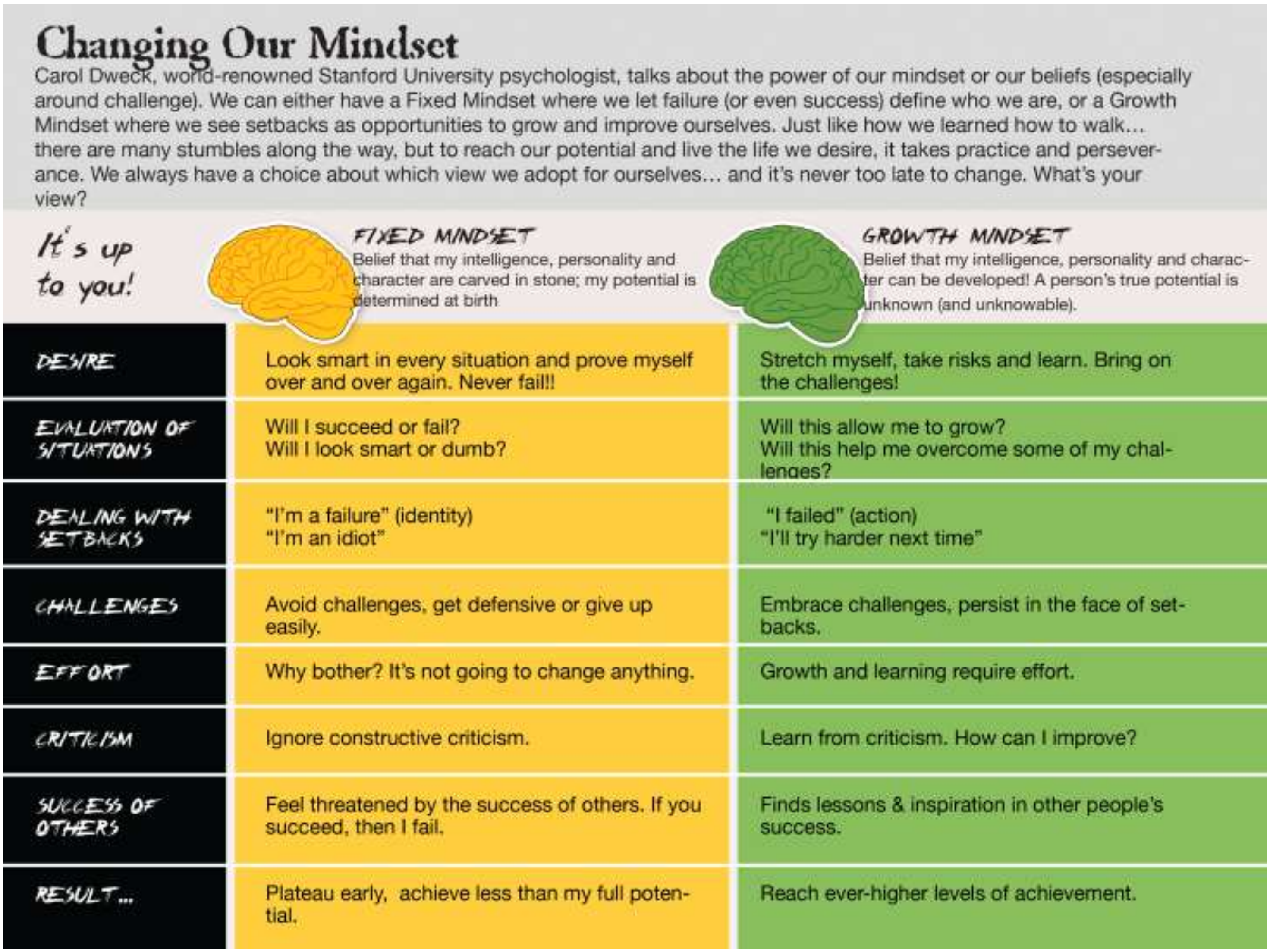
How People Learn

The field of neuroscience is just beginning to understand some of the psychological and physiological foundations of **how we learn**.

