Lesson: “What do people who are blind see?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! I want you to meet someone today: this guy. His name is Tommy Edison. Now, Tommy's job is a film critic. That's someone who reviews movies, like *Spider-Man* or *Batman*. Here's an example.

> *“Coming out of the theater, you know what? I thought it was a good movie. I didn't think it was a great movie, but it was decent. You know what? Go early. Save yourself a couple bucks.”*

Tommy has reviewed hundreds of movies. And yet, he's never actually seen a movie, ever. That's because Tommy Edison is blind. In addition to running a movie review channel on YouTube called the Blind Film Critic, Tommy has a separate YouTube channel where he answers all the many questions that people ask him about being blind. Like, "What do you think that blue, red, green, and other colors look like?" Or, “What was it like growing up blind?” Or here's one: “Tommy, is there anything good about being blind?" Let's hear what Tommy has to say about that one.

> *“People always say, oh, you poor guy. It's true. But you know what? There are plenty of good things about being blind. I go on airplanes first. I get VIP treatment at amusement parks. I got out of gym. All through school, I totally got out of gym. It was awesome. My*

hearing is so much better than everybody else's. In fact, all my senses are better than yours."

Tommy says all his senses are better than sighted people's. That's true. Being blind, Tommy doesn't get to enjoy looking at the world, so he really has to rely on his sense of touch and smell. Here's one video where Tommy answers the question, "What are your favorite things to touch?" Let's hear what he says.

"And now, it's time to talk about things I like to touch. Dice—dice are cool to touch. First off, whatever they're made out of, it's a neat material. I'm not quite sure what the heck that is. But then you can feel the numbers on them and stuff, little holes and everything. I like them. Another thing I really enjoy is with my feet to touch stuff, like to walk on the beach. I love the feel of sand on my feet, that fluffy sand. Or even when you get down close to the water, and it's like low tide and stuff. And it's all packed down and cool and everything. That's nice to touch as well. Dogs, right? They've got real coarse fur. There's nothing too soft about it, until you get to the ears. That is a nice touch. I could touch a dog's ear all day. I wish they'd make something out of that. All right, not out of the ear itself, but something that was similar."

Tommy gets lots of questions from his viewers. But by far, the most common question of all he gets is this: "What do blind people see?" Is it just blackness? Well, it depends. There are actually different kinds of blindness. Some blind people, yes, see nothing. And I guess if we could imagine it, it would look like this. But other blind people see something, more like this. Can you tell what this even is? You can tell that there's light areas and there's dark areas, and maybe a shadow of something there. But who knows what it really is, right? In fact, it's a cat sitting on a window ledge, see? So, these blind people, they can still see light and dark. But that's it. Here's the light coming in through the window. And here's the shadow of the cat. When

you have this kind of blindness, the whole world just looks like blurry shadows passing by. You can't actually see objects or things. And then, there's another category of people who aren't blind exactly, but they need to wear glasses. Like me—I wear glasses. Without my glasses, my vision is like this, blurry. It's pretty bad. Now, I'm not blind. But my vision is so bad, I wouldn't be able to drive without my glasses. What's going on in all these examples? Why these problems with vision? Why are some people, like Tommy Edison, blind? And then, why do some other people, like me, have blurry or bad vision? What do you think is going on with our eyes?

EXPLORATION VIDEO 2

You probably noticed that human beings' eyes have three really noticeable parts. First, there's the white part, which we just called the white of the eye. Second, there's this black part that's at the very center of the eye. It's what's called the pupil. And finally, there's this donut-shaped, colored part. That's called the iris. Most people in the world have a brown iris, but there are all kinds of different shades of brown. And then some people have completely different colors of iris. So, it's possible to have a green iris or a blue iris or a mixture of color. In fact, the word “iris” comes from the name of the Greek goddess of rainbows since people can be born with irises of different colors. So, that's the iris. Now, given that people have different colored irises, it's possible you thought, well, maybe that's why some people have better vision than others. But there isn't any one iris color that means having better or worse vision. There are blind people who have blue eyes and blind people who have brown eyes and so on. Hmm. So why do some people have better vision than others? Gosh, you know, it is useful to get a sense of what the outside parts of the eye are. But what are we doing here? If we want to understand how the eye works, we need to see inside the eye, right? Whenever it comes to understanding the body, that's always one of the things that medical scientists do. They look inside. We call it dissection.

