Cognitive Psychology

Lecture 7: LTM Encoding, Retrieval, & Consolidation

Memory Processes

Encoding = the process of getting information into LTM

Retrieval = the process of transferring information from LTM to WM

Encoding: Levels of Processing

Memory depends on how information is encoded

The “depth of processing” matters:

- Shallow processing
  - Little attention paid to meaning
  - Focus on physical features
  - Results in poor memory
- Deep processing:
  - Close attention to meaning
  - Results in good memory

Encoding: Levels of Processing

For example, remember “07272017”

Shallow processing

- Maintenance rehearsal
  - Repeat the numbers without any consideration of the meaning

Deep processing

- Elaborative rehearsal
  - Make connections, consider meaning
  - “The day I learned about Levels of Processing! month/day/year”

Encoding: Levels of Processing

- Levels of processing or "depth of processing"
  - Craik & Tulving, 1975

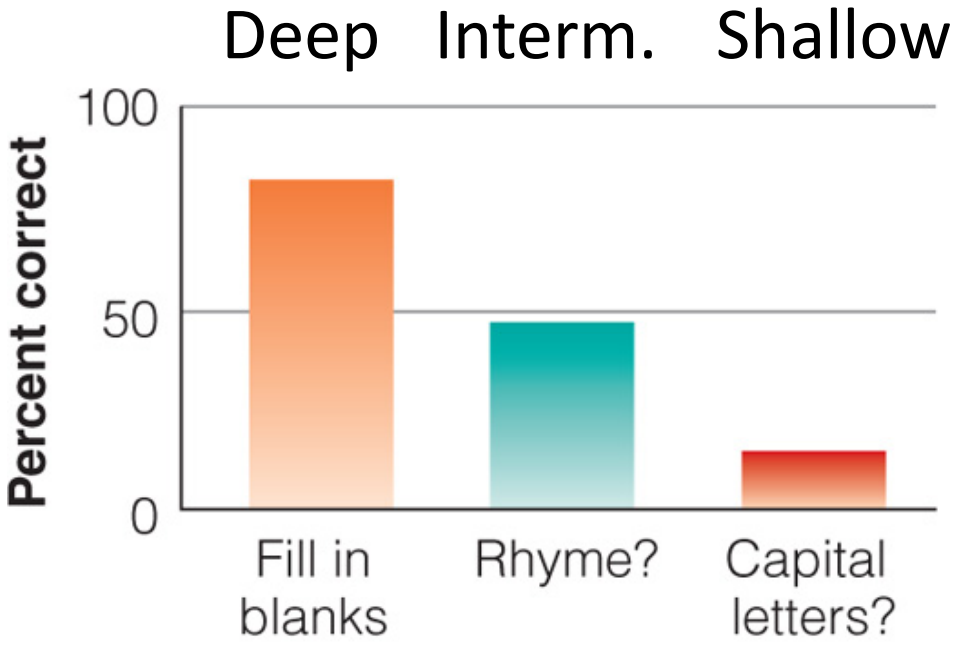
Remember "Hat"

1. **Shallow:** Upper or Lower Case
2. **Intermediate:** Does the word rhyme with *mat?*
3. **Deep:** Does the word fit into the sentence, "The mat ate his _____"?

Shallow

↓

Deep



(b)

Encoding: Levels of Processing

- [Some task] causes good memory ***because*** I used "deep" encoding
- [Some task] causes deep encoding ***because*** I had good memory
- "Depth" is not defined independently of memory performance
  - Circular

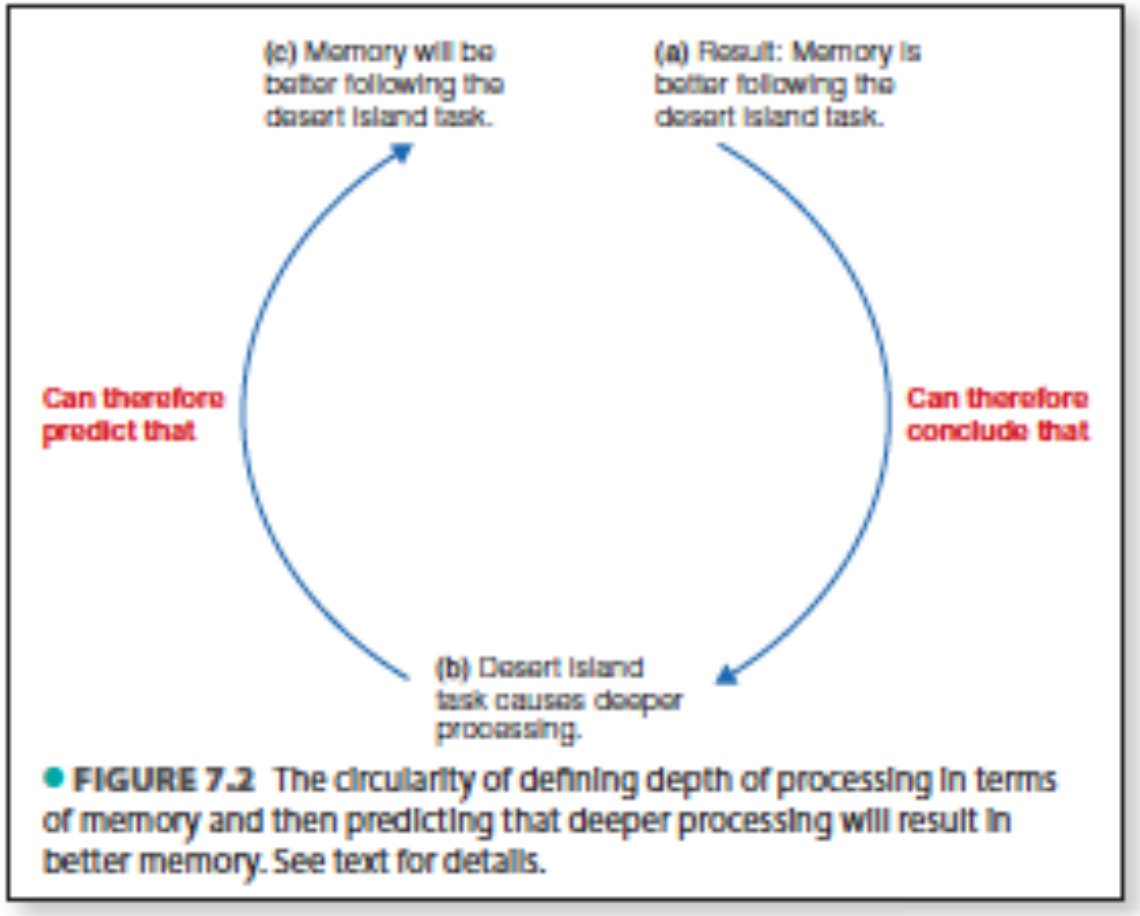
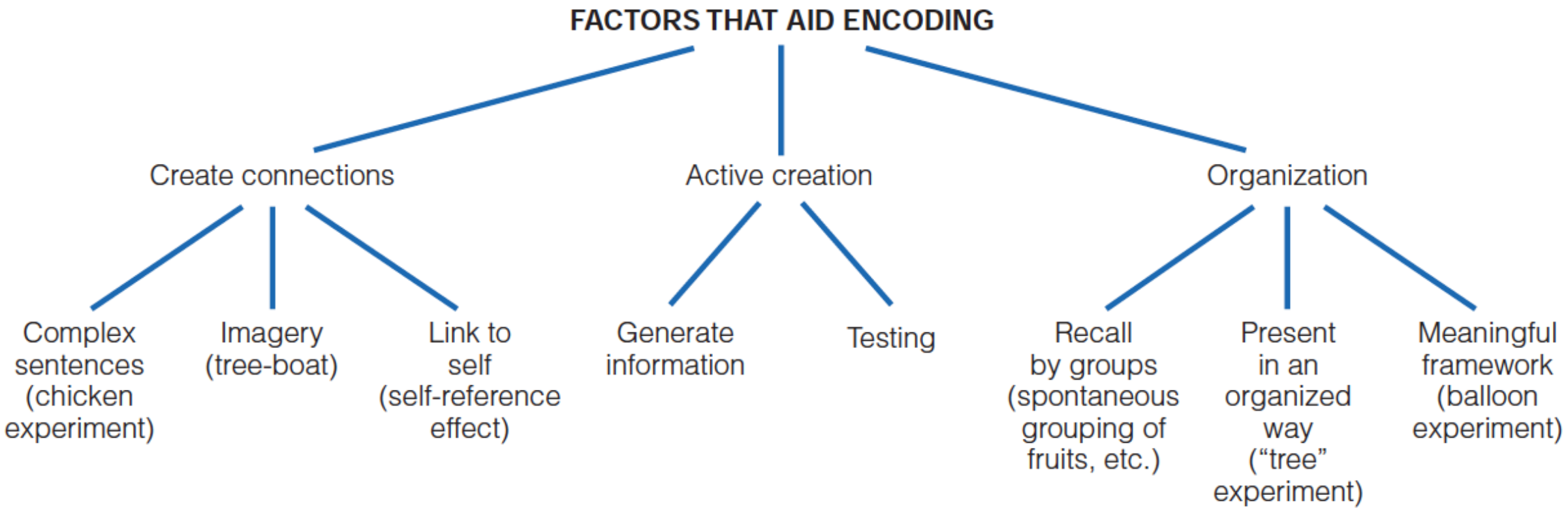