PART A: MINDSETS

One of the most important recent discoveries about learning is the importance of your **MINDSET** about learning.



Changing Our Mindset

Carol Dweck, world-renowned Stanford University psychologist, talks about the power of our mindset or our beliefs (especially around challenge). We can either have a Fixed Mindset where we let failure (or even success) define who we are, or a Growth Mindset where we see setbacks as opportunities to grow and improve ourselves. Just like how we learned how to walk… there are many stumbles along the way, but to reach our potential and live the life we desire, it takes practice and perseverance. We always have a choice about which view we adopt for ourselves… and it's never too late to change. What's your view?

It's up to you!	FIXED MINDSET Belief that my intelligence, personality and character are carved in stone; my potential is determined at birth	GROWTH MINDSET Belief that my intelligence, personality and character can be developed! A person's true potential is unknown (and unknowable).
DESIRE	Look smart in every situation and prove myself over and over again. Never fail!!	Stretch myself, take risks and learn. Bring on the challenges!
EVALUATION OF SITUATIONS	Will I succeed or fail? Will I look smart or dumb?	Will this allow me to grow? Will this help me overcome some of my challenges?
DEALING WITH SETBACKS	"I'm a failure" (identity) "I'm an idiot"	"I failed" (action) "I'll try harder next time"
CHALLENGES	Avoid challenges, get defensive or give up easily.	Embrace challenges, persist in the face of setbacks.
EFFORT	Why bother? It's not going to change anything.	Growth and learning require effort.
CRITICISM	Ignore constructive criticism.	Learn from criticism. How can I improve?
SUCCESS OF OTHERS	Feel threatened by the success of others. If you succeed, then I fail.	Finds lessons & inspiration in other people's success.
RESULT…	Plateau early, achieve less than my full potential.	Reach ever-higher levels of achievement.

According to Dr. Dweck, your mindset is not set in stone. You weren't born with either a fixed or growth mindset. **You can choose which mindset you will have**! Although, changing your internal dialogue and habit of thinking with a fixed mindset is not easy, it can be done. As you approach learning in IB Biology this year, please think with a growth mindset.

A great [TED talk video about Mindsets] is available here.

PART B: RESEARCH INTO MEMORY AND LEARNING

Research into the brain, memory and learning is a rapidly expanding area of scientific study which perfectly illustrates the cooperation and collaboration between groups of scientists. Psychologists, molecular biologists, biochemists, physicians, pharmacists, mathematicians and computer scientists all work together to understand the functioning of the brain.

The newly formed Science of Learning Institute at Johns Hopkins University illustrates the collaborative nature of brain research. The institute has the people with the following areas of expertise on the team:

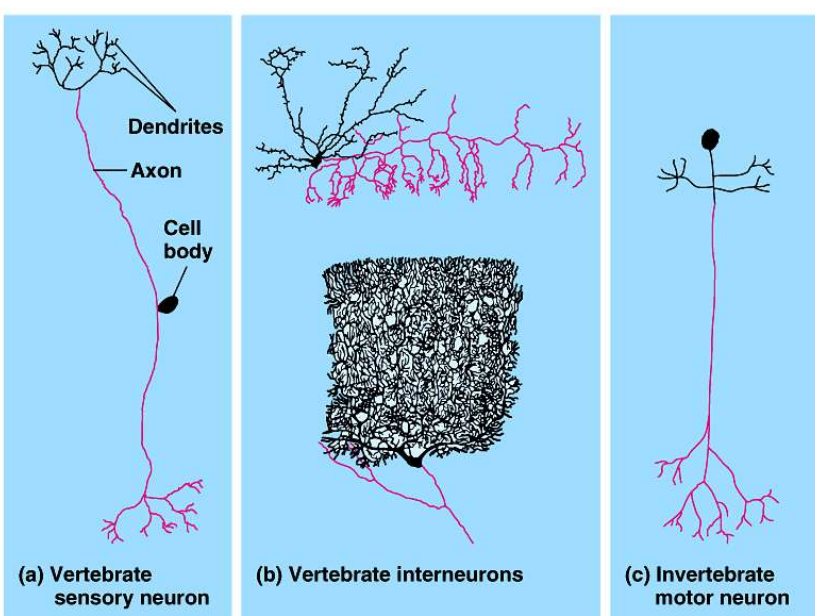
- Neuroscience
- Electrical engineering
- Computer engineering
- Psychology
- Pediatric medicine
- Cognitive science
- Surgery
- Education
- Philosophy
- Mechanical engineering
- Biomedical engineering
- Genetics
- Radiology

There are research institutions and universities around the world investigating learning and the brain. Although there is sometimes competition among scientists to be the first to make a discovery, there is also cooperation and assistance between scientists.

