The Phenomena of Memory

Mnemosyne

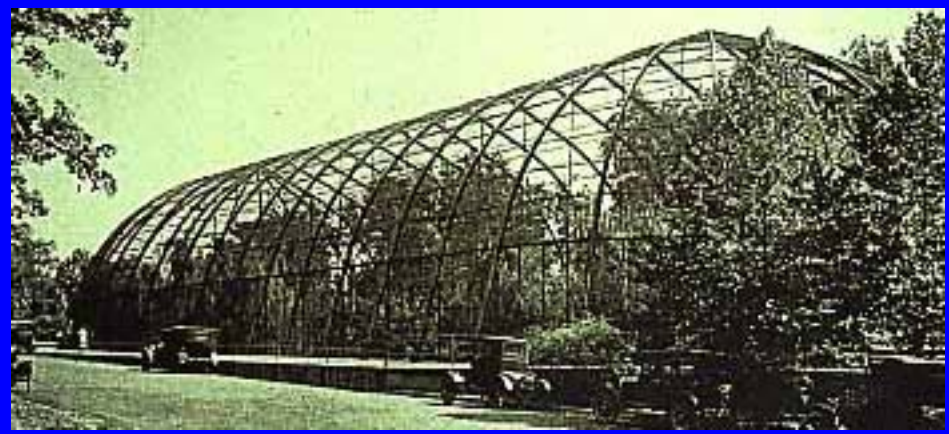
Some Traditional Metaphors of Memory

Aviary

Seal on a Wax Tablet

Library

Photograph or movie



A Bad Model for Human Memory: Computer Memory

Why is storage of information in a computer called "memory"?

- We think of memory as storage, putting something away but are able to recall it
- Some of the problems in setting up computer memory seem to resemble those we face
  - When we put information into a memory system we need some way of getting it back out
  - Computers, like libraries, rely on indexes

But there are major differences between human and computer memory

- Much of our memory is "content addressable"
- Much of our memory has emotional overtones
- Much of our memory is reconstructive

The Importance of Getting the Phenomenon Right

Most accounts of science emphasize the importance of explanation (and perhaps prediction) as scientific activities. But explanations are only valuable if they explain real phenomena.

The phenomena are not always obvious, and we may need to seek data or evidence to determine just what the phenomena are.

Memory vs. Photography - 1

Compare Franco Magnani's paintings and Susan Schwartzenberg's photographs of Magnani’s childhood hometown, Pontito, in Italy

Memory vs. Photography - 2

Magnani's childhood home

He and his mother appear in the painting

Memory Exercise

Recall your high school graduation ceremony; describing your recollection in as much detail as possible

If you were to draw it, would you be in the picture?

Recall a birthday party from your childhood

If you were to draw it, would you be in the picture?

Recall your last serious argument with someone

If you were to draw it, would you be in the picture?

Field vs. Observer Memories

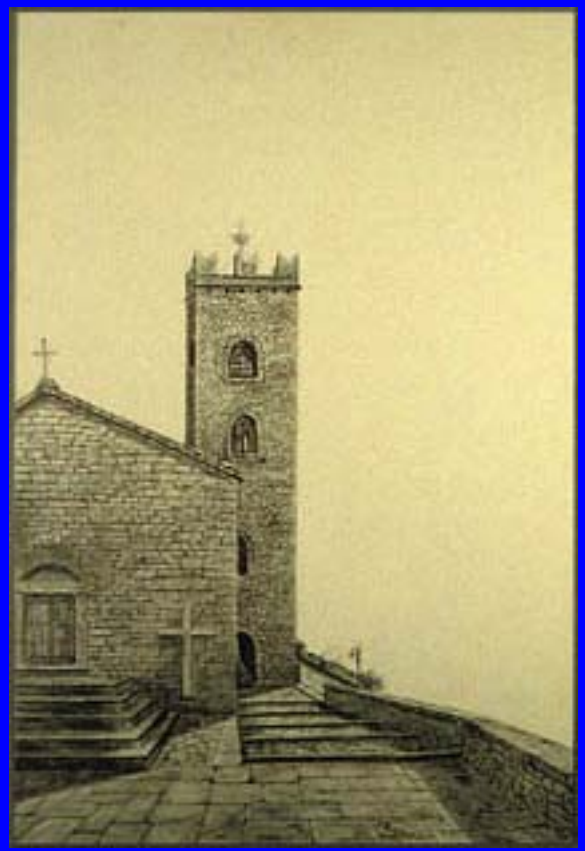
If we are recalling the event as it happened, we would of course recall it from our own point of view