FIGURE 7.2 The circularity of defining depth of processing in terms of memory and then predicting that deeper processing will result in better memory. See text for details.

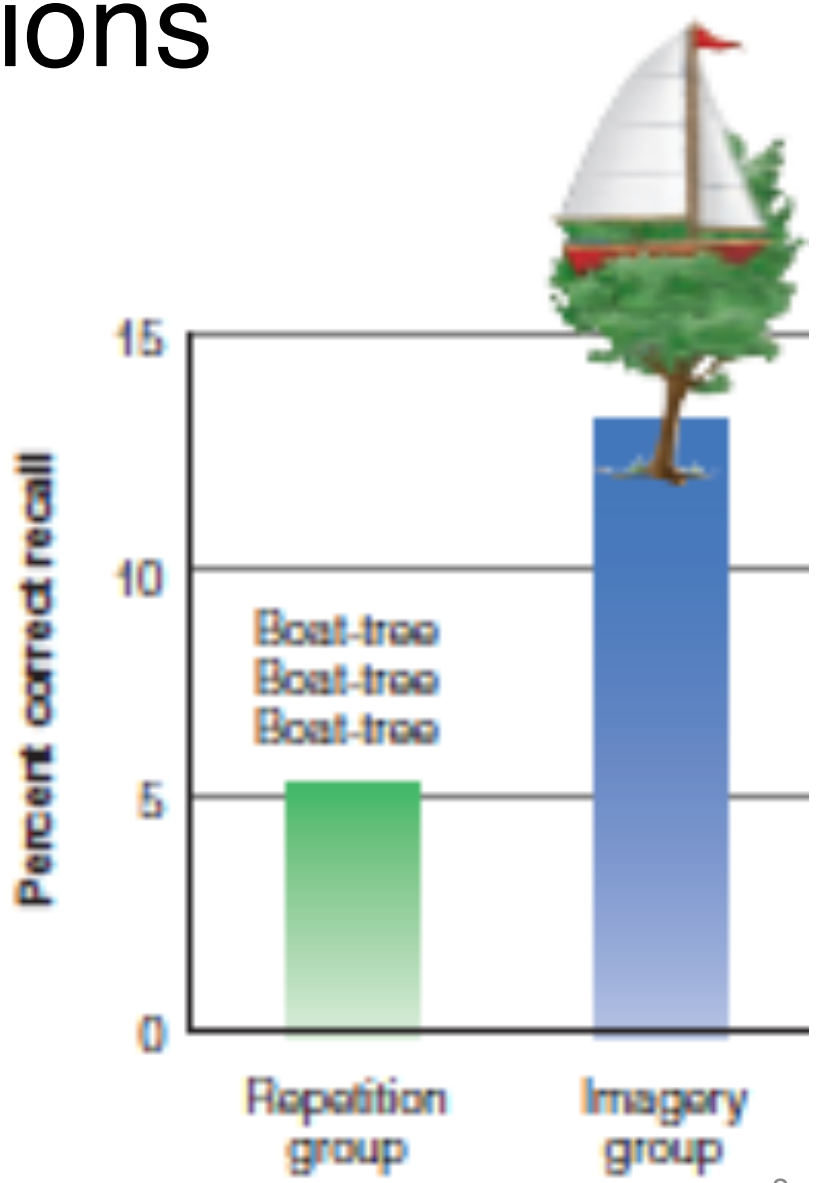
Factors that aid encoding



Encoding: Create Connections

Visual Imagery

- Study paired associates
- Two conditions:
  - Repetition (“boat-tree”, ”boat-tree”, “boat-tree”)
  - Imagery – form mental picture of two items interacting



Encoding: Create Connections

Placing words in complex sentences

- Study words in Simple or Complex Sentences
- Better memory for words in complex sentences

1. She cooked the **CHICKEN**
2. The great bird swooped down and carried off the struggling **CHICKEN**

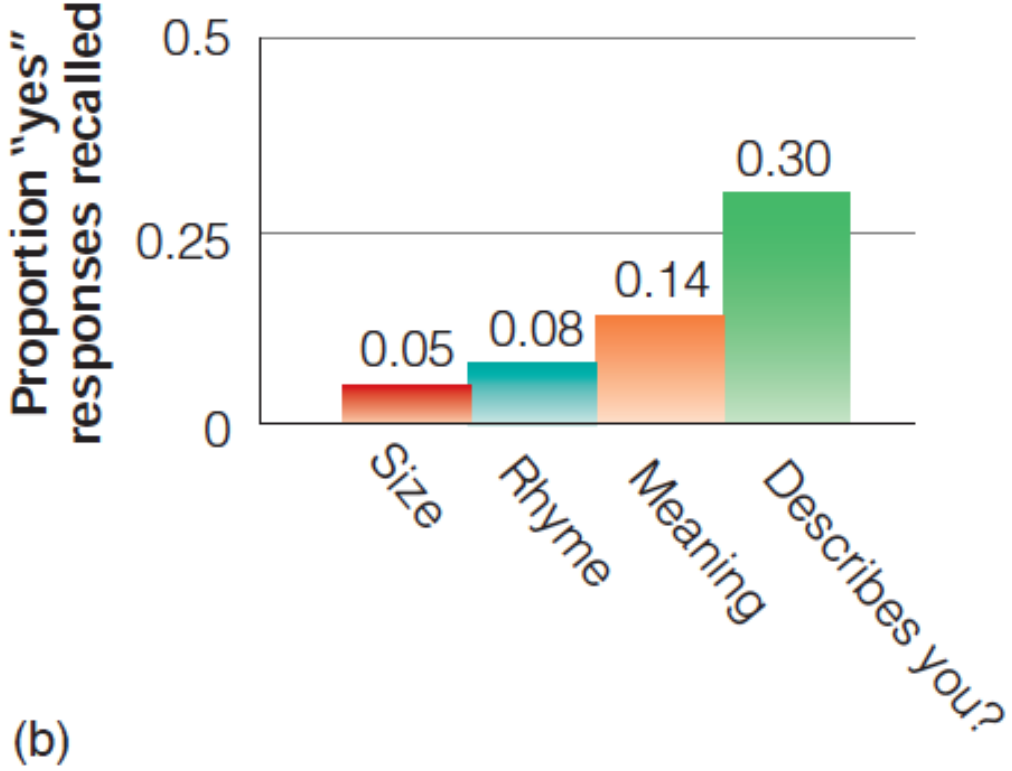
- Creates more connections between the word and other information
  - More information to serve as retrieval cues
  - May create more vivid imagery