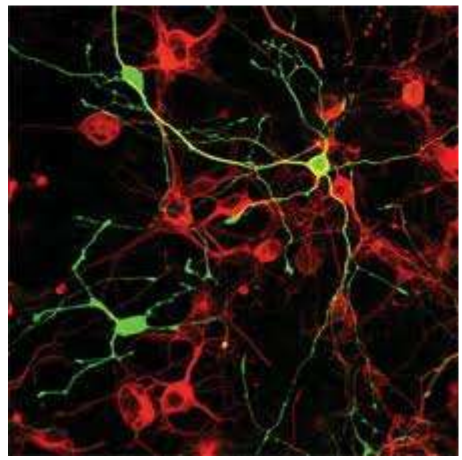
PART C: BIOLOGY OF LEARNING

The following is a basic breakdown of what we think we might know.

1. Learning is the process by which new knowledge or skills sticks to our brains. Its *functional "sticky" unit* is the **neuron**. Neurons are cells specially adapted to communicate with each other. Neurons have a **cell body** and fibers which extend from them called **dendrites** and **axons**. These fibers are the key to learning because they are the connectors between cells.

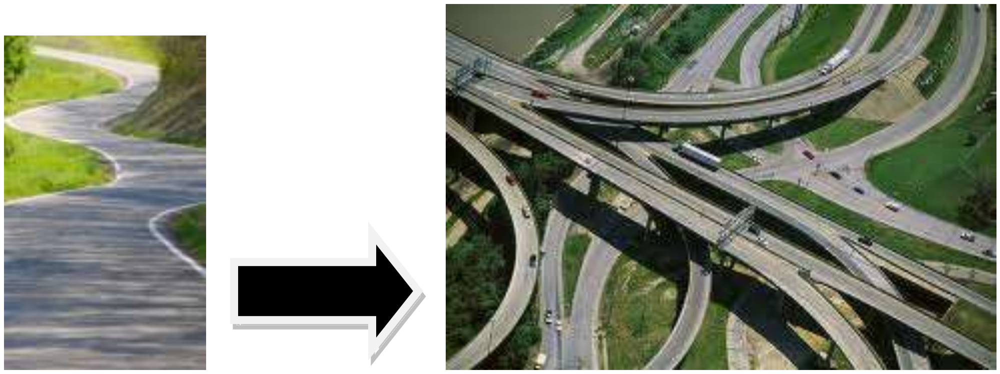


2. Everything we experience is reflected in the brain by neurons which communicate to form what are called **neural pathways**. These networks can be pictured as overlapping 3-D road maps which span brain regions responsible for processing everything from the bitter-sweet taste of dark chocolate to why your neighbor is such a grump. As we learn, these neural “road maps” interact and shift while also fading or strengthening in relation to our experiences.



3. Whether it be recognizing a friend or changing a flat tire, learning entails the formation and strengthening of *connections* or **synapses** between neurons. Brief experiences typically leave connections tracing as short-lived neural network. This might be envisioned as crisscrossing deer paths which, if left unused, fade quickly.

4. After repeated exposure to a learning experience, like the second time we change that flat tire, the associated neuronal connections are reinforced, resembling more a network of single lane country roads than deer paths. And when it comes to daily practice and *expertise* in a skill, one can imagine that the guy at the local tire shop would have the neuronal equivalent of intersecting super-highways. This strengthening of neural network connections is thought to be the physiological basis of learning.



