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Kanpur

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National Program on Technology Enhanced Learning (NPTEL)

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Course Title:

Basic Cognitive Processes

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Lecture 34: Memory - VI

Long Term Memory Encoding & Retrieval

Making Memories?

- How do you make a memory?

STUDENT #1: The main technique I use to study is to make up a story in my mind, basically a fake memory, the type a person would use to create an effective lie, in order to remember material. An example of this strategy is how I studied for our first cognitive psych exam this semester. “Jo changed his name to Hermann Helmholtz today. Jo has always been an odd one. He always infers things are there that aren’t. Like the time he liked that girl Amygdala. Speaking of Amygdala, she was an emotional girl.” When I tell this story to myself I create an image, much like a memory to associate with what I am trying to remember. That way when I take the test an entire sequence of events is recalled so that I am better able to remember the information. (Elizabeth Eowyn Waibel, University of Wisconsin)

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (p.172)

STUDENT #2: I like to go to class early and study in the classroom. To remember, I need to take notes from the book as I read. For certain harder classes, I remember better if I do this before class. Then during class I just add to my previous notes. This lets me listen more during class instead of being busy writing.... I like to start conversations with my parents or friends about what I've learned in class. They have usually learned something about it too, and remind me of details I may have forgotten. (Kristin Eddinger, Florida Atlantic University)

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (p.172)

STUDENT #3: A technique I've used has been to find someone unsuspecting, perhaps a friend or family member, and teach them what I've learnt. I did this to a mate about 5 years ago, taught him about the structure of the tooth. To this day he remembers it and always reminds me of the time I jumped him with this "random" information! (Brigitte Dunbar, Massey University, Auckland, New Zealand)

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (p.172)

STUDENT #4: My tactic is to go through my textbook (and lecture notes) and to create a sort of “tabbed” set of notes, where sub-concepts are tabbed underneath larger concepts. This follows the organization of textbooks to a degree ... so I get something like Declarative Memory–Episodic–About events in our lives–Semantic–About facts.... After reading a few paragraphs, I write down what I learned, but first I have to figure out the major and minor points. But the most important part about this is it acts as a way to test myself. I can just throw a piece of paper over my notes and slowly move it down the page, and I try to recall what is “inside” a certain heading (and explain it to myself), and then I go down it line by line to check (if I missed a sub-heading, I try to recall what’s under it, if anything). (Taylor Murphy, University of Alberta)

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (p.172)

STUDENT #5: I read each chapter, take notes (sometimes word for word, or by shorthand) on my computer where I can organize them in a way that makes sense to me. Finally, I make note cards and study these. (Natalie Tyler, Georgia State University)

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (p.172)

Rehearsal

- Getting information into memory needs rehearsal - i.e. the process of repeating information over & over.
- *maintenance rehearsal*: plainly repeating information to remember without analysing it for meaning or possible connections is called maintenance rehearsal.
- *elaborative rehearsal*: the more effective way of transferring information into LTM, involves thinking about the meaning of an item or attempting to connect the new information with prior knowledge.

- **Levels of Processing Theory:** Craik & Lockhart proposed the idea of *levels of processing* in 1972; according to which memory depends on how information is encoded, with “deeper” processing resulting in better encoding & retrieval than “shallow” processing.
- The basics: Acc. to the levels of processing approach, depth of processing is determined by the nature of the task during encoding.

DEMONSTRATION Remembering Lists

Part 1. Cover the list below and then uncover each word one by one. Your task is to count the number of vowels in each word and then go right on to the next one. Once you get to the end of the list, cover it and follow the instructions at the end of the list.

chair
mathematics
elephant
lamp
car
elevator
thoughtful
cactus

Instructions: Count backward by 3s from 100. When you get to 76, write down the words you remember. Do that now.

Excerpt: Goldstein (2010). *Cognitive Psychology: Connecting Mind, Research & Everyday Experience*. Wadsworth Publishing. (Demo., p.174)

Part 2. Cover the list below and uncover each word one by one as you did in the previous part. This time, visualize how useful the item might be if you were stranded on an uninhabited island. When you get to the end of the list, follow the instructions.

umbrella
exercise
forgiveness
rock
hamburger
sunlight
coffee
bottle

Instructions: Count backward by 3s from 99. When you reach 75, write down the words you remember. Do that now.

