Mechanisms of Memory: Can we distinguish true from false memories?

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# Schacter’s Seven Sins of Memory

<table>
<thead>
<tr>
<th>Sin</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Transience</td>
<td>Decreasing accessibility of information over time.</td>
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<td>2. Absent-mindedness</td>
<td>Inattentive processing leading to weak encoding.</td>
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<td>4. Misattribution</td>
<td>Attributing a recollection to the wrong source.</td>
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<td>5. Suggestibility</td>
<td>Memories that are implanted as a result of leading questions or comments.</td>
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<td>6. Bias</td>
<td>Retrospective distortions and unconscious influences based on current knowledge and beliefs.</td>
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<td>7. Persistence</td>
<td>Pathological remembrances – information we cannot forget.</td>
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False Memories: What are they?

1. Remember things that never happened

2. Recall what happened but misattribute it to wrong time or place

3. Think you imagined something that really is a true memory
Memory Error or Memory Distortion?
The McMartin Preschool Case

Manhattan Beach, CA
Recovered Memories or False Memories?

Memories of past abuse or other traumatic event

Forgotten and recovered many years later

Legal implications: Jail based solely on testimony of remembered abuse
Memory and the Brain

1. How are memories formed and retrieved?

2. Can brain imaging provide markers of
   a. what a person is learning?
   b. whether a person is remembering?
   c. what they are remembering?

3. Can we distinguish true from false memories in the brain?
Memory and the Brain

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H.M. and the Amnesic Syndrome

Patient H.M.

1926 born
1942 first major seizure (age 16)
1953 bilateral medial-temporal lobe resection (hippocampus & nearby structures)
1955 first published report of pervasive and profound anterograde amnesia
1962 neuropsychological examinations characterizing the amnesic syndrome
Right now, I’m wondering. Have I done or said anything amiss? You see, at this moment everything looks clear to me, but what happened just before? That’s what worries me. It’s like waking from a dream; I just don’t remember.

– H.M
Medial Temporal Lobe: Top of Information-Flow Hierarchy
MTL & Relational Memory Formation

event or episode
MTL & Relational Memory Formation

Hippocampus: event or episode

Illustration of brain structure with emphasis on the hippocampus region relevant to memory formation.
MTL & Recollection

“pattern completion”

hippocampus

partial cue
MTL & Recollection

“pattern completion”

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Approach: Use fMRI to identify brain events during an experience that predict whether the experience will be later remembered or forgotten.
Subsequent Memory Paradigm

Encoding Activation

GIRAFFE
MUSTARD
BASSOON…
Subsequent Memory Paradigm

Encoding Activation

GIRAFFE
MUSTARD
BASSOON...

Subsequent Behavior
Remembered? Forgotten?

GIRAFFE
MUSTARD
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Subsequent Memory Paradigm

Encoding Activation

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Remembered? Forgotten?

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Peri-Stimulus Time (sec)

Activation

Activation

Peri-Stimulus Time (sec)
Consider the Source: Multiple Forms of Episodic Memory
Encoding Items and Encoding the Source

[Davachi et al. (2003) PNAS]
Memory and the Brain

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Can we see evidence THAT someone is remembering?

Memory and the Brain

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Can we see evidence of WHAT someone is remembering?

(Perceive)

(Wheeler et al., PNAS, 2000)
Episodic Remembering: Recapitulation of Encoding Activation

Words $\rightarrow$ PICTURES

Words $\rightarrow$ SOUNDS

(Wheeler et al., PNAS, 2000)
Memory and the Brain

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Distinguishing true from false memories

- **Sensory reactivation regions**
  - The neural signature of experienced scenes or people will be more likely to engage primary sensory areas since these memories should include more perceptual detail.

- **Memory representation regions**
  - Will more central memory regions (such as the hippocampus) differentiate between true and false memories?

- **General cognitive processing regions**
  - False memories will require more monitoring during retrieval because the same memory evidence is not there (likewise, reaction times will be longer..)
Can Imagination be Mistaken for Reality?

Study Phase
Word-only
[imagine picture]

Word+Picture

Test Phase
Did you see a picture of this item?

Gonsalves and Paller (2000), Nature Neuroscience
Imagination Inflation: Remembering “Seeing” What You Imagined
(Gonsalves and Paller, 2000) (Okado and Stark, 2003)
Understanding Imagination Inflation

Rich vivid imagery creates a memory that resembles the contents of a memory for real experiences.

During retrieval, the reactivation of these rich imagery details is falsely attributed to having seen the stimulus rather than to having imagined it.

A form of source memory confusion

— Did I think it or did I see it?
— The closer our imagination gets to perception, the higher the likelihood of confusion.
Understanding False Memories: False Recapitulation

(Kahn et al., J Neurosci, 2004)
Sometimes False Memories are Due to False Recapitulation

A. HITS with Recollection (Item+Source)

PHc

FALSE ALARMS

B. Premotor/Prefrontal

% Signal Change

“Imaged” “Read”

“Imaged” “Read”
Misattribution

Oklahoma City bombing, 1995
John Doe #2: Product of a memory error
CLARKSVILLE, Tenn. (AP) -- One of the Korean War veterans who described the U.S. Army killing of refugees at No Gun Ri says he now recognizes he could not have been at the scene and instead learned of it second-hand from soldiers who were there.

Wartime documents found in government archives by The Associated Press show that the ex-soldier, Edward L. Daily, 69, of Clarksville, was in another unit elsewhere in Korea when 7th Cavalry Regiment companies fired on the South Korean civilians in late July 1950.

"I have to agree with your records. I can't dispute them," Daily said in an AP interview after reviewing the relevant documents. Asked whether he agreed the records showed he could not have been at No Gun Ri, he replied simply, "Yes."
Implanting False Memories in the Lab

Loftus & Pickrell (1995)

- Subjects presented with 3 true stories and 1 false story from this person’s past (between ages 4-6)

- False story (e.g., getting lost in the shopping mall) had realistic details from relatives

- Subjects recalled 68% of true events and 29% of false events
  • the false events were recalled even two weeks later

- Some subjects clung to the false memory even after being debriefed
Can the Brain Distinguish True from False Memories?

Study: male & female speakers read 6 related word lists

Test → old/new recognition of visually presented words
• TRUE items → words from the studied lists
• FALSE items → nonstudied words related to studied words
• NEW items → unrelated new words

Proportion of Old responses
• True = False > New
Can the Brain Distinguish True from Imagined (False) Memories?

Hippocampus supports memory for the semantic gist of an experience.

Parahippocampus supports memory for the perceptual details of an experience.

Can we look at brain activity and know whether a person is accurately remembering? NOT HIPPOCAMPUS

What about regions sensitive to perceptual information? FUSIFORM GYRUS and PARAHIPPOCAMPUS
Summary

• Research design and analysis has greatly improved over the past few years, allowing us to reveal some consistencies:
  • true memories tend to activate primary sensory regions more than false memories.
  • many memory related regions show equivalent activation for true and false memories
  • frontal regions tend to show greater activation for false as compared to true memories

• Basically, true and false memories look more ALIKE than they look different
• No data available on individual analysis - how reliable are the small differences?
• Data analyzing the effects of emotion on true and false recognition are equivocal (some show higher FM rate, some lower)