Inside Out Inside You

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Field(s) of Interest: Cognitive Science, Neuroscience, Psychology

Brief Overview:
Mentees will understand how memory works, from formation, to efficient storage, to use when necessary. There are several different types of memory which function differently, and information is processed on varying levels to produce memories of varying qualities/strengths. The brain stores this information by making connections for useful contextualization, which can be new and creative. Finally, memories change and grow as you use them, and as you learn new information.

Agenda:

- Introduction (5 min)
- Module 1: Making Memories (20 min)
- Module 2: Orb Organization (20 min)
- Module 3: Back to Headquarters! (10 min)
- Conclusion (5 min)

Main Teaching Goals/Key Terms:

- encoding
- sensory input
- sensory memory
  - iconic memory
  - echoic memory
- working memory
- short term memory
- long term memory
- shallow processing
- implicit memory
  - priming
  - procedural
- explicit memory
  - episodic
  - semantic
- plasticity
- amygdala
- synesthesia
- hippocampus
- the reactivation of neural networks
- retrieval failures
  - retroactive interference
  - proactive interference

Background for Mentors

Module 1 • encoding • sensory input • sensory memory • working memory • short term memory • long term memory • iconic memory • echoic memory • shallow processing	**Encoding** is the first step in memory formation. In this step, **sensory input**, or information observed through the 5 senses (feel, hear, see, taste, smell), is processed for memory through different methods. These methods reflect the different ways we understand the world around us, including visual, acoustic, and semantic encoding. We are all unique in which details we might choose to focus on. Initially, exposure to sensory input produces a **sensory memory**, which is a fleeting memory of a sense (like a temporary impression left in memory foam). **Iconic memory**, or the sensory memory of a sight, lasts for ¼ of a second, while **echoic memory**, the memory of a sound, lasts for 3-4 seconds. Sensory memory allows us to perceive our experience of the world as continuous because it acts as a buffer, holding bits of what we have experienced until it is lost (and replaced by new sensory information), or retained as a short-term memory. The next level is **working memory**, which is memory used for conscious thinking and working things out, such as math problems or reading and executing a complex set of instructions. It holds 3-4 pieces of information at once, and for a maximum of 30 seconds without active rehearsal. **Short term memory** is a broader definition of memory that temporarily holds onto items, rather than doing something with it. It is thought to hold an average of 7 items. **Long term memory** is where memories are stored if they are retained beyond the short term. This usually involves a deeper understanding or engaging with the content more thoroughly. Strategies like making personal connections and coming up with a story can help move information to long term memory. Memory athletes, or people trained to memorize large amounts of information quickly, use such strategies to make the most of their memory. **Shallow processing** is understanding on the surface level, typically focused on the look or sound of a word. For example, you could look at a word on a page and remember its font but not the actual meaning of it. **Deep processing** requires a deeper understanding based on meaning, context, and connections to other information already known. These levels of processing relate to processing of any sensory input, not just words. For example, human brains are wired for pattern recognition and can see faces/objects in clouds, exemplifying deep processing.

Module 2 ● implicit memory ○ priming ○ procedural ● explicit memory ○ episodic ○ semantic ● plasticity ● amygdala ● synesthesia	When long-term memories are stored, they are contextualized and connected in different ways. **Implicit memory** is unconscious memory that still influences your thoughts and actions. It is often something you cannot explain but just "feels right" in your head. One type of implicit memory is **priming**, where associated concepts are linked in your brain. Accessing one of these concepts can activate the other. For example, talking about bunnies then asking for a random vegetable might result in the answer "carrot" because bunnies are mentally associated with carrots. Another type of implicit memory is **procedural** memory, which is memory of how to do something, like biking, walking, or even breathing. In contrast, **explicit memory** is conscious memory, including things you might have to try to remember. One type is **episodic memory**, which describes memories of chronological events, experiences, and things that happened, e.g. the plot of a movie, how you met your friends, or what you ate for breakfast this morning. Another type, **semantic memory,** describes memories of facts and words, such as the capital of the United States, your mom's name, or the meaning of a random word. All our different memories are interconnected because the brain is good at making connections between memories, like a complex web. **Plasticity** describes the brain's ability to make new connections and grow. This means you can think of new connections at any time, and new information you learn enters this web and forms connections with existing memories. The brain is also good at making connections between memories and emotions. The **amygdala** is the part of your brain responsible for processing emotion, and, by extension connecting memory with emotion (and processing emotion). This means that memories are linked with and shaped by the emotions associated with them. Recalling a memory might cause the same emotion to resurface, and experiencing an emotion might cause you to remember a memory associated with the same emotion (like priming). This also means that memories are highly personal accounts of what happens, rather than objective records: your emotions and interests affect what you choose to remember and how you perceive it. **Synesthesia** describes a phenomenon in some people where stimulation of one sensory pathway leads to involuntary stimulation of a secondary sensory pathway due to 'cross-wiring' in the brain. The most common examples involve color, e.g. each letter or sound is associated with a color.

