The Science of Memory

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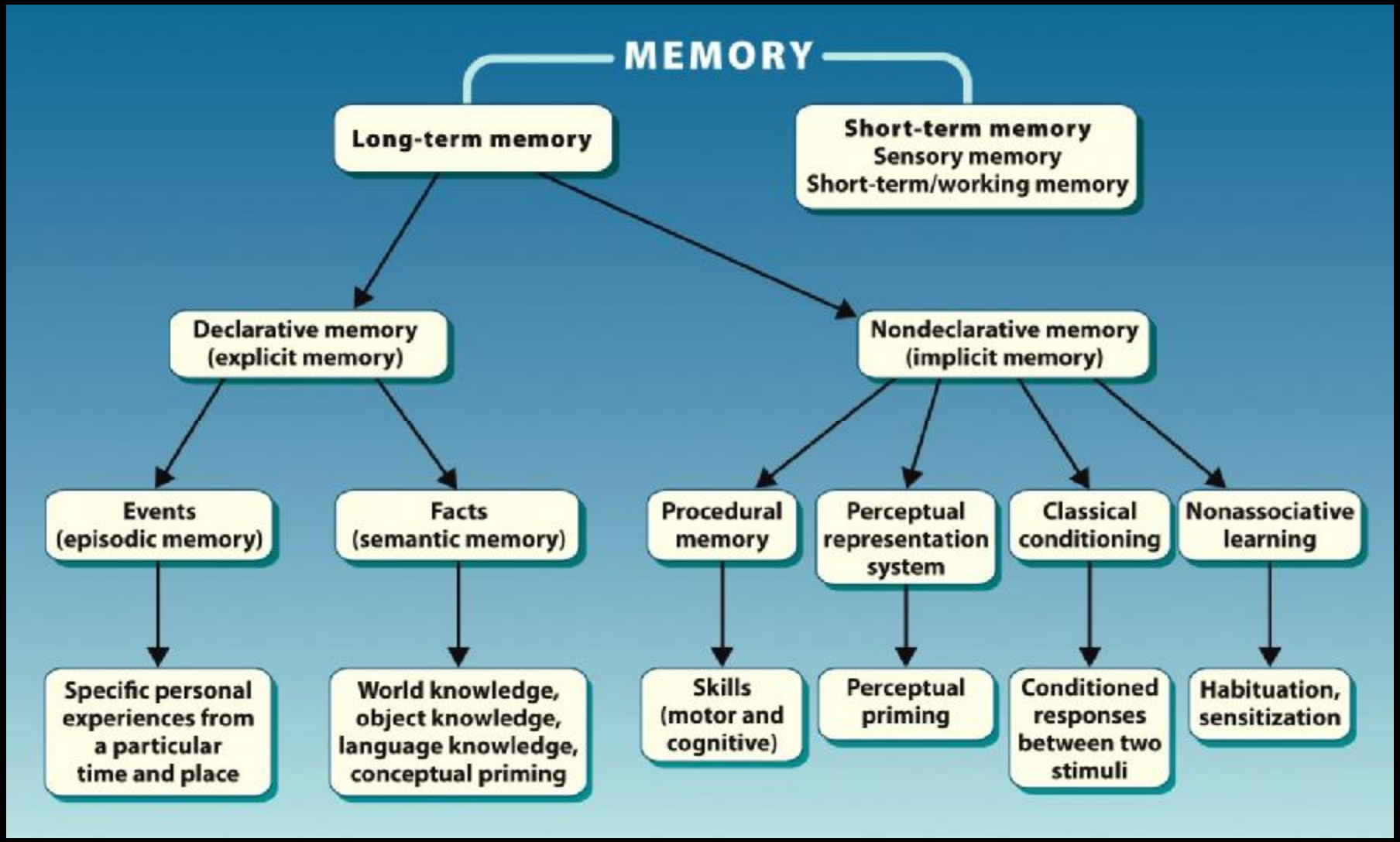
Memory

The neurocognitive capacity to encode, store, and retrieve information

(Tulving, *Oxford Handbook of Memory, 2000*)


MEMORY
Long-term memory
Short-term memory
Sensory memory
Short-term/working memory
Declarative memory
(explicit memory)
Nondeclarative memory
(implicit memory)
Events
(episodic memory)
Facts
(semantic memory)
Procedural
memory
Perceptual
representation
system
Classical
conditioning
Nonassociative
learning
Specific personal
experiences from
a particular
time and place
World knowledge,
object knowledge,
language knowledge,
conceptual priming
Skills
(motor and
cognitive)
Perceptual
priming
Conditioned
responses
between two
stimuli
Habituation,
sensitization

