BRAIN TOOLKIT

AN OWNER'S MANUAL FOR THE TEENAGE BRAIN

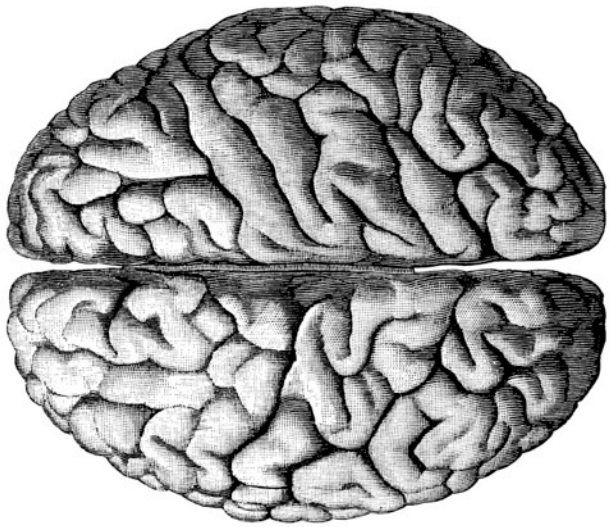
STEP-IT-UP-2-THRIVE

BRAIN BASICS

Size and Appearance

How big is the brain and what does it look like?

- **Color:** The cortex (outer layer) is gray.
- **Size:** The brain is a little larger than your fist.
- **Weight:** The average human adult brain is about 3 pounds, the weight of a large dictionary.
- **Texture:** The brain has a soft, lumpy texture similar to cottage cheese.
- **Appearance:** The cortex is folded with many grooves and looks a little like a shelled walnut. The top layer of the brain, or cortex, has deep grooves because it is crumpled up. The brain's surface is a lot bigger than if it were smooth. This makes it possible to fit more brain area inside our heads.

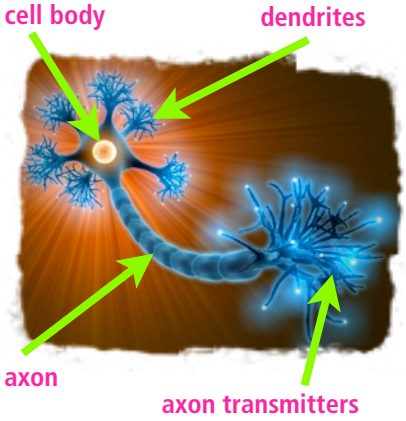


The brain is made up of billions of nerve cells called neurons. The cell bodies in these neurons make the brain appear gray. These neurons are connected together in multiple communication networks, and they "talk" to each other. When you have a particular thought or work on a skill, the thinking for that thought or skill happens in a network of cells that sends signals through trillions of connections. A trillion looks like this: 1,000,000,000,000.

Neurons have a very special shape with different parts that allow them to connect to other neurons.

Brain Anatomy

- **Cell body:** The cell body contains the nucleus and is the neuron's main control center. The cell body listens to the messages from other neurons and decides when to fire a signal to send the message further along the pathway of communication.



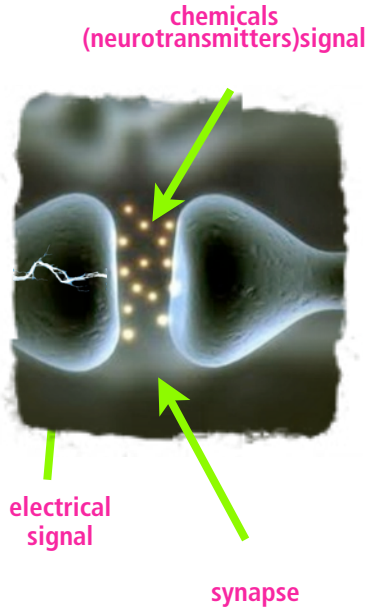
- **Axon:** The axon carries the electrical signal down the neuron to the space between cells (synapse). There, the Axon Terminal Transmitters, change the message to a chemical signal.

- **Axon Transmitters:** The splayed ends of the axon that change an electrical signal from the cell body to a chemical signal. Chemicals are called neurotransmitters and they cross the space between nerve cells.

