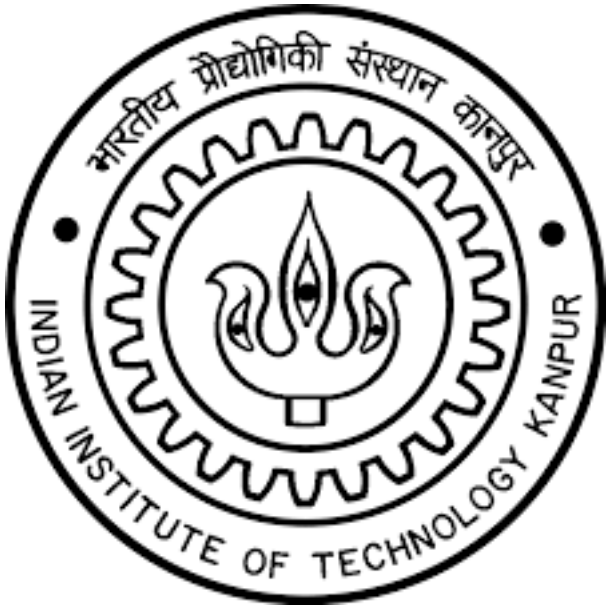

Indian Institute of Technology
Kanpur

In Collaboration
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National Program on Technology Enhanced Learning (NPTEL)

Presents

Course Title:

Basic Cognitive Processes

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Lecture 32: Memory - IV

What is Long – Term Memory?

- it can be a memory of anything from a few minutes past to a few decades old…
- it can both, be a memory of events or episodes, i.e. declarative memory or
- it can be memory of skills learnt over a period of time, i.e. procedural memory.

"What year is this, Mr. G?" I asked, concealing my perplexity under a casual manner.

"Forty-five, man. What do you mean?" He went on, "We've won the war, FDR's dead, Truman's at the helm. There are great times ahead."

"And you, Jimmy, how old would you be?" Oddly, uncertainly, he hesitated a moment, as if engaged in calculation. "Why, I guess I'm nineteen, Doc. I'll be twenty next birthday." Looking at the gray-haired man before me, I had an impulse for which I have never forgiven myself—it was, or would have been, the height of cruelty had there been any possibility of Jimmy's remembering it.

"Here," I said, and thrust a mirror toward him. "Look in the mirror and tell me what you see. Is that a nineteen-year-old looking out from the mirror?"

He suddenly turned ashen and gripped the sides of the chair. "Jesus Christ," he whispered. "Christ, what's going on? What's happened to me? Is this a nightmare? Am I crazy? Is this a joke?"—and he became frantic, panicky.

"It's okay, Jim," I said soothingly. "It's just a mistake. Nothing to worry about. Hey!" I took him to the window. "Isn't this a lovely spring day. See the kids there playing baseball?" He regained his color and started to smile, and I stole away, taking the hateful mirror with me.

Two minutes later I reentered the room. Jimmy was still standing by the window, gazing with pleasure at the kids playing baseball below. He wheeled around as I opened the door, and his face assumed a cheery expression.

"Hiya, Doc!" he said. "Nice morning! You want to talk to me—do I take this chair here?" There was no sign of recognition on his frank, open face.

"Haven't we met before, Mr. G?" I said casually.

"No, I can't say we have. Quite a beard you got there. I wouldn't forget you, Doc!"

Excerpt from: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (p. 148).

"You remember telling me about your childhood, growing up in Pennsylvania, working as a radio operator in a submarine? And how your brother is engaged to a girl from California?"

"Hey, you're right. But I didn't tell you that. I never met you before in my life. You must have read all about me in my chart."

