

The Physiology of Memory

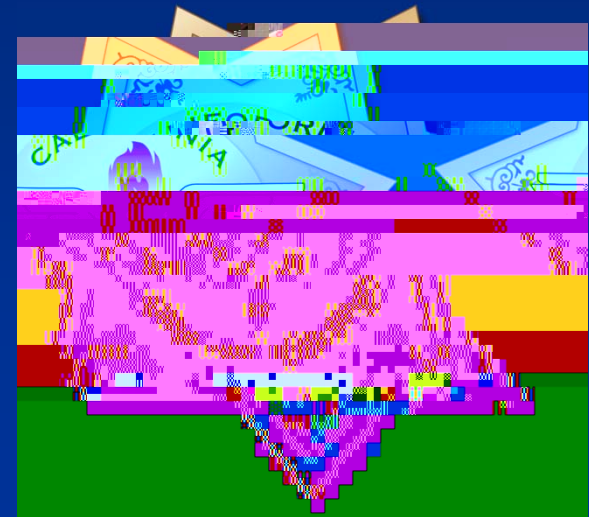
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Physiology of Memory

- ™ Neurons are the basic means of information transfer within the nervous system
- ™ Information in the form of a stimulus is detected by a specific type of neuron (sensory neuron).
- ™ The information is then passed to an adjacent neuron (interconnecting neuron) and so on till it gets to where it's going in the brain
- ™ It is an electro-chemical process that allows this to happen

Types of Neurons

TM

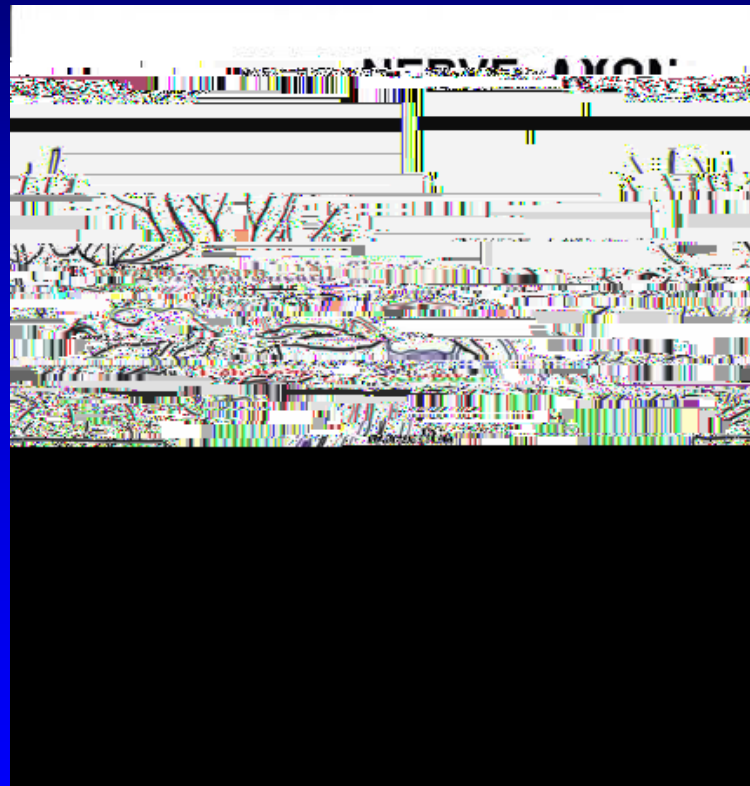
How Information Is Moved

- ™ All stimulus or nerve messages are picked up by the dendrites protruding from the cell body.
- ™ When the stimulus is strong enough, the cell body fires an electrical impulse.
- ™ An electrical impulse travels down the axon or “outgoing branch”. Then the axon terminals and buds at the end are stimulated to release chemicals called neurotransmitters (tiny molecules)