Encoding and Memory

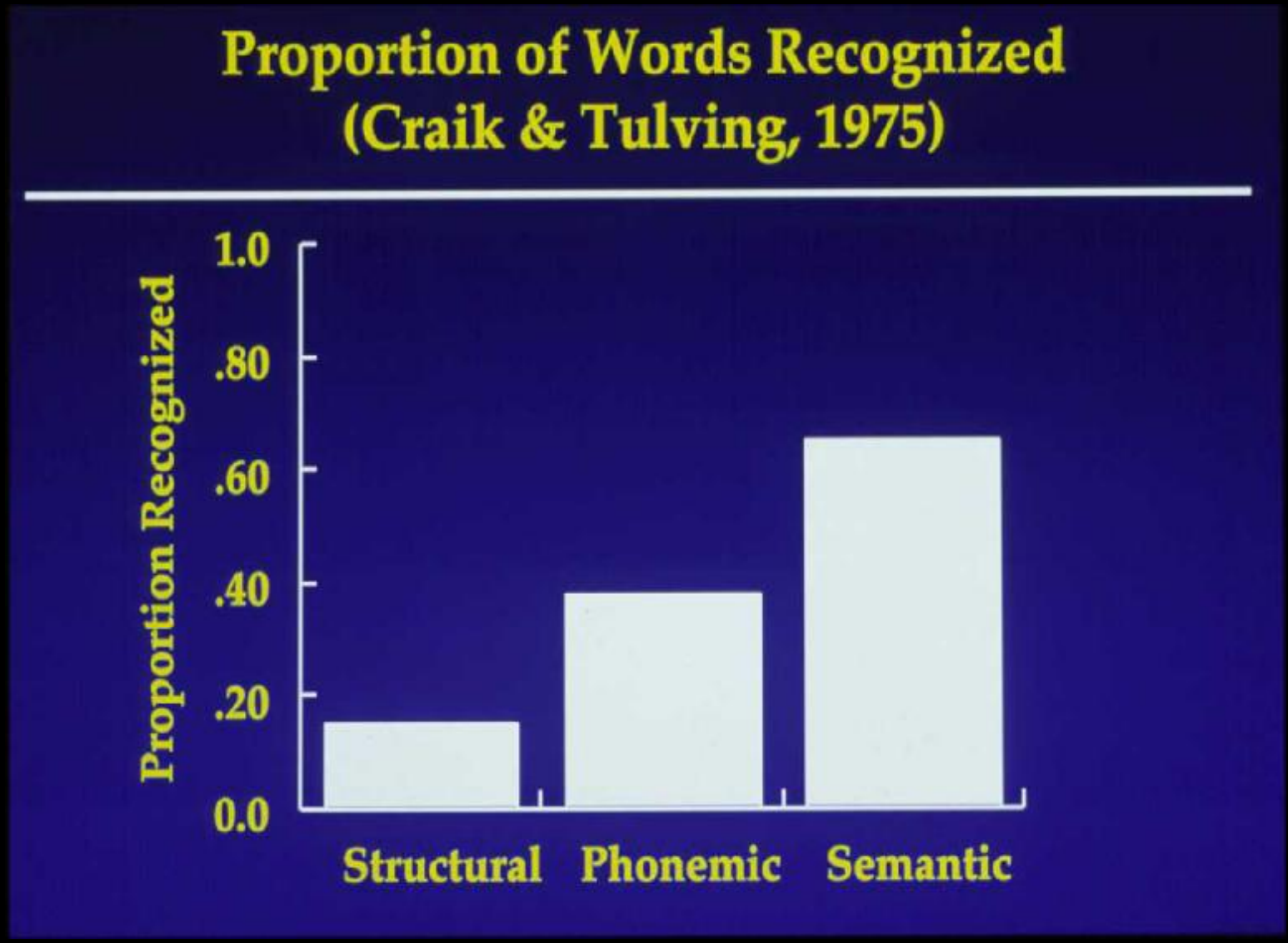
*Encoding: How we perceive/interpret our experiences; has a large influence on retention.