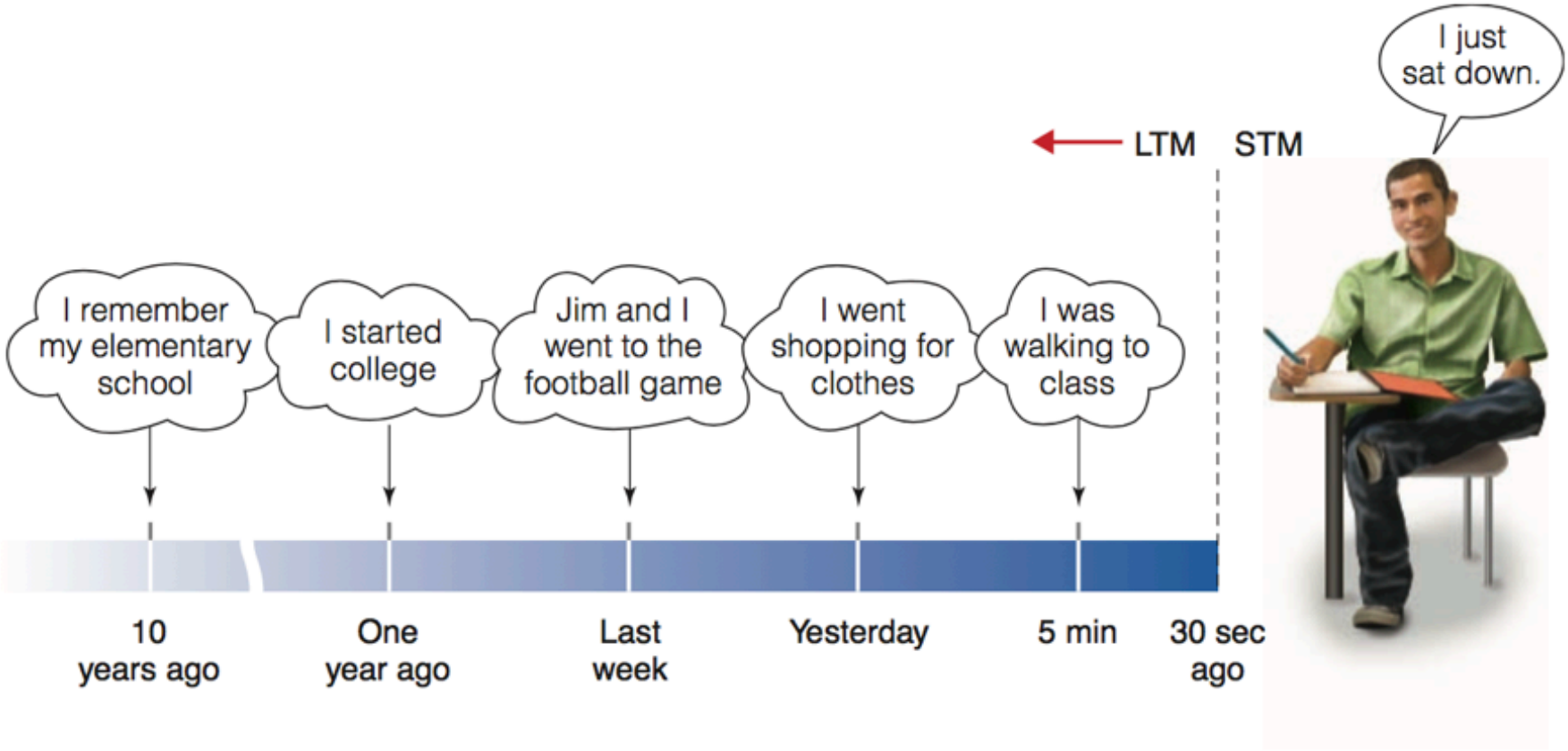
"Okay," I said. "I'll tell you a story. A man went to his doctor complaining of memory lapses. The doctor asked him some routine questions, and then said, 'These lapses. What about them?' 'What lapses?' the patient replied."

"So that's my problem," Jimmy laughed. "I kinda thought it was. I do find myself forgetting things, once in a while things that have just happened. The past is clear, though." (Sacks, 1985, p. 14)

Excerpt from: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (p. 148).