But often we "see" ourselves in our recollections—we take the position of an observer

Older memories are more often from an observer's point of view

Field memories, memories from our own point of view, often are far more emotional

Memory vs. Photography - 3



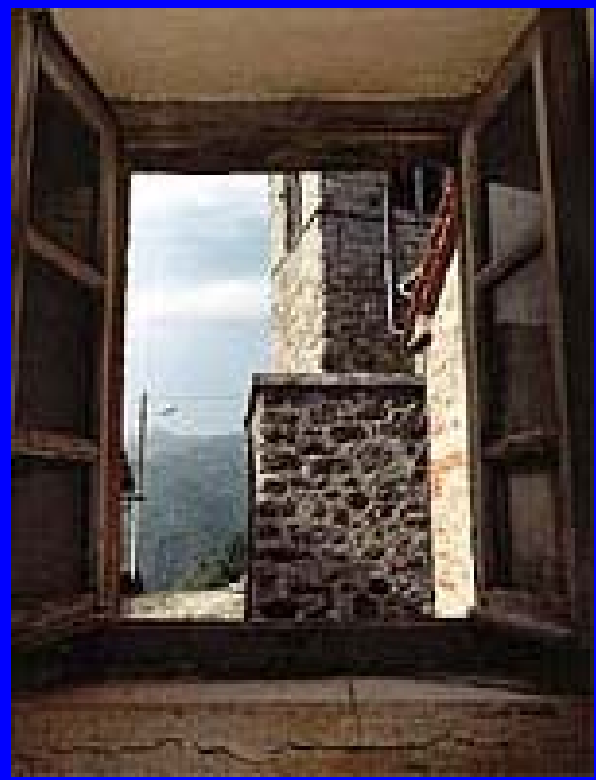
Magnani could see the *campanile* (bell tower) from his bedroom window. It was a major part of his life

Compare the perspective
Compare the height of the tower

Memory vs. Photography - 4

The painting and photograph are from Magnani's bedroom window

The painting shows more than can be seen from any one point of view



Memory vs. Photography - 5

A walk Magnani frequently took

- Note the overall accuracy of the rooflines, etc.
- Note the differences in the windows

Retrieval: Reinstantiation or Reconstruction?

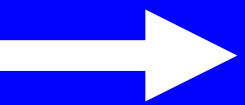
Common view: successful recall reinstantiates an event as it happened—recall, when it happens, is veridical

Alternative view: recall is a reconstruction of the previous event utilizing whatever information is available that can be combined into a coherent account