*LTM benefits from **semantic encoding**: *when we meaningfully associate new information to what we already know.*

Encoding and Memory

Example: ***Encoding tasks used with a series of words:***

Semantic: think about meaning (e.g., abstract/concrete)
Phonemic: think about sound (e.g., rhyme)
Structural: think about appearance (e.g., upper/lower case


Proportion of Words Recognized
(Craik & Tulving, 1975)
Proportion Recognized
1.0
.80
.60
.40
.20
0.0
Structural
Phonemic
Semantic

Retrieval of LTM

***Memory is highly *cue dependent*:**

Availability/accessibilty

Encoding/retrieval match

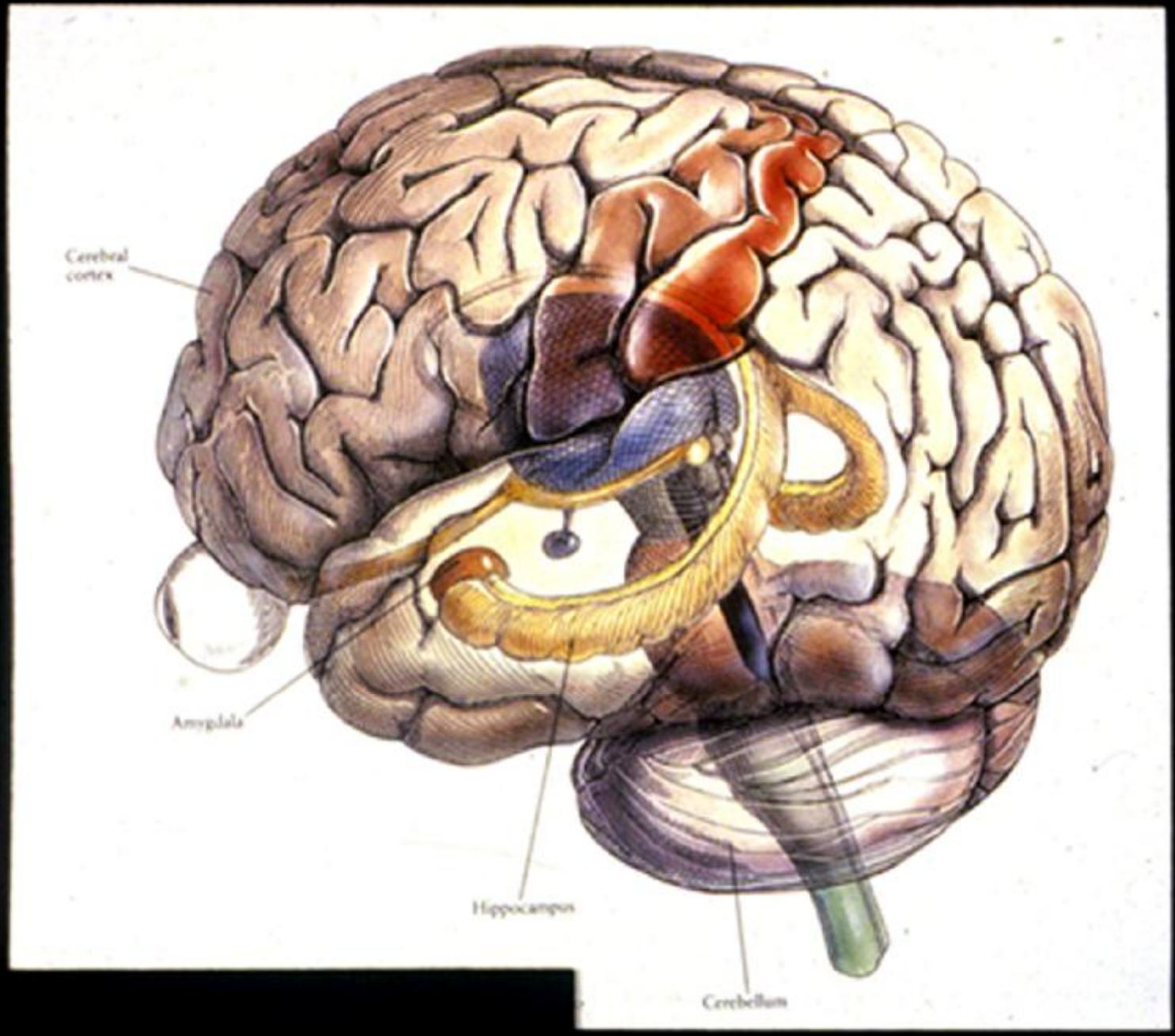
Retrieval of LTM

***Memory is highly *cue dependent*:**

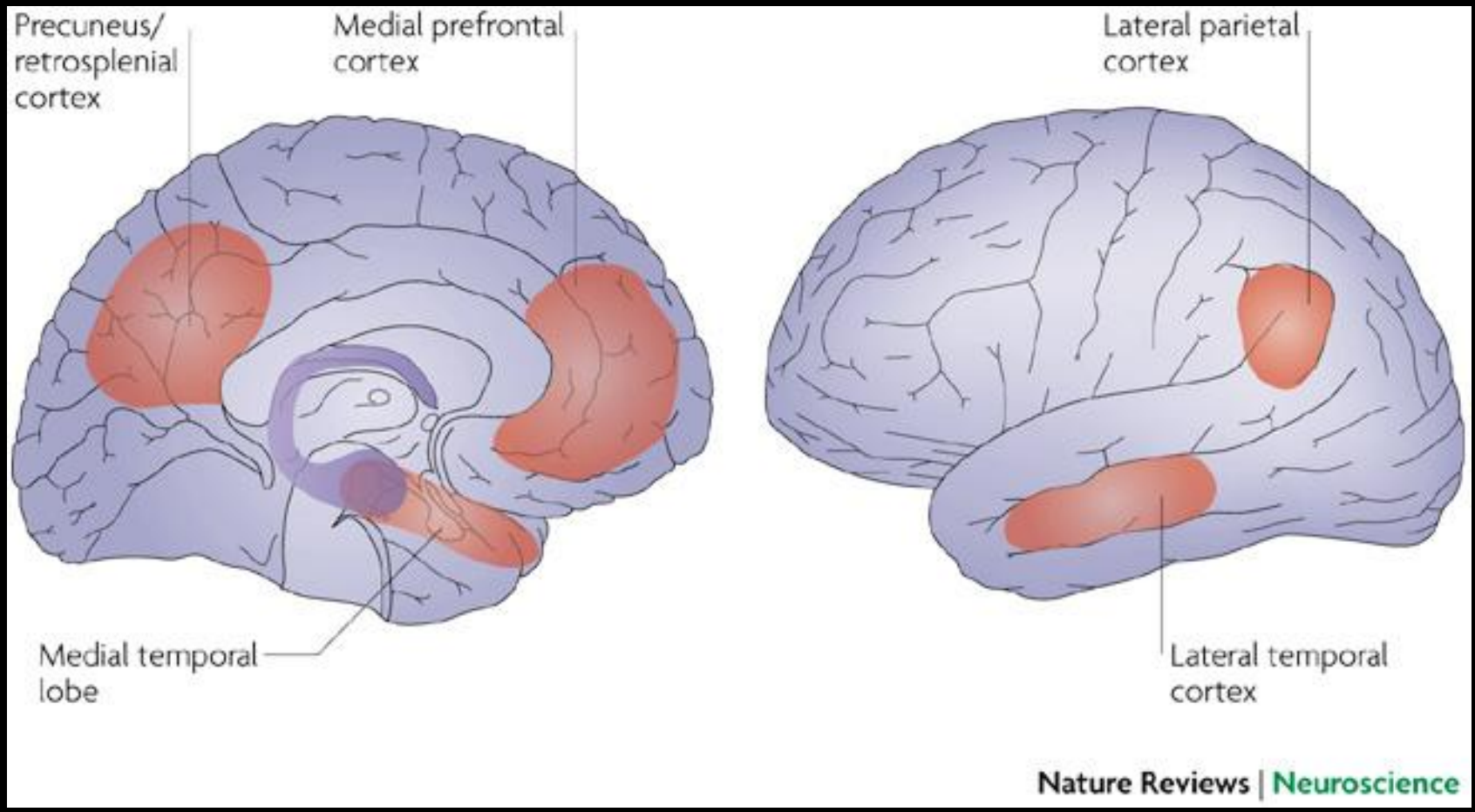
- **Availability/accessibilty**
- **Encoding/retrieval match**

***Consequences of retrieval:**

- **Strengthen subsequent memory**
- **Impair/inhibit subsequent memory**
- **Change subsequent memory (may be related to process of “reconsolidation”)**


Cerebral cortex
Amygdala
Hippocampus
Cerebellum

Core Network Involved in Remembering Past Events and Imagining Future Events (Schacter, Addis, & Buckner, 2007)

