

# Memory: Encoding and Storage

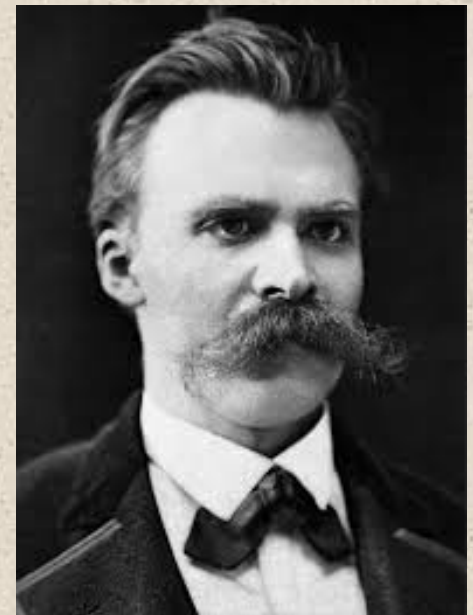


# Lessons of Memory

- Memory is tied to a sense of self / consciousness. Without memory, we'd be untethered to the past.
- Memory is not a unitary thing. There are multiple memory systems that work together.
- Memory can be surprisingly limited, given how important it is.
- Memories are not what they seem. They are an inference, not a faithful reproduction of the past.
- We forget / edit the past. And that is a good thing.

A leaf flutters from the scroll of time, floats away – and suddenly floats back into the man's lap. Then the man says 'I remember' and envies the beast, who at once forgets and for whom **every moment truly dies**, sinks back into night and mist, **extinguished forever**

**Friedrich Nietzsche**





Memory is not a single thing

# Types of memory

- **Sensory memory**
  - Lasting sensory trace



# Types of memory

- **Sensory memory**
  - Lasting sensory trace
  - Function is to hold information long enough to
    - Make connections between stimuli
    - Be processed deeper



# Types of memory

- **Sensory memory**
  - Lasting sensory trace
  - Function is to hold information long enough to
    - Make connections between stimuli
    - Be processed deeper
  - Short lasting, high capacity
  - You would go mad if it lasted longer!



# Types of memory

- **Types of sensory memory**
  - iconic memory: sensory memory associated with your *visual* field
  - What if your iconic memory lasted longer than a split second?
    - Your visual field would be a blurry mess!
    - But a sense memory of about  $\frac{1}{4}$  second allows you to streamline visual images from one to the next
    - Wave your finger in front of you: Blur is due to iconic memory

# Types of memory

- **Types of sensory memory**
  - echoic memory: sensory memory associated with what you *hear*
    - Lingers for 3-4 seconds
    - Watch the next time you ask someone, “what did you say?” but realize what they said a second later.
    - That’s your echoic memory helping out.

# Types of memory

- **Sensory memory**
  - Famous test of iconic memory
  - Example is given in the book but it's really hard to appreciate unless you do it
  - *Let's do this experiment together:*

# Sperling's partial and whole report task



## Sperling's **whole report** task

- You will see a 3 rows of 4 letters (very briefly!)
- Try to perceive and remember as many letters as you can.
- Write the letters down

# Sperling's whole report task

- *Ready?* I S

B U W D

O L N E

## Sperling's whole report task

- That was hard.
- I bet most of you didn't get more than 20-25% of the letters
- But we can make it easier.

## Sperling's **partial report** task

- I'm only going to have you report one line
- The trick though, you won't know which line to report until the display disappears
- You'll hear a tone after the display is removed
  - High tone, report top line
  - Medium tone, report middle line
  - Low tone, report bottom line