Long - Term Memory Processes

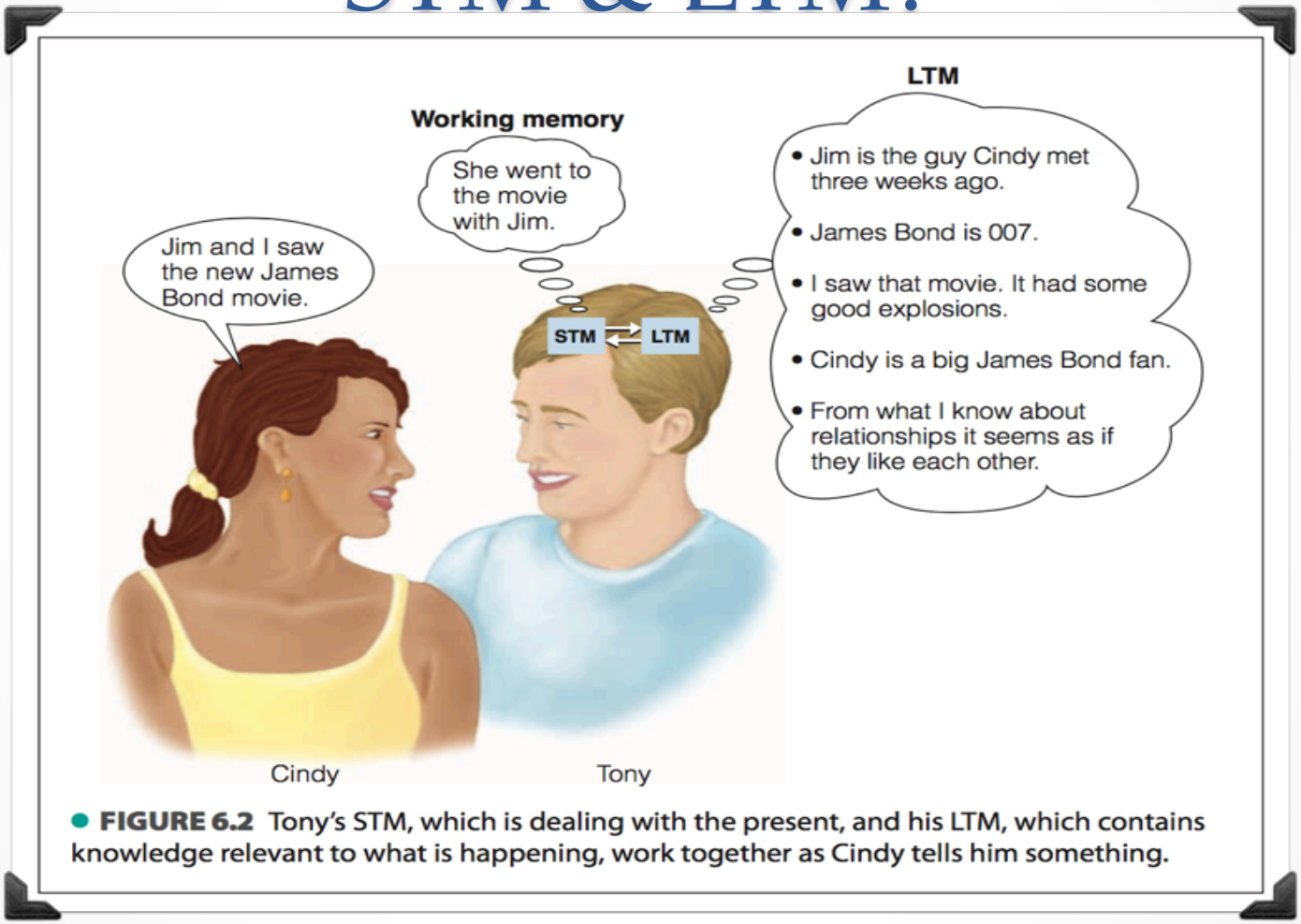
- is the system that is responsible for storing information for long periods of time.
- an archive of information about past events in our lives and knowledge we have learned.
- the span could be huge…



● **FIGURE 6.1** Long-term memory covers a span that stretches from about 30 seconds ago to your earliest memories. Thus, all of this student's memories, except the memory "I just sat down" and anything the student was rehearsing, would be classified as long-term memories.

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Fig. 6.1, p. 149).

What is the difference between STM & LTM?



● **FIGURE 6.2** Tony's STM, which is dealing with the present, and his LTM, which contains knowledge relevant to what is happening, work together as Cindy tells him something.

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Fig. 6.2, p. 150).

- The distinction between STM & LTM was studied in a classic experiment by Murdoch (1962):

DEMONSTRATION Serial Position

Read the stimulus list below (omitting the numbers) to another person at a rate of about one word every 2 seconds. At the end of the list, tell the person to write down all of the words he or she can remember, in any order. This is the recall procedure we introduced in Chapter 5 (page 123).

1. barricade
2. children
3. diet
4. gourd
5. folio
6. meter
7. journey
8. mohair
9. phoenix
10. crossbow
11. doorbell
12. muffler
13. mouse
14. menu
15. airplane

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Demo, p. 151).