Creates the possibility that memory is not always veridical

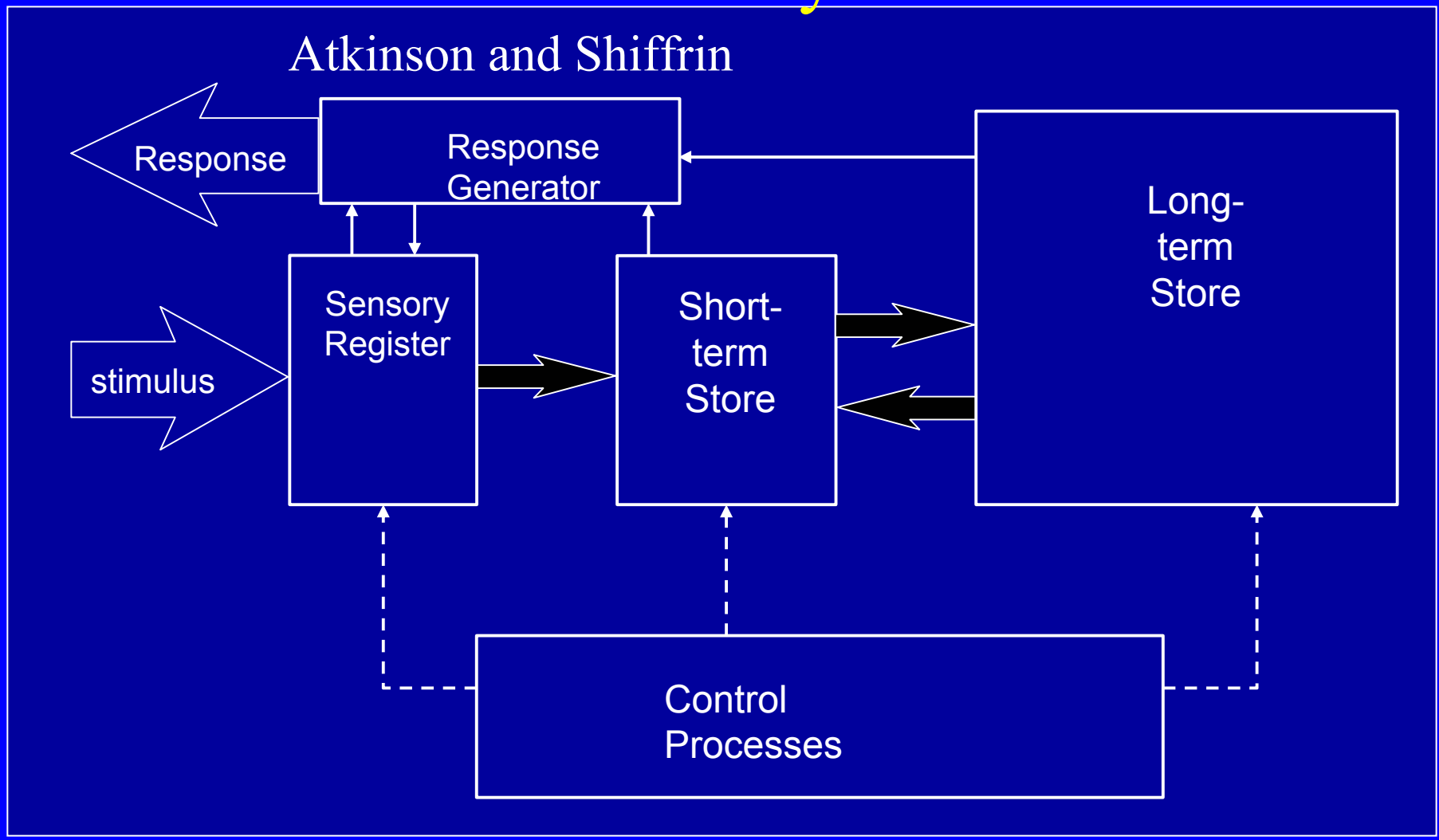
Memory Exercise

Some rows of letters will appear. After they are gone, an arrow will direct you to remember a particular row. Right down as many letters from that row as you can, then any others that you remember



G	L	R	B
U	K	Q	O
C	M	I	W
N	X	D	J
S	F	Y	H

Long-term, short-term, and echoic memory



Long-term Memory Systems

One response to identifying the variety of phenomena that constitute remembering is to

- Distinguish type of memory
- Propose different *systems* responsible for each type of memory

"Most important, we have now come to believe that memory is not a single or unitary faculty of the mind, as was long assumed. Instead, it is composed of a variety of distinct and dissociable processes and systems. Each system depends on a particular constellation of networks in the brain that involve different neural structures, each of which plays a highly specialized role within the system" (Schacter, 1996, p. 5).

Types of Long-Term Memory

- Semantic memory: conceptual and factual knowledge: dogs are mammals, birds fly, San Diego is in California
- Episodic or autobiographical memory: explicitly recalling previous experiences—belief that the memory is a true replica of the previous event and part of one's own past—mental time travel
- Procedural memory: skill memory, classical and operant conditioning, priming

Episodic Memory and Personal Identity

Hume: what we are is a bundle of memories—where memories are episodic memories of life episodes.

What memories seem critical to self identity?