# Sperling's **partial report** task

- *Tone examples*

# Sperling's partial report task

- *Ready?* I S

B U W D

O L N E

## Sperling's partial report task

- That should have been easier
- Many of you may have gotten all the letters

—F V I S

- Let's try another example

# Sperling's partial report task

- *Ready?* ~~B~~ Z Y K

W D F L

Q O D G

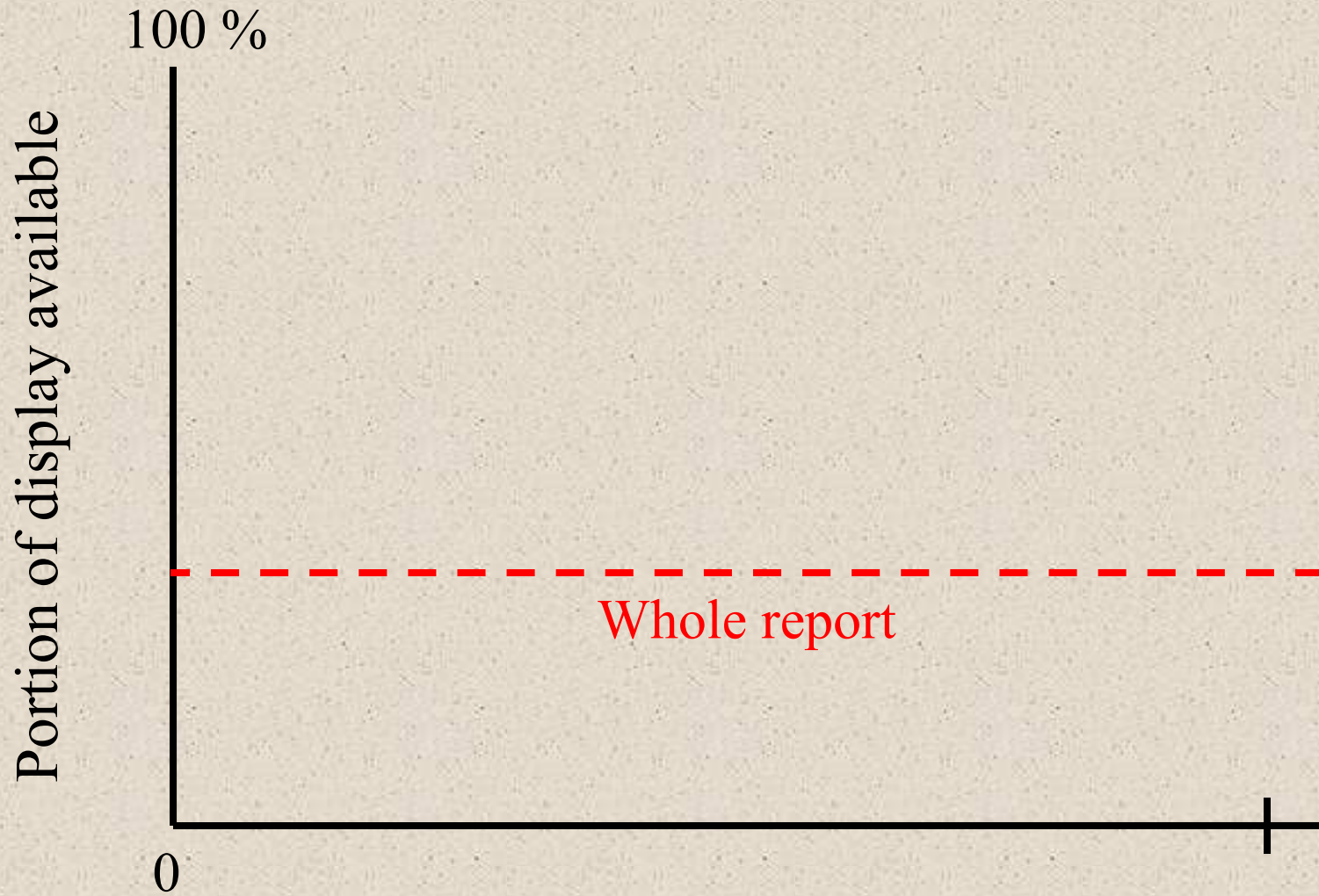


# Sperling's partial report task

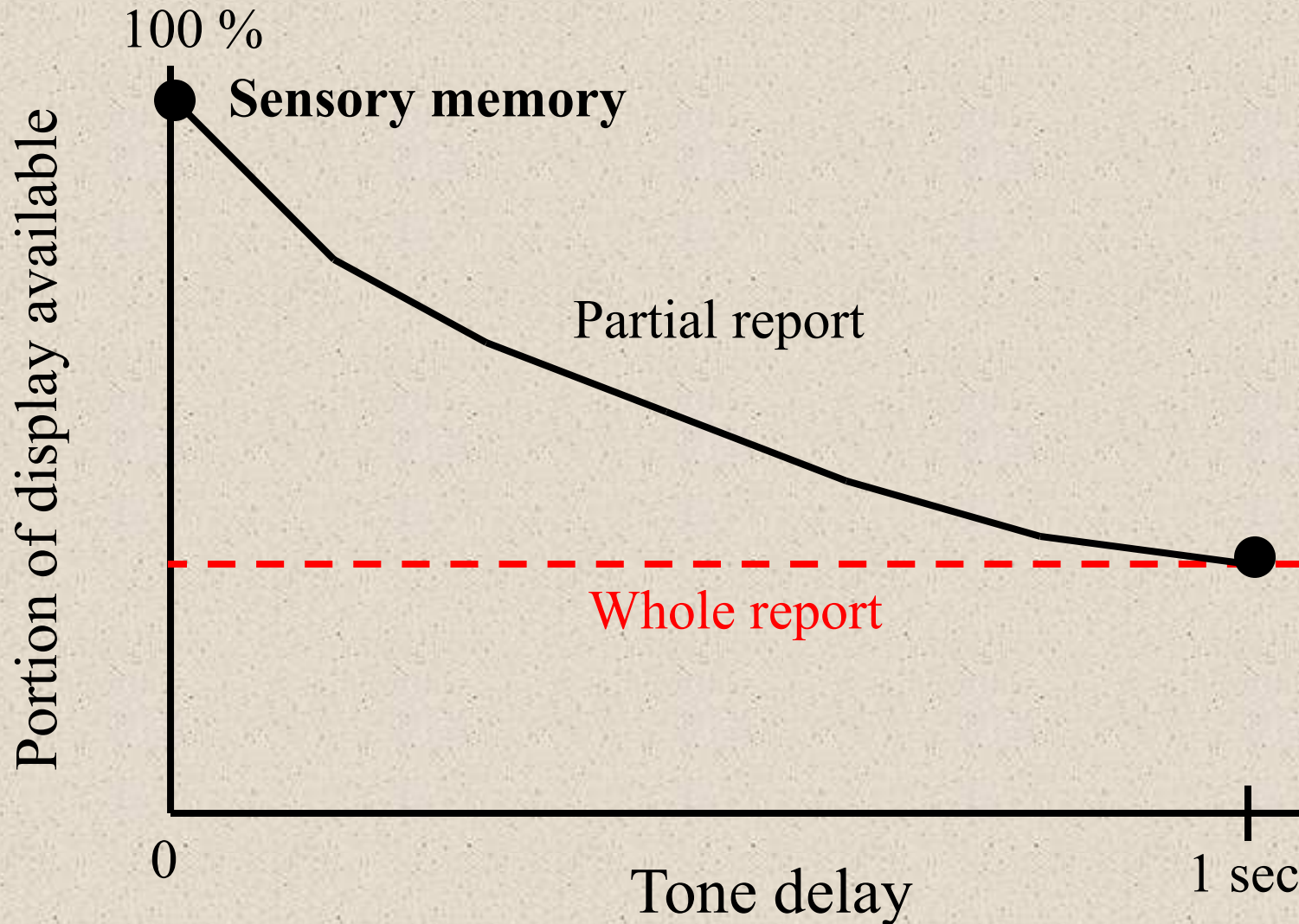
- How was that?
  - QODG
- The tone is only effective if presented shortly after the display offset.
- Why is that?

# Whole and partial report data

# Whole and partial report data



# Whole and partial report data





# Types of memory

- Sensory memory
  - Lasting sensory trace
  - Short lasting, high capacity
- **Short-term memory**
  - The ability to keep important information active in the mind when it is no longer in the environment
  - Relatively stable, but decays over time
  - Low capacity

# Types of memory

- Sensory memory
  - Lasting sensory trace
  - Short lasting, high capacity
- **Short-term & Working memory**
  - The ability to keep important information active in the mind when it is no longer in the environment
  - Relatively stable, but decays over time
  - Low capacity

**37 X 11**

How important is working memory?

# Working memory

- Mental workspace
- Contents of consciousness and attention
- Involved in nearly everything that we do
- Try to imagine running an errand or carrying on a conversation without working memory!



# Working memory

- Working memory is also highly correlated with intelligence and measures of ability
- Suppose I wanted to give each of you a five minute test to predict what your GPA will be when you complete your degree. What is the best way to do this?
- Probably a short working memory test
- Very quick and highly predictive

# Working memory

- Given the importance of working memory, you would think we'd be experts at it
- Truth is our working memory capacity is very poor!