- When Murdoch did this experiment on a large number of participants & plotted the percentage recall for each word against the word's position on the list, he obtained a function called the ***serial position curve*.**

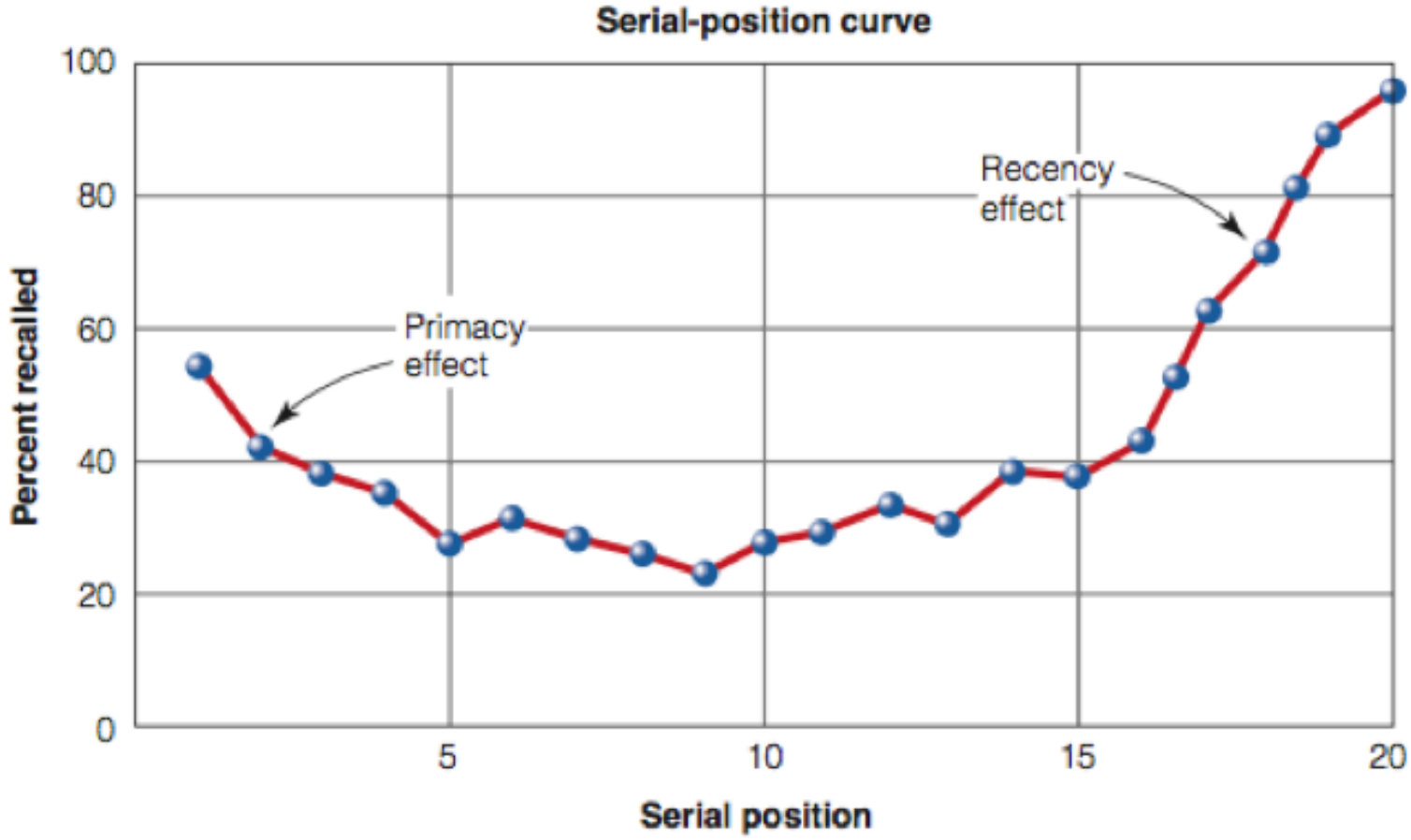


FIGURE 6.3 Serial position curve (Murdoch, 1962). Notice that memory is better for words presented at the beginning of the list (primacy effect) and at the end (recency effect). (Source: B. B. Murdoch, Jr., "The Serial Position Effect in Free Recall," *Journal of Experimental Psychology, 64,* 482–488.)

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Fig. 6.3, p. 152).

- Murdoch's serial position curve indicates that memory is better for words at the beginning of the list & at the end of the list than for words in the middle.

- Superior memory for stimuli presented at the beginning of the sequence is called the ***primacy effect*.**

- a possible explanation of the effect is that the participants had the time to rehearse these words and transfer them to the LTM.

- Acc. to this idea, participants begin rehearsing the first word right after it is presented because no other word is presented yet it receives the person's 100% attention. When the second word is presented, attention is spread over two words & hence less rehearsal is possible.