Adapted from Fisher & Craik 1980

Encoding: Create Connections

Link to self (The self-reference effect)

- Relate information to yourself
- E.g.
  1. Does this word describe you?
  2. “shy”
  3. Answer: Yes
- Later test memory for words



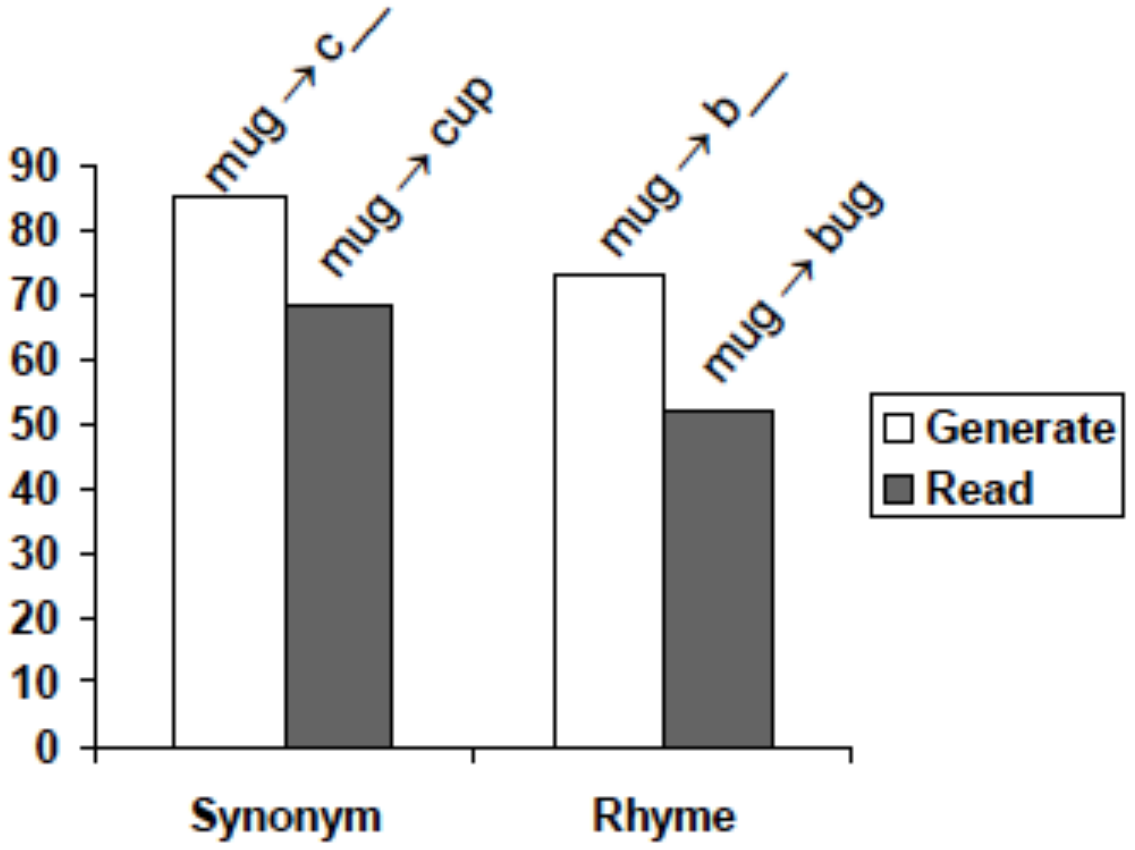
(b)

Encoding: Active Creation

The generation effect

- Better memory for material that you generate yourself

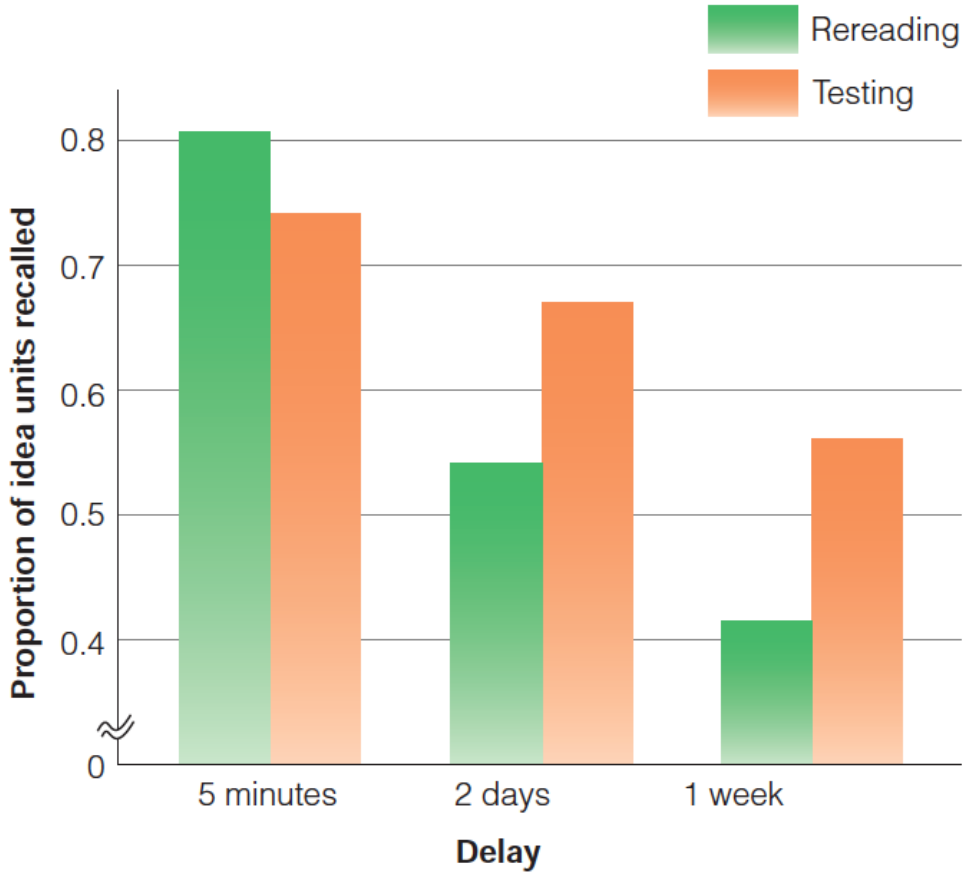
- e.g., note-taking
  - Should you copy straight from the text or rephrase into your own language?
    - Creates connections / cues
    - Generation effects



Encoding: Active Creation

Testing Effects

- Being tested on material helps later recall
  - Related to retrieval cues (to-be-discussed later)