	But, there can be different cross-sensory connections. For example, reading certain words might induce certain tastes. More research is needed on this topic, but highlights just how good the brain is at producing connections between memories—synesthesia occurs when there are *too many* such connections.

Module 3 ● hippocampus ● reactivation of neural networks ● retrieval failures ○ retroactive interference ○ proactive interference	After memories are stored, they still need to be retrieved, or recalled, to be used in the future. Think of the recall tube from *Inside Out*. The **hippocampus** is a part of the brain involved in every stage of memory formation, storage, and use. We have two hippocampi, each above the ears. This part of the brain acts as a librarian, filing information away to the right "brain shelves" with related information, and directing you back to it when you are trying to remember. This part of the brain helps keep the experience as smooth as possible. Through the direction of the hippocampus, we remember things with the **reactivation of neural networks**. When we remember something, we walk through the memory mentally and rewrite it each time we remember. It's like retracing your steps when you lose something. Remembering one detail can help lead you to the next. Because of this process, our memory is not always accurate. For example, if you are reminiscing with a friend and your friend adds a detail you did not initially know (e.g. you both went to a party where your friend saw Sabrina Carpenter but you didn't), you might incorporate it into your memory and include the detail next time you tell the story ("I saw Sabrina Carpenter at that party"). There are several ways that this can go wrong as well. There are **retrieval failures**, which describes when a memory cannot be recalled correctly. There is **retroactive interference** when new information prevents the recall of old information (e.g. you call last year's teacher by the name of this year's teacher). There is also **proactive interference** when old information prevents the recall of new information (e.g. you call this year's teacher by the name of last year's teacher). Another example: retroactive interference would be reading a book series and forgetting the plot of the first book after reading the second, and proactive interference would be forgetting the plot of the second book and only remembering the first.

Introduction

This lesson aims to introduce the concept and mechanics of memory so that mentees can understand its role in their everyday lives. By understanding this process, mentees can improve their memory in order to remember things that are meaningful to them.

Mini Module 0: Ask mentees to remember some “secret message” until the end of the lesson.

Concepts to Introduce	**Questions to Pique Interest**
● You can compare long term memory to a big library ○ A lot of information is there, but it’s stored away, like in Inside Out. ● Compare procedural memory to a Google search. ○ "The answer" comes up quickly and doesn't require a lot of effort. ● Senses: sight, hearing, smell, taste, and touch. ● Neural networks: different parts of the brain are highly interconnected, like a game of connecting the dots. ● *Inside Out* comparisons	● Do you remember what you ate for lunch a week ago? What about the most recent thing you ate? ● What’s the oldest memory you have? ○ Experiences get stored in long term memory, while what you had for lunch last week get forgotten. ● Why do you have to think to conjure a memory but don’t have to think in order to remember how to walk/breathe? ○ Introduces the idea of implicit/explicit ● Who has a favorite song? Do you remember the lyrics? How did you memorize them all?
Scientists, Current and Past Events	**Careers and Applications**
● Alois Alzheimer: a psychiatrist and neuropathologist who coined the name Alzheimer's disease which affects your memory ● Hermann Ebbinghaus: studied memory and created the term "forgetting curve" which illustrates how information is lost over time.	● Many careers implicitly involve use of memory. For example, lawyers have to memorize laws, doctors have to memorize medical facts, and musicians have to memorize lyrics and scores. ● Clinical Neuropsychologists work with patients who have brain injuries and neurological conditions. They use memories, long and short term, to rebuild neural connections. ● Cognitive neuroscientists study cognitive functions including memory ● Memory is used in your everyday life, it helps everyone understand themselves better

Module 1: Making Memories (Encoding)

Through 3 stations, students will understand how memory formation begins, starting with sensory input from the external world.