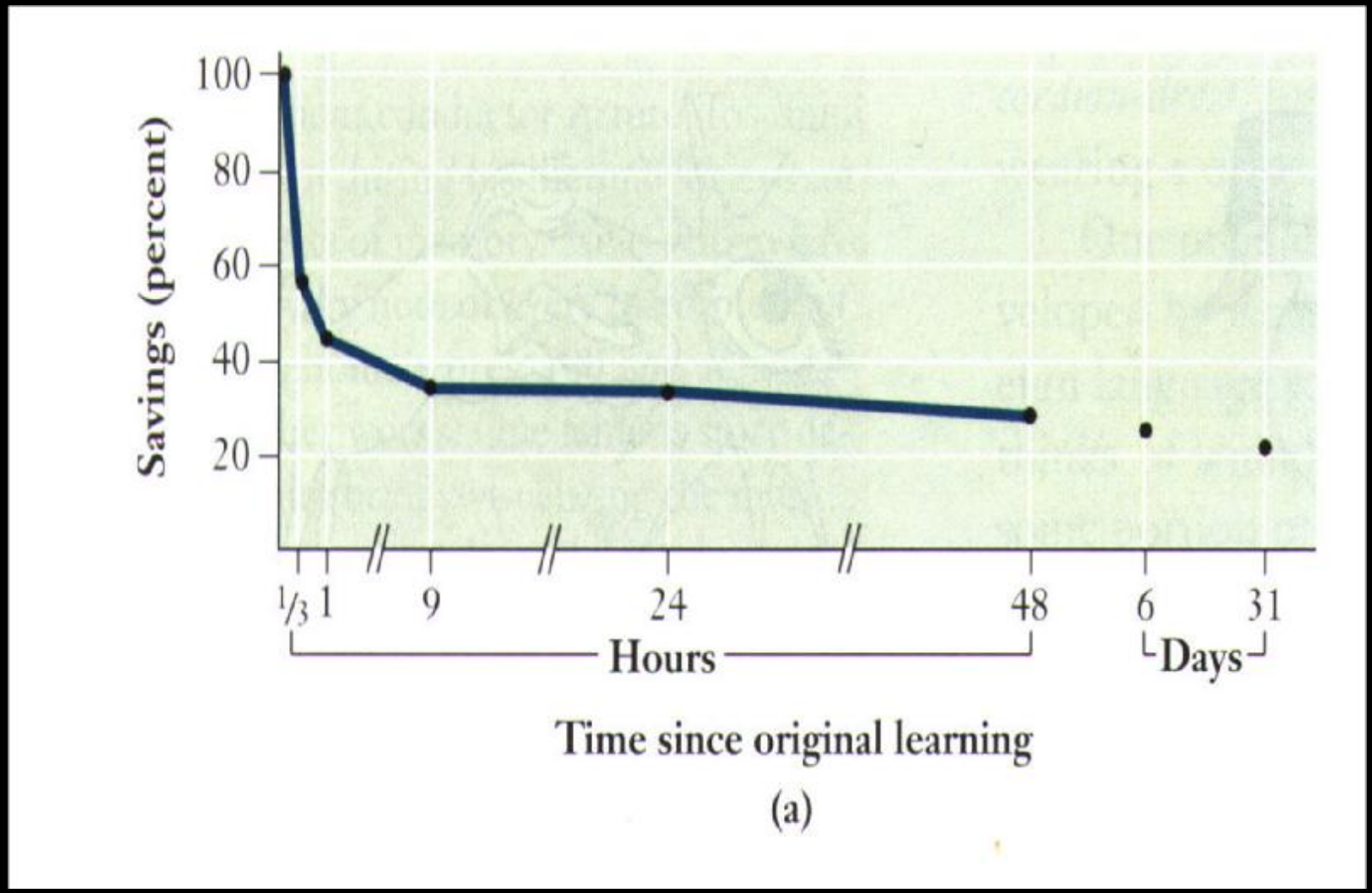


The Seven Sins of Memory

- ***Transience:*** **decreasing accessibility over time**
- ***Absent-mindedness:*** **lapses of attention; forgetting to do things**
- ***Blocking:*** **temporary inaccessibility of stored information**
- ***Misattribution:*** **attributing memories to incorrect source; false recogn**
- ***Suggestibility:*** **implanted memories**
- ***Bias:*** **retrospective distortions produced by current knowledge and**
- ***Persistence:*** **unwanted recollections that people cannot forget**

Schacter (1999, 2001)

The Ebbinghaus forgetting curve (from Gray, 1999)



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Schacter (1999, 2001)

False Recognition of Semantic Associates

(Deese, 1959; Roediger & McDermott, 1995)