- The idea of more rehearsal for words presented in the beginning of the list was tested by Dewey Rundus (1971), who derived a serial position curve by presenting a list of 20 words at a rate of 1 word/ 5 seconds & then asking his participants to write down all of the words they could remember.

- the resulting serial position curve, (the red one) demonstrates the same primacy & recency effects as Murdoch's curve.

- But Rundus, added a further twist to his experiment by asking his participants to study the list as it was being presented by repeating the words out loud during the 5 second intervals between words.

- They were not told which words to repeat.

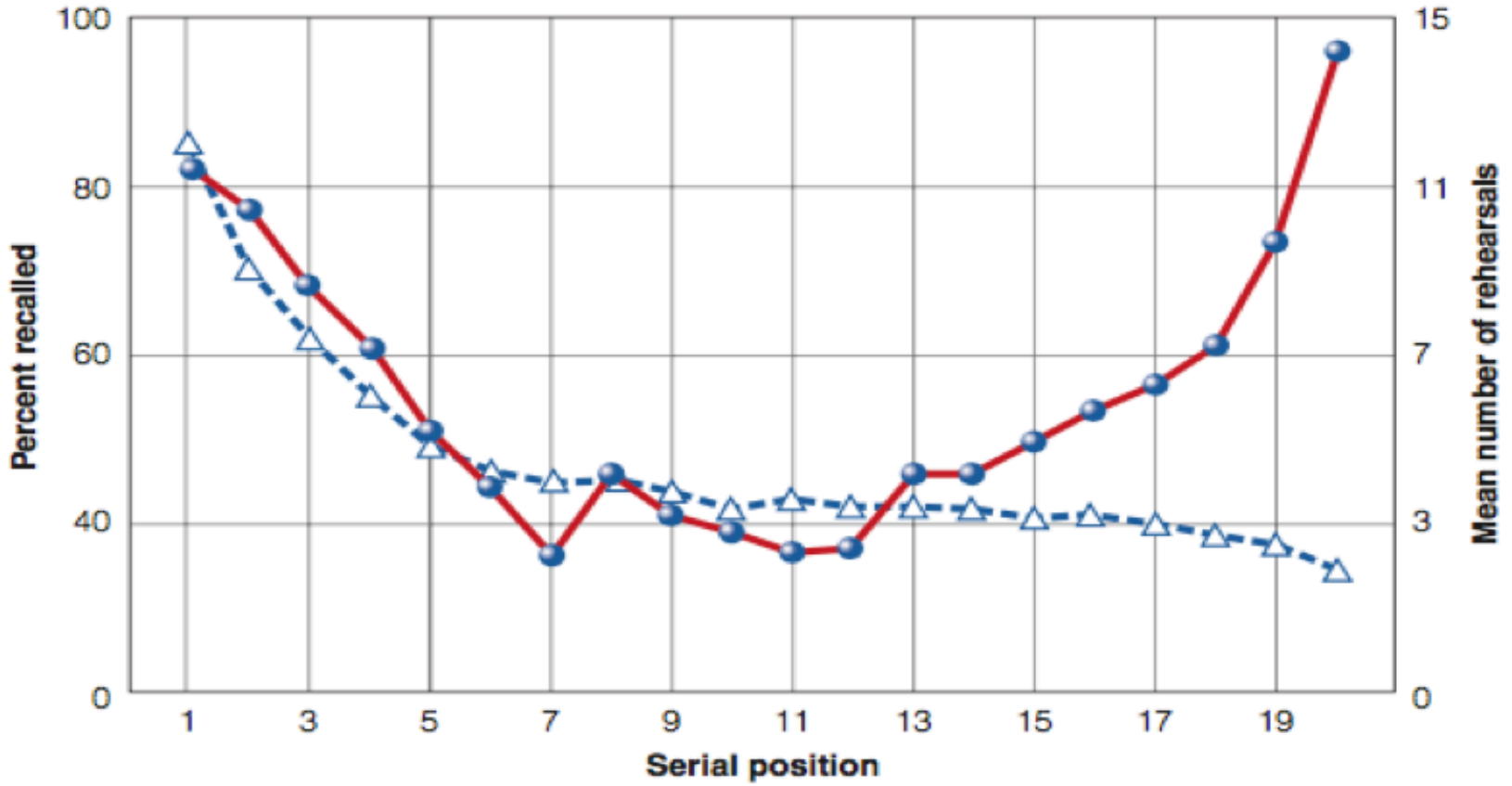


FIGURE 6.4 Results of Rundus's (1971) experiment. The solid red line is the usual serial position curve. The dashed blue line indicates how many times the participant rehearsed (said out loud) each word on the list. Note how closely the rehearsal curve matches the initial part of the serial position curve. (Source: D. Rundus, "Analysis of Rehearsal Processes in Free Recall," *Journal of Experimental Psychology, 89,* 63–77, Figure 1, p. 66. Copyright © 1971 by the American Psychological Association. Reprinted by permission.)

