# Lesson: “How does your brain control your body?”

## VIDEO TRANSCRIPT

### EXPLORATION VIDEO 1

Hi, it's Doug! One day, people were going to work in a small town outside of Dublin, Ireland. And as they did so, they stumbled across something terrifying. It was this: a giant crack had opened up in the street. Now, some people were curious. And so they walked up to the edge. Would you? I mean, you'd have to be so careful, right? Look at that. Looks like you could fall right in—wait, wait a second. What just happened? What is going on? Ah, that's not a crack. It's not a crack at all. It's just a sidewalk painting. It's artwork painted by an artist named Edgar Mueller. It just looked like a crack in the ground. It was that realistic-looking. This is what's called an illusion. And for a moment, it tricked you, didn't it? Now, to be more exact, it tricked your brain. Your brain is an interesting organ. And we're going to trick it with some more illusions today. Now, you probably already know that your brain is one of the most important organs in your whole body. We think of it as the body's boss or commander, really. It's in charge. Scientists have discovered that without your brain, your legs wouldn't walk, your mouth wouldn't talk, your heart wouldn't even pump. And we think of the brain as really us too, right? It's who we are. I mean, think about it. As you get older, the different parts of your body, they start to get older too. They wear out. So if some future technology let you replace some of your body parts as they get older—like replace your heart, or replace a leg—you'd get on pretty well. You'd still be you, just with a new heart or a new leg. But what if you got a new brain? That'd be terrible. You'd lose

everything, all the great memories you'd have. You'd lose memories of all the good times with friends and all the trips you'd taken. You wouldn't even know who your parents are. You wouldn't know your favorite food. Scientists have figured out a lot about the human body. They know how hands work, and muscles, and eyes. But the brain, so much of who we are—so much of what we do—is our brains. It's our thinking and our memories. And yet, of all the parts of the human body, the brain is maybe the most mysterious to scientists. Like, for example, how exactly does your brain store all those memories you have? Do you know no one has figured that out yet? Or why do our brains dream at night? That's a mystery. Now, it's not that scientists have figured out nothing about the brain. They have some interesting clues. And also, unlike so many other organs, doing a dissection of the brain and looking at it with just our eyes, that hasn't been super helpful. It's not like your hands, where scientists can look inside and easily see how those work—you know, little strings pulling on bones. The brain doesn't have any moving parts in there. There's no wheels or gears that are turning in there. When you have a great idea, there's no light bulb inside that actually goes off. So what is this thing inside that head of yours? What is your brain? What does it do? That's the subject of today's Mystery. Now, to get some sense of its jobs, let's consider another illusion, a quick experiment that might surprise you. Do you think that you can make it look like you have a hole in your hand? Watch my friend, Pat, do this. Then, you'll have a chance to try it. First, she rolls up a sheet of paper to make a tube. And then, keeping both eyes open, she looks through the tube with one eye and covers her other eye with her hand. As she slowly moves her hand forward away from her eye, when she gets the distance just right, she sees this. See? She can totally make it look like she has a hole that goes right through her hand. Try this out for yourself. The next slide shows you what to do after you roll a sheet of paper into a tube.

## EXPLORATION VIDEO 2

If it looked like you had a hole in your hand, you can't blame your eyes because each eye was just reporting to the brain what it saw. The reason it looked like you had a hole in your hand was because each eye saw different things. One eye saw a hole, the rolled-up sheet of paper. But the other eye saw your hand. Your brain took the information from each eye and combined it into one picture, a hole in your hand. But then your brain did something next. It had to make a decision based on what it was seeing. It had to ask itself, is this real? Do I really have a hole in my hand? Obviously, this was a really quick decision. You knew right away you didn't actually have a hole in your hand. It's not like you were going to call for an ambulance or something. But that's only because your brain didn't just receive information from your eyes. You know you have other senses too. Your brain got information from down in your hands, down in your sense of touch or your sense of feeling. And you knew you didn't feel any pain in your hand. When scientists look carefully in dissection, we can see that all the senses have cords going back to the brain. These cords are called nerves. They carry information from your senses to the brain. This includes not just your eyes and your sense of touch, but your other senses too, like your nose, your tongue, and your ears. So in the hole-in-the-hand illusion, you observed one of the brain's many jobs, one that it's constantly doing, and that's to take in information from all of your senses and combine that information and then make decisions about that information. In other words, your brain has to think. Most of the time you didn't even notice your brain making decisions, like with the hole in your hand. It just seemed automatic. You knew there wasn't really a hole. But scientists have figured out an experiment to slow down that thinking, to make thinking a little harder so that you can really notice yourself trying to think or make decisions. You're going to do one of these experiments now. Go to the next slide. And if you're in a group,

have a volunteer tried out in front of everyone first, and then everyone can have a turn. See if you can notice your brain's thinking or making decisions when you do this experiment.