5. **To summarize**: The neural pathway becomes “entrenched” through repetition of the stimulus. The more times the neural pathway is used the more dendrite connections. The more dendrite connections, the faster the message can be sent. Think of singing the song “twinkle twinkle little star.” The very first time you sing the song, you don’t know the words because no neural pathway exists. The next time you sing it, it is easier to remember the words because you have started to create a neural pathway. Eventually, all you need to hear is “twinkle twinkle…” and the rest just comes into your brain. This happens because you have forged a strong neural pathway through the repetition of singing the song.

6. The path → country road → city street → freeway analogy is really good – but what is happening at cellular or molecular level when learning occurs? The answer is that we still have a lot to learn about learning!

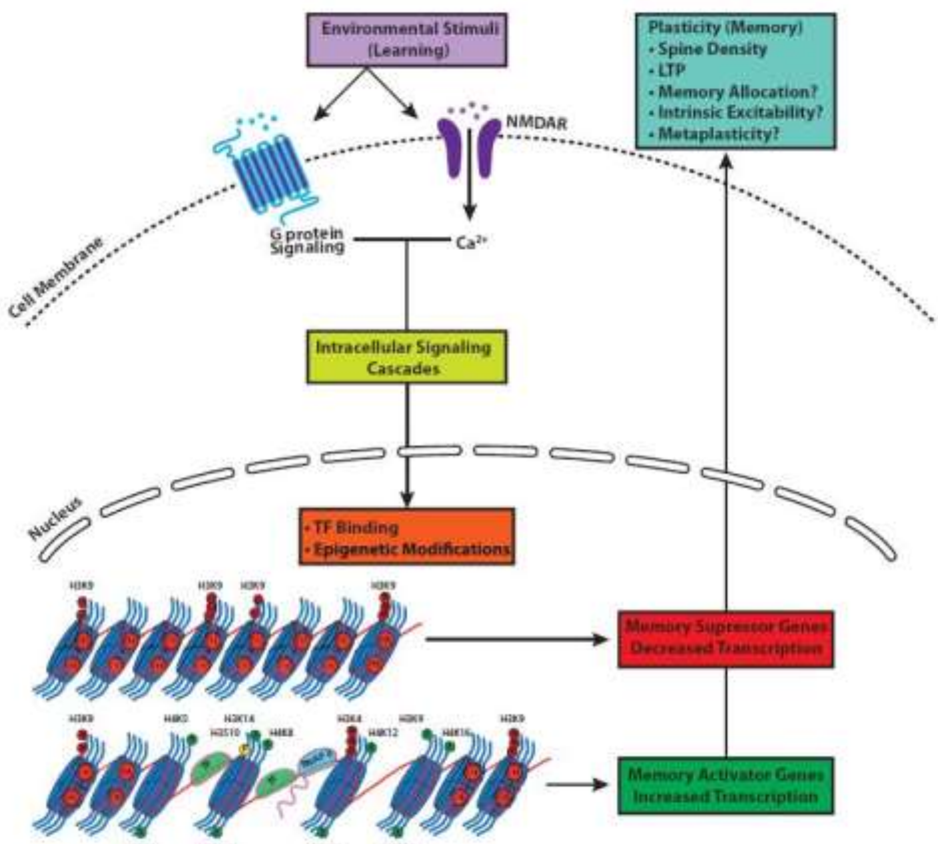


Figure 2. A model depicting the role of epigenetic mechanisms in memory formation and maintenance. Environmental stimuli, which consist primarily of associative learning tasks in animal models, initiate cellular communication by activating specific post-synaptic receptors. Receptor activation stimulates specific intracellular signaling cascades that lead to particular patterns of epigenetic modifications, which in turn regulate the access of transcription factors (TF) and RNA polymerase II (RNA P II) to gene promoters. These regulatory processes result in an increased transcription of memory activator genes and decreased transcription of memory-suppressor genes, which ultimately promote memory formation and maintenance through effects on long-term potentiation (LTP), spine density, memory allocation, cell excitability, and metaplasticity.

PART D: IMPORTANCE OF REPETITION

Remember, each time you are exposed to a learning stimulus the neural connection becomes stronger and stronger. Therefore, **REPETITION IS THE KEY TO LEARNING**. We've actually known this for a long time!