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Fig. 6.4, p. 152).

- the dashed curve, which indicates how many times each word was repeated bears a striking resemblance, to the first half of the serial position curve.

- words presented early in the list were rehearsed more & hence were likely to be remembered better.

- This result supports the idea that the primacy effect is related to the longer rehearsal time available for the earlier words on the list.

- Superior memory for items at the end of a sequence is called the ***recency effect***.

- one possible explanation for the recency effect is that the most recently presented words are still in the STM.

- To test this idea, Glanzer & Cunitz (1966) first derived a serial position curve in the usual way (the red curve); then, in another experiment they measured the curve again after having their participants count backwards for 30 seconds right after hearing the last words of the list.

- This counting prevented rehearsal & allowed time for information to be lost out of the STM: the delay caused by counting eliminated the recency effect. Glanzer & Cunitz therefore concluded that the recency effect is due to storage of recently presented items in STM.

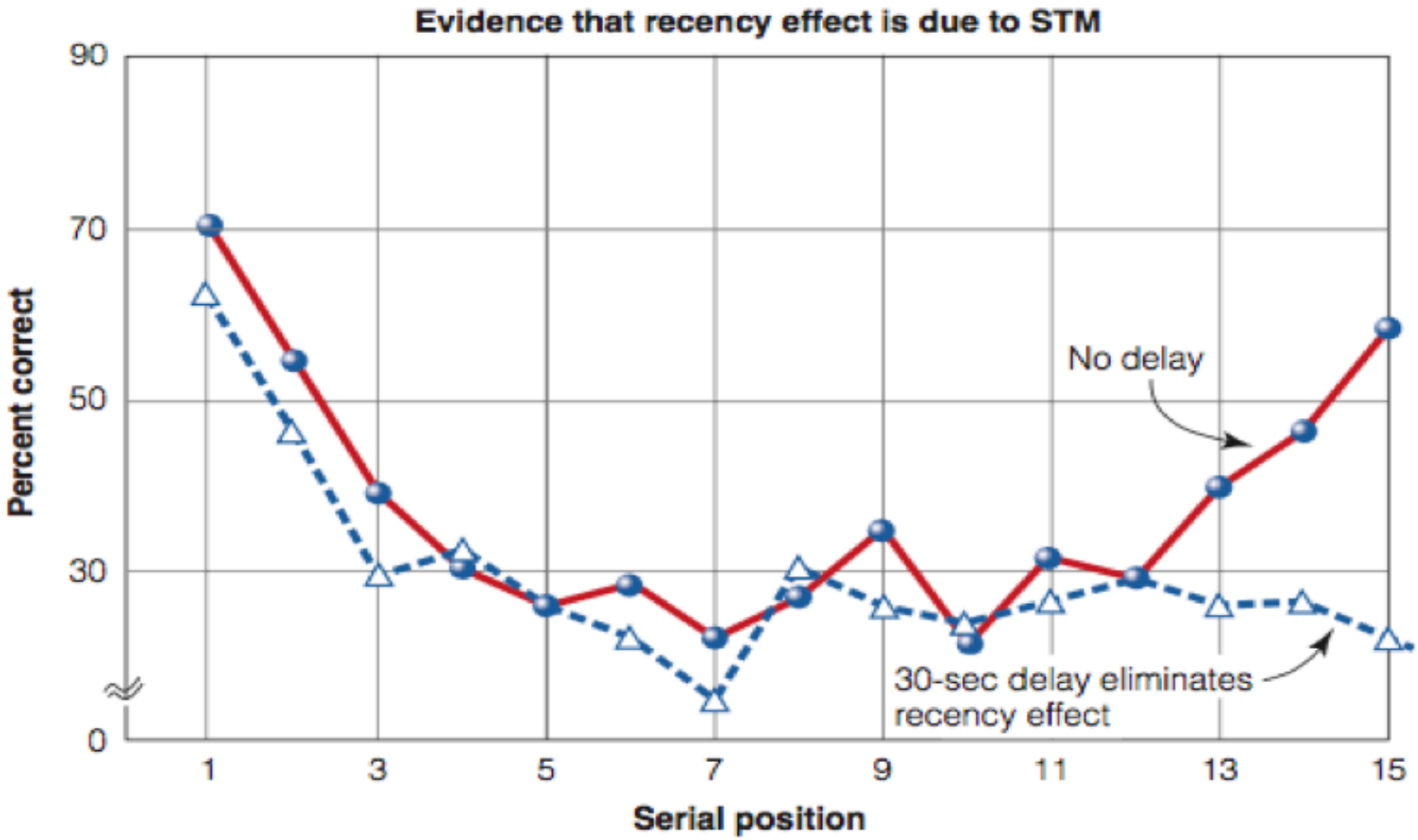


FIGURE 6.5 Result of Glanzer and Cunitz's (1966) experiment. The serial position curve shows a normal recency effect when the memory test is immediate (solid red line), but no recency effect if the memory test is delayed for 30 seconds (dashed blue line).

(Source: M. Glanzer & A. R. Cunitz, "Two Storage Mechanisms in Free Recall," *Journal of Verbal learning and Verbal Behavior, 5,* Figures 1 & 2, 351–360. Copyright © 1966 Elsevier Ltd. Republished with permission.)

Image: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (Fig. 6.5, p. 153).

Coding in Long – Term Memory

- All three types of coding viz. auditory, visual & semantic can take place for the LTM too.

- However, for the LTM, semantic coding is the *predominant* type of coding.

- Semantic coding is illustrated by the kind of errors that people make in the tasks that involve the LTM. for e.g. misremembering the word *tree* as *bush* would indicate that the meaning of the word tree (rather than its visual appearance or the sound of the word *tree*) is what was registered in the LTM.

- A study by Sachs (1967) demonstrated the importance of meaning in LTM. Sachs had participants listed to a tape recording of a message and then measured their recognition memory to determine whether they remembered the exact wording of the sentences in the passage or the general meaning of the passage.