- If we lost these memories, would we be the same person?
- If someone replaced many of these memories with others, would we still be the same person?

Patients who lose memory of their past lives (like GR) report a loss of identity

Is this kind of memory unique to humans?

Memory Exercise

Remember a present you received on your last birthday

Do you remember actually receiving the present, or only that you received it?

Recall seeing this picture in our last class:

Do you remember actually seeing it, or only remember that you saw it—you know that it was in the presentation?

Remembering vs. Knowing

We are familiar with recalling an event with a feeling of having experienced it

- Perhaps complemented with imagery of the event
- Sometimes having many associations to the event

But sometimes we know the event occurred without feeling like we are recalling it.

- GR (and other retrograde amnesics) can learn about their past *without* any sense of having experienced what they learned happened

Means of retrieval sometimes determines whether one reports remembering or only knowing that something happened.

Memory and Learning

One of the kinds of memory Schacter describes is implicit:

> "we've opened up a whole new world of implicit, nonconscious memory that underlies our abilities to carry out effortlessly such tasks as riding a bicycle or playing a piano, without having to direct each movement consciously every time we attempt the task."

Traditionally, one would have spoken of *learning* to ride a bicycle or play the piano.

Likewise, we would have spoken of learning new facts rather than acquiring semantic memories

Encoding, Storage, and Retrieval

Richard Semon (1878-1918) differentiated engraphy, engram, ecphory

Terminology preserved in Lashley's reference to an engram

Modern terminology: encoding, storage and retrieval

- Encoding: laying down of a memory
- Storage: trace in the brain
- Retrieval: accessing the memory

Challenge for research: getting evidence about one process independently of the other—most measures of memory require all three

Ebbinghaus—first encoding study

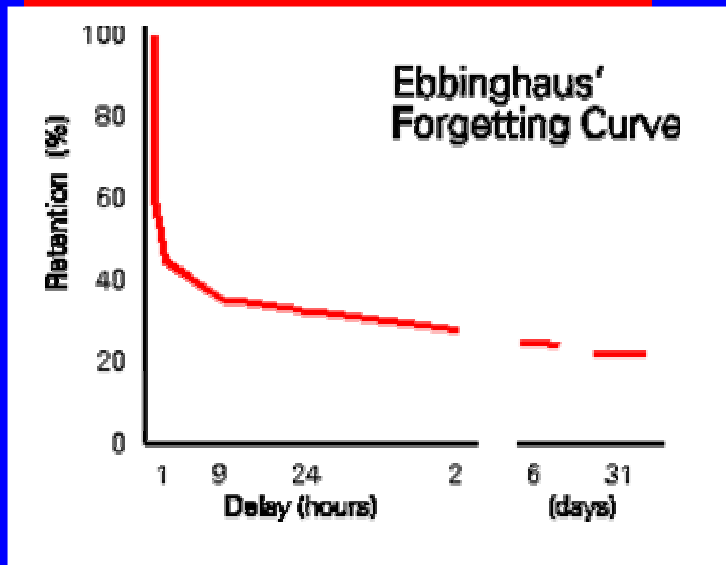
Created and studied lists of *nonsense syllables*

Consonant-Vowel-Consonant triads such as DAR, BEL, FOT, MUK, LIM

Count the number of times he had to repeat the list before he remembered it perfectly

After a delay period, tried to recall the list. If he failed, counted the number of trials before he had relearned it.

delay	savings
immediate	100%
20 minutes	60%
1 hr	45%
9 hr	35%
1 day	30%
2 days	25%
6 days	22%
30 days	20%



Memory Exercise

Simply read each sentence as it appears:

Is *Bagdad* in Turkey?
How many letters are in *celery*?
Can one use one's *hands* in soccer?
What do you do with a *spoon*?
Is *bike* in italics?
Is there a "u" in *summer*?
How many letters are in *formula*?
Does a *friend* stand by you?
Do your parents *love* each other?
Does *utopia* start with a vowel?

Memory Exercise

Count backwards from 92 by 3s.

Write down all the words that you can remember

How many of the following words did you remember:
Celery, bike, summer, formula, utopia?

