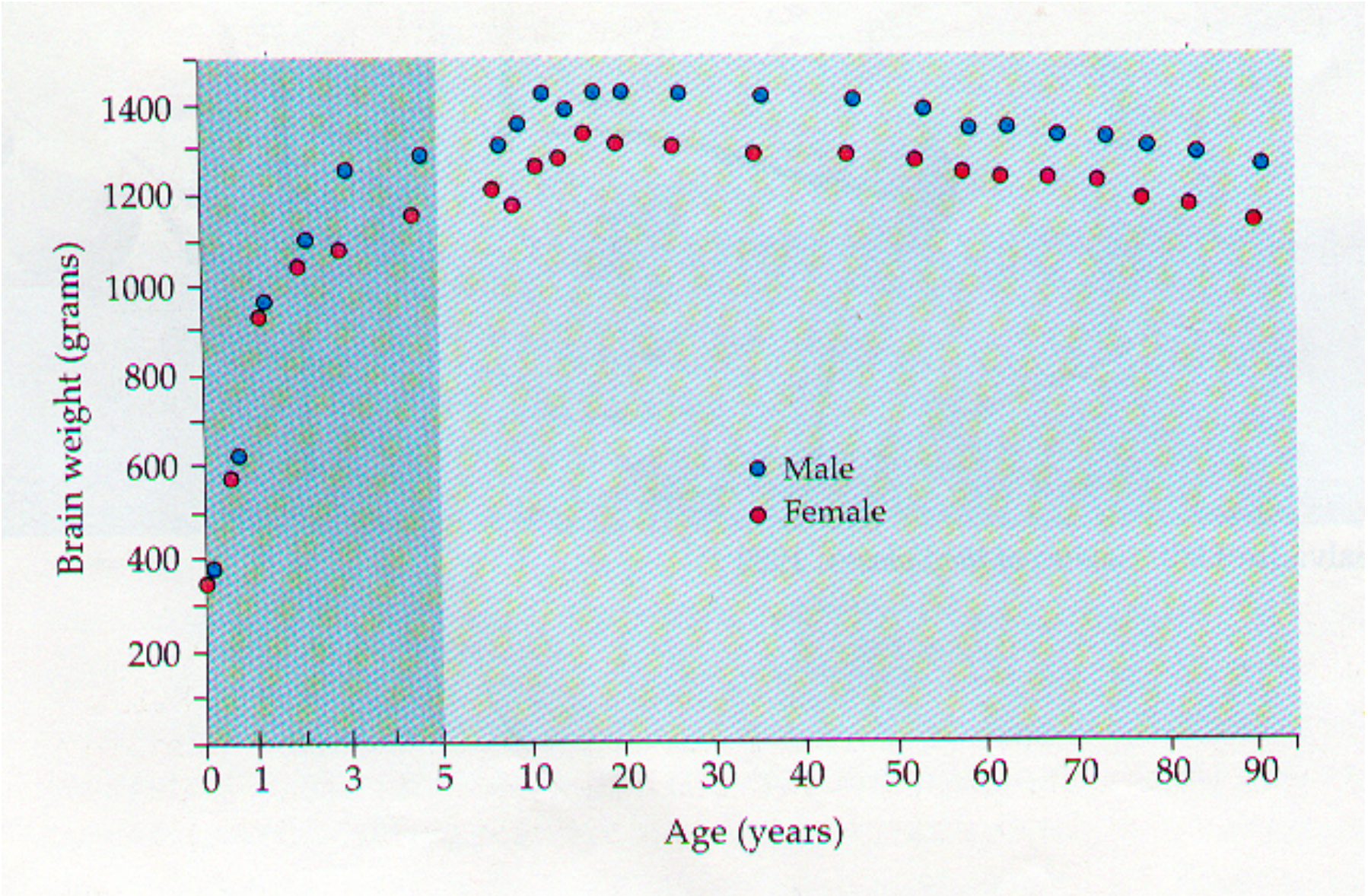
Increased neurotransmitter release
Increase receptors
Structural changes

Aging


25 week
30 week
33 week
Term
Adult



Brain Weight and Aging



Effects of ageing

- Generally, results of research studies indicate that there may be some naturally occurring decline in some aspects of memory among older people; however, **memory decline is not an inevitable consequence of aging**.
- If a decline in memory is experienced through aging, effects are more likely to be experienced in **working memory** and the **declarative memory systems** (episodic and semantic memories) than in procedural memory.

Effects of ageing on STM

- In general, if the task is relatively simple, such as remembering a list of words, STM is not affected by age.
- However, if a task is more complicated, requiring simultaneous storage and manipulation of information in working memory, or when attention must be divided between tasks, then age-related factors may impact on effective STM functioning (Whitbourne, 2001).

Effects of ageing on STM

- Neuroimaging studies have shown that beyond 60 years of age, there is a decrease in the activation of areas in the frontal lobes of the brain believed to be involved in STM.
- In addition, the nervous systems of older people are less efficient at receiving and transmitting information, and therefore the rate or speed at which information is processed in STM is slower (Rypma & D'Esposito, 2000).