- **Dendrites:** Dendrites are extensions attached to the neuron's cell body, that are out in the space receiving the chemical signal from the other neurons.

- **Synapse:** The synapse is the space between neurons where chemical messages are sent from one cell to others.

- **Message Speed:** When you are stimulated by something, whether it be something touching your skin or communication from other cells in the brain—that stimulus causes neurons to fire off signals. Messages travel as fast as 1000 feet per second, or 680 miles an hour. That is the speed of a fast jet plane. Connecting signals become thoughts and those thoughts trigger actions.



- **Neurotransmission:** The word that describes a combination of electricity and chemicals that work together to send messages on nerves, around your brain and body.

- **Electricity:** When a neuron gets stimulated—for instance, by something touching your skin—it builds up an electric charge. The charge flows through the dendrites to the cell body. The cell body triggers the charge to flow down the axon to become a chemical at the synaptic space.

- **Chemicals:** Every neuron makes chemicals called neurotransmitters. When an impulse travels down the axon, it triggers the release of these chemicals into the space between it and the next neuron (the synapse). The chemicals cross the gap and lock into receiving sites on the next neuron's dendrites, sending along the message.

LEARNING AND THE BRAIN

What is learning? What is happening in your brain when you learn?

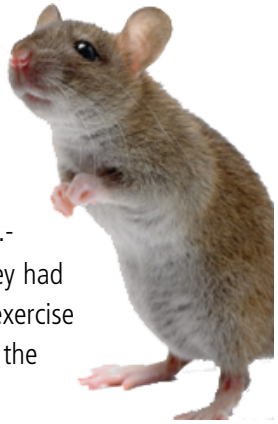
Networks of neurons

When you think or practice something, the neurons in your brain communicate by sending messages through a network of connections. The neuronal dendrites grow and lay down new connections with each other. The more you learn, the more connections, and the bigger the nerve cell network!

These growing networks process information faster and faster as they grow stronger. This means that you can think and remember something better, as the brain cells repeat and repeat their communication patterns.

Research: How do we know that the brain grows with learning?

Remarkable Rats



Twin rats were raised in two different environments: either in a bare cage with food and water, or in a cage with lots of puzzles, toys, and exercise equipment to explore. In the bare cages, the "cage potato rats" just ate and drank and lay around. In the enriched environment, the "summer camp rats" were busy exploring and exercising their brains.

It turned out that the summer camp rats became much smarter than the cage potato rats.- Summer Camp rats were better at learning new things. And their brains were heavier too. They had more connections between the neurons in their brains. This research shows that active mental exercise builds up the brain and makes it smarter. Even old rats were able to develop their brains in the enriched environment. This fact proves that you're never too old to grow your brain!

Guerilla Warriors

Growing your brain might work with rats but is this also true for people? A team of leading brain researchers took a group of Spanish-speaking guerrilla warriors who were completely isolated since they were young. They had never seen books and did not have any formal education. They didn't know how to read or write. After the war, and to help them re-adjust into society, the scientists worked with them and taught them how to read. A couple of years after the classes, they measured their brains. Just like the rats, their brains grew in the "reading areas", compared to the people who were not taught how to read.