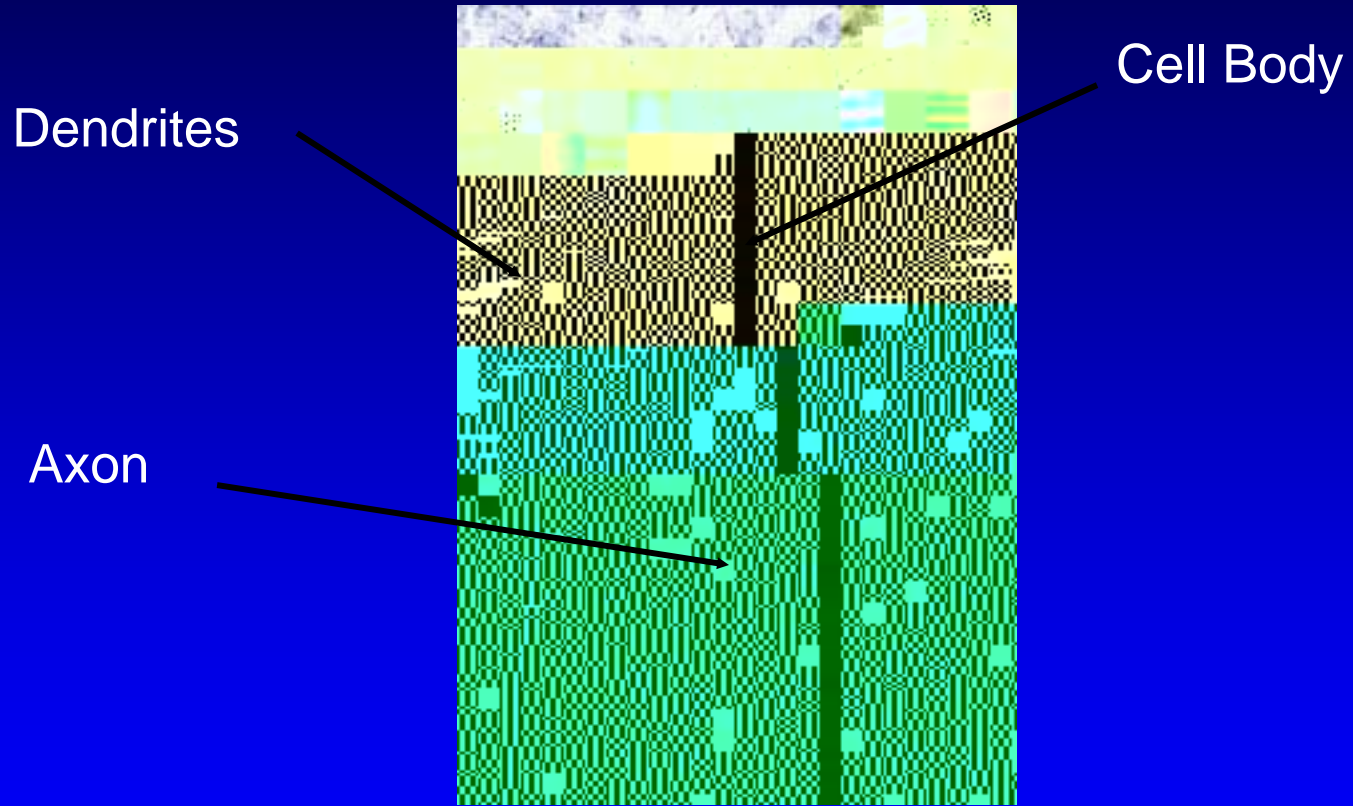
How Information Is Moved

- ™ Neurotransmitters are chemicals that are used to relay, amplify and modulate signals between a neuron and another cell.
- ™ The dendrites or “incoming branches” of other neurons pick up these chemicals as they cross the synapse.
- ™ The synapse is the space between the buds of one neuron and dendrites of the adjacent neuron.
- ™ What it comes down to is brain cells, or neurons, communicating with each other through electro-chemical pathways.

Here is another picture of a neuron
showing the transfer of
neurotransmitters at the synapse