Encoding: Active Creation

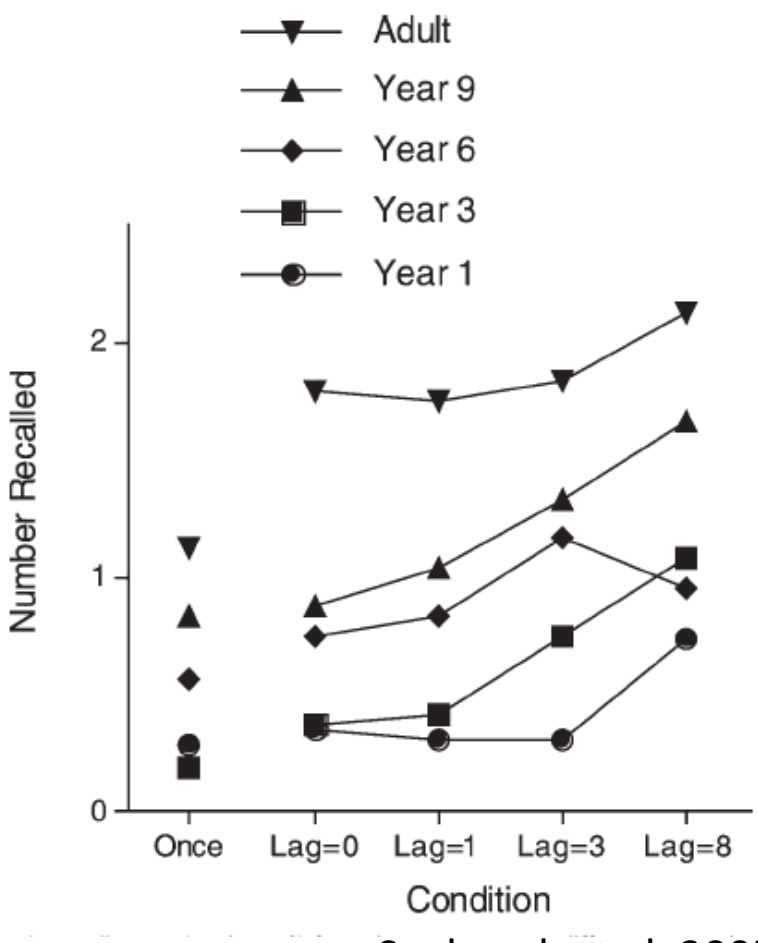
Massed vs. Distributed Learning

- The timing of learning matters

- Improved memory with distributed practice
  - Most likely related to generation effects, testing effects, etc.

The Spacing Effect

- Memory is better when studying is broken down into smaller, spaced out sessions