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. (Demo, p.174)

- You would have noticed that the second process results in better memory.
- Craik & Lockhart's levels - of - processing theory states that memory depends on the depth of processing that an item receives.
- Shallow Processing involves little attention to meaning. Shallow processing occurs when attention is focused on physical features, such as whether a word is printed in lowercase or capital letters, or the number of vowels in a word etc.
- Deep Processing involves close attention, focusing on an item's meaning and relating it to something else (that you already know).

METHOD Varying Depth of Processing

The procedure for the Craik and Tulving experiment is diagrammed in ● Figure 7.1a. A question was presented, followed by a word, and then the participant responded. Shallow processing was achieved by asking questions about the word's physical characteristics; deeper processing was achieved by asking about the word's sound; and the deepest processing was achieved by a task that involved the word's meaning. The following examples are similar to those used in Craik and Tulving's experiment.

1. Shallow processing: A question about physical features of the word

Question: Is the word printed in capital letters?

Word: *bird*

2. Deeper processing: A question about rhyming

Question: Does the word rhyme with *train*?

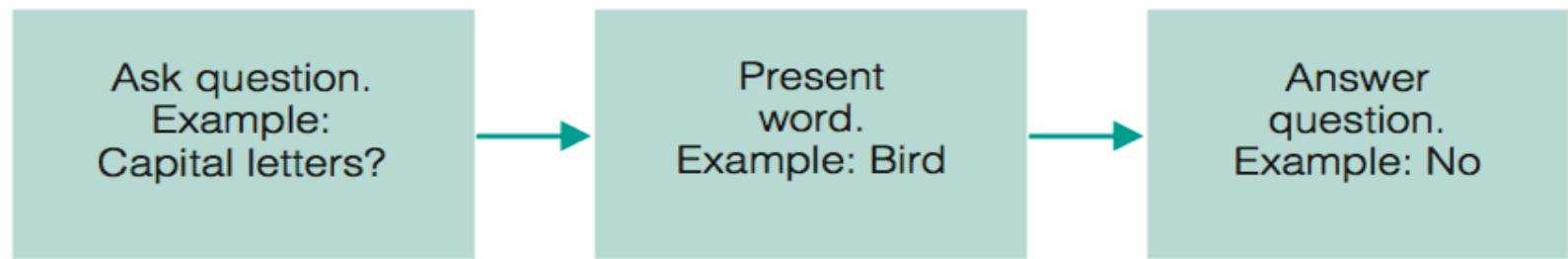
Word: *pain*

3. Deepest processing: A fill-in-the-blanks question

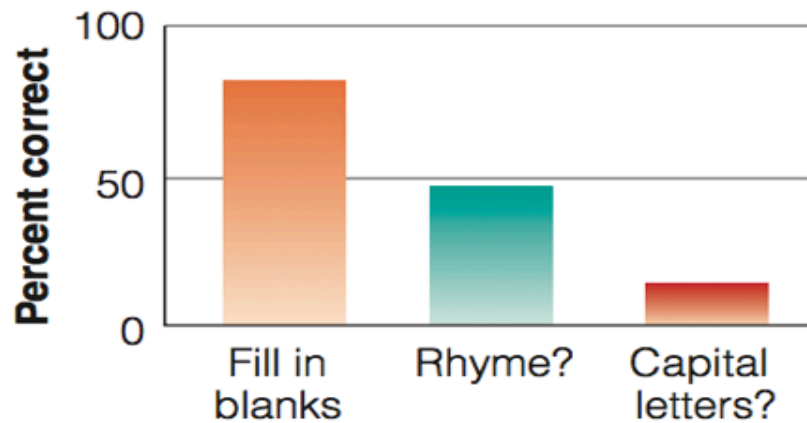
Question: Does the word fit into the sentence "He saw a _____ on the street"?