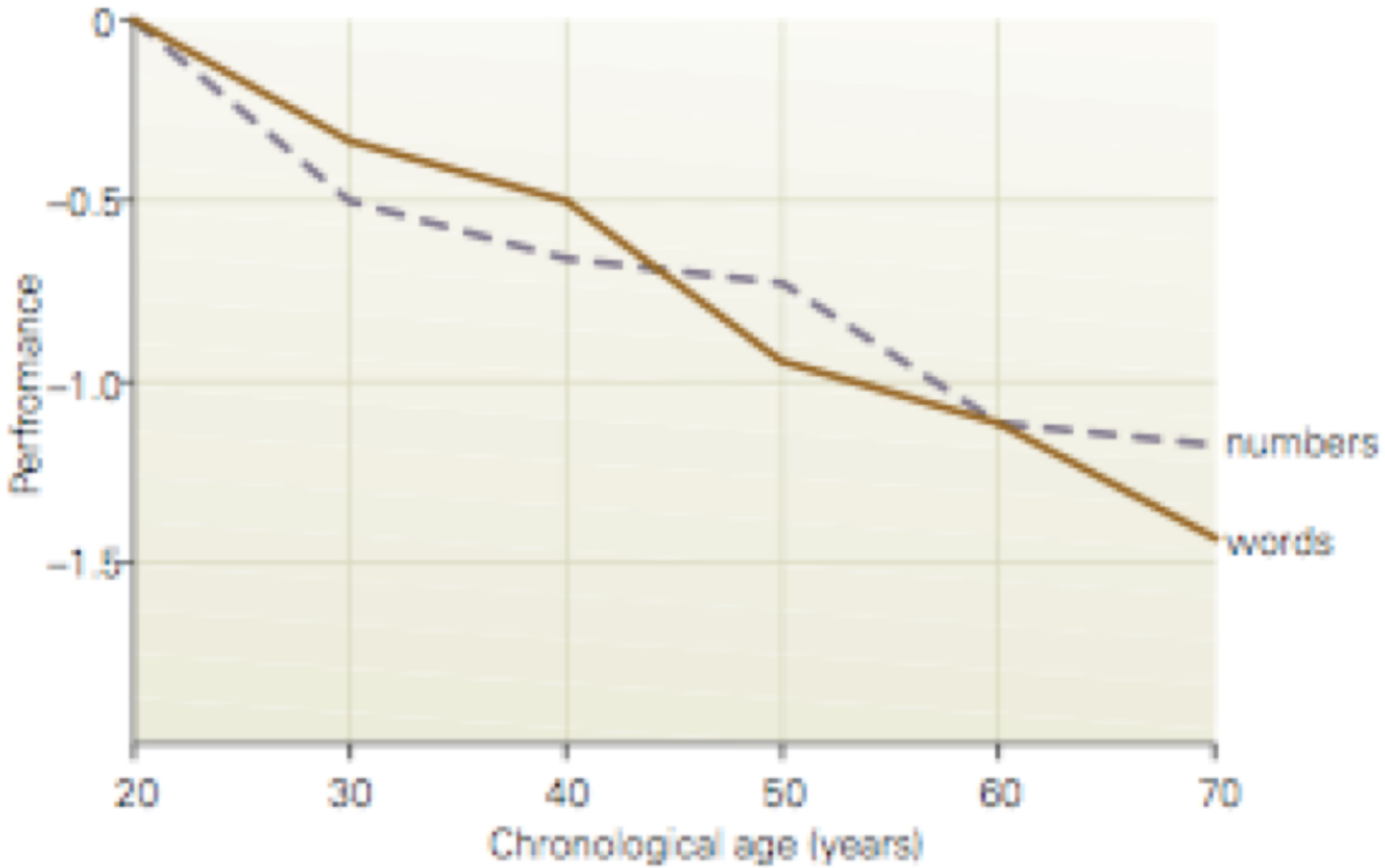


Figure 10.20
This graph shows the effect of age on working memory. The zero score on the y-axis represents the mean level of performance of younger research participants on both arithmetic and word tasks. As we age, our ability to process information is less efficient.

Effects of aging on LTM

- Research findings indicate that some LTM stores are more likely to be affected by age than others.
- For example, most studies of **episodic memory** have found a steep decline in this type of memory as people age.
  - Episodic memory can start to decline as early as age 30 or as late as age 50.

Effects of aging on LTM

- Although many semantic and procedural memories are not easily lost, older people take longer to learn new information and skills—including information that would be stored as semantic and procedural memories respectively.
  - It seems that older people do not encode new information with as much detail or as precisely as young people.
  - Furthermore, the speed and fluency or retrieval of information from semantic memory particularly can decline with age (Baddeley, 1999).

Effects of aging on LTM

- Psychologists have proposed several explanations for the memory changes that tend to occur as people age.
- These include:
  - lack of motivation
  - loss of confidence in their memory
  - kind of measure of retention used
  - the slowing of the central nervous system functioning