How many of the following words did you remember:
Bagdad, hands, spoon, friend, love

Characteristics of Encoding

The manner of encoding affects what gets stored

Levels of processing (Craik and Tulving): Shallow vs. deep encoding:

- Attending only to features (letters of a word) versus developing associations (meaning of a word)
- Generally, the more meaningful the stimuli, the better the recall.

Affect of imagery—pictures better recalled than words, and more imageable words are better recalled than less imageable (more abstract)

Encoding Techniques

Method of loci—placing items to be remembered in locations and creating an appropriate image. Then recall items by mentally going to the different locations

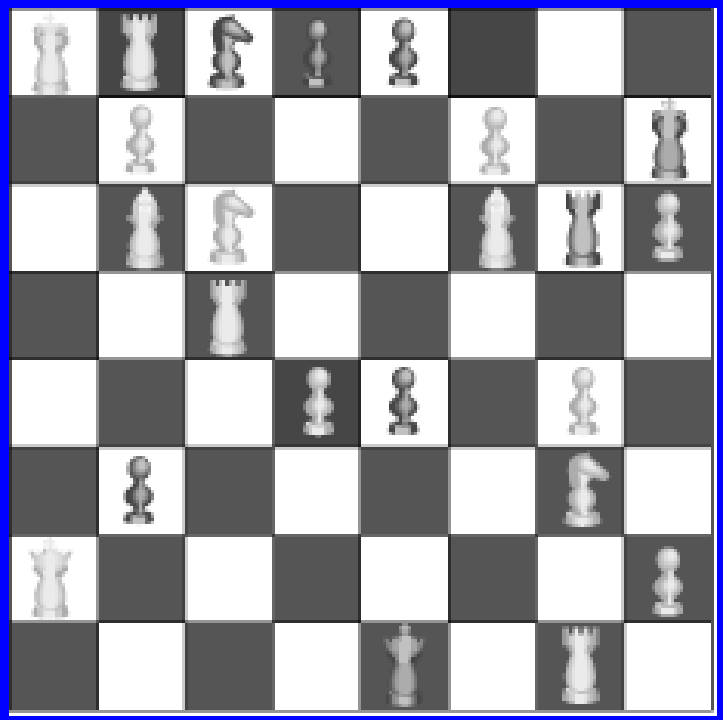
Chunking: I R S T W A C I A U S A S L

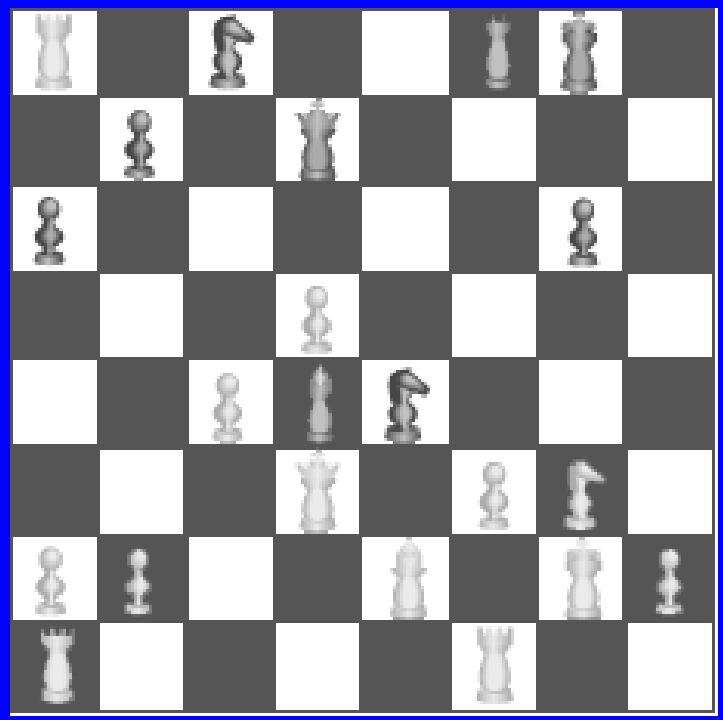
chess masters memory for board conditions

But successful chunking depends upon detailed knowledge of the domain

Expert chess players ability to chunk lost when non-possible board positions are used

Recall stimuli for chess experiment





Neural evidence for elaborative encoding

PET studies of deep encoding in left inferior prefrontal cortex

- Required block trials
- With event related fMRI possible to show increased activation on encoding episodes for those stimuli that were later recalled.