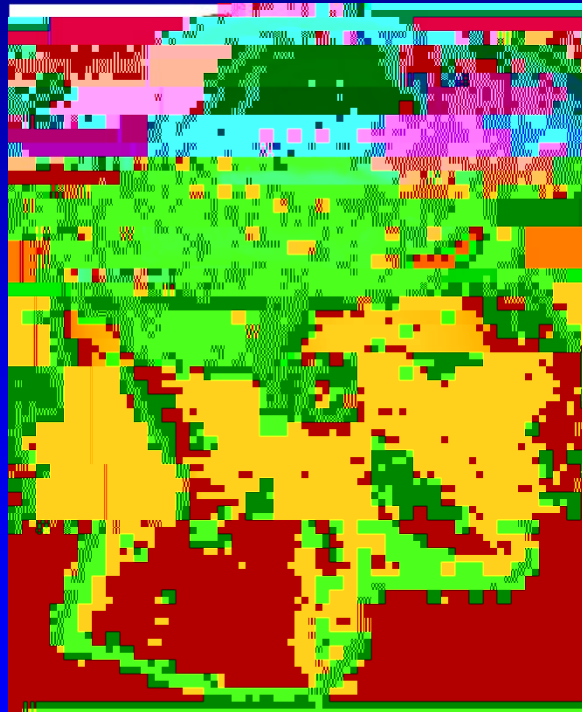


Actual Neuron



Following the Pathway

Most nerve messages from the senses are first routed to the frontal lobe of the brain).



Types of Storage

TMNeurologists divide memory into sensory storage, short-term memory, or "working" memory, and long-term memory.

Sensory Storage

- TMIn the sensory storage the stimulus is held for a fraction of a second.
- TMIf the information has some meaning it will be moved to short-term memory.
- TMIf it has no importance it will be dumped.

Short-Term Memory

- ™ Short-term memory (STM) is the brain's system for remembering information in use.
- ™ Most people can only hold five to nine items in their short-term memory at one time. If they try to remember more than that, they will often end up forgetting the middle items.
- ™ Unless an individual pays attention to encode the stimulus into short-term memory, it will be lost.
- ™ The memory is stored on something akin to an electronic tape loop. Once a complete loop is made, three things can happen:

Short-Term Memory

Long-Term Memory

- ◀ In the past, it was thought that all memory was stored in the cerebral cortex of the brain. We have now learned that long-term memories are stored in multiple regions throughout the nervous system. (In other words, they are not localized but stored through circuitry).

Long-Term Memory

Long-Term Memory

- ◁ Research has shown that some memory may even be stored in muscle tissue.
- ◁ This became evident with organ transplants. People who have received donor organs have reported experiencing cravings or emotional reactions to certain incidents that they never had before.

Primary Storage Area

The cerebral cortex is the primary area of storage in the brain. The cerebral cortex is often referred to as gray matter and covers the outer portion (1.5mm to 5mm) of the brain.