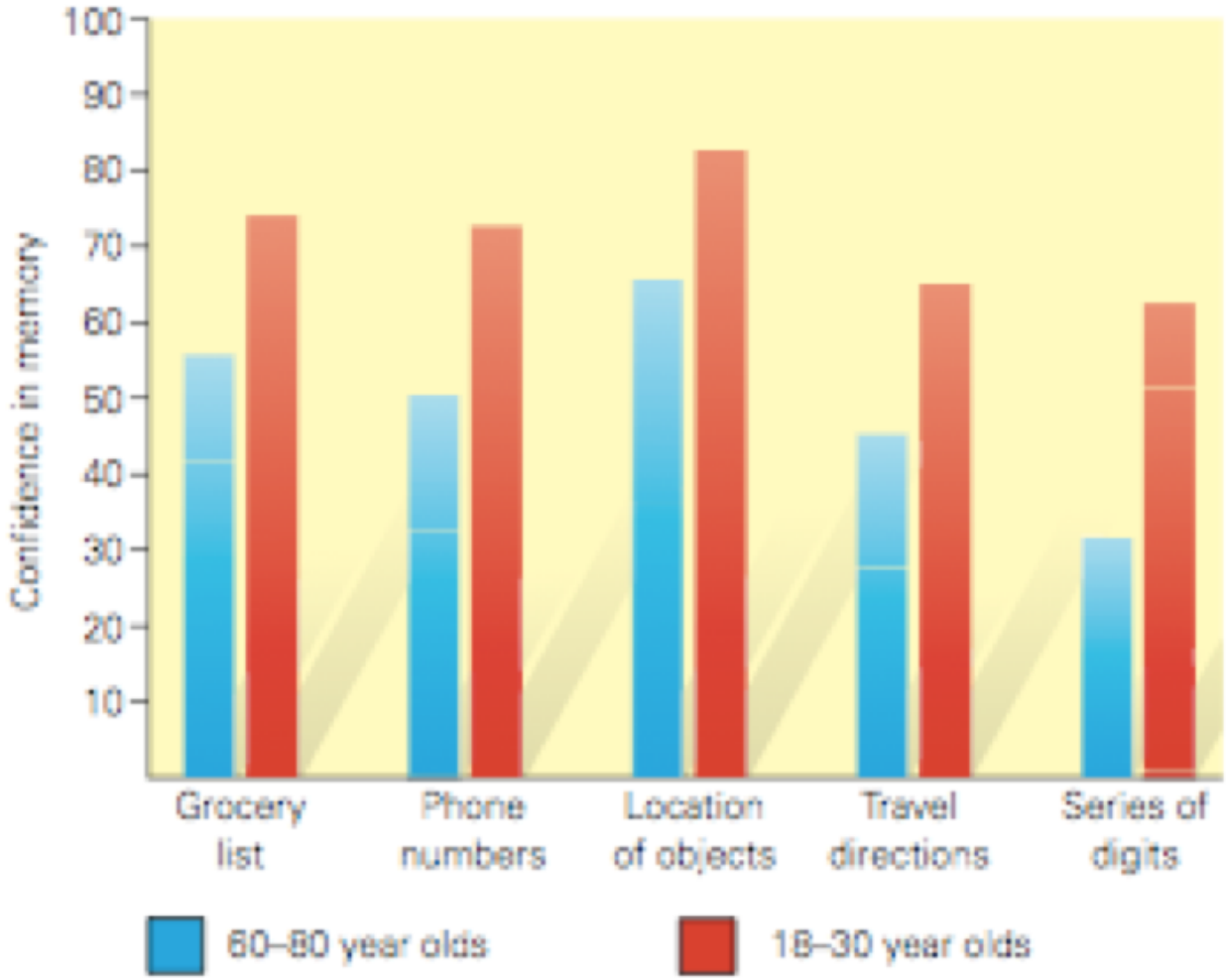
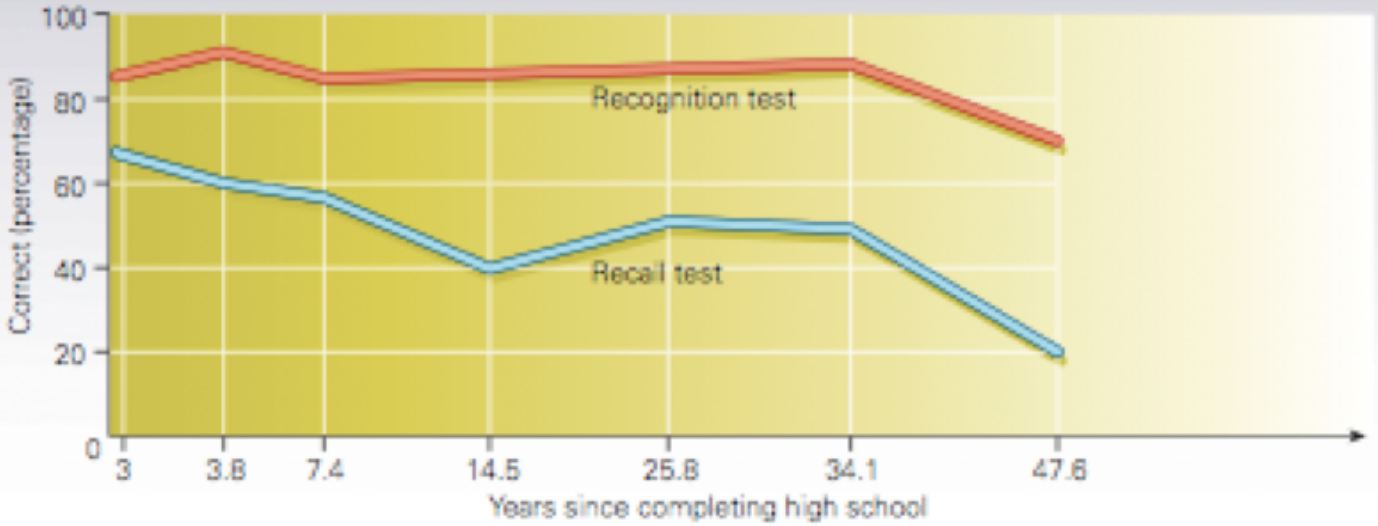


Figure 10.21
Participants were asked to rate how confident they were on a scale of 0–100 in their ability to perform various memory tasks. Consistently, older participants were less confident than the younger participants.

Figure 10.22
A test of recognition showed little decline over time in participants' ability to identify high-school classmates, even though they had left school 47 years before. A test of recall, however, showed a significant decline in their ability to remember the same names and faces.



Amnesia

Organic Amnesia

- The term **amnesia** is used to refer to loss of memory, either partial or complete, temporary or permanent.
- Many causes of forgetting have an **organic** or physiological basis, which results from some sort of damage to the brain, usually in a specific structure or area of the brain associated with memory.
  - Brain damage may be caused by disease, stroke, head injury, long-term alcoholism, severe malnutrition, brain surgery or through aging.

Anterograde Amnesia

- If brain damage causes loss of memory only for information or events experienced *after* the person sustains brain damage, it is called **anterograde amnesia**.
  - *Antero* means forward: in this case, forward in time.
- In general, the memory of information or events experienced prior to the damage still remains.