So, let's do that. I'm going to show you an eye dissection—not of a human eye, though. Instead, we'll look at a cow's eye. Now I realize that may sound kind of gross, but if an animal like a cow is already dead, you might as well not let the eye go to waste, right? So, here it is. This is the eyeball from a cow. It has a black pupil, and the iris also happens to be really dark, like almost black colored. Now, right away, one thing to notice is why we call it the eyeball. Usually, you only see the very front part of the eye, but as you can see here, the whole thing, it really is shaped like a ball. The same thing is true for a human eyeball. Ours is just a little bit smaller than this, about the size of a ping pong ball. OK, so now you see the scientist is going to cut the eyeball in half so that just the front part of the eyeball is left, the part that has the iris and the pupil. Here she is taking it off. Here's something really crazy to notice. That's the front of the eye. Look as the scientist picks the front of the eye up, and, look, you can see through the center of the eye. You can see her glove in the background there. Now remember the pupil looked like a black spot, but now we can see that it really isn't. It's a hole in the eye. This isn't just true for cows' eyes. Human eyes are the same way. The pupil looks like a black spot, but it's actually a hole. It just appears black because it's a hole into the eyeball, which is dark on the inside. Here's a helpful way to think about it. The inside of the eyeball is kind of like a dark room, a dark room that has a little hole or window in the front. That window is just like the hole in an eye. It's just like the pupil. Light comes into the eye through the pupil. Now if you look at an eye from the side, you can imagine the whole thing now, the whole eyeball. You can see the parts we already talked about on the outside, but now you can also see one more part that you hadn't noticed before. Look, right there, there's a clear layer over the very front of the eye. This is called the cornea. It acts like a protective layer so that dust or dirt can't get in through your pupil. But the cornea has another very special function. The cornea is a lens. So we're going to call this part the cornea lens. Now, if you're not exactly sure what a lens does, you're going to find out very

soon. Before we go any further, though, let's just quickly summarize what we learned from the dissection by looking at the front of the eye. Imagine it's a bright sunny day. The sun is shining on all the objects around you. In other words, you can see things around you. If the sun weren't out or there were no light, you wouldn't see anything. The light from the sun hits those objects around you, and then that light enters your eyeballs. I'm going to show the light with an arrow. So as the light comes toward your eye, it goes through the cornea lens, the clear layer at the front. Then the light goes through the pupil. And then what? Well, then it shines on to the back of the eye. At the back, there's a layer that's a lot like a screen in a movie theater. This screen is called the retina. The retina senses the light that hits it and sends a message to the brain. At the very, very back of the eyeball, behind the retina, there's a cord that connects the eye to the brain. This cord takes messages from the retina to the brain. So you've got the front of the eye—which has a cornea lens and the pupil where light can come in—and you've got the back of the eye, which has the retina—the screen that detects light and sends messages to the brain through the cord. OK, so now we know all these parts of the eye and that light goes into the eye. But how do we actually see? I mean, all these parts together are what allow us to see the world. But how? Well, you can figure it out. In the next video, I'll show you how to build a model of the eye.

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to make a model of the eye. Then you'll use your model to figure out how an eye works. Sometimes people make models that look just like the real thing, but don't really work—like this model of a car that only looks like a car. It doesn't actually work like a car. But some models, like ours, don't exactly look like the real thing, but it's going to work just like one. This is going to work just like a real eye. You see, to make an eye that works, we don't

really need the whole eyeball—we just need the front of the eye with the pupil and the cornea lens, and we need the back of the eye with the screen. So we're going to keep it simple and just make those two parts. They'll look like this. The front of the eye with a hole in lens and the back of the eye with the retina. The retina may not look like much, but just wait. Once you build these two parts, you're going to do some experimenting. Just like in a real eyeball, you'll let light shine through the cornea lens and pupil onto the retina of your eye model. And then you'll see what really goes on inside your eyeballs. Ready? Here's how to make one, step by step.

ACTIVITY STEP 1

Get these supplies. You'll also need a cornea lens, but you'll get that later. When you're done with this step, press the arrow on the right.

ACTIVITY STEP 2

Cut out the rectangle, then color in the iris. You get to choose the iris color. Notice you're making the front of the eye.

ACTIVITY STEP 3

Flip the paper over so the eye faces down. Then, fold the paper in half this way. Run your fingernail over the fold to make a sharp crease.

ACTIVITY STEP 4

Flip the paper over and fold the paper in half, like this. Run your fingernail over the fold to make a sharp crease.

ACTIVITY STEP 5

Cut on the dotted line like this. You'll be cutting through a few layers of paper. When you're done, you'll have made the pupil.

ACTIVITY STEP 6

Unfold the last fold. Your paper should look like this, with the eye facing down.