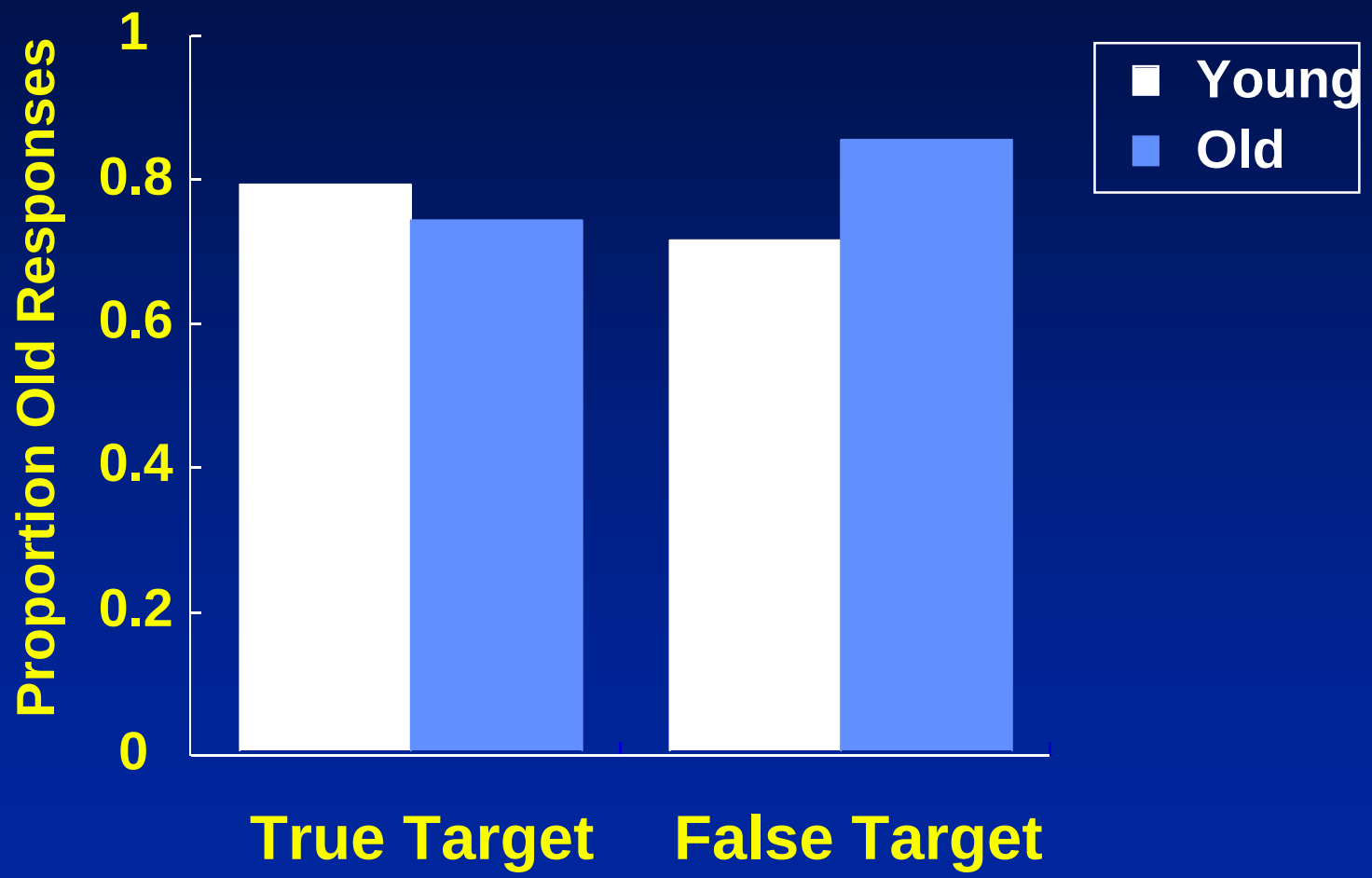
- **Participants study semantic associates that all converge on a non-presented theme word:**

  candy, sour, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart, cake, eat, pie

- **Tested with words from the study list (*taste*), unrelated words that were not presented (*point*), and associative related theme word or critical lures (*sweet*).**

- **Extremely high levels of false alarms to theme word, accompanied by high confidence**

True and False Recognition



Norman & Schacter, 1997

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Schacter (1999, 2001)

N.J. Supreme Court imposing sweeping changes in crime witness testimony

Stuart Rabner, chief justice of the New Jersey Supreme Court, says new instructions to jurors will discourage actions that could help put the wrong person behind bars.

Published: Monday, July 23, 2012

After Labor Day, judges will be required to give jurors plenty of precautions before they consider the testimony they heard during trials.

For example, jurors will be told: "Human memory is not foolproof. Research has revealed that human memory is not like a video recording that a witness need only replay to remember what happened. Memory is far more complex ... Eyewitness identification must be scrutinized carefully."

Nature Neuroscience, February 2013

COMMENTARY

Memory and law: what can cognitive neuroscience contribute?