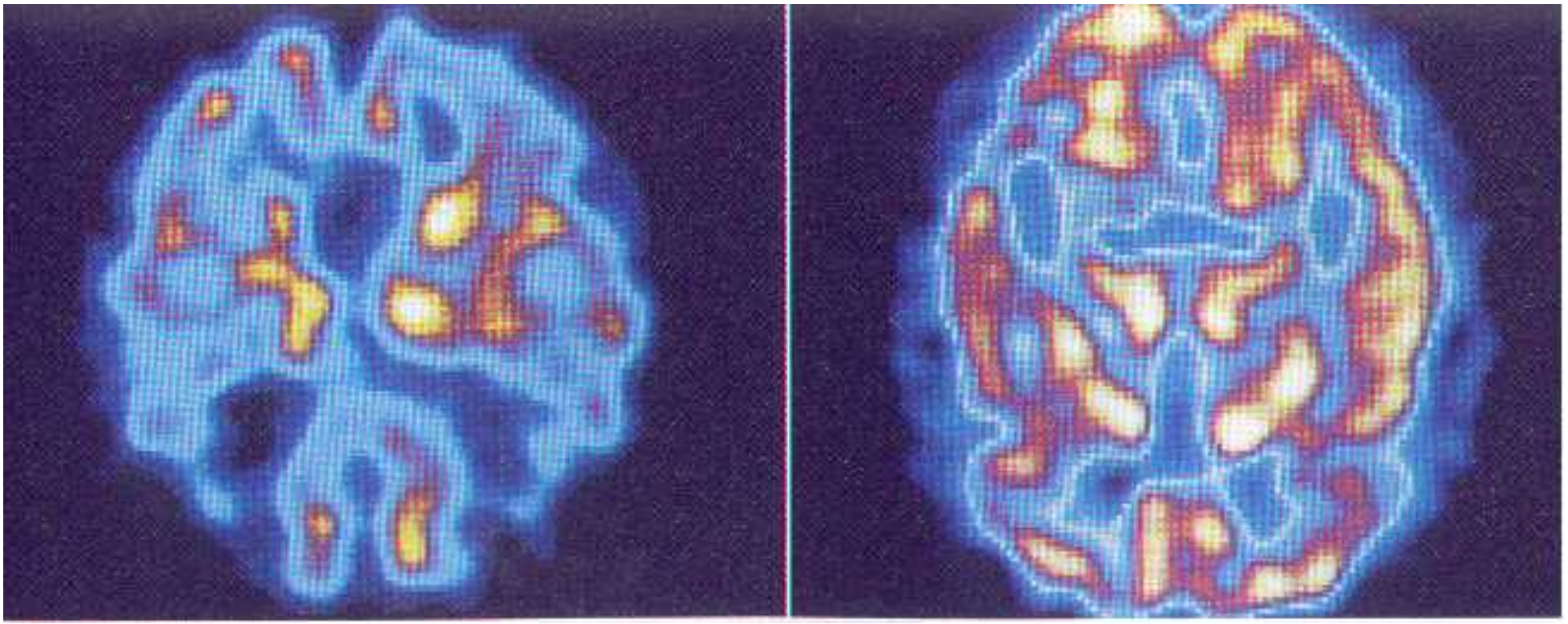
Anterograde Amnesia

- For people who experience anterograde amnesia, information enters sensory memory, is attended to and transferred to STM.
- It can be manipulated in STM and rehearsed indefinitely, but the brain structures involved in transferring it from STM to LTM (and/or implanting it in LTM) are damaged, therefore no new permanent memories can be formed.
- Research findings suggest that the hippocampus has a key role in the transfer of information from STM to LTM.

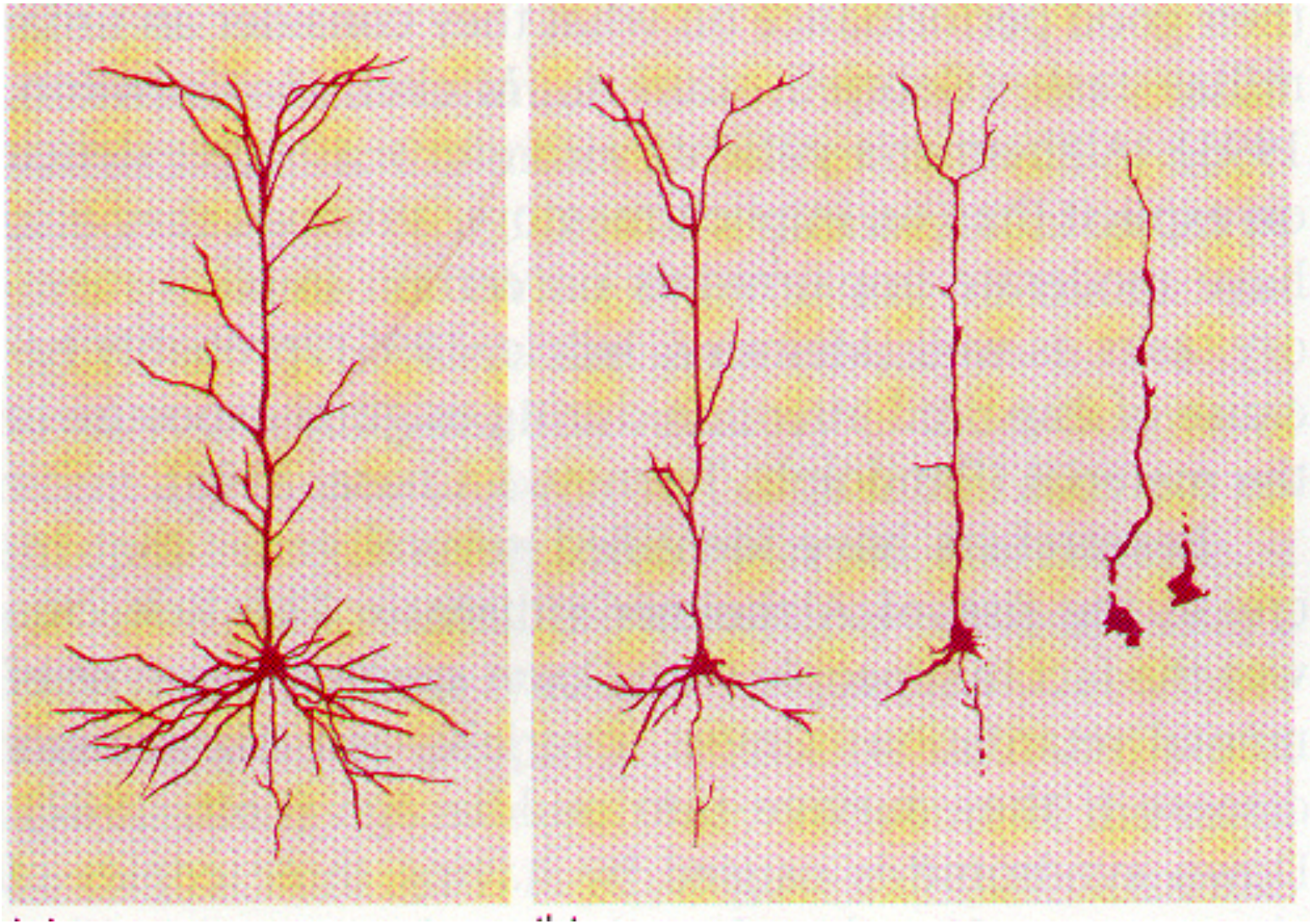
Anterograde Amnesia

- **Korsakoff's syndrome** is a medical condition, mainly affecting alcoholics, causing acute inflammation of the brain which results in brain damage that impacts on their ability to form new memories.
- **Alzheimer's disease:** An organic disorder involving the gradual widespread degeneration of brain cells which produces increasingly severe deterioration of mental abilities, personal skills and behaviour.