Recognition memory is the identification of a stimulus that was encountered earlier. The procedure for measuring recognition memory is to present a stimulus during a study period and later to present the same stimulus plus others that were not presented. For example, in the study period a list of words might be presented that includes the word *house*. Later, in the test, a series of words is presented that includes *house* plus some other words that were not presented, such as *table* and *money*. The participant's task is to answer "Yes" if the word was presented previously (the word *house* in this example) and "No" if it wasn't presented (the words *table* and *money*). Notice how this method is different from testing for *recall* (see Method: Recall, Chapter 5, page 123). In a recall test, the person must *produce* the item to be recalled. An example of a recall test is a fill-in-the-blanks exam question. In contrast, an example of recognition is a multiple-choice exam, in which the task is to pick the correct answer from a number of alternatives. The way Sachs applied recognition to the study of coding in long-term memory is illustrated in the next demonstration.

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (p. 154).

Read the following passage:

There is an interesting story about the telescope. In Holland, a man named Lippershey was an eyeglass maker. One day his children were playing with some lenses. They discovered that things seemed very close if two lenses were held about a foot apart. Lippershey began experimenting, and his "spyglass" attracted much attention. He sent a letter about it to Galileo, the great Italian scientist. Galileo at once realized the importance of the discovery and set about building an instrument of his own.

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (p. 154).

Now cover up the passage and indicate which of the following sentences is identical to a sentence in the passage and which sentences are changed.

1. He sent a letter about it to Galileo, the great Italian scientist.
2. Galileo, the great Italian scientist, sent him a letter about it.
3. A letter about it was sent to Galileo, the great Italian scientist.
4. He sent Galileo, the great Italian scientist, a letter about it.

Excerpt: Goldstein (2010). Cognitive Psychology: Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* (p. 154).

- Sentence 1 is the only one that is identical to one in the passage; however a number of people identified 3 & 4 as matching one on the passage, even though the wording was different.

- These participants apparently remembered the sentence's meaning but not its exact wording.