Daniel L Schacter & Elizabeth F Loftus

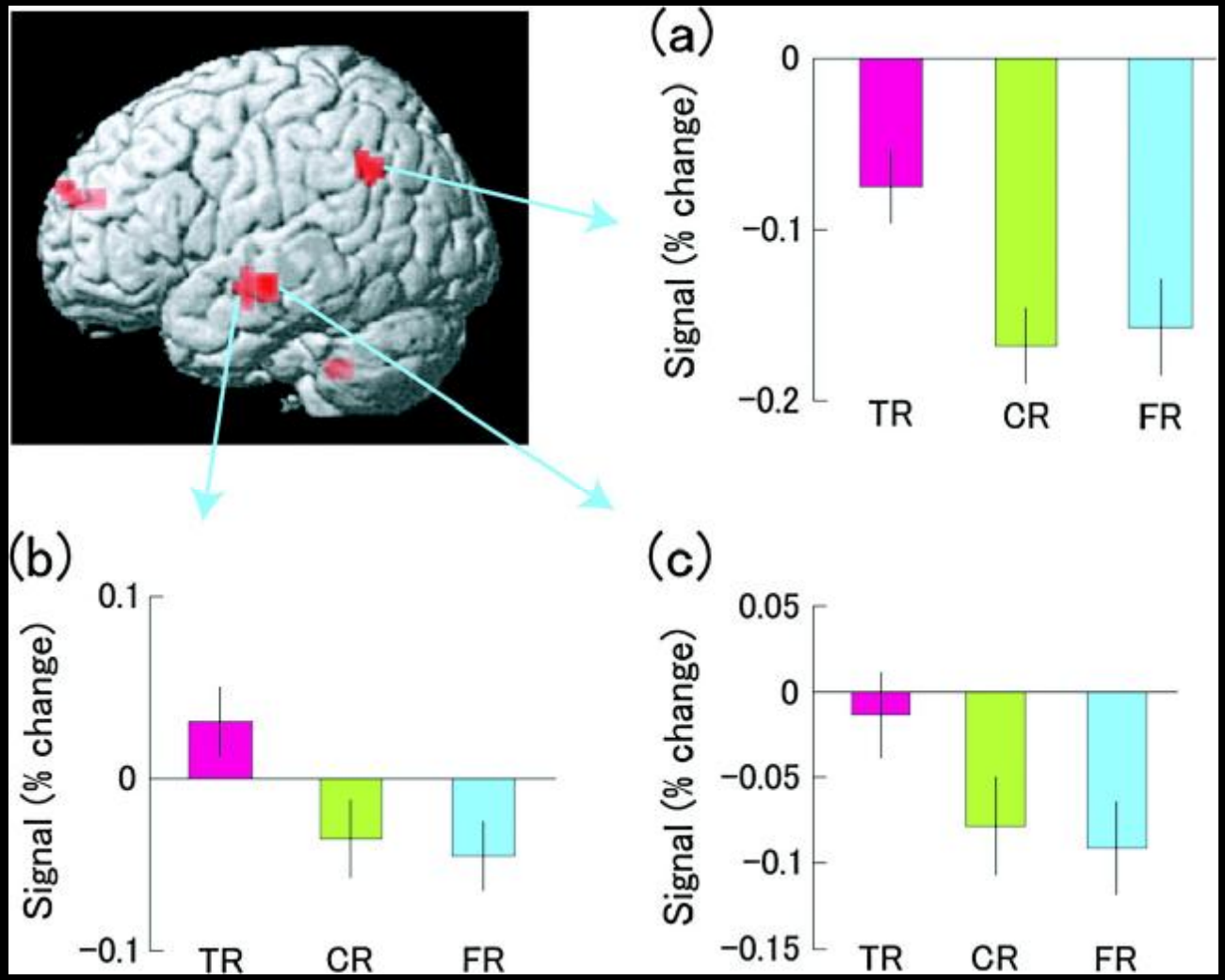
A recent decision in the United States by the New Jersey Supreme Court has led to improved jury instructions that incorporate psychological research showing that memory does not operate like a video recording. Here we consider how cognitive neuroscience could contribute to addressing memory in the courtroom. We discuss conditions in which neuroimaging can distinguish true and false memories in the laboratory and note reasons to be skeptical about its use in courtroom cases. We also discuss neuroscience research concerning false and imagined memories, misinformation effects and reconsolidation phenomena that may enhance understanding of why memory does not operate like a video recording.