Decreased Cerebral Metabolism



Neuronal Degeneration



Normal **Alzheimer's**

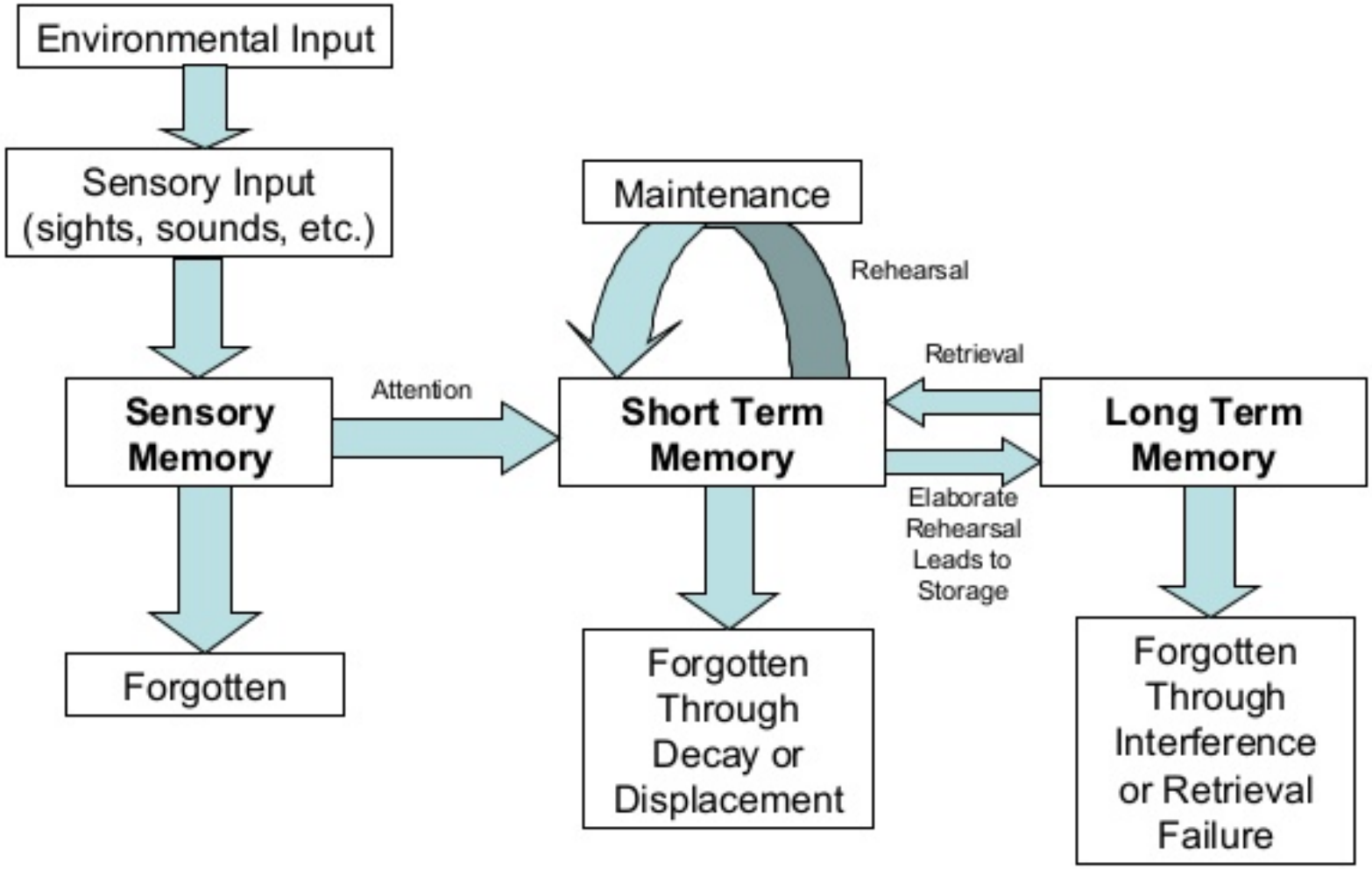
Retrograde Amnesia

- If brain damage affects memory for information or events experienced *before* the person sustains the damage, it is called **retrograde amnesia**.
  - *Retro* means backwards: in this case, backwards in time.
- The memory loss may extend back a few moments, days, weeks or sometimes years.