Word: *car*

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. Wadsworth Publishing. (Demo, p.175)



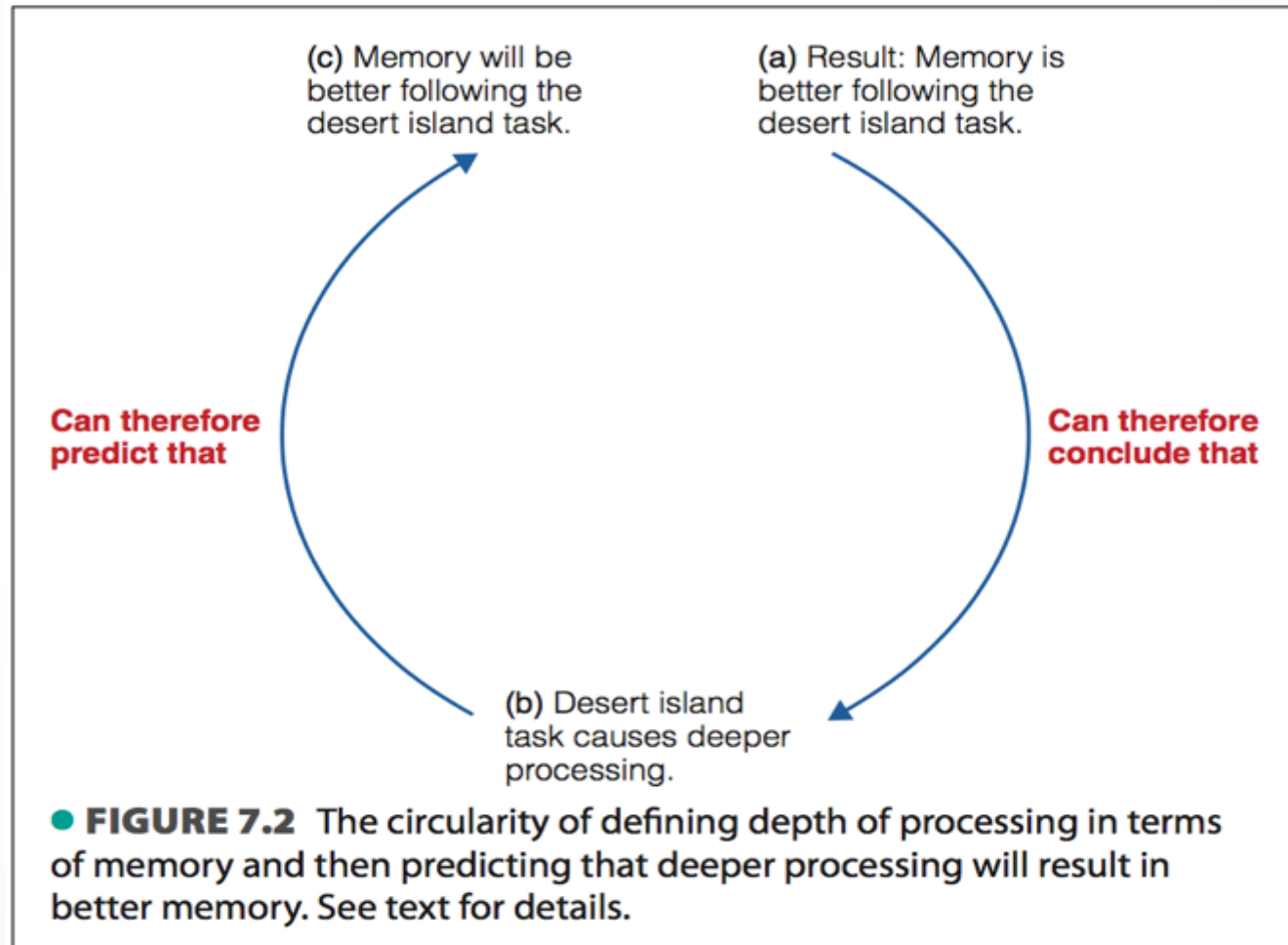
(a)



(b)

● **FIGURE 7.1** (a) Sequence of events in Craik and Tulving's (1975) experiment. (b) Results of this experiment. Deeper processing (fill-in-the-blanks question) is associated with better memory.

- The difficulty: It's difficult to decide what leads to a particular depth of processing.



Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. Wadsworth Publishing. (Fig. 7.1, p.176)

Moving further: Encoding & Retrieval

- let us test how encoding influences retrieval, by varying types of encoding and how retrieval is affected.