Clever Cabbies

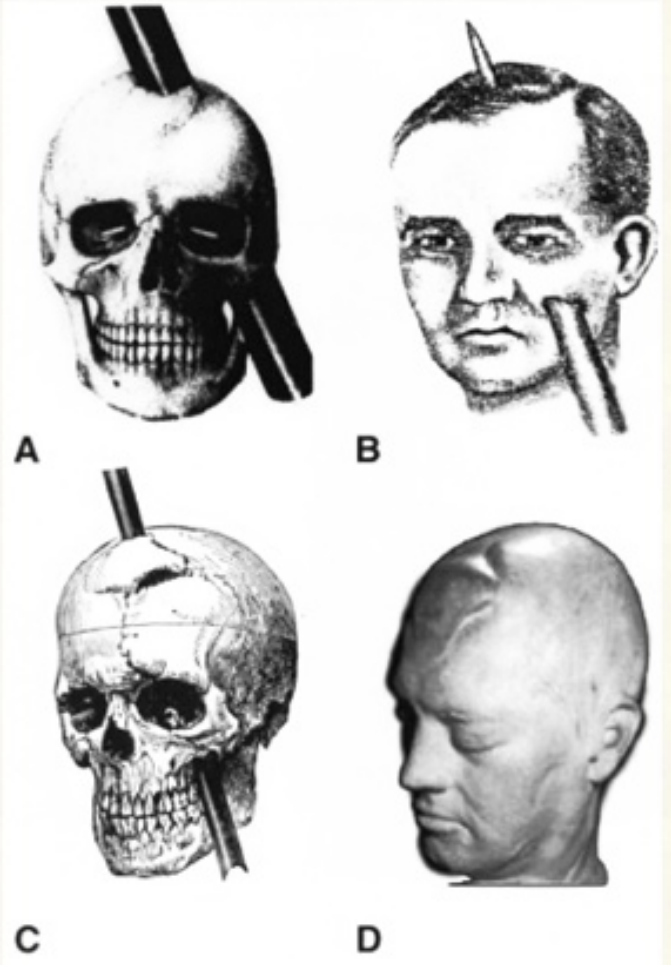
London cabbies have to learn the locations of many different places, because their streets don't have numbers. Scientists measured these cabbies' Hippocampus - the area of the brain that remembers information about places. The scientists compared their brains to other people. The cabbies' Hippocampus area was bigger, and the longer the cabbies were on the job, the bigger this area of the brain became! This shows that learning and practicing this skill made that area of their brain grow.

Phineas Gage

A man named Phineas Gage was a very successful railroad worker over 160 years ago, in 1848. He had a "well-balanced mind". He worked quickly, was patient, planned ahead, and was very good at business. All of this changed one day when an accidental gunpowder explosion sent a large iron spike through the front of his face! It went through the frontal lobe of his brain.

Fortunately, Phineas Gage's injury healed pretty quickly and he did not die from the accident. But he was left without most of the frontal lobe in his brain. Since the frontal lobe controls things like planning ahead or keeping emotions under control, poor Phineas showed little self-control. Instead of being a good businessman, or biting his tongue when he was angry, he'd insult people. He would say things that were mean, and he didn't have any patience.

His frontal lobe never grew back. Instead, Phineas formed new connections and created new pathways. It



THE GROWTH MINDSET

What is a growth mindset?

The growth mindset is the belief that your basic qualities and abilities are things that you can change and grow. Through effort, the right strategies and getting help from others, you can achieve more than you thought you could. With this brain toolkit, you know about how your brain can change.

How does it affect you?

A mindset about your intelligence, physical ability or personality can affect many parts of your life. Like the rats and guerilla fighters, you can grow your brain to become better at math, writing, or any sort of academics. You can grow ability in the same way that Michael Jordan grew his ability. Once he shot free throws for three hours, after missing an important shot. Even your personality can change and develop. Think of Phineas Gage who changed his ways. You can grow aspects of your personality too.

What is a fixed mindset?

Unfortunately, some people don't know abilities change, and they operate with a fixed mindset. These people believe that they have a certain amount of intelligence, or a kind of personality, or a certain moral character, that cannot be fundamentally changed. When they encounter something that is very hard for them, this belief causes them to quit too early because they don't think they can succeed.

How you develop a growth mindset?

Life gives everyone hard challenges. Most times, you can improve greatly by trying this:

- increase effort
- adjust strategies
- seek help.

When you are actively using and practicing a skill or thought pattern, people and animal studies show the brain lays down more neuronal connections that speed up the ability to think in that network. What starts out hard, gets easier.

Your brain is like a muscle.

It grows through effort and challenging exercise.

WHAT MAKES YOU SMART?

We are all wired differently, in terms of our starting genetic makeup. In our early childhood, these differences lead each of us to experience some tasks as initially easy and others as initially hard. Nature is then very smart in its design of the brain. This "lump of clay" is designed for you to sculpt and shape it, throughout your lifetime. You stimulate your brain's genetic coding and determine what grows strong and what skills slide away from disuse.

Intelligence can include many different skills such as using language, solving math problems, being sensitive to other people's behavior; or figuring out how objects move in space. But all forms of intelligence have one thing in common. They depend on strong neuronal connections that pass messages well, through the network associated with that type of skill.