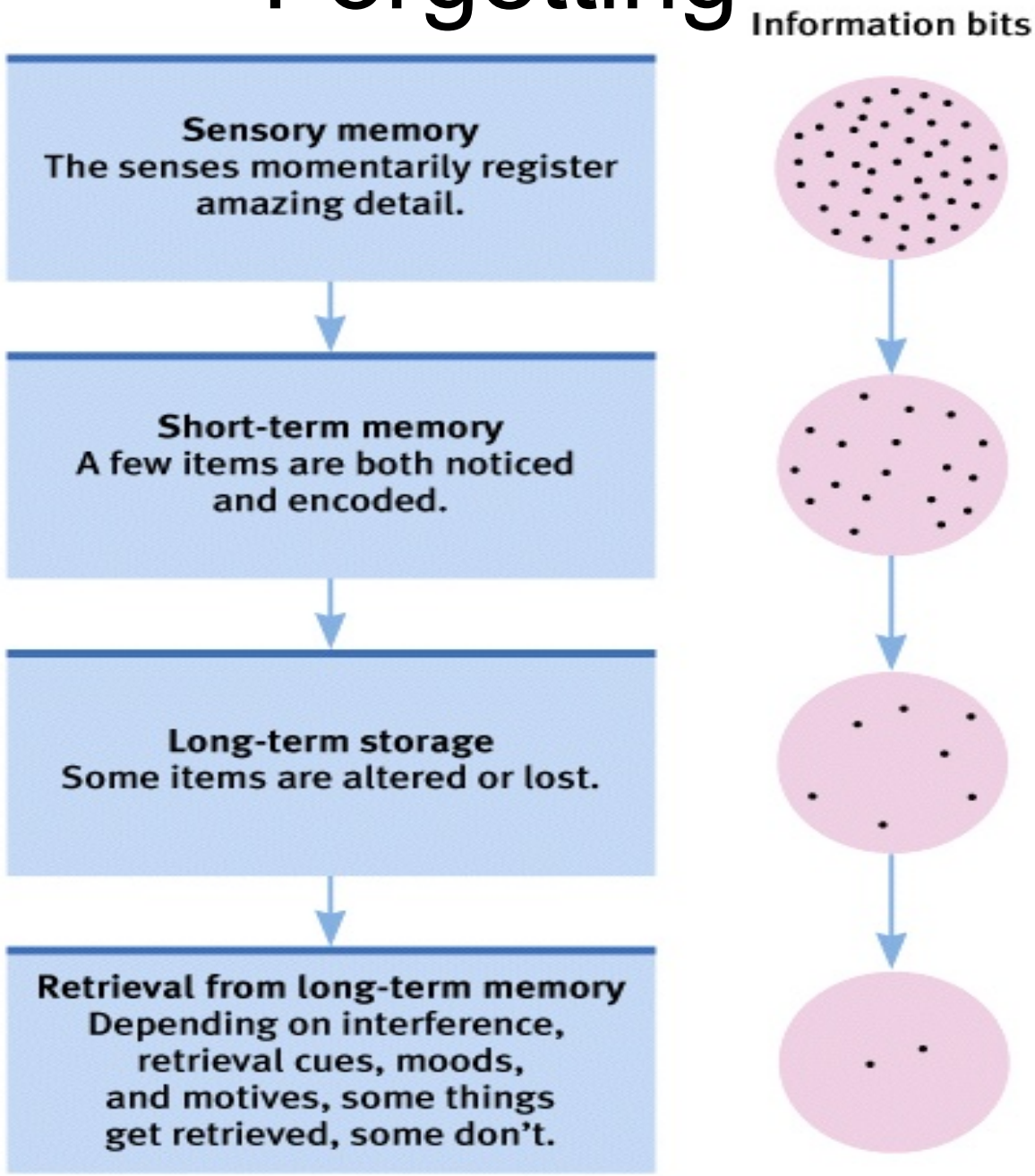
Retrograde Amnesia

- Typically, people who experience retrograde amnesia find that their inability to remember information and events leading up to the brain trauma gradually disappears.
- However, people who have experienced retrograde amnesia typically find that their memory for the period immediately before the accident is never recovered.

Multi Store Model - Atkinson & Shiffrin



Forgetting


Information bits
Sensory memory
The senses momentarily register amazing detail.
Short-term memory
A few items are both noticed and encoded.
Long-term storage
Some items are altered or lost.
Retrieval from long-term memory
Depending on interference, retrieval cues, moods, and motives, some things get retrieved, some don't.

Eidetic Memory

What is it?

- Commonly known as photographic memory

- "The ability to store visual information vividly and faithfully, so that random details can be "read" out of the image later."

Haber Criteria

- Seeing image as projected on to space
- Use of present tense when reporting
- Ability to superimpose two images to make composite image

Figure 7.9

FIGURE 7.9 Test picture like that used to identify children with eidetic imagery. To test your eidetic imagery, look at the picture for 30 seconds. Then look at a blank surface and try to "project" the picture on it. If you have good eidetic imagery, you will be able to see the picture in detail. Return now to the text and try to answer the questions there. (Redrawn from an illustration in Lewis Carroll's Alice's Adventures in Wonderland.)