Teaching Goals	**Materials**
1. **encoding:** the first step in memory formation, where sensory information is processed for memory through different methods. a. Visual, acoustic, semantic, etc. 2. **sensory input:** something you can feel, hear, see, taste, or smell. 3. **sensory memory:** fleeting memory of a sense. a. **iconic memory:** specifically memory of a sight. b. **echoic memory:** memory of a sound. 4. **working memory:** memory used for conscious thinking and working things out. 5. **short term memory**: memory that temporarily holds onto items, rather than doing something with it. It is thought to hold an average of 7 items. 6. **long term memory:** where memories are stored if they are retained beyond short term. 7. **shallow processing:** understanding on the surface, typically focused on the look or sound of a word. 8. **deep processing:** deeper understanding based on meaning, context, and connections.	Station 1 ● Optional: sound clip of simple jingles (and phone to play) ● Mentees! Station 2 ● Drawing reference ● Pencils ● markers Station 3 ● List 1 ● List 2

Different Methods for Teaching

Give a couple of different teaching techniques that you think would be the most effective way for mentors to teach this module/the different teaching goals . For example...

9. **Iconic memory:** Ask if any mentees have or have heard of photographic memory! This can help them understand the concept, but make sure they know photographic memory is *not* real according to science.
10. **Levels of procession and long term memory:** Ask follow up questions! How well did the strategy work? What might improve it next time? How might this be useful in real life?

Procedure

Break off into 3 equally sized groups, and rotate every 7 minutes. Ideally, you would have 1 mentor for Station 1 and 2 for Stations 2 and 3.

1 *Sensory Memory: Echoic*

1. Do a clap pattern, and have the mentees repeat it back to you.
    a. Optionally, mentors could play a short jingle instead and have mentees hum/sing it back.
2. Continue with more and more elaborate clap patterns until mentees start losing track of the pattern.
3. After the explanation, ask mentees to recreate the last clap pattern again.
    a. Most of them should not remember, since echoic memory only lasts for a few seconds.

2 *Sensory Memory: Iconic*

4. Print outs should be passed out face down.
5. Have groups flip the print outs over and observe for 10 seconds without drawing before flipping back over.
6. Allow 3 minutes to draw the drawing from memory as best as possible.
7. Compare to actual drawing.
    a. Mentees should have main components of original drawing but missing some details.
    b. Each mentee might have remembered different parts of the picture, showing how each person can naturally focus on different details.

3 *Levels of Processing:*

8. Allow mentees to study List 1 for two minutes. Optionally, read the list.
    a. This likely resembles shallow processing, as mentees are mostly focusing on the look and sound of the unrelated words/items.
9. Call on volunteers to try reciting the list from memory.
    a. If any mentees get all of them correct, ask them to share their strategy.
    b. Most, if not all, mentees should struggle since working memory can only hold 5-9 simple items, 7 considered the ‘sweet spot’.
10. Offer mentees a strategy before the next list: using the words to make a story.
    a. Contextualizing the information should help with

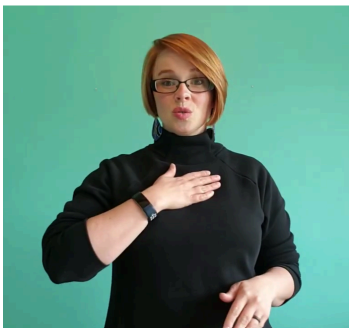


Figure 1: *Echoic: “Boom”*

Figure 2: *“Snap”*

Figure 3: *“Clap”*

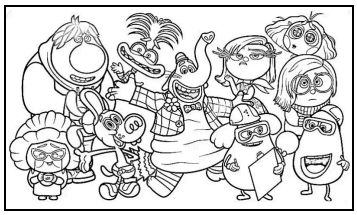


Figure 4: *Iconic: Drawing reference*

Figure 5: *Levels of Processing: List 1*

deep processing.