CITATION

Effects of repetition and spaced review upon retention of a complex learning task. Database: PsycARTICLES
Reynolds, James H.; Glaser, Robert [Journal Article]
Journal of Educational Psychology, Vol 55(5), Oct 1964, 297-308. doi: 10.1037/h0040734

ABSTRACT

2 experiments were conducted to evaluate the effects of (a) amount of S-R repetition and (b) the spacing of periodic review sequences upon retention of academic materials taught to junior-high-school Ss by programed instruction methods. Repetition was varied by constructing programed sequences which contained 3 different levels of stimulus and response repetitions for each of a number of scientific terms being taught. Spaced review consisted of presenting review frames of previously learned materials after Ss had received other interpolated learning tasks. Results indicated that variations in repetition had only transitory effects upon retention, but that spaced review produced a significant facilitation in retention of the reviewed material.

Science 16 September 1966:
Vol. 153 no. 3742 pp. 1351-1358
DOI: 10.1126/science.153.3742.1351

ARTICLES

Time-Dependent Processes in Memory Storage

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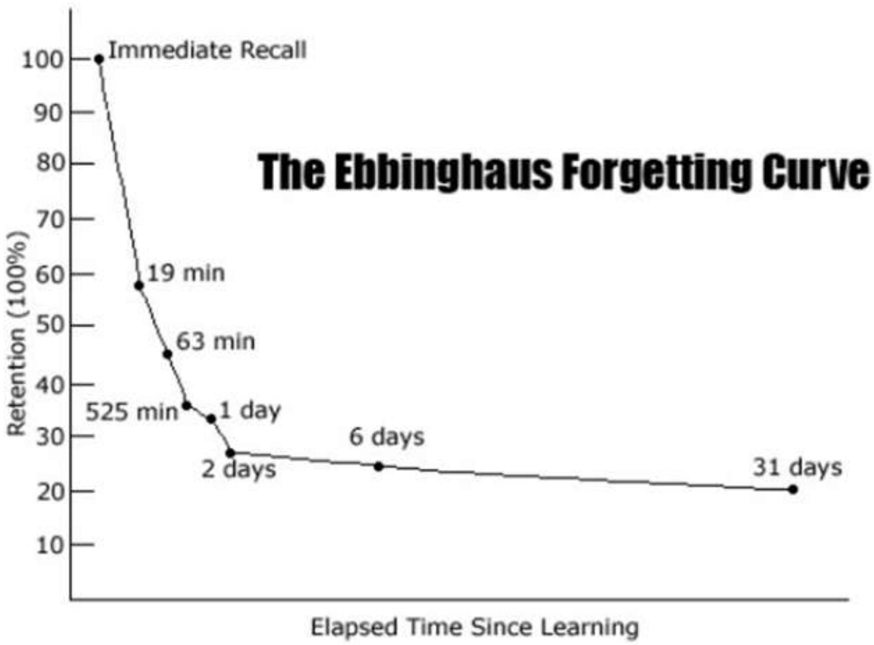
ABSTRACT