ACTIVITY STEP 7

Fold the four solid lines, like this. Make a good crease on each fold. When you're done, it'll look like this.

ACTIVITY STEP 8

Tape each side down by putting stickers or tape on the dark grey rectangles. Now you have a paper pocket, which you'll put a lens in later.

ACTIVITY STEP 9

Everyone get a cornea lens. Look through it and notice how it changes what you see.

ACTIVITY STEP 10

Slide the cornea lens into the paper pocket, like this. Now the front part of your eye model is all done.

ACTIVITY STEP 11

Look at the blank side of the three-by-five card. Write "retina" up in the corner. This card is the retina, the screen at the back of your eye.

ACTIVITY STEP 12

Teacher, turn off the lights, but also open any curtains or blinds so light comes in through the windows. You need a dark room with just one or two sources of light. A window is ideal, but if you don't have one, a lamp with a lampshade will also work.

ACTIVITY STEP 13

It's time to experiment. Grab both parts of the eye and stand up. Then turn your body so one shoulder is pointed at the window. When everybody is in this position, go to the next step.

ACTIVITY STEP 14

Turn the eye so it's looking at the window. Hold the retina just behind it. Watch the retina as you move it farther away. Do you see anything on the retina? Keep experimenting until you see something interesting.

ACTIVITY STEP 15

Did you see a picture on the retina? If not, you might be too close or too far from the window. Change where you're standing and try again, if you need to. Just remember, wherever you stand, make sure your eye model is looking at the window.

ACTIVITY STEP 16

Make the picture on the retina as sharp as you can. Then make it blurry.

ACTIVITY STEP 17

Discuss this question as a class.

ACTIVITY STEP 18

Discuss this question as a class.

ACTIVITY STEP 19

Take the cornea lens out of the eye and try to make a picture on the retina. Can you do it?

ACTIVITY STEP 20

Discuss this question as a class.

WRAP-UP VIDEO

So, once you created your model, you were asked to do some experimenting with it in order to see how the eye works. Let me show you some things we found by experimenting with this eye model. So, one thing you hopefully noticed is that when you get the back part of your eye model just the right distance from the front part of the eye model, presto: an image comes into focus at the very back. That is exactly what's going on inside the eye of a person who has great vision. The back of their eye is just the right distance from the front of their eye, so that what they see is

always in nice, sharp, crystal-clear focus. But notice, though, that if the back of the eye is just even a little bit too close to the front of the eye, or if it's just a little bit too far from the front of the eye, then the image isn't focusing well anymore. Now the image looks blurry. You've just discovered a major reason why some people have blurry vision: their eyeballs are just a little bit too long like this or a little bit too short, like this. Either way, they see the world as a bit blurry. The distance between the front of the eye and the back of the eye has to be just right to see clearly. If you do have blurry vision, luckily it was discovered that if you put another lens right in front of the cornea, you can correct this, making the image at the back of the eye nice and focused. Watch one more time, but this time pay close attention to the back of the eye. See, the extra lens makes the image clearer. Does this seem familiar? This is what eyeglasses do. Glasses are just an extra lens in front of your eye that makes the image on the back of the eye sharp and clear instead of blurry. It's the perfect solution if your eyes are just a little bit too long or too short. What about blind people, though, like Tommy Edison. Why can't they see? Well, there are two main reasons that people can be blind. The first reason is that there's something wrong with the front of the eye—specifically, the cornea lens. Hopefully, you tried experimenting with not having a cornea lens. Without one, you don't see an image at all. Some people can actually be born this way, without a cornea lens that works. They have a corneal lens, it just looks like this. It might be cloudy instead of clear. This is how Tommy Edison's eyes look when he opens them. Without a working cornea lens, a person will only be able to tell light from dark. They won't be able to see objects, like that cat on the windowsill. So that's one form of blindness—blindness caused by a problem in the front of the eye. But there's also a second kind of blindness, and that would involve something going wrong in the back of the eye. For example, the screen part of the eye, the retina, might not work correctly. Or the cord that connects the retina to the brain might not work. Either way, this form of blindness is caused by a

problem in the back of the eye, and usually, it means you can't see anything—like this. Light is coming in from the front of the eye just fine, it's just not getting to the brain. Now, one final note: you might have noticed as you used your eye model that the image on the back of your eye is upside down. Did you notice that? What's going on? This isn't a mistake in the model. This happens in real eyes too. If you're curious about why, you can find out more in the Extras. I hope you had fun making your eye model, but don't take it home just yet. If you do the next lesson of Mystery Science, you'll need this model again. See you next time!