11. Show mentees the List 2 as in Step 8.
    a. *For older sites:* Give them 2 minutes to come up with a story in groups.
    b. *For younger sites:* Come up with the story as a class, or provide your own story. Keep it short and simple.
        i. E.g. **Lemon**ade is good in **sun**ny summer. You go down to the **water** and see people **running** by it. Then, you get in the **car** to take a road trip down to a carnival with a **Ferris Wheel** and get **popcorn** to watch a movie with sound through **headphones**. Then, you sit under the **star**s and tell **ghost** stories in a **triangle**-shaped tent under the **tree**s.
        ii. E.g. **Lemon**s are yellow like the **sun**, sun makes you thirsty so you drink **water**, you also drink water when you **run**, running takes you fast like driving a **car**, cars have wheels like **Ferris Wheel**s, these wheels look like a movie reel, at the movies you eat **popcorn**, you can also watch movies with **headphones**, movies have **star**s (celebrities), some celebrities are dead so they're **ghost**s, some dead people are buried in pyramids which are **triangle**s, pyramids are in Egypt which is a desert and has few **tree**s.
12. Call on volunteers to recite the list from memory.

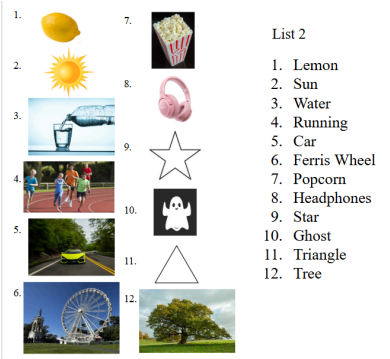


Figure 5: *List 2*

Classroom Notes

Spend only a few minutes on explanation before starting on the activities. Rotations need to be switched roughly every 7 minutes.

Module 2: Orb Organization (Storage)

Mentees will understand teaching goals by building a “neuron map” showcasing connections between different memories and links to emotion.

Teaching Goals	**Materials (per group)**

1. **implicit memory:** unconscious memory that still influences your thoughts and actions.
   a. **priming:** associated concepts are linked in your brain; accessing one can activate the other.
   b. **procedural:** memory of how to do something.
2. **explicit memory:** conscious memory, things you might have to try to remember.
   a. **episodic:** memories of chronological events.
   b. **semantic:** memories of facts and words.
3. **plasticity:** the brain’s ability to make new connections and grow.
4. **amygdala:** the part of your brain responsible for connecting memory with emotion (and processing emotion).
5. **synesthesia:** stimulation of one sensory pathway leads to stimulation of a secondary sensory pathway due to ‘cross-wiring’ in the brain
	• White string
	• Emotion stickers
	• Brain poster paper
	• markers
	• print out pictures
	• extra paper for drawings
	• Paper fasteners
	• Pencils
	• Fun stickers (reward)
	• Optional: electronic device for synesthesia.me website

Different Methods for Teaching

Give a couple of different teaching techniques that you think would be the most effective way for mentors to teach this module/the different teaching goals . For example...

1. **priming:** Write on the board in a certain color or order (e.g. write in orange orange and ask mentees to name a vegetable) as a demonstration. This can also be done verbally by introducing certain words. Keep it lighthearted and come up with an idea before site! It’s OK if it doesn’t work, you can still explain the idea.
2. **implicit vs explicit memory:** Explicit memory is you consciously recalling the rules of the sports. Implicit memory is you knowing how to do whatever action (kicking, throwing, hitting, etc) without thinking about *how* you are doing that.
3. **plasticity:** Maintaining the brain is like growing a garden: when you water and maintain your plants they will flourish, but if you stop weeds will grow and your garden won't be so nice, the great thing is that you can just maintain it again.