In November 2003, Larry Henderson was accused of holding a gun on James Womble while another man shot Rodney Harper to death in a Camden, New Jersey apartment on New Year's Day of that year. Almost 2 weeks after the murder, Womble identified Henderson from a photo array. Womble again identified Henderson at trial, and Henderson was easily convicted of reckless manslaughter and aggravated assault, among other charges. An open and shut case? Turns out not so. There were problems with Womble's seemingly convincing evidence: for instance, Womble failed to identify

deter inappropriate conduct by law enforcement and will help jurors to better evaluate evidence based on eyewitness memory. As a result of the Henderson case, defendants who can show some evidence of suggestive influences are entitled to a hearing in which all factors that might have a bearing on the eyewitness evidence are explored and weighed. If, after weighing the evidence presented at the hearing, the judge decides to admit the eyewitness evidence into trial, then the judge will provide appropriate, tailored jury instructions that will guide jurors on how to evaluate the

memory is not foolproof. Research has shown that human memory is not at all like a video recording that a witness need only replay to remember what happened. Human memory is far more complex." Later on, the instructions urge jurors to consider various factors that could affect the eyewitness testimony, and provide explicit information on how to think about those factors. For example, in cases involving the identification of a stranger of a different race, the instructions state: "You should consider that in ordinary human experience, people may have greater difficulty in

True Recognition > False Recognition



Abe N et al. (Cerebral Cortex 2008); replication of Schacter et al. (Neuron, 1996)

PERSPECTIVES ON PSYCHOLOGICAL SCIENCE

How to Tell If a Particular Memory Is True or False

Daniel M. Bernstein[1] and Elizabeth F. Loftus[2]

[1]Kwantlen Polytechnic University and University of Washington, and [2]University of California, Irvine

ABSTRACT—How can you tell if a particular memory belonging to you or someone else is true or false? Cognitive scientists use a variety of techniques to measure groups of memories, whereas police, lawyers, and other researchers use procedures to determine whether an individual can be believed or not. We discuss evidence from behavioral and neuroimaging studies and research on lying that have attempted to distinguish true from false memories.

Consider the following situation. Mary X sits on the witness stand in court, recounting an emotionally charged memory involving childhood sexual abuse. Her report is both detailed and emotional. She explains how her grandfather molested her and how she had repressed the event for many years before recovering the memory in therapy. Is Mary's report the result of a real memory or a product of suggestion or imagination or some other process?

This hypothetical example has many real-world parallels: Individuals claim that they have recovered memories of events long forgotten. Lacking corroborative evidence or a confession that can be trusted, what are we to make of these claims? Although the field of memory research has demonstrated repeatedly that memory is fallible and prone to distortion, often we are faced with a difficult question: How do we tell if a particular memory is true or false? We regard this as one of the biggest challenges in human memory research.

Cognitive scientists have developed several techniques to measure groups of memories. Also, police, lawyers, and researchers have developed techniques to help them judge whether a person can be believed or not. These two approaches—focusing on the memories reported or the person reporting the memories—represent two very different ways of answering the thorny question we have posed. Unfortunately, neither approach presently can assess whether a particular memory is true or false.

We discuss these two approaches in turn, and then discuss a third approach to answering our question that involves focusing on the particular memory.

FOCUSING ON GROUPS OF MEMORIES

Historically, memory researchers have focused on groups of memories for pallid material like nonsense syllables (e.g., VIF, HOD) and words. In a typical study, subjects study a list of items (words, nonsense syllables, pictures, tones, etc.). After a delay, subjects either try to recall the studied items (recall test), or they try to recognize which items were presented prior and which items are new (recognition test). Researchers may manipulate the types of activities that subjects perform while studying and/or remembering the items. In a word study, these activities might include a manipulation of the depth of processing in which subjects read words, generate a synonym for words (Craik & Tulving, 1975), or even unscramble the words (Watkins & Peynircioglu, 1990). Other manipulations include presenting semantically related word lists (e.g., dream, pillow, tired, nap, slumber) without a critical lure word that is strongly related to all the list words (e.g., sleep; Roediger & McDermott, 1995). Subjects in these experiments then try to recall or recognize studied items. Typically, the critical lure is falsely remembered, demonstrating the fallibility of recent memory. In addition to studies involving words, researchers use groups of autobiographical memories reported by individuals to study true and false memory. In these studies, subjects recall events from their past often using diaries or other such means to record their memories.

Over the past few decades, cognitive scientists have turned to neuroscience in hopes of learning what the brain can reveal about memory and cognition. In the 1950s, Wilder Penfield, a neurosurgeon, observed a curious phenomenon when he electrically stimulated various brain regions in awake epileptic patients. Some of Penfield's patients reported fragments of

“it might be virtually impossible to tell reliably if a particular memory is true or false without independent corroboration.”