Famous People

People who are famous for their skill are like many, many other people when they start. They began to stand out from the crowd with practice and lots of focused effort. They don't start out as genius. They work at it!

- The Beatles put in 10,000 hours of practice to become great. They used to play 8-hour shows to improve their playing.
- Founder of Microsoft computer software, Bill Gates, used to wake up at 3:00 a.m. to spend hours using the supercomputer at a local college. He started with computers as a teenager and worked very hard to reach success.
- Wilma Randolph, the first American woman to win three gold medals for in the Olympics, was paralyzed as a child. She put in at least 10,000 hours of practice to go on and win track and field medals.

With challenge, the smarter you become!

Intelligence is the ability to think, and especially the ability to take new information and use it in creative ways. When you learn new things, you make new connections in your brain. The more connections between brain cells, the more you create new thoughts. You will actually notice yourself feeling smarter. In fact, the used brain areas actually grow bigger as your knowledge increases. You will find things become easier when you work on them.

What's the best way to exercise your brain and make it smarter?

When you don't know very much about a subject, it can make you feel "dumb." Then you may feel like giving up. But this is only because you haven't built up the networks of connections in that area of your brain. If you work out your brain, it gets stronger, just like muscles that are exercised.

WHAT DOES YOUR BRAIN NEED?

Tip #1: Feed Your Brain!

Fuel

The brain is the biggest energy eater in your body, burning about 30% of the fuel your body uses. Eggs, nuts, and fish are some food sources that provide your brain with the chemicals it needs.

Sleep

Your brain needs to spend one-third of the time sleeping to recharge (8-9 hours a day). When you don't get enough sleep, you can have trouble remembering and learning things. In fact, your test scores can be 15-30% lower than they would have been if you had gotten enough rest.

Exercise

Your brain works better when you get regular exercise. When you exercise the brain grows new cells and learns more easily.

Challenge

When you challenge your brain, you build more connections, which allows you to retrieve information more easily and improve.

Tip #2: Keep the Focus!

Using too many channels at once for different kinds of information can pull your brain in different directions and gives you brain static! Try to avoid texting, doing homework and surfing the web at the same time!

Tip #3: Go Multimedia!

Using all your information channels (sight, hearing, body movements) for one activity will increase your brain's learning power. This is because you will be using more of your brain for learning. It can also make learning more fun. Get active in your learning by writing things down, drawing pictures or talking it out with someone else.

QUESTIONS ABOUT THE GROWTH MINDSET

Here are answers to some common questions that people have:

If my brain can keep growing does that mean it can burst out of my skull?

No. Your brain will never outgrow your skull. When you work your brain, more connections are made, and your brain becomes more dense.

Do people change into a completely different person from one day to the next?

NO! Having a growth mindset doesn't mean that you have to believe that people are turning into different people from one day to the next. People aren't like werewolves that change when the moon comes up. People change slowly and gradually, and it takes effort, the right strategies, and help from others to change the pathways in your brain.

If someone is shy and wants to become outgoing, it is not true that the most shy person on Friday will become the most outgoing person on Monday. But it is true that no matter where someone starts out, they have at least some room for growth and change— even if they are old or have habits that are really set in their ways. The brain is like clay, and can be re-molded with effort.

A friend or family member has a bad habit. Is it my job to change that person by myself?

NO! People have to change themselves. Other people (like you) can help, but one person can't take the whole responsibility for changing another person.

If your family member or friend has a bad habit, or if an acquaintance at school does mean things, there are efforts you can make to help them change. You can point out how their behavior affects you, or be patient as that friend tries using different brain pathways to develop new, better habits.

However, change has to come from within a person. This means that although you can help someone change by giving them support, or being patient with that person, change usually takes the person's own decisions and experiences, and support from lots of people.

With a growth mindset, will I always overcome my challenge, for sure?

No, sometimes it takes more than effort. To be successful at a challenge, you must also pick the best strategies and at times, seek help too. Sometimes you do all these things, and you just aren't getting there. There might be a barrier that you can't control. Then, consider picking an alternate goal, still moving in a forward direction.

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