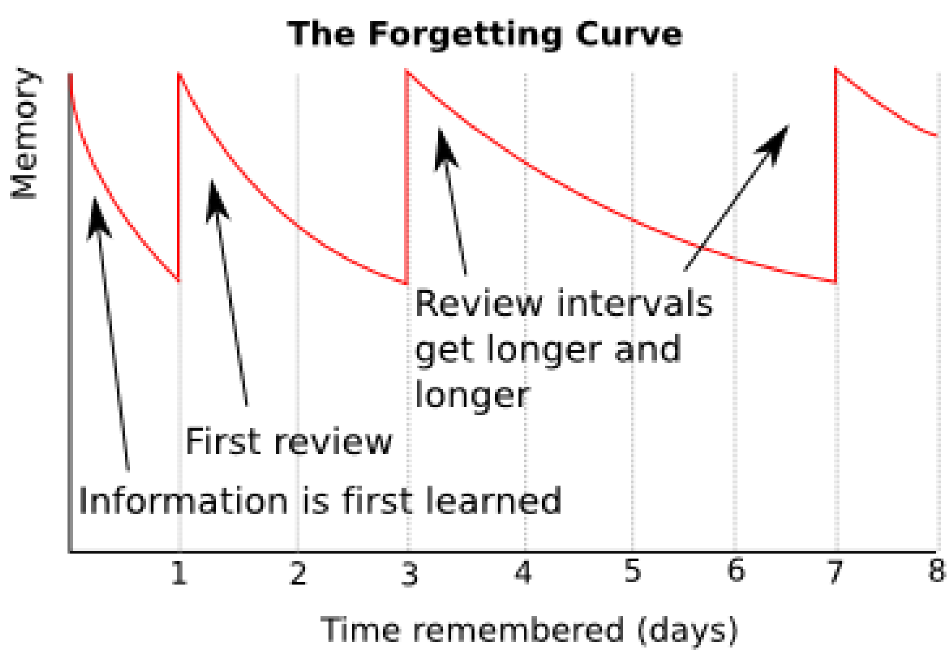
These observations indicate that the long-lasting trace of an experience is not completely fixed, consolidated, or coded at the time of the experience. Consolidation requires time, and under at least some circumstances the processes of consolidation appear to be susceptible to a variety of influences— both facilitating and impairing— several hours after the experience. There must be, it seems, more than one kind of memory trace process (31). If permanent memory traces consolidate slowly over time, then other processes must provide a temporary basis for memory while consolidation is occurring. The evidence clearly indicates that trial-to-trial improvement, or learning, in animals cannot be based completely on permanent memory storage. Amnesia can be produced by electroshock and drugs even if the animals are given the treatment long after they have demonstrated "learning" of the task.

Without repetition, what the brain is able to recall after initially learning something diminishes with time. The “forgetting curve” shows the percentage of recall over time, and more importantly, the percentage of information forgotten.



Without review, the further out the test is from learning the material, the lower you can expect to score. **Duh.**

7. To be efficient, you as a learner need to expose the brain to the information you wish to learn at key times. These are 24 hours, 48 hours, one week and once a month for as long as you wish to remember the details of the subject. Through repetition, knowledge can be kept at an optimal level. This isn’t made up, real science supports this.



PART E: MULTITASKING WHILE LEARNING

Do you have your phone near you? Put it away.
Do you have multiple internet browser tabs open? Close all but this one.
Are you texting? Stop.
Are you sending an instant message? Type *brb* or *g2g*.

The fact of the matter is, we cannot learn well while the brain is multitasking. According to BrainFacts.org…

More than one task splits the brain

Whenever you need to pay attention, an area toward the front of the brain called the prefrontal cortex springs to action. This area, which spans the left and right sides of the brain, is part of the brain's motivational system. It helps to focus your attention on a goal and coordinates messages with other brain systems to carry out the task.
While the right and left sides of the prefrontal cortex work together when focused on a single task, the sides work independently when people attempt to perform two tasks at once. Scientists at the Institut National de la Santé et de la Recherche Médicale (INSERM) in Paris discovered this when they asked study participants to complete two tasks at the same time while undergoing functional magnetic resonance imaging (fMRI). When the scientists told the group they would receive a larger reward for accurately completing one of the two tasks, they found that nerve cell activity increased in only one side of the prefrontal cortex. However, when the greater reward was associated with the other task, the other side became more active. The findings suggest that when there are two concurrent goals, the brain divides in half, says INSERM neuroscientist Etienne Koechlin, who led the study.

When the scientists asked the study participants to attempt yet another task, they found that the participants regularly forgot one of the three tasks they were asked to perform. The participants also made three times as many errors as they had made when attempting only two tasks. Koechlin says the study demonstrates that while we can readily switch between two tasks, we "might be in great trouble when we try to juggle more than two tasks, simply because we have only two frontal lobes."

To put it simply, when we are multitasking, the brain is not able to "consolidate" information. Watch this YouTube video to learn more. *Note: the biologist in me must point out that humans and dinosaurs did not live on the planet at the same time.*