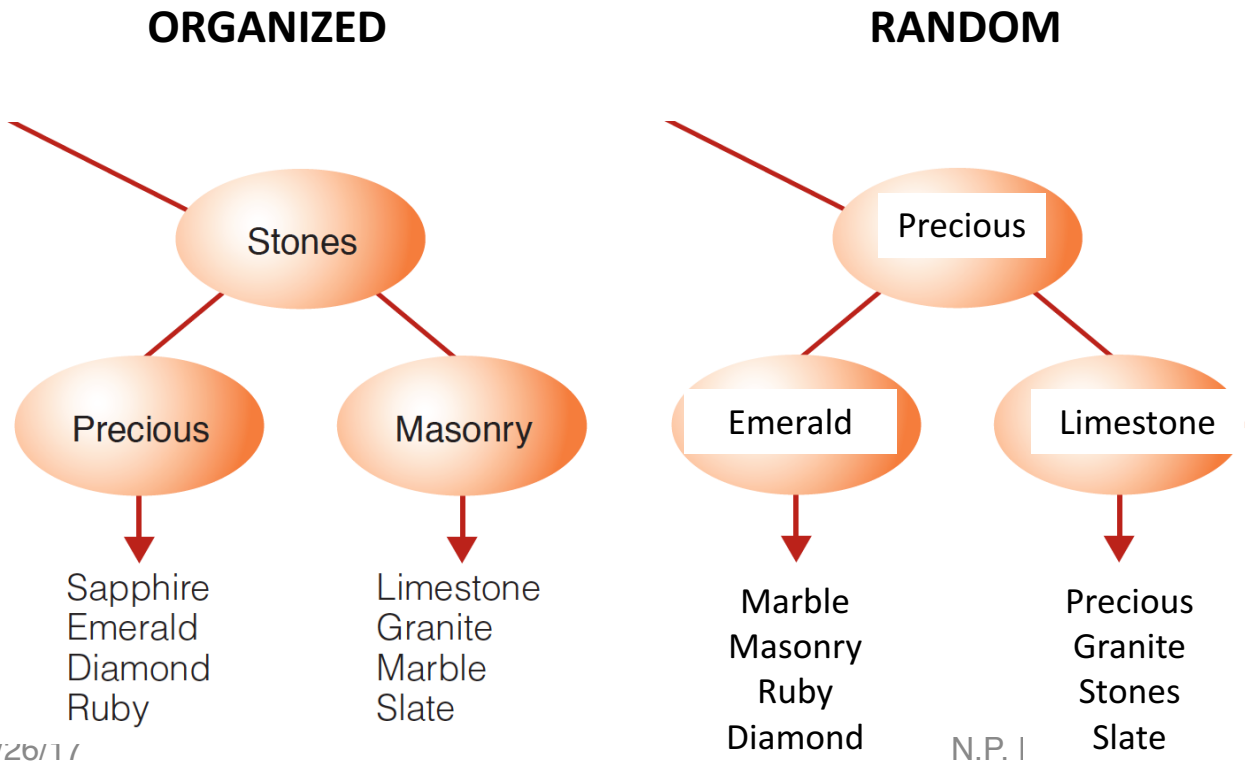


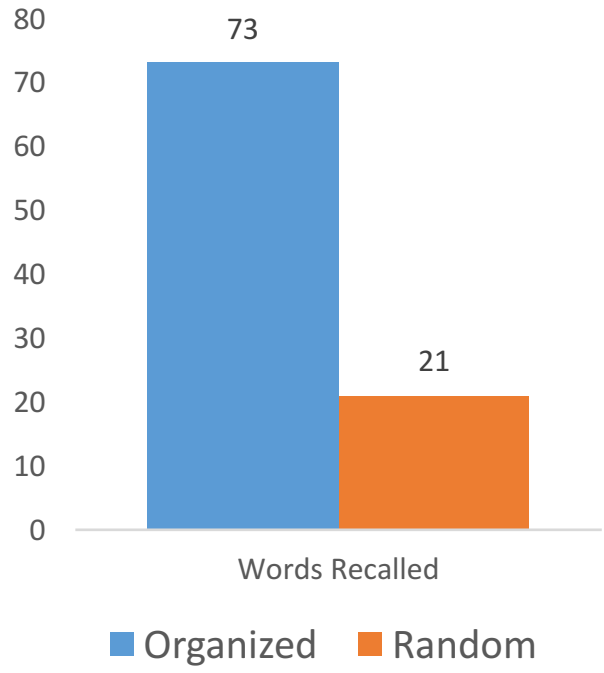
Seabrook et al. 2005

Encoding: Organization of Information

Organized information is easier to remember

- Presenting information logically organized improves memory

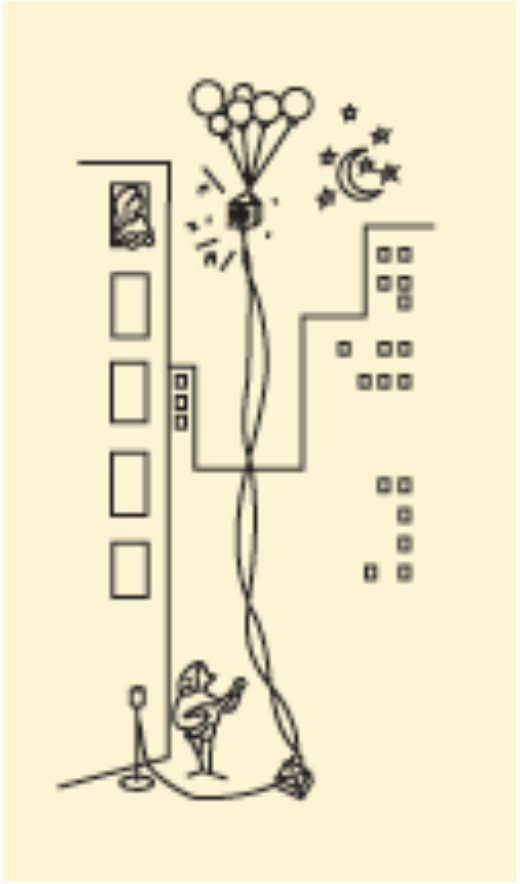




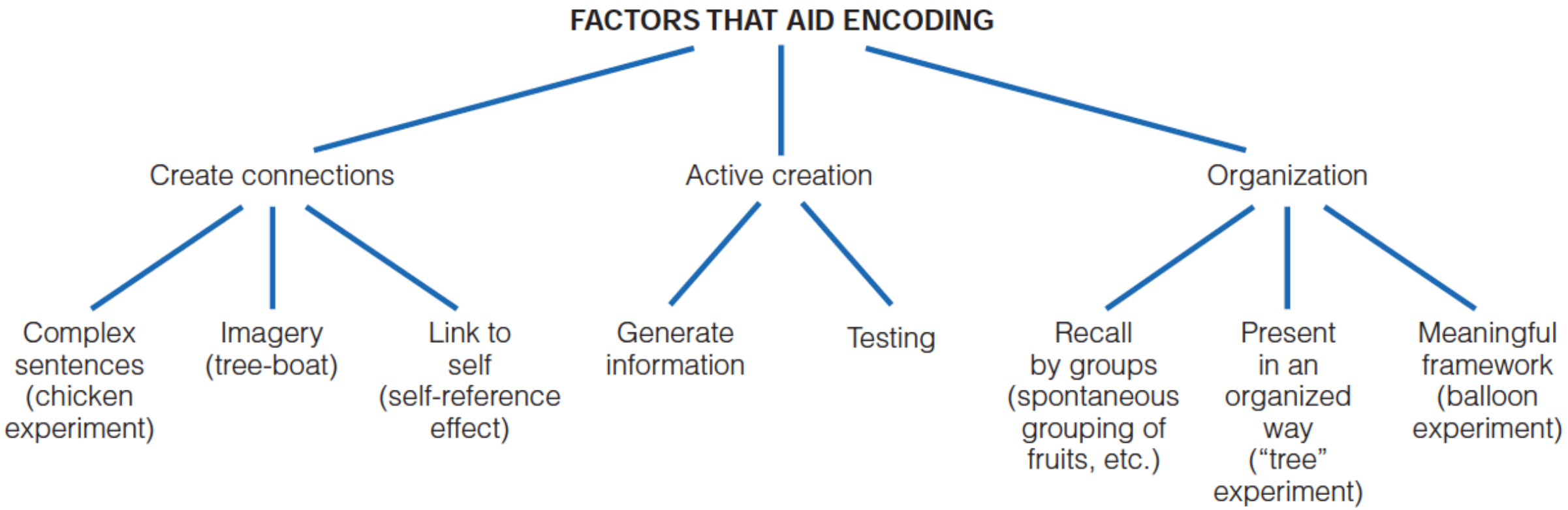
Encoding: Organization of Information

Preventing organization hurts memory

If the balloons popped, the sound wouldn't be able to carry since everything would be too far away from the correct floor. A closed window would also prevent the sound from carrying, since most buildings tend to be well insulated. Since the whole operation depends on the steady flow of electricity, a break in the middle of the wire would also cause problems. Of course, the fellow could shout, but the human voice is not loud enough to carry that far. An additional problem is that the string could break on the instrument. Then there would be no accompaniment to the message. It is clear that the best situation would involve less distance. Then there would be fewer potential problems. With face to face contact, the least number of things could go wrong. (p. 719)



Factors that aid encoding



From encoding to retrieval

- Levels of processing assumes stable relationship between encoding and subsequent memory

- However, later research showed that encoding effects depended on how memory is tested later on
- The processes by which learned information is accessed are called retrieval processes

Retrieval

- Once memory is stored, how do we retrieve it?
- Several different methods in everyday life
  - Can be used in the laboratory as well

- The importance of retrieval cues
  - Retrieval Cue: A piece of information that elicits retrieval of a memory of a prior event

Retrieval

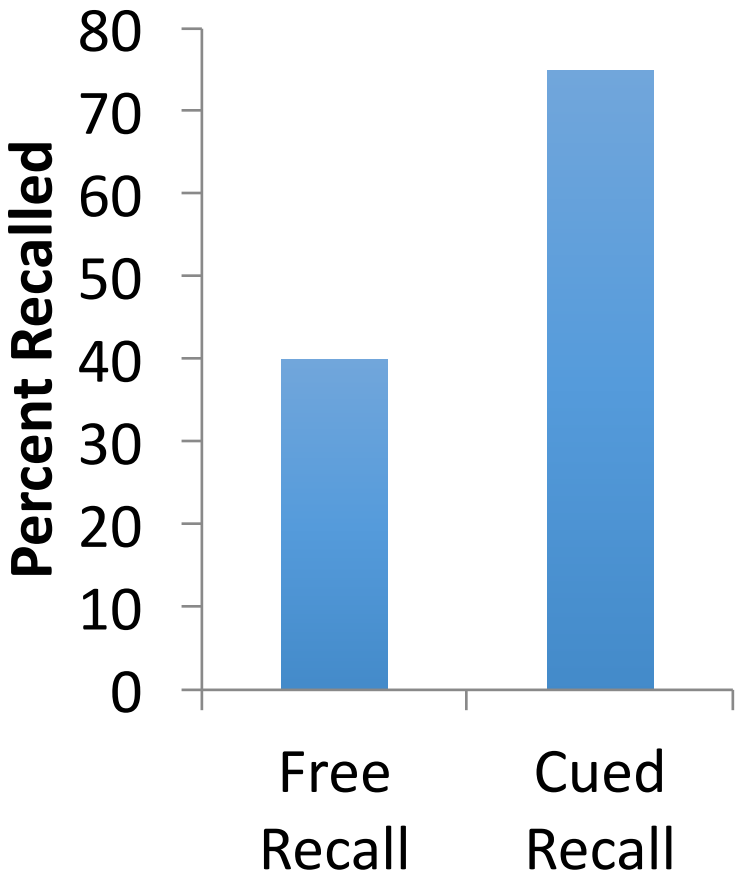
Lemonade = Retrieval Cue

Elicits Memory of Running a Lemonade Stand

Retrieval

Retrieval cues help memory

- Study: List of Words Presented
- Free Recall Group: “Recall the Words”
- Cued Recall Group: “Recall the words. The categories were birds, furniture…”



(adapted from Tulving & Pearlstone 1966)