ERP—P300—larger deviation correlates with greater recall

Encoding Strategies

What are good strategies to enhance recall?

Know you have to stand in front of a class the next day and lecture on it!

What are some strategies you use when you want to remember a particular body of information (e.g., for a test)?

Retrieval Processes

Semon's ecphoric stimulus can critically determine what is remembered

The trace may be available, but not accessible

Different types of recall tasks: free recall, cued recall, recognition

Recall on the words you can from the earlier word list

What body part was mentioned?

What food was mentioned?

What utensil was mentioned?

What season was mentioned?

Was *friend* on the list?

Was *equation* on the list?

Was *utopia* on the list?

Tulving's *encoding specificity principle*

Explicit remembering depends upon the similarity of encoding and retrieval processing

State dependent recall—match between person's state at encoding and retrieval affects level of recall

If you study after drinking, you might want to drink before the exam. (Better not to drink while studying!)

Are encoding and retrieval separate neural processes?

Tulving et al.'s (1994) HERA (Hemispheric encoding/ retrieval asymmetry) model:

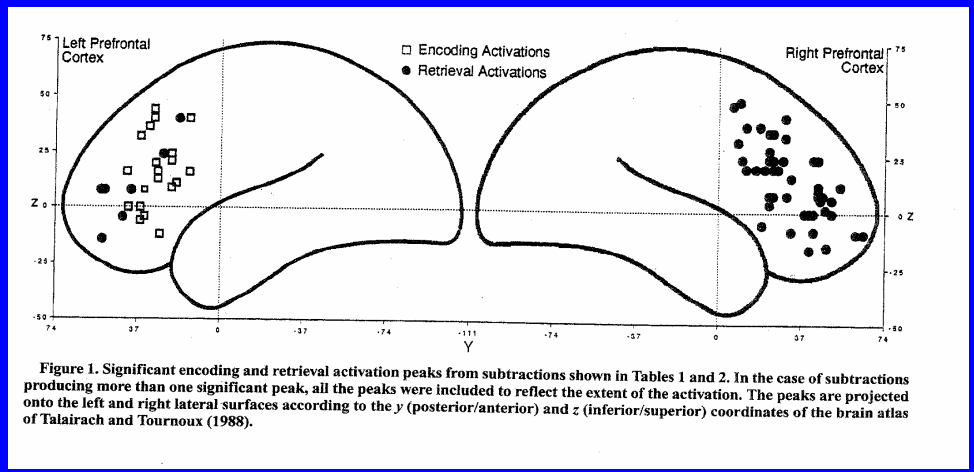


Figure 1. Significant encoding and retrieval activation peaks from subtractions shown in Tables 1 and 2. In the case of subtractions producing more than one significant peak, all the peaks were included to reflect the extent of the activation. The peaks are projected onto the left and right lateral surfaces according to the *y* (posterior/anterior) and *z* (inferior/superior) coordinates of the brain atlas of Talairach and Tournoux (1988).

- Right prefrontal areas are more active than left prefrontal areas in episodic retrieval
- Left prefrontal areas are more active than right prefrontal areas in semantic retrieval and episodic encoding

Additional Activations in Retrieval

- Processing areas in inferior left prefrontal cortex active in semantic memory tasks (stem completion) are also active in episodic memory tasks (stem completion for words on memorized list)
- Likewise, right inferior prefrontal area active in task matching face in working memory is also active in face recognition task using episodic memory.