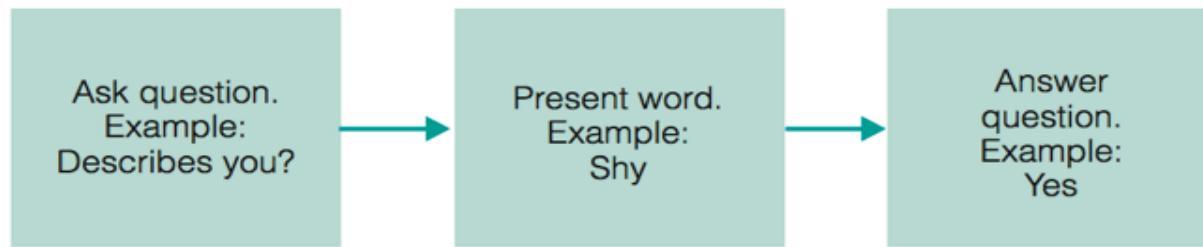
- **Placing words in a complex sentence:** How to remember the word *chicken*?
 - 1. She cooked the chicken.
 - 2. The great bird swooped down and carried off the struggling chicken.
- Craik & Tulving (1975) found that memory for a word is much better when the word is presented in a complex sentence.
 - Apparently, most of the participants in Craik & Tulving's experiment found the giant bird sentence to be more memorable.

- **Forming Visual Images:** Bower & Winzenz (1970) decided to test whether using visual imagery - “images in the head” that connect words visually - can create connections that enhance memory.
- They used a procedure called paired - associate learning, in which a list of word pairs is presented. Later, the first word of each pair is [resented, and the participant’s task is to remember the word it was paired with.

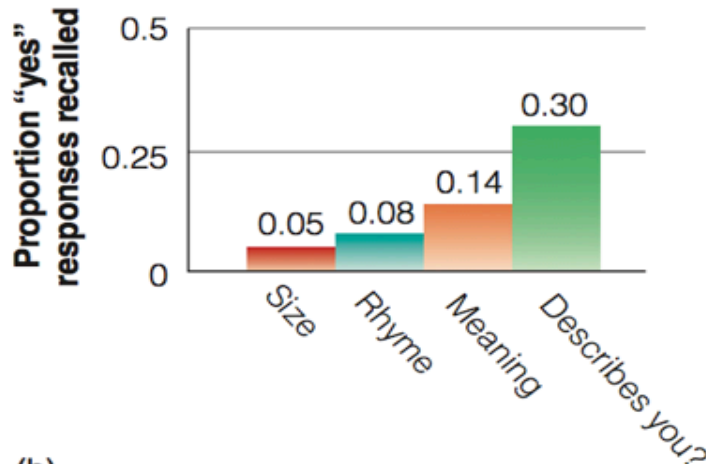
- Bower & Winzenz presented a list of 15 pairs of nouns, such as *boat-tree*, to participants for 5 seconds each.
- One group was told to silently repeat the pairs as they were presented & another group was told to form a mental picture in which the two items were interacting.
- Which group remembered the words better?

- **Linking Words to Yourself:** An example of how memory is improved by encoding is the *self - reference effect*, i.e. memory is better if you can relate the word/information to be learned to yourself.
- Rogers & coworkers (1977) demonstrated this by using the same procedure Craik & Tulving had used in their depth - of - processing experiment.

- Here are examples of the four types of questions:
 - 1. Physical characteristics of word “Printed in small case?”
Word: *happy*
 - 2. Rhyming
“Rhymes with *happy*?” Word: *snappy*
 - 3. Meaning
“Means the same as *happy*?” Word: *upbeat*
 - 4. Self-reference “Describes you?” Word: *happy*



(a)



(b)

● **FIGURE 7.4** (a) Sequence of events in Rogers et al.'s (1979) self-reference experiment. This is the same as the design of Craik and Tulving's (1975) experiment shown in Figure 7.1, but some of the questions refer to the person being tested. (b) Results of the experiment. (Source: T. B. Rogers, N. A. Kuiper, & W. S. Kirker, "Self-Reference and the Encoding of Personal Information," *Journal of Personality and Social Psychology*, 35, 677–688, 1977.)

- **Generating Information:** Generating material yourself, rather than passively receiving, enhances learning & attention.
- Slameka & Graf (1978) demonstrated this effect, called the *generation effect*, by having participants study a list of word pairs in two different ways:
- *Read* group: Read these pairs of related words.-> king - crown; horse - saddle; lamp - shade etc.

