NEUROSCIENCE

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CHAPTER 1

MIND CONTROL

Nathan Copeland can play video games with his mind. It all started with a car accident. He was just 18. The crash left him paralyzed. He could not move his arms or legs. Scientists later contacted him. They had a question. Did Nathan want to be part of an experiment? He said yes. Nathan Copeland controlling a remote robotic arm with his brain



Four machines were planted in his brain. These are called Utah arrays. They have electric wires. Each is hooked up to the brain. They go in different parts. Nathan thinks. His brain sends out signals. These go through the wires. They make a pattern. A computer reads this. Then it does what he wants.

A video of Nathan went viral. He is playing a game. It is *Final Fantasy* XIV. His character raids dungeons. It fights off beasts. **Brain waves** do the work.



His thoughts can also control a robotic arm. It can move objects. Nathan helps around the house. The hand sends messages back to him. They go to his **sensory cortex**. This hacks into his sense of touch. He can "feel" what the hand is doing. Nathan calls himself a cyborg. His brain is part machine.



Founder of the Gazzaley Lab UCSF Neuroscience Imaging Center studying neural mechanisms through gaming

He is not the only one. There is a woman in Spain. Her name is Berna Gómez. She was blind. But

Fast Fact

Some video game companies are developing electrodes that sit on the scalp. Players can navigate by thought control without needing a brain implant. This technology is still in its testing phase and is not yet available for public use.

now she sees. A machine was put into her sensory cortex. It takes in information. This comes from a camera. The data goes right to her brain. This lets her see lines and shapes. She does not use her eyes. All of this is possible because of **neuroscience**. This is the study of the brain. It also includes the **nervous system**. The work



combines many fields. Biology and psychology are two. People use math and computers. The tools are high tech.

Now we can ask big questions. How do we think? Why do we feel? What makes us act? Neuroscientists work to find answers.





CHAPTER 2

THE AMAZING BRAIN

The brain may not look important. It is pink and gray. The surface is wrinkly. It is also jiggly. This is a bit like Jell-O. The brain weighs about three pounds. It feels soft. Most of it is fat.

But look closer. There is much more to see. Our brain controls how we think. It also tells us how to act. How does it do that? The brain is made up of cells. These are **neurons**. They are not like other cells. Neurons can talk to each other. Signals pass between them. These send messages. They tell the body what to do.



Ancient Views About the Brain

Ancient people did not know what to make of the brain. The Egyptians preserved mummies, or bodies, of the dead. They saved the body parts they deemed important, such as the heart or the stomach, in jars. But the brain was thought to be useless. It was scooped out through the nose with a hook and thrown away.

Greeks thought the brain's job was to cool the heart. It did this by oozing mucus. The Chinese believed the brain was part of the kidneys. It contained a sea of marrow that nourished the body. René Descartes was a famous French philosopher. He believed the brain was full of animal spirits. They flowed through the body like wind.

How many neurons are in your brain? There are about 100 billion. Here is one way to picture this. You could stretch them out. Put them end to end. The line would be 600 miles long. What is the most complex object in the universe? It is the brain. Signals race through it. They move faster than 250 miles per hour. Many signals happen at once. People have tried to count them all. But there are trillions per second. All of this happens using very little power. A light bulb uses more.

The brain is like the world's greatest supercomputer. We each have our own. But it does more than calculations. It is aware. The brain gives us a personality. We can feel and think. It dreams up endless ideas. Understanding how this happens is a big job. It starts with looking at the brain's smallest parts.

Fast Fact

A team of engineers from Washington State University is trying to build a computer chip that acts more like the human brain. It is made of tiny pieces of dried honey that are placed between metal electrodes. These mimic the neurons in the brain.

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The human brain is squishy, jiggly, and weighs approximately three pounds. Yet it is the most complex thing in the known universe. Discoveries about the human brain have led to extraordinary medical treatments, and scientists are learning more and more about this small, yet vital organ every day.







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