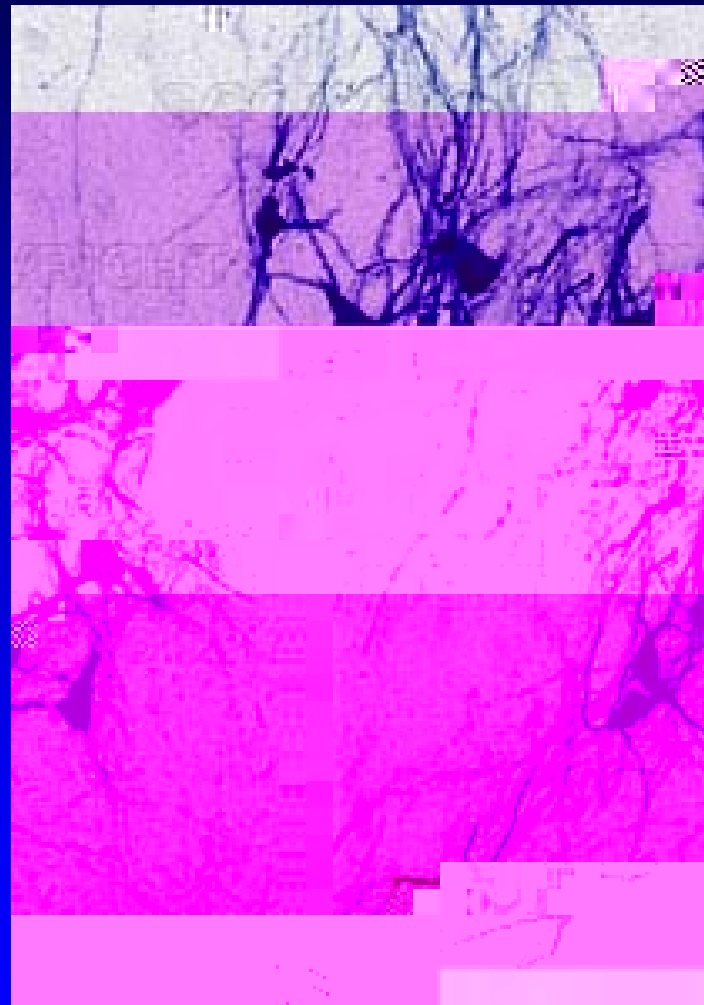
Getting Learning To Stick

TM For learning to “stick”, the synapses need time to “gel” (create new connections and synapses). If the synapse doesn’t “gel” then recreating the event (recalling the memory) is difficult, if not impossible.

The Memory Process

- ™ Simply put, memories are stored in subgroups of neurons that are activated in response to various sensory experiences.
- ™ The interconnections which are formed are subject to continual change. If you look at the next slide you will see a group of neurons. This is what takes place as learning occurs. You can see the neurons start to line up and new connections are formed.
- ™ The storage of information in LTM is a function of new interconnections and synapses and the production of new protein molecules.

Memory Bundle





Implications

TM Recent studies have found patterns of neural activity during sleep that is identical to those seen when learning a new task. It is believed that this aids in the consolidation and storage of memory. Adequate sleep is important to memory.

Implications

- ™ Excessive stress and obesity produce an over-production of a complex set of stress hormones called glucocorticoids (cortisol being one example). Over exposure to glucocorticoids damages and destroys neurons in the brain's hippocampus – a region critical to learning and memory.
- ™ One really good way to burn off excess cortisol is through exercise. So for those experiencing particularly high stress levels exercise is not only beneficial, it is necessary.

Why Do We Forget?

TM This is a difficult and complicated area for researchers. I will try to point out the different theories and give you some personal thoughts.

Decay Theory

TMA memory trace is created every time a new memory is formed. Decay theory suggests that over time, these memory traces begin to fade and disappear. If information is not retrieved and rehearsed, it will eventually be lost.

TMMemories fade away rapidly when not reviewed or used. The curve of forgetting is like a playground slide; we forget most immediately after we learn - in the first 24 hours; then it proceeds slowly.

Decay Theory

^TM Motor learning seems to be better retained than verbal learning because a motor act has to be completely done to be done at all and so requires a higher degree of organization and competency which involves over learning.

Personal Thoughts

- ™ One problem with this theory, however, is that research has demonstrated that some memories which have not been rehearsed or remembered are remarkably stable in long-term memory.
- ™ When we don't use a connection or recall a memory the memory trace (connection) is weak. With some memories the initial memory trace (connection) was extremely strong for some reason. This could be due to motivation, association, importance, fun, emotion, etc. The initial strong trace makes it easier to remember even if we don't use it.

Interference Theory

- ™ This suggests that some memories compete and interfere with other memories.
- ™ When information is very similar to other information that was previously stored in memory, interference is more likely to occur. There are two basic types of interference: Proactive and retroactive

Proactive Interference

- ™ Proactive interference is when an old memory makes it more difficult or impossible to remember a new memory.
- ™ A task you have done for years makes it more difficult to make minor changes. This is also know as “habit capture.”

Personal Thoughts

TM There is more interference between two similar subjects, ideas, or tasks than between two that are unlike. (Follow the study of history with chemistry rather than English history with literature.)

Storage Failure

- TM We also forget information because it never actually made it into long-term memory. Encoding failures sometimes prevent part of the information from entering long-term memory.
- TM When we have to fill in the missing parts on retrieval we use assumptions and make mistakes

Personal Thoughts

- ™ Very often only information that is important is encoded. We don't encode a lot of the details and they are not stored in memory.
- ™ Another reason is that under high stress (cortisol production) cortisol interferes with the transfer of information from short-term memory to long-term memory. The synapses are blocked by the cortisol and make it difficult to transfer the information.

Personal Thoughts

- TM Try this test: Draw both sides of a penny from memory, and then compare your results to an actual penny.
- TM How well did you do? Chances are that you were able to remember the shape and color, but you probably forgot other minor details. The reason for this is that only details necessary for distinguishing pennies from other coins were encoded into your long-term memory.

Motivated Forgetting

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Why Do We Remember Negative Events

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