- *Generate* group: Fill in the blank with a word that is related to the first word. king - cr; horse -sa; lamp - sh etc.
- After either reading or generating the list of word pairs, they were presented with the first word in each pair and were told to indicate the word that went with it.

- **Organising Information:** The memory system also uses organisation to access information.

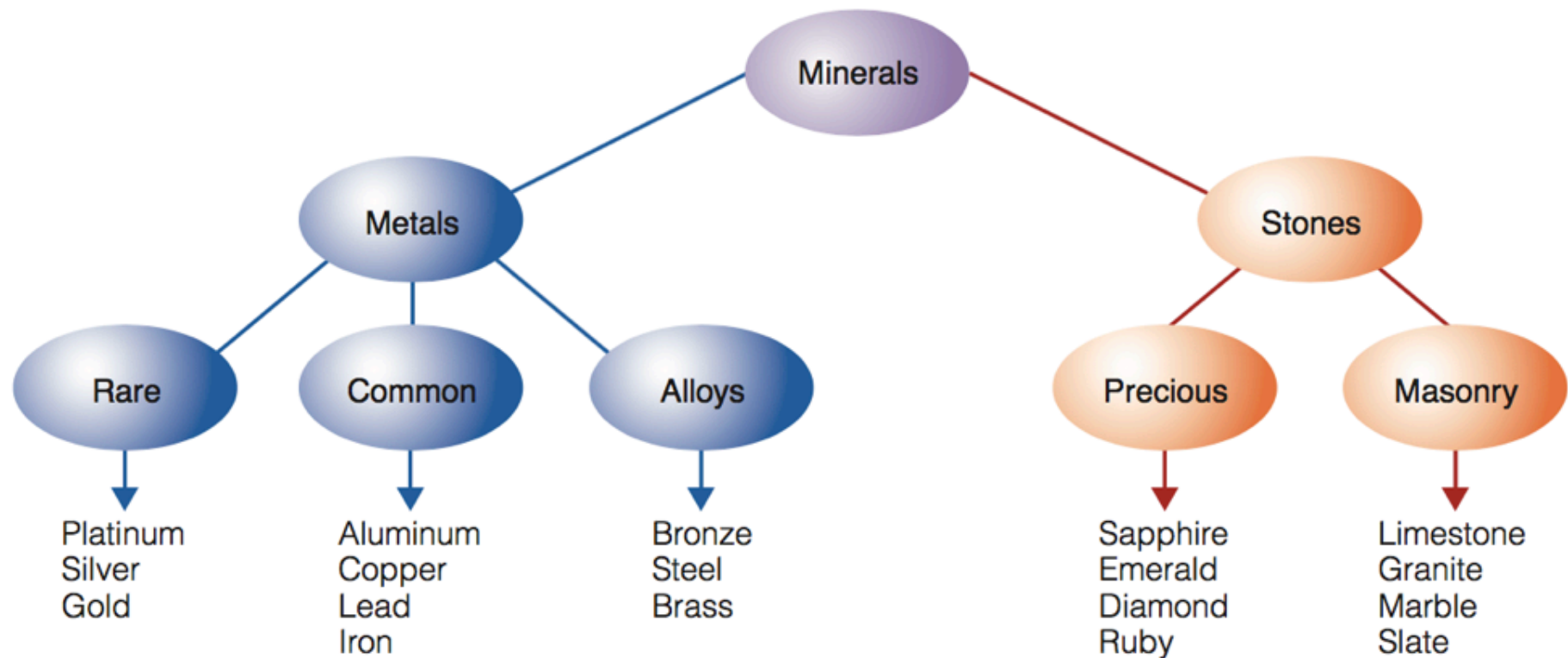
DEMONSTRATION Reading a List

Get paper and pen ready. Read the following words, then cover them and write down as many as you can.

apple, desk, shoe, sofa, plum, chair, cherry, coat, lamp, pants, grape, hat, melon, table, gloves

STOP! Do the demonstration now, before reading further.