Procedure

1. Go through which pictures/words are which type of memory with mentees.
    a. This can be done as a group or as a “quiz” based on how mentees feel.
2. Fasten pictures and drawings representing memories onto poster paper.
    a. Make sure to use a mix of nouns, adjectives, and verbs, as words or pictures.
    b. Optionally, allow mentees to cut out their own shapes/sketches.
3. Allow mentees to plan for 2 minutes what they want to connect with groups.
4. Connect concepts mentees think are related with yarn (looping around the pushpins).
    a. New connections and ideas represent plasticity.
5. Use stickers to show emotion associated with concepts and threads.
6. To represent synesthesia, add a colored sticker to members of a certain category of the mentees’ choice (e.g. all animals).
    a. Discuss how synesthesia could also be with other senses, not just sight and color.
7. Ask mentees to share their thought process in making the map.
8. Based on each group’s map, offer a few example “thoughts” and have mentees trace the path with their fingers to see how things are stored in association.

Optional:

9. Show mentees how their name looks to one person with synesthesia through the website synesthesia.me.
    a. Call on volunteers if limited

Figure 1: *Pictures for the memory map*

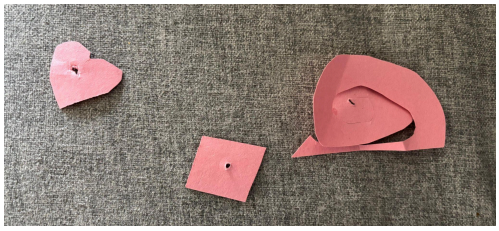


Figure 2: *Pictures (substituted with shapes here) should have holes for fasteners.*

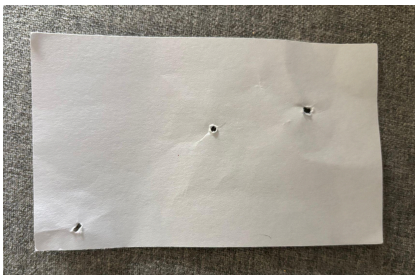


Figure 3: *Optionally, punch holes in poster paper (should have brain drawn on).*

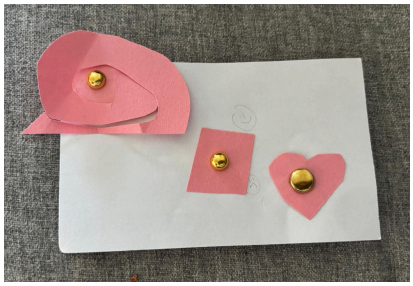
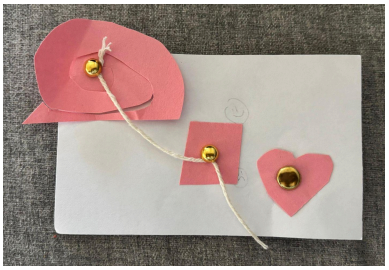


Figure 4: *Fasten pictures to poster.*



time.

10. *Extra Optional:* Let mentees draw their names with marker.

Figure 5: *Connect concepts by looping string around fasteners.*

Figure 6: *Make multiple connections.*

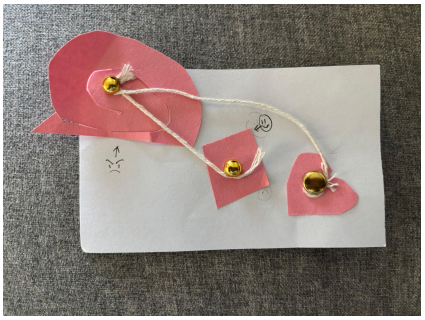


Figure 6: *Add emotions to pictures or connection threads (using stickers).*

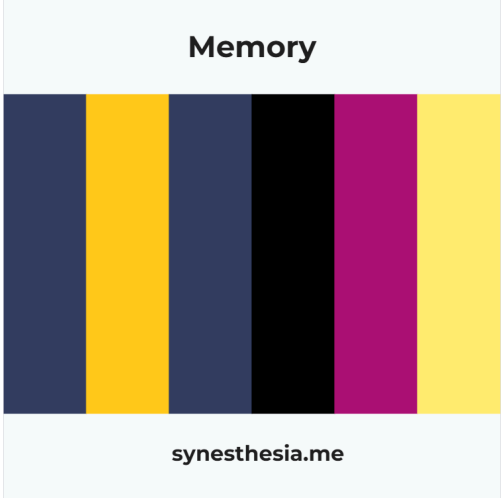


Figure 7: *Demonstration of synesthesia.me website*

Classroom Notes

While mentees are planning their connections, walk around and ask their ideas. If they are stuck, help them brainstorm connections.