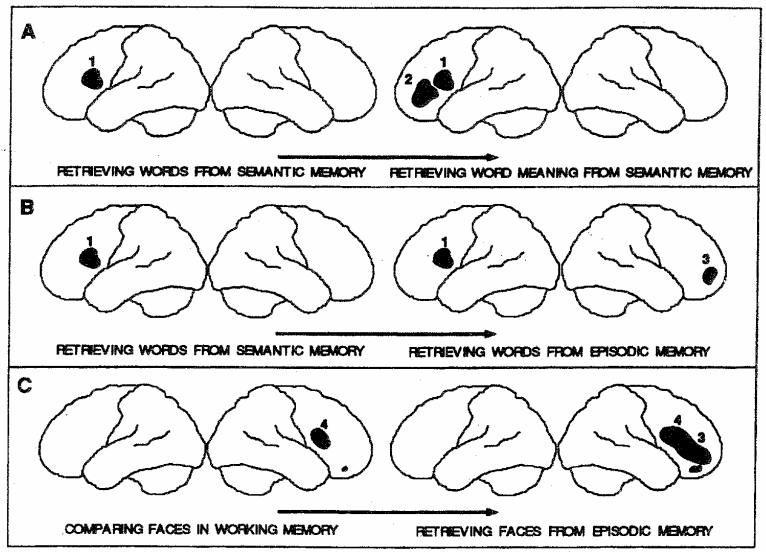


Figure 2. Three sets of tasks are depicted to illustrate memory-related activation of separate prefrontal areas. Each pair of hemispheres shows left and right lateralized activations from a single task image, with activations indicated by shading. (A) Activations across two tasks relying on verbal semantic retrieval are illustrated. Two separate areas in the left prefrontal cortex (labeled 1 and 2) are activated differentially across the two tasks (see text). (B) A comparison between a task relying on verbal semantic retrieval and one relying on verbal episodic retrieval is shown. This comparison reveals a specific right anterior prefrontal area activated only during episodic retrieval (labeled 3) (see text). (C) Two tasks are compared that utilize nonverbal (face) information. Remarkably, when the task involves episodic retrieval of faces, the same right anterior prefrontal area is activated as in verbal episodic retrieval (labeled 3). However, in the case of face retrieval, this area is activated in addition to a more posterior right-lateralized area (labeled 4) that is not present in any of the verbal tasks.

What subtraction conceals

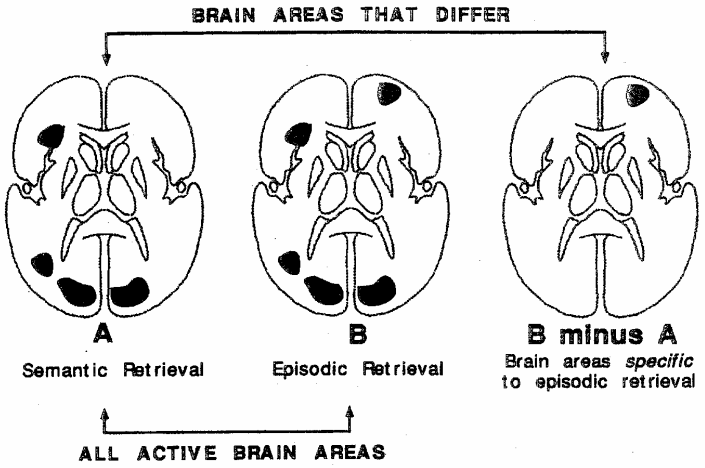


Figure 4. Representative activations are displayed for two different memory tasks (from Buckner, Petersen, et al., 1995), one relying on semantic retrieval (left section, labeled A) and one relying on episodic retrieval (middle section, labeled B). The activations displayed in these two sections are determined in relation to a low-level control task which contains minimal memory demands. Making such a broad comparison shows that many cortical brain areas are activated because of the many demands of the memory retrieval tasks, including areas activated in common by the two memory tasks as well as those differentially activated. If, on the other hand, the two tasks are compared directly, then only the brain areas differentially activated across the two kinds of memory tasks are visible (right section, labeled B minus A). The latter kind of comparison allows one to observe brain areas specialized for the processes that differ between the two tasks. However, the complete pattern of activation is only appreciated by observing both kinds of comparisons.

Beginnings of a mechanistic decomposition?

Tulving: encoding and retrieval of episodic memories are separate processes

Alternative: encoding and retrieval draw differentially on underlying processes

Hippocampus vs frontal processing

- Automatic retrieval generates greater hippocampal activity
- Effortful retrieval generates greater frontal activity