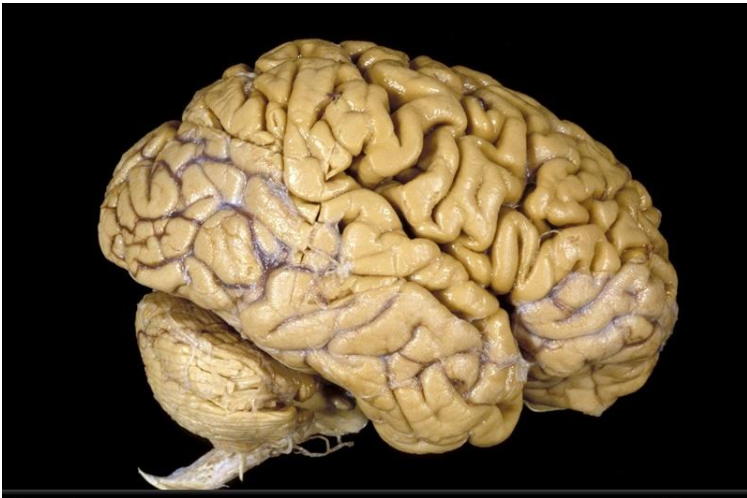


Understanding How the Brain Naturally Learns

- The brain is the most complex part of the human body. It is about the size of a cantaloupe.
- This three pound organ is the seat of intelligence, interpreter of the senses, initiator of body movement, and controller of behavior.
- The brain is the crown jewel of the human body.

Understanding How the Brain Naturally Learns



What happens inside your brain?

Brain-friendly ways to learn better

How homework helps your brain

**How emotions affect learning and
memory**

How We Learn

10% of what we ???

20% of what we ???

30% of what we ???

50% of what we ???

70% of what is ???

80% of what is ???

95% of what we ???

How We Learn

10% of what we **READ**

20% of what we **HEAR**

30% of what we **SEE**

50% of what we **SEE** and **HEAR**

70% of what is **DISCUSSED** with **OTHERS**

80% of what is **EXPERIENCED PERSONALLY**

95% of what we **TEACH TO SOMEONE ELSE**

Natural Learning Process

- More than 8,000 people – from 2nd graders to graduate students have reported how they learned to be good at something outside of school.
- Every group, without exception, has reported the same **sequence of stages** by which they learned.
- What have you learned to be good at outside of school?

The Natural Learning Process

This is how the brain learns.

The brain learns by constructing knowledge through sequential stages.

Stage 1: **Motivation**/watch, have to, show interest

Stage 2: **Start to Practice**/practice, trial and error, ask questions

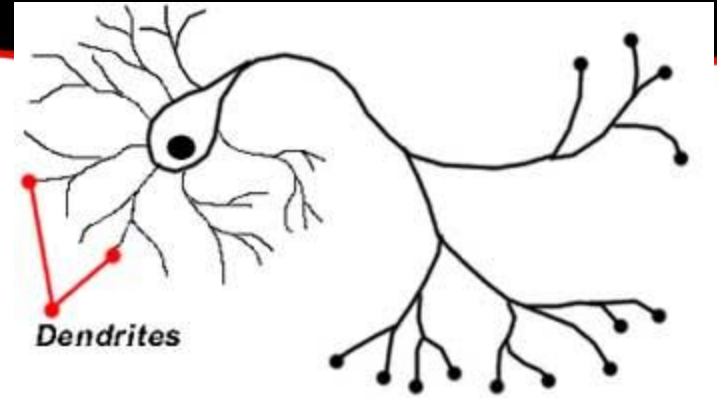
Stage 3: **Advanced Practice**/practice lessons, read, confidence