## EXPLORATION VIDEO 3

In the experiment you did with colored words, it was the switch from reading words to naming colors that took a lot of effort. A lot of decision-making was going on inside your brain. Rather than doing what you were used to doing, you had to think really hard to ignore the words and instead say the colors. So we've seen now that the brain is always getting information from your senses with nerves leading into the brain. And then, there's thinking or decision-making that the brain does with that information. As this last experiment with colored words showed you, you could really feel your brain thinking hard. But what good is all that information and thinking, if you can't do anything? As it turns out, through dissections and experiments, scientists discovered that there's another different set of nerves leading outward from the brain into your arms and legs out to all the different muscles and the body. It's by using these movement nerves that the brain controls the movement of your body. This way, you can respond to the information and thinking that your brain has been doing. For example, if you'd really thought there was a hole in your hand, you might pick up the phone and call 911. You can only do that because of the movement nerves that connect your brain to the muscles in your arm and hand. Now, what you're seeing here is just an illustration. It's been drawn by somebody. But movement nerves are real things. They look like this. This is a photo of real nerves on display at a museum. So there are nerves running into the brain from your senses—the sensory nerves—and nerves running out from your brain to your muscles—movement nerves. So now, let's see how all these work together—sensory nerves, thinking, and movement nerves—in a little experiment that you can do right now in your classroom. I'm going to show you how in the next video.

## ACTIVITY INTRODUCTION VIDEO

In today's activity, you and a partner are going to do an experiment called Think Fast. This experiment lets you measure how fast your brain can see something happening, and then react to it. Here's the setup. A partner will hold a ruler between your fingers, like this. Then, without any warning, your partner will drop the ruler. And you have to try to grab onto it. To figure out how fast you were, you'll look to see what centimeter mark is right by your thumb when you grab it. Now, a low number, like eight, means your reaction time was really fast. You caught the ruler before it had time to fall very far. But a high number, like 19, means you had a slower reaction time. So how fast do you think your brain can react? I'll show you what to do now, step by step.

## ACTIVITY STEP 1

Find a partner to work with. Decide who will be the Dropper and who will be the Catcher. And don't worry, you'll switch jobs later. When you're done with this step, press the arrow on the right.

## ACTIVITY STEP 2

Get your supplies. Here's what each group needs.

## ACTIVITY STEP 3

Look at your ruler. Notice how one edge shows inches and the other edge shows centimeters. For this experiment, you'll be using the centimeter side.

## ACTIVITY STEP 4

Before you begin the experiment, we're gonna show you an example of how to do it. But don't do anything yet. Just watch. OK, Catcher, you'll rest your hand off the table, like this. Dropper, you'll hold the ruler up. And then, you'll drop it. Catcher, you'll try to catch it. You got it? OK. Now that you know what you'll be doing, go to the next step.

## ACTIVITY STEP 5

Now there are two rules you have to follow to keep the experiment fair. They're written right here on the handout, but I'll also talk through them right now. Rule number one: the Dropper has to hold the ruler so that the 1-centimeter mark is between the Catcher's fingers. Only then can you drop the ruler. Rule number two: the Catcher can't move their fingers or touch the ruler until they see the ruler drop. If they do what the person in the video's doing, that's cheating. Now that you know the rules, go to the next step, and you'll start the experiment.

## ACTIVITY STEP 6

Now, try the experiment. PS, Catcher, hold on to the ruler after you catch it, like that. So that you can check the number of centimeters. After every catcher has had a chance to catch the ruler once, you can move on to the next step.

## ACTIVITY STEP 7

Catcher, read off the number where you caught it. Dropper, write it on their handout. The smaller the number, the faster you're reacting.

## ACTIVITY STEP 8

Now, do two more trials. Then, switch jobs, and let the other person do their three trials. Don't forget to fill out your experiment sheets as you go.

## ACTIVITY STEP 9

Figure out your fastest reaction time using this chart at the bottom of your experiment sheet. This chart converts the number of centimeters into the time. Once you figure it out, circle the award for your fastest time.

## ACTIVITY STEP 10

Discuss these questions as a class.

## WRAP-UP VIDEO

So your partner dropped the ruler, and you could see it dropping the instant they let go of it. But come on, why weren't you able to grab it right away? You might have realized it's because it takes time for all these things to happen. It takes time for messages to travel through your nerves. Think about all the things your brain had to do during that experiment. And here's the ruler you had to grab. And this is you stripped down to just your brain and your eye nerves and your arm nerves. So when your partner dropped the ruler, your eyes saw that and then sent that information to the brain. Then your brain had to realize what it was seeing and send a message down your neck through your arm all the way down to your finger muscles saying, grab it. But even though it feels like you should be able to do all of this immediately, it's always going to take a little time for all these steps to happen, even if that time is just a little tiny part of a second. It's

not instant. Now maybe you notice that the catcher got better with practice, like you got faster on your third try than you were on your first try. When you make a movement over and over, your eyes and nerves and brain get better at it. But no matter how good you get at something, it will always take some time for your eyes to tell your brain to tell your hand to move. In fact, it's been said that if you use $1 bill or any paper money instead of a ruler, if you held it and dropped it from the center, like this, watch. Almost no one on earth is fast enough to grab it by the time it falls. You should definitely try this out some time. So we've seen now three of the brain's really important jobs. One, it takes in information that it gets from your senses. Two, it makes decisions about that information, or, in other words, it thinks. And three, it controls the pulling of your muscles to make your body move. And there's even more that the brain does, like it stores all your memories across your whole life. And it's also the organ involved with your emotions, like happiness, sadness, anger, and so on. But that's another topic. You've seen today that we can at least get some understanding of how the brain works just by giving it certain tests, like the hole-in-the-hand the illusion, the word color test, and the ruler reaction time test. But so much about the brain and how it works still remains a mystery, questions like, why do we dream, and how are our memories stored? There's so much to be solved, and hopefully someday some scientist will crack some of these great secrets about the brain. Maybe that future scientist is even sitting in the room right there with you. Will the scientist to solve these mysteries be you? Stay curious and see you next Mystery!