Retrieval

TASK	
Free Recall	What items were on the list?
Cued Recall	What item was paired with *window*? What item began with rea____?
Yes/No Recognition (new / old)	Was *Reason* on the list?
Forced Choice Recognition	Which was on the list, *reason* or *tree?*
Remember / know	Do you “remember”, “know”, or think it was not on the list

Retrieval

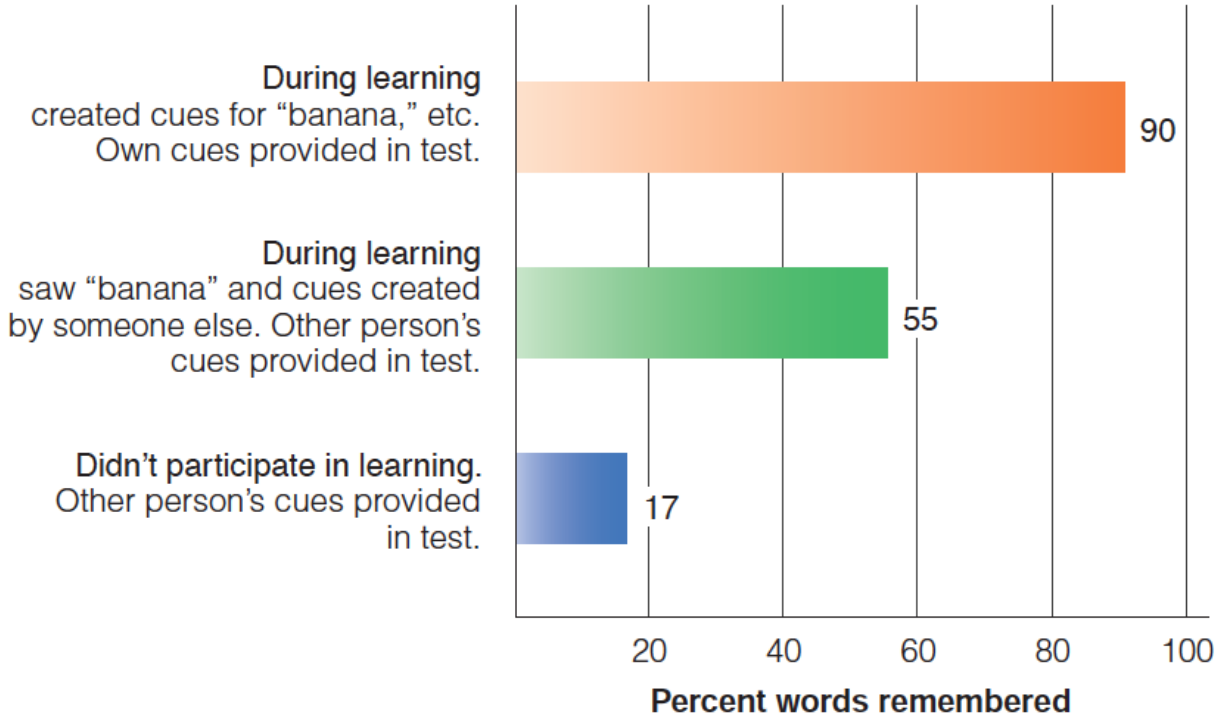
TASK	CUES
Free Recall	Context (task context, etc.)
Cued Recall	Context + part of list item
Yes/No Recognition (new / old)	Context + entire list item
Forced Choice Recognition	Context + entire list item + entire-non-list-item
Remember / know	Can be same as recognition or forced choice

Retrieval

Retrieval cues generally help memory…

However, the type of cues present during encoding AND retrieval can have a large influence on recall

- E.g., self-generated cues are significantly more effective



Retrieval

General Principle: Retrieval can be increased by matching conditions between encoding and retrieval

- Encoding Specificity
  - Context-Dependent Memory
- State-Dependent Memory
- Transfer Appropriate Processing

Retrieval

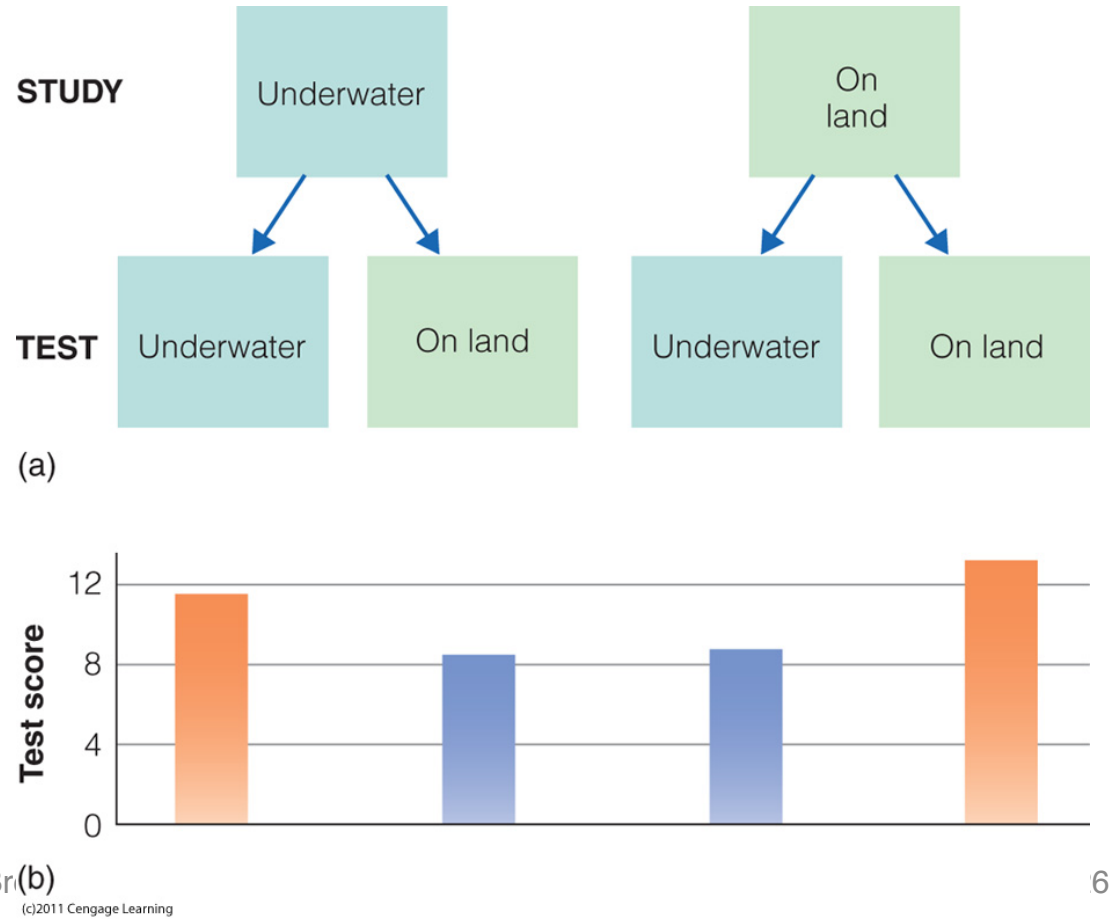
Encoding Specificity or Context-Dependent Memory

- The physical context present during encoding and retrieval
- We encode information together with all the contextual details present during encoding
  - You are encoding the information on this slide in the context of this room
- As a result, information is best remembered when encoding and retrieval contexts match!