Module 3: Back to Headquarters! (Retrieval)

Students will understand how memories are recalled and used through a group activity.

Teaching Goals

- **hippocampus:** a part of the brain which acts as a librarian filing information away and directing you to it when you are trying to remember
- **reactivation of neural networks:** how we remember things; we rewrite our memory each time we remember by walking through it mentally, so it's not always accurate.
- **retrieval failures:** when a memory cannot be recalled correctly.
    - **retroactive interference:** new information prevents the recall of old information.
    - **proactive interference:** old information prevents the recall of new information.

Materials

- Mentees!
- Map from previous module
- red string

Different Methods for Teaching

Give a couple of different teaching techniques that you think would be the most effective way for mentors to teach this module/the different teaching goals . For example...

1. **reactivation of neural networks:** A fun technique could be "lying" to the mentees. Ask them something like "What color was my dress last site?" You're introducing new information, that you were wearing a dress–perhaps this might somehow alter old memories. They might swear they remember you wearing a dress.
2. **types of interference:** Have older mentees think about the meaning of "retro" and "pro" as they know them to help keep the two ideas distinct.
    a. pro = forward, active = moving: forward-moving old information interferes with new
    b. retro = back, active = moving: back-moving new information interferes with old

Procedure

1. Have students get in a big circle.
    a. Ask if they know how to play Telephone!
2. Pick a mentee to start the game with a sentence from below:
    a. Joy jumps jubilantly just juggling jellybeans.
    b. Sadness sits sniffling, spilling soggy cereal.
    c. Fear frantically flaps, fleeing from fuzzy feathers.

Figure 1: *Mentees form a circle.*

    d. Disgust despises dirty dishes and droopy doughnuts.
    e. Anger's arguing about alarm clocks again!
3. Ask each mentee to remember what they said.
4. Have them whisper the sentence from one mentee to the next, passing the message around the circle.
5. Have the last mentee in the circle say the final message out loud.
6. Compare to the initial message. There should be changes.
    a. If not, try again with a more complex starting sentence.
7. Trace the path of the message from start to finish by asking each student what they heard.
    a. This should catch where the mistakes occurred.
    b. Explain that this game of telephone mirrors the reactivation of neural networks with the message being your memory: your brain isn't perfect each time it recalls a memory, and the memory is rewritten each time you access it.
8. Trace how remembering works using red string and the mind maps from the previous module.
    a. Provide mentees with prompts based on their map. For example, say something like "Summer vacation" and allow mentees to form new connections as they think of memories related to the topic.
9. (If time permits) Repeat Steps 1-7 with a different starting sentence.

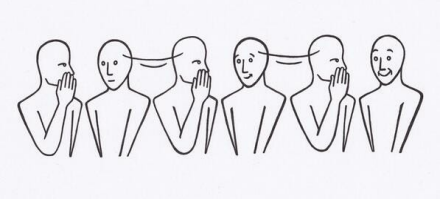


Figure 2: *Pass message from mentee to mentee.*

Classroom Notes

Take mentees outside for this activity if they are starting to get antsy.

If a mentee is purposefully saying the wrong thing, have another mentor pull them aside. They don't need to be able to participate in the activity if they can't follow the rules.

Conclusion

1. Ask mentees to recall the secret message from the start of class.
    a. If they have forgotten, discuss why. This could include retroactive interference and the limitations of short-term memory.
    a. If they remember, discuss what strategy, if any, they used to remember. What stood out to them?

References

- Simply Psychology, Saul McLeod, Encoding, Storage, Retrieval.
- Cleveland Clinic, Synesthesia.
- PubMed, G Richter-Levin, Hippocampus and Amygdala in Memory.

Summary Materials Table

Material	**Amount per Site**	**Expected $$**	**Vendor (or online link)**
poster paper	5	$14.29	Link
paper fastener	several		
Colored pictures			
Tape (optional)			
String (2 Colors!!!)	2	$20	Link
Emotion stickers	several	$7.99	Link
markers	several		
Colored stickers	several	$5.39	Link
Fun stickers	At least 1 per mentee		Link