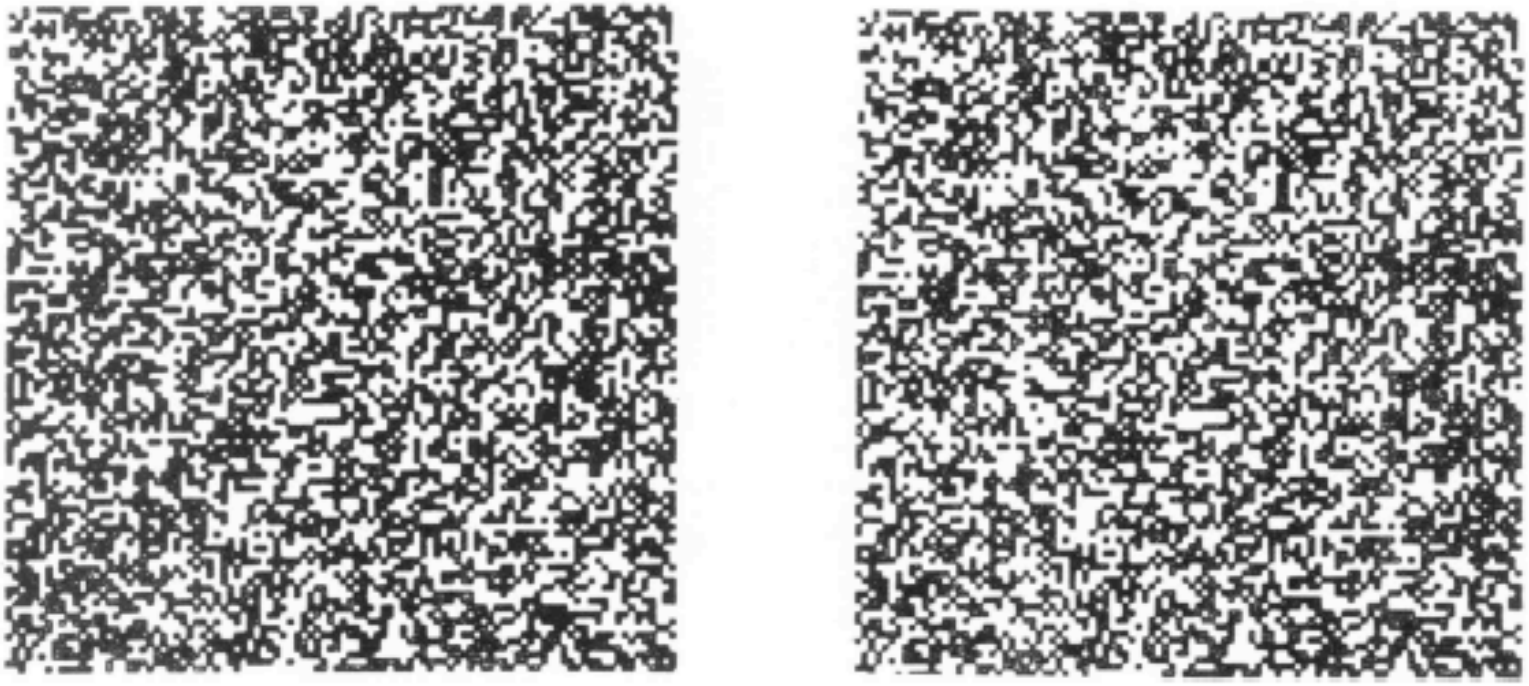


Fig. 2. Stereogram test. Cover your right eye and with your left eye carefully examine the left pattern for about 10 minutes. When you have a detailed image of the pattern, cover your left eye and look at the right pattern with your right eye. Try to project the image in your closed left eye onto this pattern. If you see a sharp figure, a few inches in depth, you have remarkable eidetic ability.

Other Criteria

- Ability to “see” the image that is exact copy of original sensory experience
- Recall image at a later time (minutes, hours, days, months)
- Recall in vivid detail
- Ability to scan the image with eyes in its absence (usually during recall)

Critics

Marvin Minsky on "photographic memory"

"unfounded myths....only professional magicians or charlatans can produce such demonstrations" (1985).

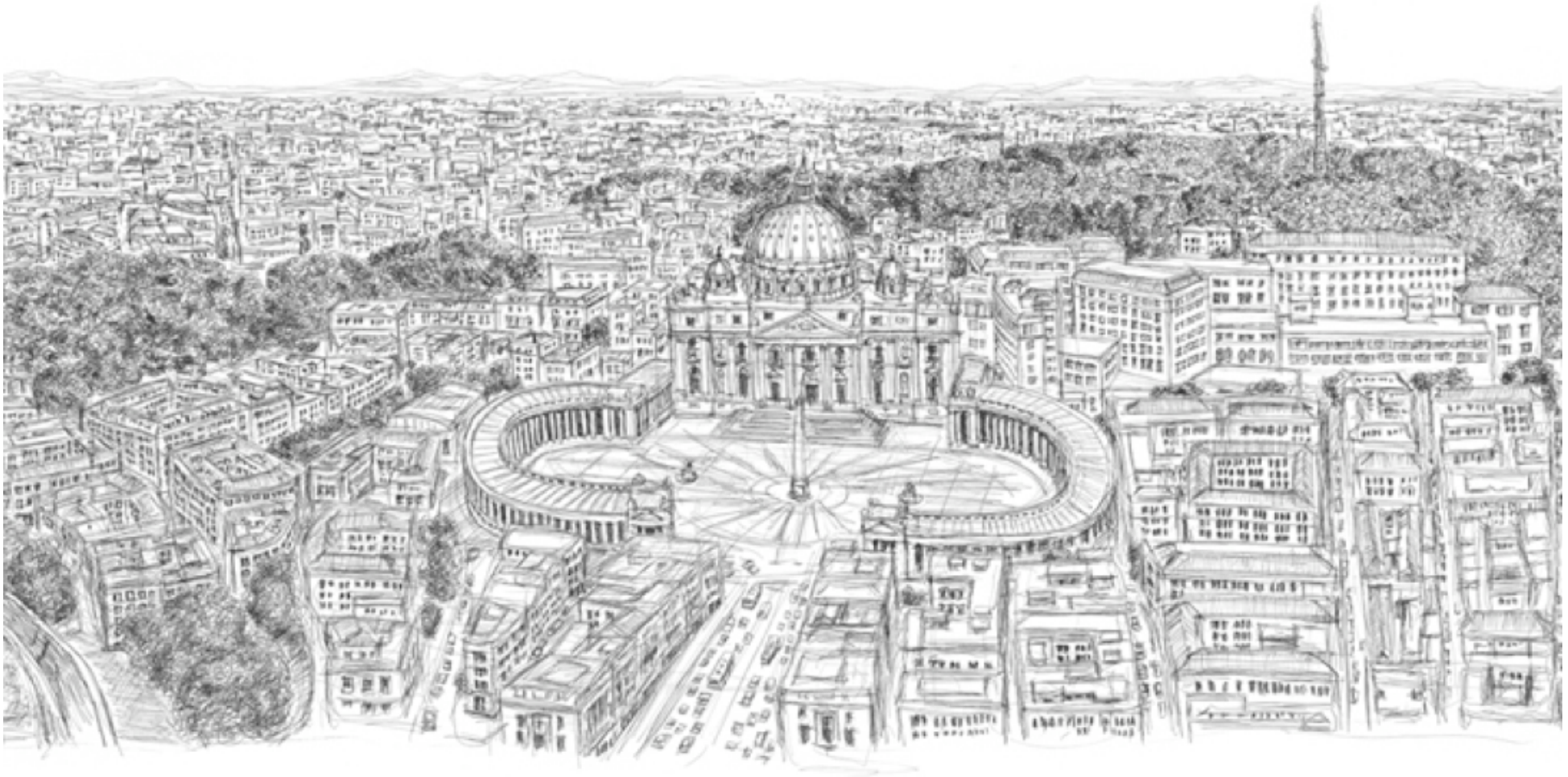
Examples of Eidetics/Eidetikers

- Elizabeth
  - Tests performed by Stromeyer and Pstoka (1970) at Harvard
  - Write poetry in foreign language after years
  - Stereogram, both eyes scan different dot image to create one
- Controversial
- Never repeated