Stage 4: **Skillfulness**/some success, enjoyment, sharing

Stage 5: **Refinement**/improvement, natural pleasure, creative

Stage 6: **Mastery**/teach, recognition, higher challenges

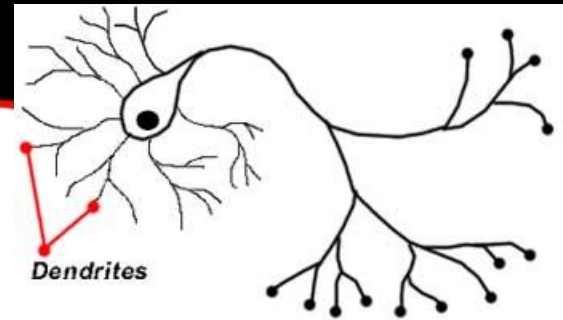
How the Brain Learns



- Brain cells are called **neurons**.
- You are born with at least 100 billion **neurons**.
- **Dendrites** (fibers) grow out of the neurons when you listen to/write about/talk about/ practice something.

Dendrites can grow only from a **dendrite** (fiber) that is already there – from something the learner already knows.

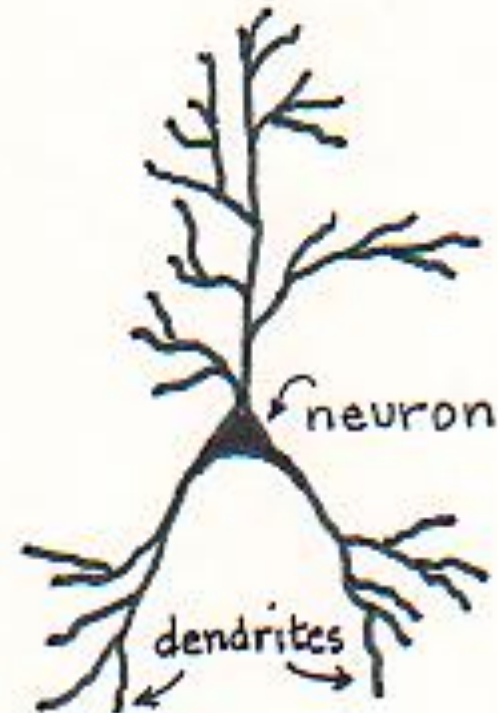
How the Brain Learns



- Like twigs on a tree dendrites can grow only from a twig or branch that is already there.
- Then like twigs growing on a tree, learning is constructed, higher and higher.
- As dendrites get higher and higher, what do you think happens?

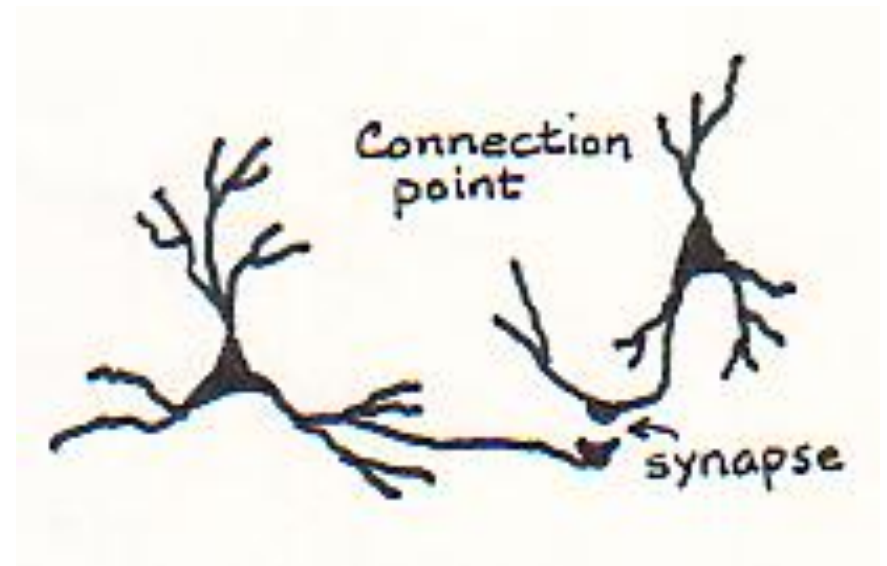
Learning is Natural!