Retrieval

Godden & Baddeley, 1975

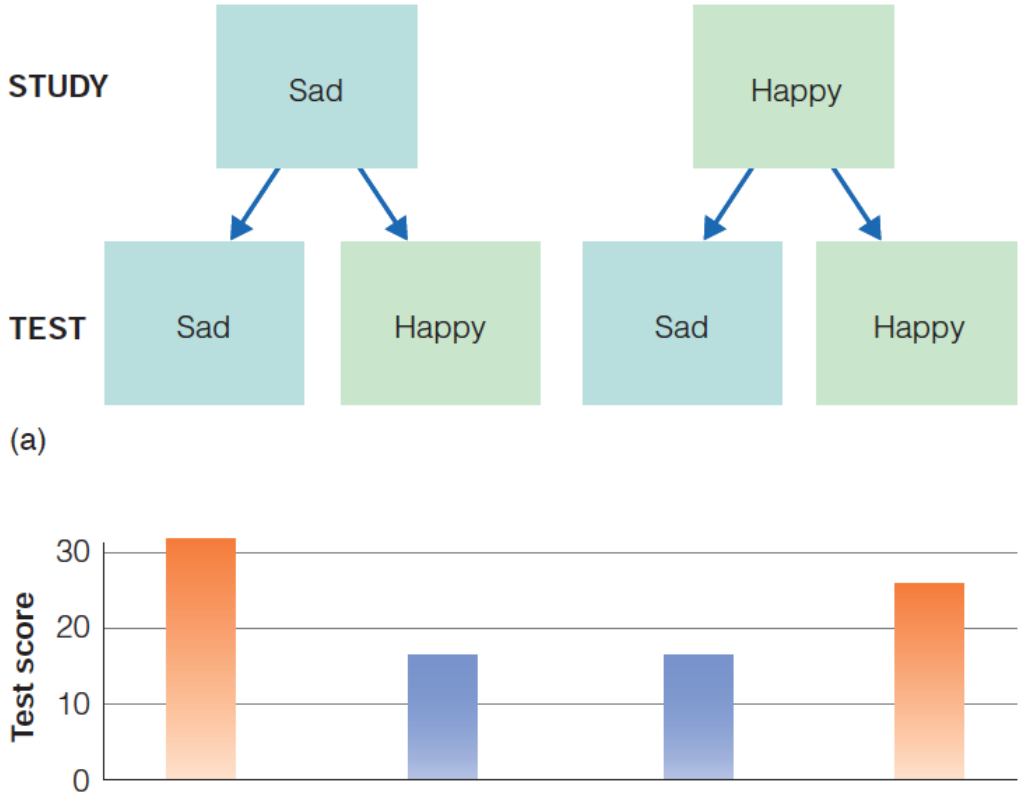
- Context-dependent memory



Retrieval

State-Dependent Learning

- The “internal context” present during encoding and retrieval
- E.g., mood or state of awareness



Retrieval

Transfer Appropriate Processing

- The “processing context” present during encoding and retrieval
- Different kinds of tasks require different kinds of cognitive processing

- E.g., asking for a word that rhymes with *MAD* requires different cognitive processes than asking for a word that is synonymous with MELONCHOLIC
  - Even if you come with the same answer in both cases (sad)

Retrieval

Morris et al., 1977

- Two study conditions:
  - Rhyme Judgment: “Does **EAGLE** rhyme with legal?”
  - Semantic Judgment (meaning): “Does this sentence make sense: The **TRAIN** had a silver engine”
- Two test conditions
  - Item recognition: Did you see **TRAIN**?
  - Rhyme recognition: Did you see a word that rhymed with regal?

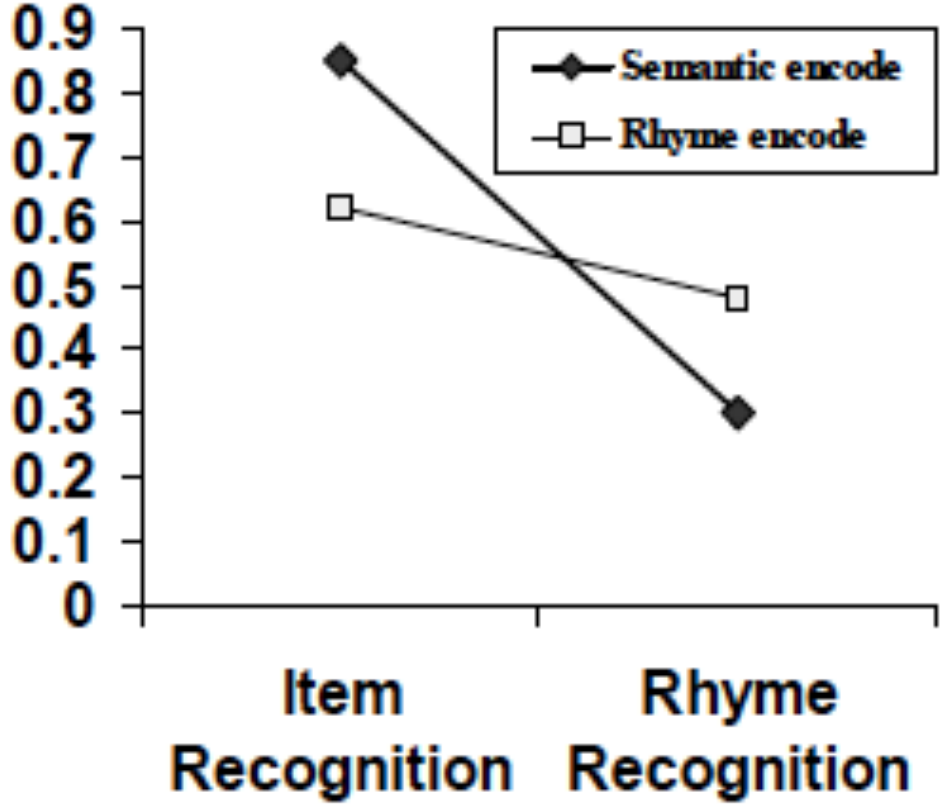
Retrieval

		Study Condition	
		Semantic (meaning)	Rhyme
Test Condition	Item (meaning)	match	mismatch
	Rhyme	mismatch	match

Retrieval

Morris, et al. 1977

- Memory is best when the material is processed in the same way at study as at test
  - Transfer Appropriate Processing