Examples

- Kim Peek
  - Memorized (90% recall) over 12,000 books.
    Each eye can read its own page separately.
- Real “Rain Man”
- Autistic savant

Stephen Wiltshire



Stephen Wiltshire

- Stephen Wiltshire
  - Called “Human Camera”
  - Create extraordinarily detailed sketches of places after only seeing once.
- Autistic savant

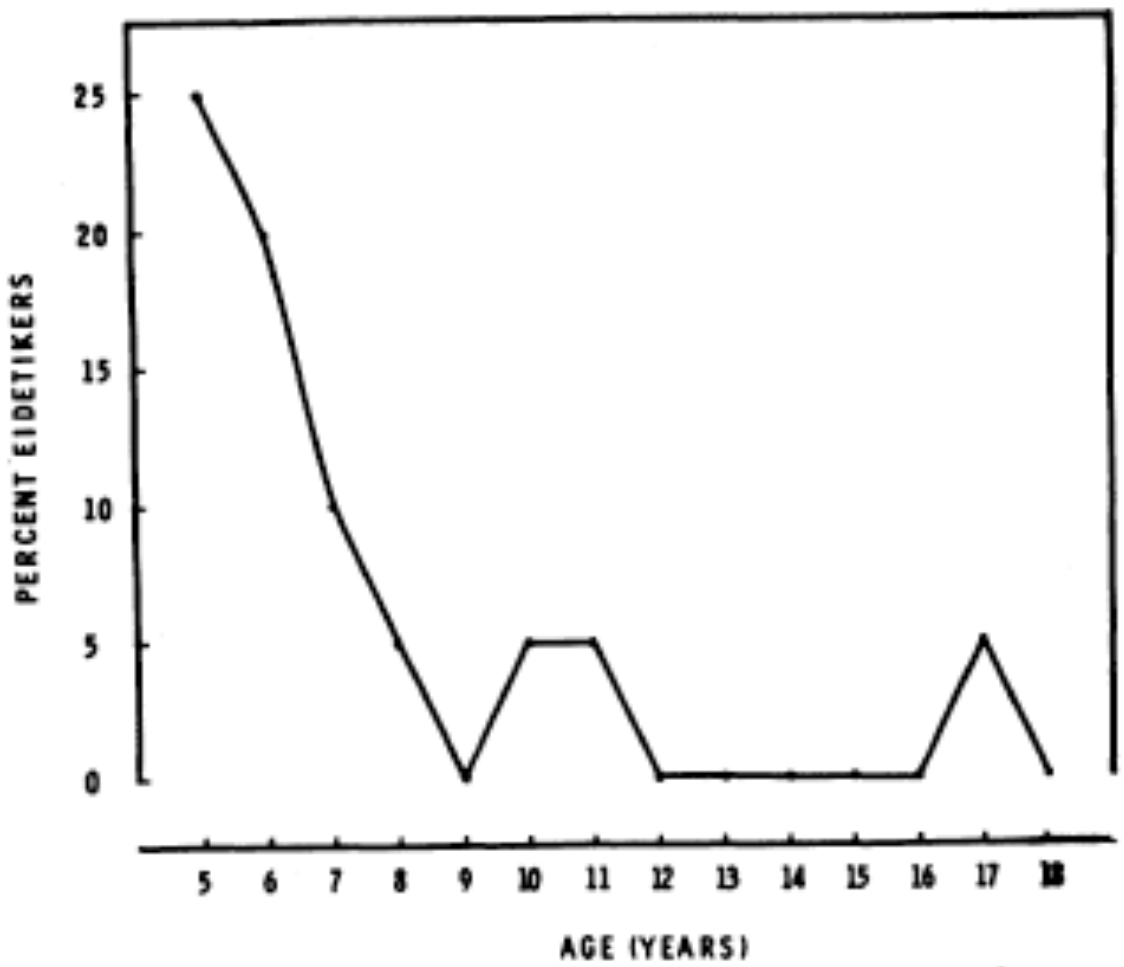


FIG. 1.—Incidence of eidetic imagery as a function of age

Explanations

Virtually everyone uses visual memory and has the capacity to improve their recall through practice and mneumonics...

What makes eidetikers eidetikers?

Myths about Eidetic Imagery

- Can have absolute recall
- Linked to intelligence
- Prevalent in adults
- "Hollywoodization"
  - Good Will Hunting
  - X Files
- Mnemonist
  - Darren Brown

Memory Experts

- Ericsson and Chase (1982)
  - They had a university student (SF) practice the digit span task for 1 hour per day for 2 years
  - Over this time, his span increased from about 7 items to 80 items
    - Encoding and retrieval principles in action:
      - He increased his span to 18 items by relating numbers to known running times (e.g. 3594 = "Bannister's time for the mile")
      - He further increased his span by organizing those chunks into a hierarchical structure
    - Speed-up principle in action:
      - He became much faster at chunking and organizing the numbers with extensive practice
  - However, his newfound ability did NOT generalize to other memory tasks
    - He maintained average letter and word spans

Memory Experts

- Thompson et al. (1991)
  - Rajan Mahadevan: Previously held the world record for memorizing the most digits of *pi (30,000)* *(note: new record Akira Haraguchi 83,431 digits)*
  - Found that he had an unusual digit span:
    - 59 visually presented digits
    - 63 for heard digits
  - He chunked digits into strings of 10–15 digits, not the typical 3–4
    - This initially suggested a natural enhancement of his basic memory capacity
    - However, arguing against a natural superiority, he has an average:
      - Symbol span
      - Ability to remember the position and orientation of various objects
      - Memory for word lists and stories
    - It turns out that he uses various associations and patterns to group digits.

Thank You!