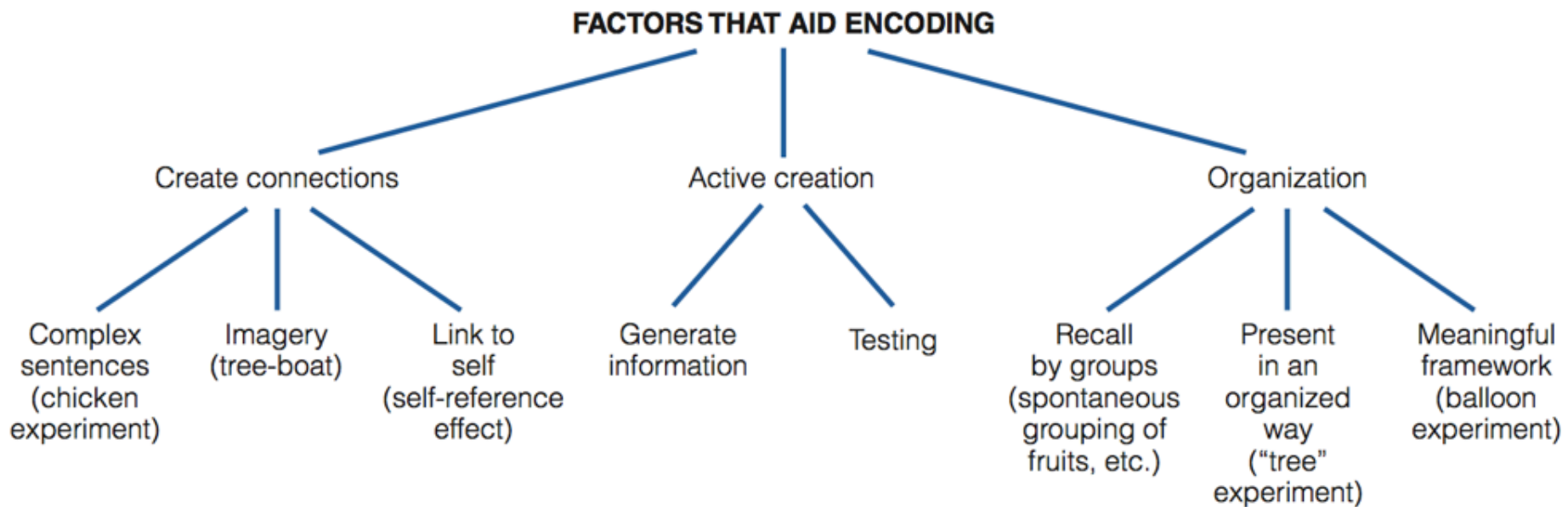
- The words are recalled better if they are grouped together.
- One reason is that remembering words by a category serves as retrieval cue for other words in that category.
- Bower & coworkers (1969) tested for memory of words which were presented in an organised manner from the beginning, during encoding. In from of an “organisational tree”.



● **FIGURE 7.5** The “organizational tree” for minerals used in Bower et al.’s (1969) experiment on the effect of organization on memory. (Source: G. H. Bower et al., “Hierarchical Retrieval Schemes in Recall of Categorized Word Lists,” *Journal of Verbal Learning and Verbal Behavior*, 8, Figure 1, 323–343. Copyright © 1969 Elsevier Ltd. Republished with permission.)

- One group of participants studied four separate trees for mineral, animals, clothing, & transportation for 1 minute each and were then asked to recall as many words as they could from all four trees.
- In the recall test, participants tended to organise their responses in the same way as the trees were organised.
- Participants average an overall 73 words from all four trees.