# *Examples*

# Working memory

## – Exercise:

- Take out a sheet of paper!
- We're going to check your short-term memory capacity
- I will read you lists of numbers
- Keep them in your mind,  
and only write them down when I tell you to
- *Ready?*
- I'm going to show the numbers
- Make a note of which rows you got the *exact numbers* correct



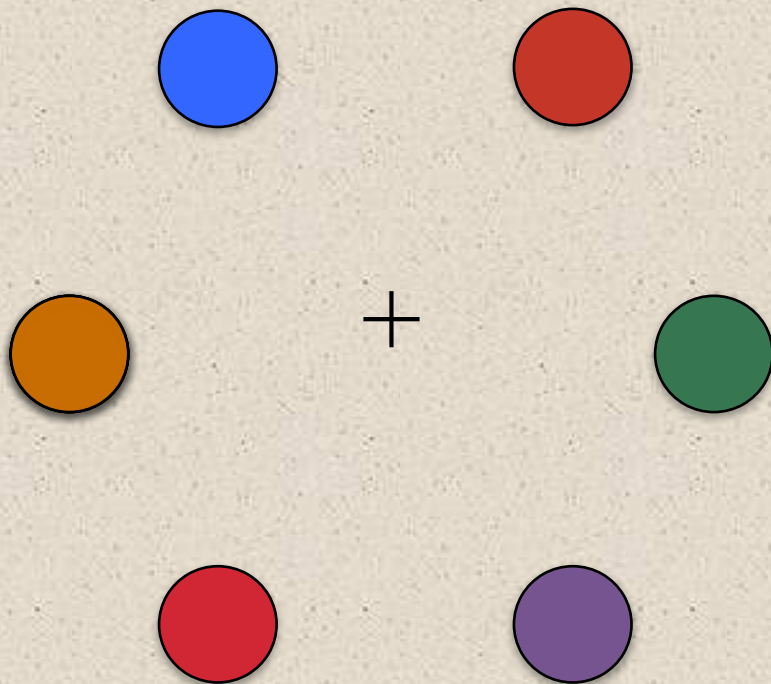
# Working memory

- 3 7 6 5 4
- 6 2 7 4 1 8
- 0 4 0 1 4 7 3
- 1 9 2 2 3 5 3 0
- 4 8 6 8 5 4 3 3 2
- 2 5 3 1 9 7 1 7 6 8

# Working memory

## – Another example:

- This time you will be remembering the color of simple circles
- Pay attention, the circles will be presented *very briefly*
- *Ready?*



# Working memory

- How much can we store in working memory?
- A famous estimate suggested around 7 ‘bits’.
- More recent estimates suggest that 7 is too many!
- Perhaps we can only store 3 or 4 ‘bits’.
- But what exactly is a “bit” of information?



# Working memory

- *Class exercise*
- I will show you a series of numbers, for 10 seconds.
  - Try to remember them in their exact order
  - Do not write anything until I say so.
  - Ready?
- 9 2 4 1 7 2 1 6 8 1 4 3 7 6 2 0 9 2  
5 1

# Working memory

- *Class exercise*
- Now I am going to show you the same numbers in a different order, also for 10 seconds.
  - Try to remember them in their exact order
  - Do not write anything until I say so.
  - Ready?
- 9 7 1 – 1 4 9 2 – 2 0 2 1 – 1 2 3 4 5 6 7 8 9

# Working memory

- Let's see how you did
  - How many got all from the first group right?
  - 9 2 4 1 7 2 1 5 8 1 4 3 7 6 2 0 9 2 5 1
  - How many got all from the second group right?
  - 9 7 1 – 1 4 9 2 – 2 0 2 1 – 1 2 3 4 5 6 7 8 9
- Why did more remember the second group?
  - Those were the *exact same numbers*  
(just given in a different order)

# Working memory

- Chunking = organizing bits of information into familiar, manageable units
  - As you can see, chunking helps memory
  - Allows us to turn 21 bits of information (first string of numbers) into 4 bits of information (second string)
  - Allows our memory to remember more, but still within the limits of working memory



# Working memory

- There is a trick that will allow you to remember fifty-six letters

# Working memory

# Working memory

- There is a trick that will allow you to remember fifty-six letters  
**= 56 letters!**

# Types of memory

- **Sensory memory**
  - Lasting sensory trace
  - Short lasting, high capacity
- **Short-term memory**
  - The ability to keep important information active in the mind when it is no longer in the environment
  - Relatively stable, but decays over time
  - Low capacity
- **Long-term memory**
  - Stored life experience
  - Long lasting (can last a lifetime!)
  - Seemingly unlimited



# Long-term Memory

- Long-term Memory = the persistence of learning over time via the *encoding*, *storage*, and *retrieval* of information
  - Encoding = process of putting information into a form (codes) that the memory system can accept and use
  - Storage = retention of encoded information over time
  - Retrieval = process of getting information stored in memory
- Failure at any of these three stages means a failure in memory!

# Memory

- Long-term Memory = the persistence of learning over time via the *encoding*, *storage*, and *retrieval* of information
  - **Encoding = process of putting information into a form (codes) that the memory system can accept and use**
  - Storage = retention of encoded information over time
  - Retrieval = process of getting information stored in memory
- We will talk about these three processes involved in memory in some detail
- Failure at any of these three stages means a failure in memory!