- **Neurons** (brain cell) know how to grow **dendrites**, just like a stomach knows how to digest food.
- **Learning = Growth of dendrites.**
- New **dendrites** take time to grow; it takes a lot of **practice** for them to grow.

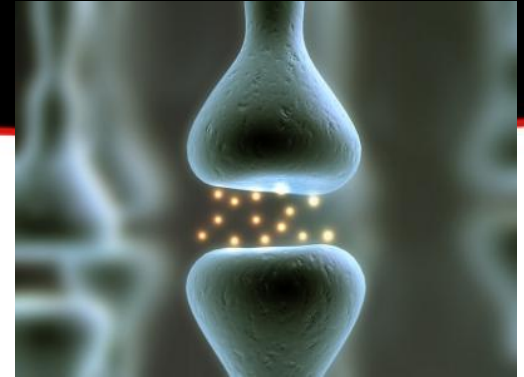


Connections Form Between Neurons (Brain Cells)

- When two *dendrites* grow close together, a contact point is formed.
- A small gap at the contact point is called the *synapse*.
- Messages are sent from one neuron to another as electrical signals travel across the *synapse*.

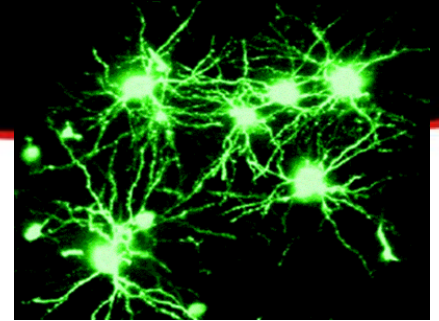


As We Learn...



- As we learn, specific dendrites grow so that specific neurons connect at specific synapses to create large and more complex networks.
- There can be as many as 10,000 connections (synapses) per neuron (100 billion neurons).
- Do the math!! - a very complex network.

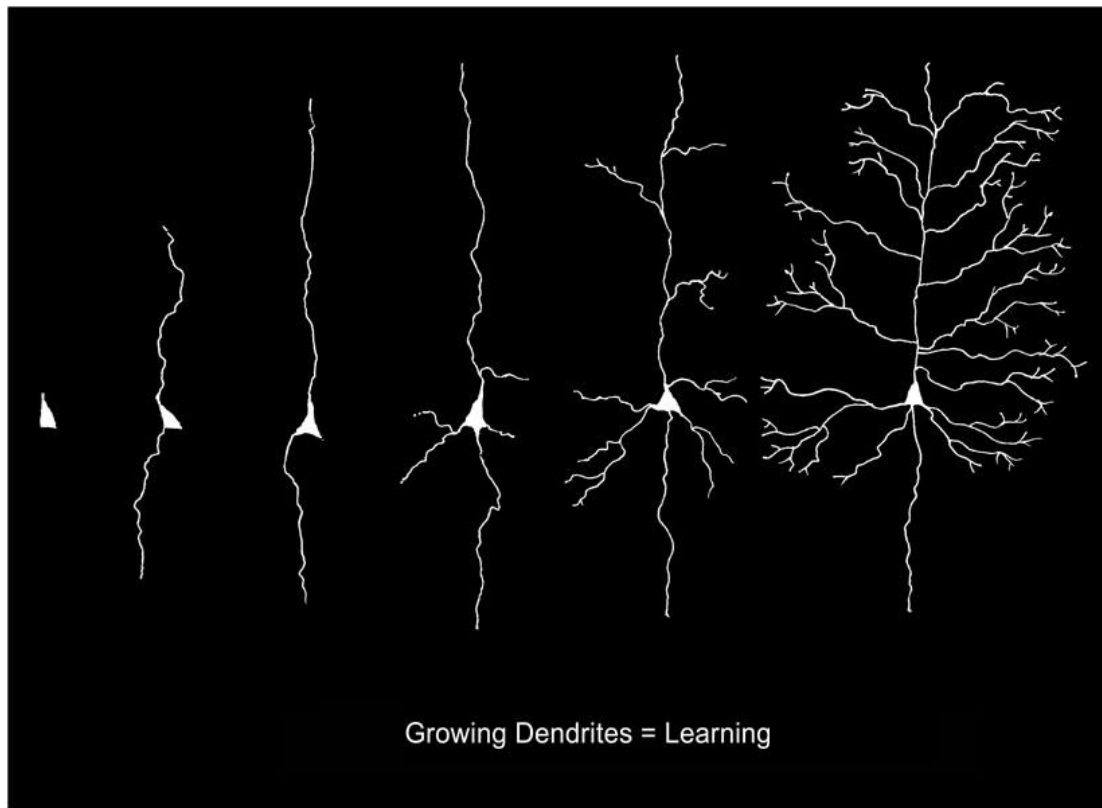
As We Learn ...