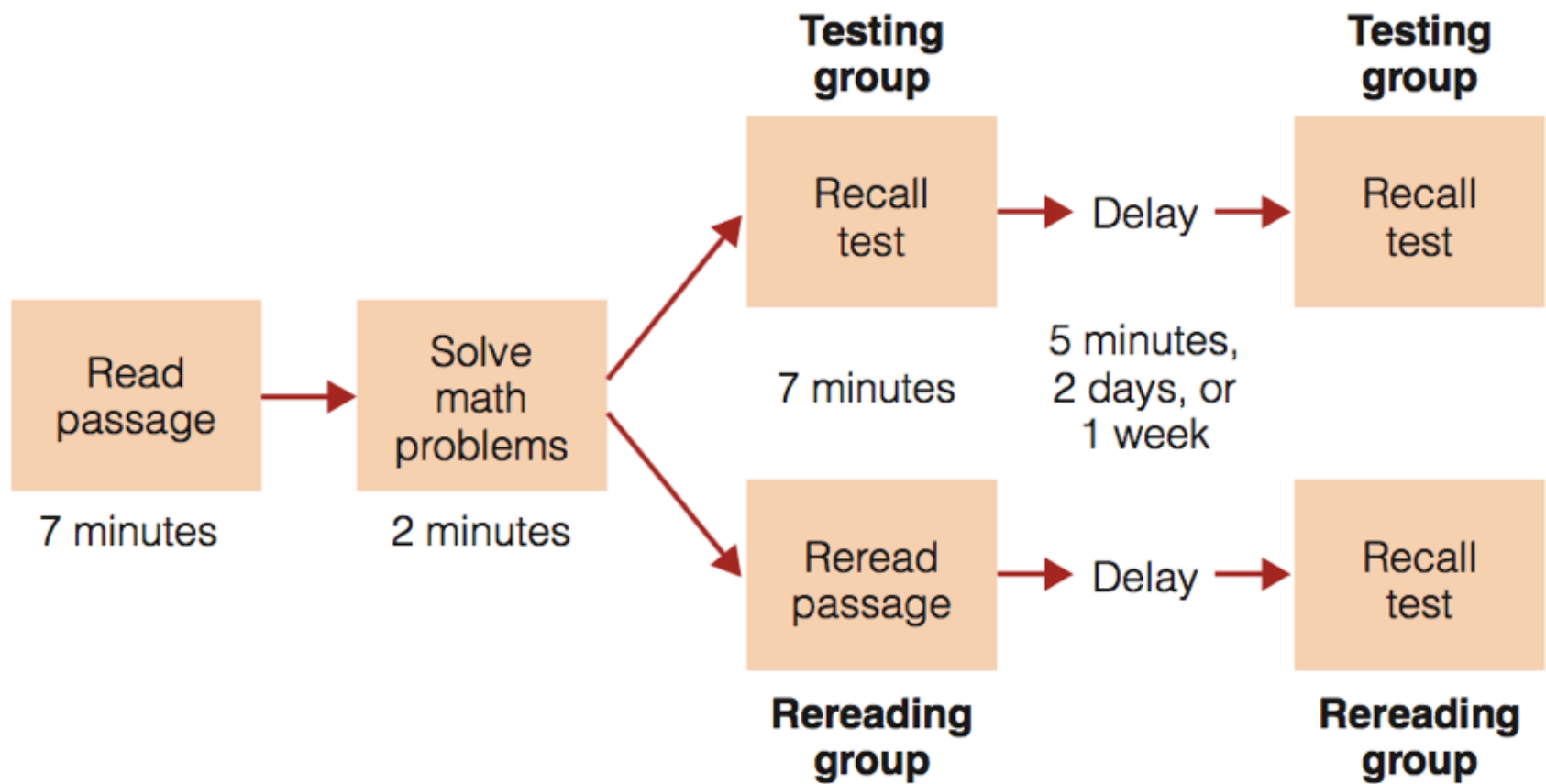
- Another group of participants also saw four trees, but the words were randomised such that each tree contained a random assortment of minerals, animals, clothing and transportation.
- These participants were able to remember only 21 words from all four trees.
- Thus organising material to be remembered results in substantially better recall.



● **FIGURE 7.6** The organizational tree for some of the material about encoding presented in this section of the chapter.

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. Wadsworth Publishing. (Fig. 7.6, p.179)