Long – Term Memory in the Brain

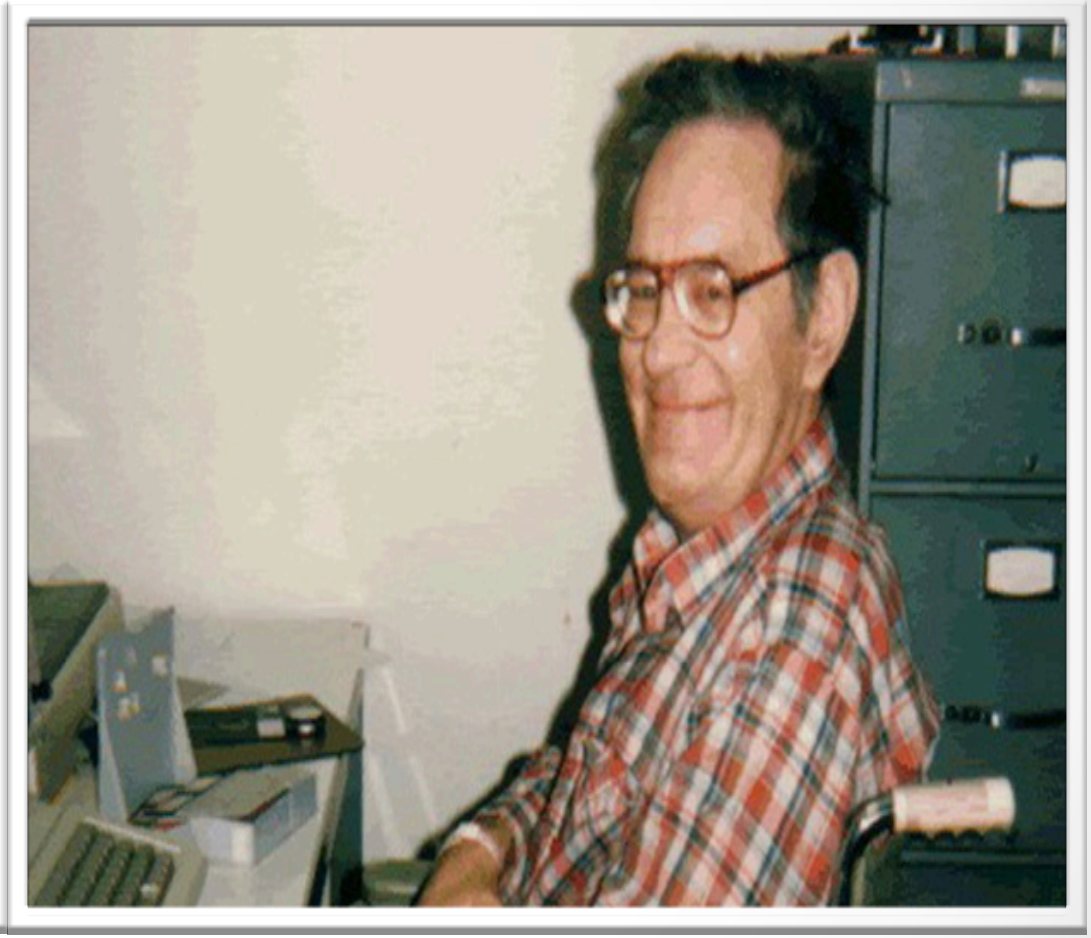
- Neuropsychological Studies: the method of dissociations has been used in memory research to differentiate between STM & LTM by studying people with brain damage that has affected one of these functions while sparing the other.

- there are patients with double dissociations between STM & LTM.

- The operation eliminated H.M.'s seizures, but unfortunately also eliminated his ability to form new memories (LTMs).

- H.M.'s unfortunate situtaipm occurred because in 1953, the surgeons did not realise that the hippocampus is crucial for the formation of new LTMs.

- Once they realised the devastating effects of removing the Hippocampus on both sides of the brain, H.M.'s operation was never repeated.



Henry Molaison or H.M.

- Brain Imaging: Some brain imaging experiments have demonstrated activation of different areas of the brain for the STM & LTM.

- for e.g. Deborah Talmi & coworkers (2005) measured the fMRI response to tasks involving STM & LTM. They first presented a list of words to participants; but instead of asking participants to recall the words they presented a single "probe" word.

- The probe was either (1) a word from near the beginning of the list , (2) a word from near the end of the list, or (3) a word that hadn't been presented earlier.

- The participant's task was to indicate whether the word that had been presented before.
- Their brain activity was measured with fMRI after the probe was presented and as they were preparing to respond.
- The results indicated that probe words that were from the beginning of the list activated areas of the brain associated with long terms memory & short term memory.
    - because words at the beginning of the list would be in LTM & would then be transferred to the STM when they were being recalled.

- In contrast, the words at the end of the list only activated areas that were associated with the STM.
    - This would be expected because the recently presented words would be directly recalled from the short term memory.
- Although Talmi's experiment demonstrated activation of different areas for STM & LTM, the results of many other experiments have not been as clear - cut.

References

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