# Encoding

- Long-term memory processes happen at two different levels that we discussed during material on consciousness
- *Effortful processing*
  - Encoding that requires attention and conscious effort
  - Results in explicit memories = memories we consciously know
  - Related words: explicit, conscious, effortful, controlled
- However, even when you do not consciously try to remember something, it can be registered in your memory
- *Automatic processing*
  - Encoding that happens automatically and often unconsciously
  - Results in implicit memories = memories we hold but are not aware of
  - Acquired for example through classical conditioning, etc.
  - Related words: implicit, unconscious, easy, automatic



# Encoding

- Our ability to encode memories into long-term memory also may depend on the type of encoding we use
  - Some types of encoding lead to better memory
  - What do I mean by types of encoding?
- *Class exercise:*
  - Concerns coding of verbal information (words)
  - I will be reading a list of words
  - We will divide the class into two groups
  - The different groups in class will process the words differently



# Encoding

- Our ability to encode memories into long-term memory also may depend on the type of encoding we use
  - Some types of encoding lead to better memory
  - What do I mean by types of encoding?
- Class exercise:
  - Concerns coding of verbal information (words)
  - I will be reading a list of words
  - We will divide the class into two groups
  - The different groups in class will process the words differently
  - **Group 1: Keep your eyes open.**
  - **Groups 2: Keep your eyes shut!**

# Encoding

- FOR EACH WORD I READ, MENTALLY ESTIMATE THE NUMBER OF VOWELS FOUND IN THE WORD

# Encoding

- Our ability to encode memories also may depend on the type of encoding we use
  - Some types of encoding lead to better memory
  - What do I mean by types of encoding?
- Class exercise:
  - Concerns coding of verbal information (words)
  - I will be reading a list of words
  - We will divide the class into two groups
  - The different groups in class will process the words differently
  - **Group 2: Keep your eyes open.**
  - **Groups 1: Keep your eyes shut!**

# Encoding

- FOR EACH WORD I READ, MENTALLY RATE THE USEFULNESS OF THE ITEM, ON A 1-5 SCALE, IF YOU WERE STRANDED ON A DESERT ISLAND



# Encoding

- Now everyone open your eyes, and I will read the list of words...
  - Do NOT write anything down while I read the list
- Now, you will have one minute to write down as many words as you can from the list I gave you.
- Go!

# Instructions correspond with 2 types of encoding of verbal information

## Encoding

**shallow  
processing**

- Two different sets of instructions:
  - “For each word I read, mentally estimate the number of vowels found in the word.”
  - “For each word I read, mentally rate the usefulness of the item, on a 1-5 scale, if you were stranded on a desert island.”

- Who do you think remembered the most?

**deep  
processing**

# Encoding

RAINCOAT, ORCHESTRA, SAILBOAT,  
DIAMOND, UNIVERSITY, MACARONI,  
BINOCULARS, GARDEN, UNDERWEAR,  
NEWSPAPER, ALCOHOL, FLOWERS,  
MICROSCOPE, CAMOUFLAGE, POLLUTION,  
RESTAURANT, INSECT, ELEPHANT, SULPHUR,  
LEMONADE, MOSQUITO, BOTTLE

# Encoding

- Shallow processing: what a word *looks* or *sounds* like
- Deep processing: what a word *means*
  - *semantic* encoding
- How else can you help encode deeply?
- Tying words and ideas to pre-existing knowledge structures helps with *semantic* encoding
- Especially true if those knowledge structures have to do with the self
- self-reference effect = tying ideas to aspects of the self is especially powerful for remembering
  - Example: You will remember concepts in your classes if you can see how they apply to your life



# Encoding

- Another way to think of deep processing:
- The harder it is you have to work at remembering something, the more likely you'll remember it
- Why reading the text is not as good for memory as taking multiple choice quiz questions.
- Multiple choice questions require harder work.
- Even better: When you take practice multiple choice questions, cover up the response options
- This will force you to *recall* the answer, which is harder than recognizing the answer.
- Book: “Don’t be lulled into overconfidence by your ability to recognize information.”
- You could also use this technique on an actual exam...
- Reduces chance of being distracted by alternatives.

# Learning Diary

When discussing sensory memory, iconic memory and echoic memory are described, but other sensory modalities seem to be largely ignored (i.e., touch, taste, and smell). Why do you think this is? Are there advantages to understanding how our memories within other sensory modalities function? How could we study sensory memories for other modalities?

# Memory: Encoding and Storage