- Synapses can change in number minute by minute.
- Some synapses are strong, and some are weak – so weak they don't even send a signal.
- Through learning, weak synapses can become strong.
- No matter how many synapses a neuron has, it also has the potential to grow more.



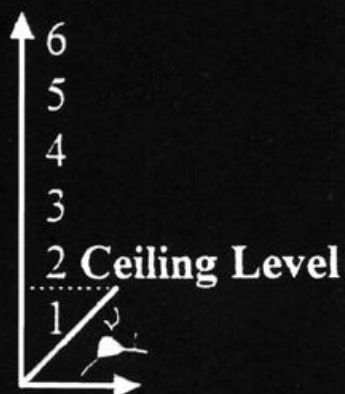
Growing Dendrites = Learning





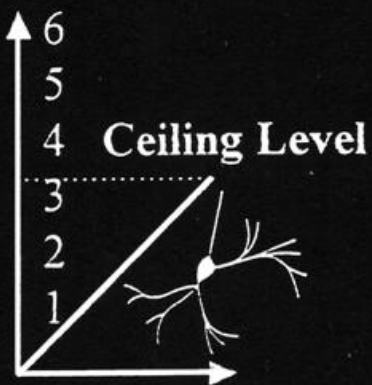
Neural Network Growth

Knowledge and Ceiling Level Increase with Neural Network Growth



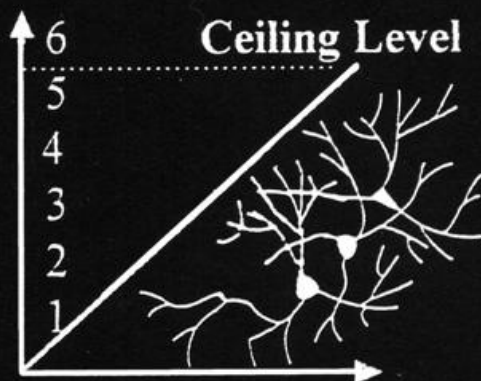
Little time and effort

Low ceiling level



More time and effort

Medium ceiling level

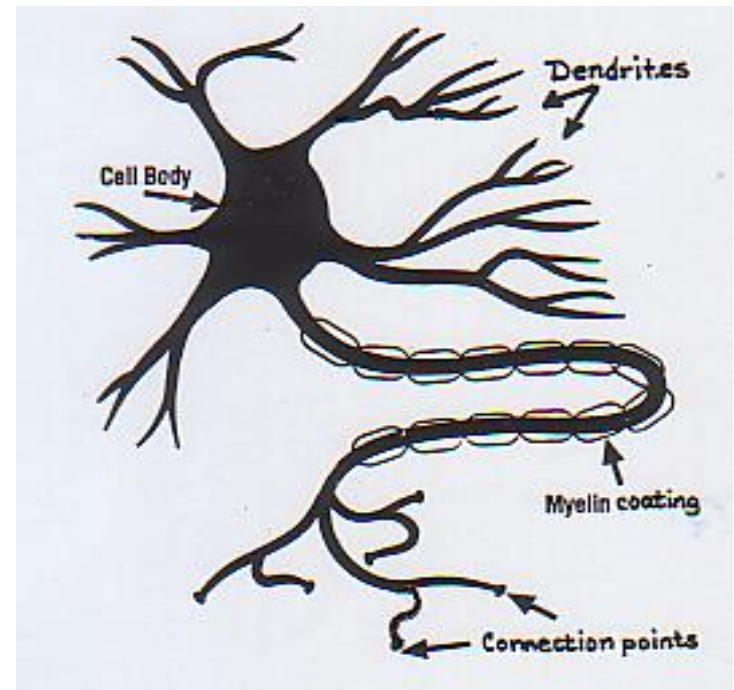


Much more time and effort

High ceiling level

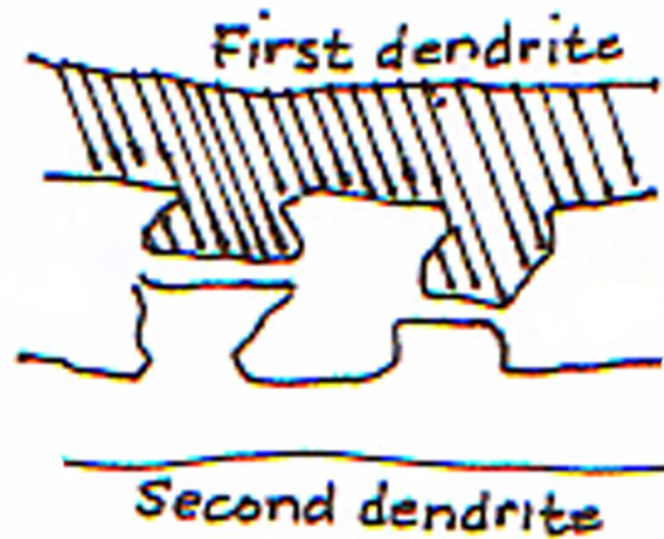
“Practice” Builds Stronger Connections

- When you practice something, the **dendrites** grow thicker with a fatty coating.
- The thicker the **dendrites**, the faster the signals travel. The coating also reduces interference.
- Have you ever noticed how some people seem to come up with the answer quicker than others?
Thicker dendrites.



“Practice” Builds Double Connections

- With enough practice, the dendrites build a ***double*** connection.
- Faster, stronger, double connections last a very long time.
You remember what you learned!



Implications

If students have not had the opportunity to grow the foundation *dendrites* for a new topic or skill, they don't have the basis from which to grow – on which to connect and construct – the *dendrites* for the higher levels of skill and knowledge.

Should we judge students as incapable or of less intelligence or talent and throw them and their potential away because they never had that opportunity?

No one can understand anything if it isn't connected in some way to something they already know.

Short-term Memory Is Very Short!

- If you learn something new and do it only ***once*** or ***twice***, the ***dendrite*** connection is very fragile and **can** disappear within hours.
 - Within 20 minutes, you remember **only 60%**.
 - Within 24 hours, you remember **only 30%**.

But if you practice within 24 hours, and then practice again later, you **remember 80%**.

Make the Most of Practice Time

- You grow *dendrites* for **exactly** the same thing you are practicing.
- If **you listen or watch** while math problems are solved, **you grow dendrites for listening or for watching.**
- If **you actually solve** the problems **yourself**, you grow dendrites for solving.

$$\begin{array}{r} 82 \\ - 77 \\ \hline \end{array}$$

$$31 \overline{) 12,012}$$

$$8^2 + 2(A + A^2) = 27$$

$$\sqrt{6} \qquad 3 \frac{8}{9}$$