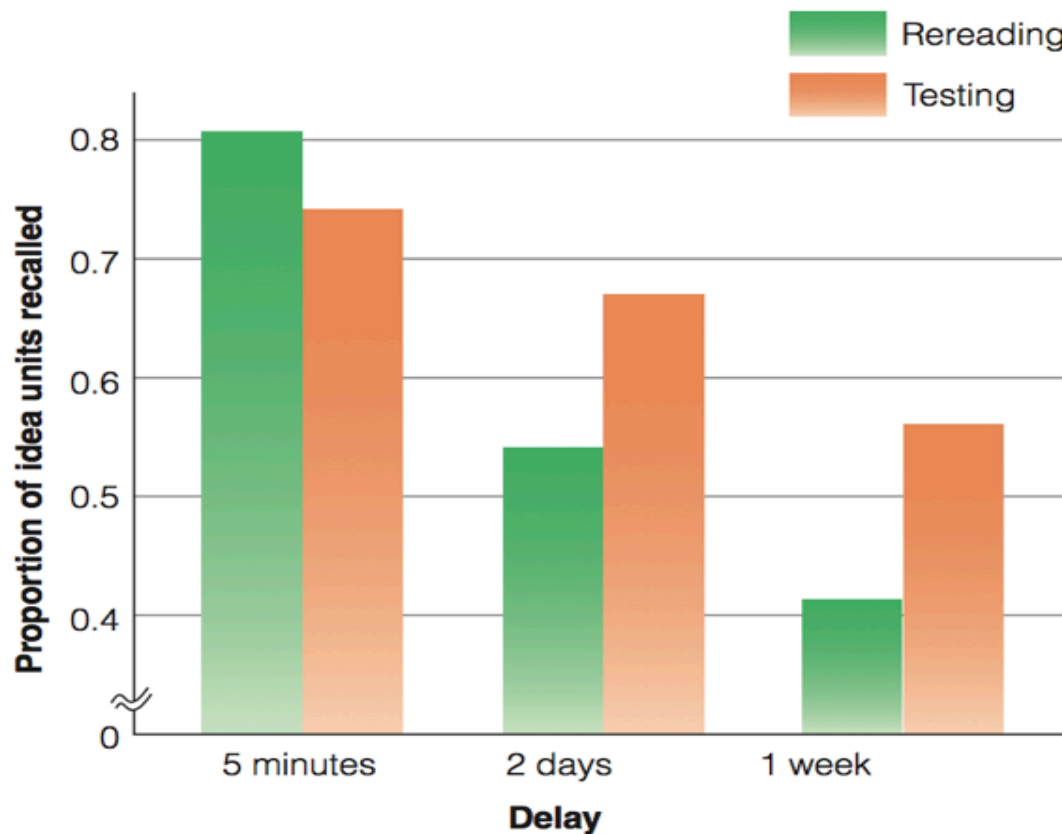
- **Testing:** Recent research shows that being tested on the material being learnt results in better recall than rereading the material.
- Roediger & Karpicke (2006) demonstrated the advantages of testing.



● **FIGURE 7.8** Design of the Roediger and Karpicke (2006) “testing effect” experiment.

- In the first phase of the experiment, college students read prose passages for 7 minutes followed by a 2 - minute break during which they solved math problems.
- Then one group took a 7 minute recall test in which they were asked to write down as much of the passage as they could remember, in no particular order.
- The other group were given 7 minutes to re-read the material.

- In the second phase of the experiment, which occurred after a delay of either 5 minutes, 2 days, or 1 week participants were given the recall test in which they wrote down what they remembered from the passage.
- The results show that there was little difference between the two groups after 5 minute delay; but the testing group was much better in performance after 2 day & 1 week delays. This is the **testing effect**.



● **FIGURE 7.9** Results of the Roediger and Karpicke (2006) experiment. Note that at longer times after learning, the performance of the testing group is better than the performance of the rereading group. (Source: H. L. Roediger & J. D. Karpicke, "Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention," *Psychological Science*, 17, 249–255, 2006. Reprinted by permission of John Wiley & Sons, Inc.)

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. Wadsworth Publishing. (Fig. 7.9, p.181)

To Sum Up

TABLE 7.1 Encoding Procedures That Affect Retrieval

Condition	Experiment/Result
Word in complex sentence	Better memory for a word ("chicken") used in a complex sentence (more detailed description of the word)
Forming visual image	Pairs of words remembered better if images formed (compared to just reading word pairs)
Linking to self	Words associated with self are remembered better (self-reference effect)
Generating information	Memory better if second word of a word pair is generated by the person, compared to just being presented with the word (generation effect)
Organizing information	Studying information that is organized, as in a "tree," results in better memory; presenting information so organization is difficult ("balloon" story) results in poor memory
Testing	Testing following learning results in better memory than rereading material after learning (testing effect)

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. Wadsworth Publishing. (Table 7.1, p.181)

References

- Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing*. 4th ed.