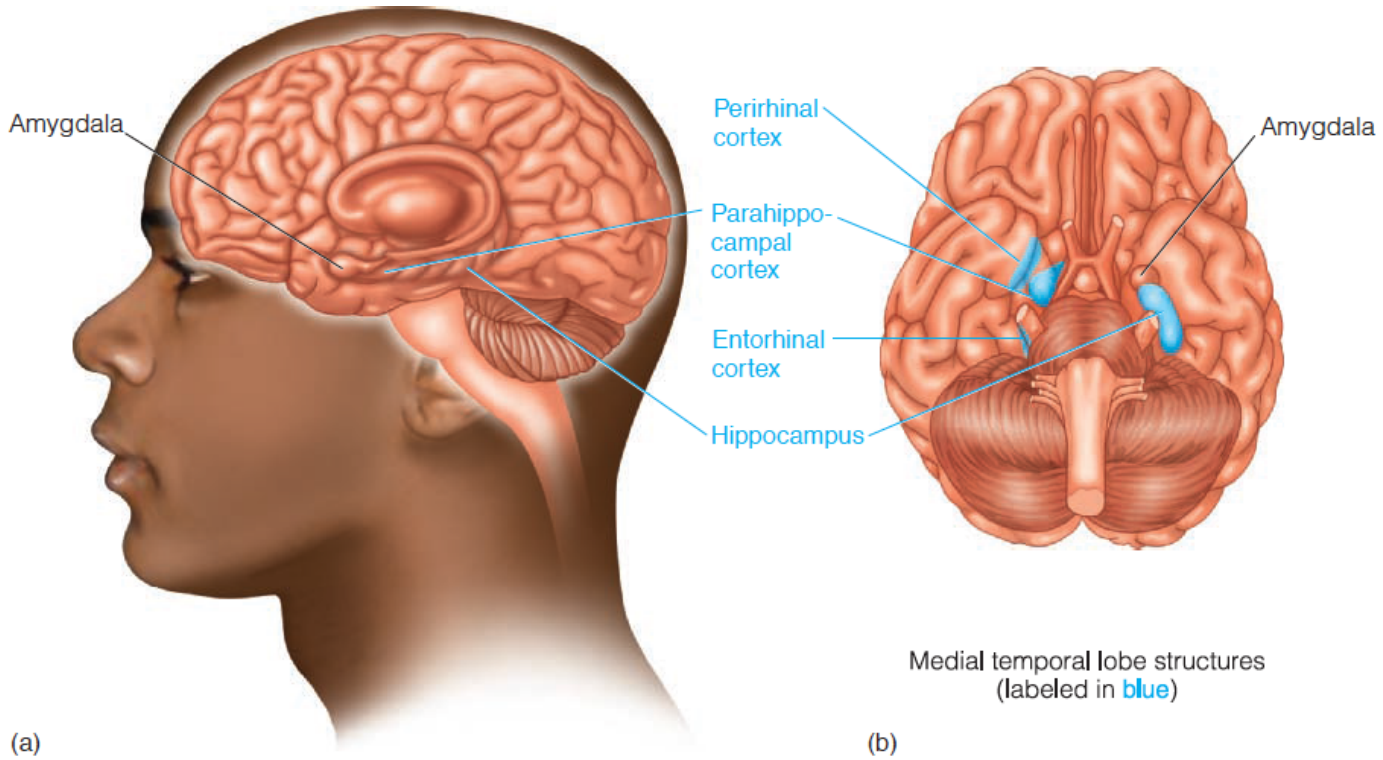
Memory and the brain

- Neurons can learn
  - **Long-term potentiation (LTP)**: enhanced firing after repeated stimulation

- Evidence that experiences can cause changes at the synapse
  - Memories cause changes in many thousands of synapses
  - Memories are probably represented by the firing of this pattern of neurons
  - Distributed coding (or distributed neural representations)

Memory and the brain

- Medial Temporal Lobe is important for memory
- Amygdala is important for emotional memory

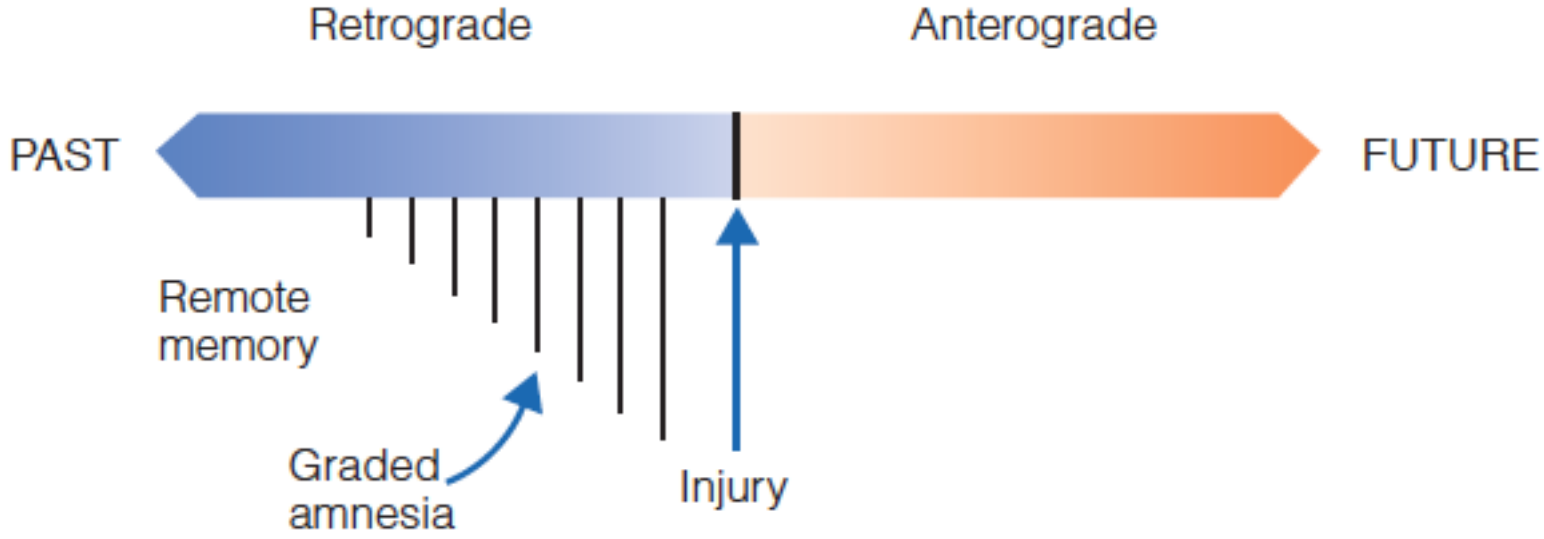


● **FIGURE 7.17** (a) Side view of the brain and (b) underside of the brain, showing the amygdala and structures in the medial temporal lobe (perirhinal cortex, parahippocampal cortex, entorhinal cortex, and hippocampus).

Memory and the brain

The process of consolidation

- The process that transforms new memories from a fragile state to a more permanent state
- Graded amnesia provides some evidence that new memories are fragile



Memory and the brain

The process of consolidation

- Synaptic consolidation
  - Changes at the level of the synapse
  - Occurs over the course of minutes
- Systems consolidation
  - Gradual reorganization of circuits within brain regions
  - Can last weeks, months, or even years

Memory and the brain

The "standard model of consolidation"

- Incoming information activates a number of areas distributed across the cortex
- **Before consolidation,** these cortical areas are not yet connected and rely on the hippocampus to coordinate them
- **After consolidation**, the cortical connections have been made and no longer require the hippocampus
  - Retrieval of recent (unconsolidated) memories require the hippocampus for retrieval
  - Retrieval of remote (consolidated) memories do not require the hippocampus

Memory and the brain

The "standard model of consolidation"

- A major mechanism of consolidation is **reactivation**
  - The hippocampus replays the neural activity associated with a memory
  - This "replaying" results in the formation of connections in the cortical areas
  - Reactivation is thought to occur when we sleep or during relaxed wakefulness
  - Reactivation can be enhanced by conscious rehearsing of a memory

Putting it all together now…

Improving your memory for course material:

- Improving Encoding:
  - Create Connections
  - Active Creation
  - Organization
- Improving Retrieval
  - Match study and testing contexts
  - Match study processing with test processing
    - Transfer Appropriate Processing

Beware

Avoid ”Illusions of familiarity”

- Rereading results in greater fluency (becomes easier each time) which creates an illusion of learning
- Rereading can create a **familiarity effect**
  - We misinterpret this familiarity as long-term learning

Beware

Beware the "you don't know me" effect

- "Those experiments are neat but.. I'm different and cramming works for me"

- Personal studying strategies we have used for a long time might be easy for us, but may not necessarily be the best strategies
  - Because they are well-practiced they may seem effective (fluency, familiarity)
  - New strategies might be harder, and take longer, which might give the impression that they are ineffective