Mysteries of Your Brain

An original Bell Museum Production

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Production Script
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1. **SP010 SPACE FLIGHT:** 1

EXT. SPACE Stars, planets, a slow exploration of the wonders of the universe.

In the middle of the journey, we hear the GIRL SIGH. The sigh punctures the buoyant feel of the opening. A shooting star streaks across the sky.

GIRL

Ooh... shooting star! I love looking up at the night sky and thinking about all the planets and stars and galaxies. But it makes me wonder...

ZOOM IN quickly past galaxies, nebulae, to earth...

2. **MF010 MIND FOREST: CHARACTER INTRODUCTION** 2

...to a GIRL of about 12 sitting on a rock under an interesting tree shape. Her mind is racing with thoughts

GIRL

...who's thinking all of this. And then I forget all about the stars and wonder - what's going on in my head. Who am I?

Her questions have called the CROW into being from a constellation. He is a bit of a mad cap character. A figment of her inquisitiveness.

CROW

Who are you?!? Squawk! You... are your brain!!!

GIRL

[Breath] My brain? What? Hey - wait a minute - what are you?

CROW

Oh ho ho! Squawk Squawk! I'm a figment of your imagination. A conjuring of your consciousness.

And I'm here to take you on a journey to discover who you are and why you do the things you do! Let's go!

A WHOOSHING sound and the scene vanishes.

3. **BR010 BRAIN INSIDES: BRAIN OVERVIEW** 3

We find ourselves in the middle of the glass brain, navigating and exploring the colorful neural networks surrounding us.

GIRL

Wow. Where are we?

CROW

We're inside your brain.

GIRL

Ahh, it looks like another universe.

CROW

Isn't it amazing!? These are pathways connecting different regions of your brain, made by special cells called neurons! There are billions of neurons in your head. Almost as many as all of the stars in the Milky Way! The multitude of tiny neurons work together to make your memories, your emotions, your thoughts and dreams! They make you truly unique!

GIRL

How do they do that?

CROW

That, my featherless friend, is one of the MYSTERIES OF YOUR BRAIN!!

Music SWELLS as we see signals passing through neural networks, lighting up different areas of the brain.

4. **TITLE TREATMENT: MYSTERIES OF YOUR BRAIN** 4

5. **MF020 MIND FOREST: BEAR GROWL MESSAGE** 5

Back on the floating island, the GIRL pulls the CROW out of his grand pose

GIRL

Wait wait wait wait. STOP!. Seriously.

How does a neuron make me, me? Aren't they just special cells in the brain?

CROW

Ohhh, not just the brain. They're all over your body making up the... nervous system!

GIRL

Yeah, we learned about that in school. But I still don't get how these little cells create my thoughts and personality?

CROW

Ah, one thing at a time. First, let’s look at how neurons send messages throughout your body to drive everything you do.

GIRL

What do you mean by a message?

CROW

Well, let's see. A message could start with anything. Something you see, smell, taste or hear.

An island with a cave has floated up behind them. A BEAR GROWL sound with waveform signal emits from the dark cave.

GIRL

That sounded like a bear!

CROW

And your brain is going to send a message to your legs to run! Let's follow it!

6. **BR020 BRAIN INSIDES: FOLLOW THAT MESSAGE** 6

We see an electrical pulse start from the amygdala and traveling through parts of the neuron and reaching the synapse. Other neurons show up to receive the signal, linking together.

CROW

The message is an electric pulse that zooms along the part of the neuron called the axon.

(MORE)

CROW (CONT'D)

It passes from neuron to neuron, linking your brain, your spinal cord, your stomach, eyes, legs...everything!

GIRL

Okay, that makes sense. It’s like a bunch of wires.

CROW

Oh, not quite, an important thing that allows signals to move from cell to cell is the tiny space between neurons -the synapse!

ZOOM IN on the synapse to illustrate the following

CROW (CONT'D)

The axon of the neuron with the message squirts out a chemical across the synapse. Dendrites on the next neuron detect it. If the message is strong enough, an electrical pulse is created, and off it goes.

Camera zooms along with the signal along the axon. Above us, we see the axons covered with myelin.

GIRL

Hey, why does the axon go into that tunnel?

CROW

Good question! Some neurons have a shiny, white wrapping called myelin.

A bright signal is seen traveling along the myelinated neuron.

CROW (CONT'D)

It covers the axon, but as you can see, there are gaps. The message jumps from gap to gap, traveling even faster. Come on, let’s take the express lane!!

You see, neurons with and without myelin respond to events, carrying signals to different places at different speeds.

We slide from the un-myelinated path to the myelinated path and zoom along even faster. Like a record scratch, we pull back to forest.

GIRL

Hold on, Crow. Why do some messages go fast and some go slow?

CROW

Weeeeellll, say you happened to collide with a bird beak.

The Crow swoops down and pecks her on her outstretched hand. The Girl jumps away.

GIRL

Ahhh! What are you doing?!

CROW

Ha-ha, science!

Cut to silhouette of GIRL with pain signal zapping to arms and legs popping from standing outline to pulling away outline.

CROW (CONT'D)

That message zipped along a fast, myelin-coated path. Your brain immediately sensed danger. And you jumped away before you even realized what I did.

Back to GIRL rubbing her hand looking at CROW

GIRL

Owwwww.It hurts!

CROW

Of course it does!

Back to silhouette of GIRL with slow spreading pain signal travelling from pain point on hand.

CROW (CONT'D)

The pain traveled more slowly, along your unmyelinated axons. You didn't feel the "ow" right away.
The pain reminds you not to let an imaginary crow peck you for science.

Return again to GIRL as she gleefully puts the CROW in his place

GIRL

Hey bird brain - watch it. I can unimagine you pretty easily.

The girl snaps her fingers and the crow disappears.

CROW

Ok, I'm sorry! Squawk!

GIRL

Huh. There is some amazing stuff going on in my brain. I wonder if all animal brains are the same?

NARRATOR

I thought you'd never ask! Welcome to the Amazing Brains of Nature!
Brains, brains, brains! From the gargantuan to the infinitesimal, most animals have brains. What do they have in common? Neurons! But don't be fooled - a brain is not a brain is not a brain. Different kinds of animals evolved different kinds of brains, each with neurons organized in unique ways.

Let's take a look at a few, shall we?

9. **AB020 AMAZING BRAINS: ROTIFER** 9

NARRATOR

First up is one of the smallest brains in existence. So tiny, in fact, that you couldn't see it without a microscope. It's located in an aquatic animal called a Rotifer. That's right, a Rot-i-fer. It may be more miniscule than a mustard seed but it has a brain! About 200 neurons let this one swim around and sense food. 200 may seem like a negligible number of neurons, but the Rotifer's brain takes up a quarter of its body!
That's a lot of brain for a pint- sized plankton like this!

10. **AB030 AMAZING BRAINS: ELEPHANT** 10

NARRATOR

Pack up your trunk for the next stop on our tour. We've got a magnificent mammal that may be famous for its nose but its brain is a twelve pound marvel with over 250 billion neurons! The African Elephant has the largest brain on legs. Four times bigger than a human's! Not only can it tame the 40,000 muscles in its trunk but it can also remember every watering hole it ever visited. Incredible! I can't even remember what I had for breakfast this morning. This mammoth mind is truly one of the greats! But size isn't everything.

11. **AB040 AMAZING BRAINS: DOLPHIN** 11

NARRATOR

Stupendous Cetaceans also require recognition on our run through of amazing brains in nature.
(MORE)

NARRATOR (CONT'D)

The brain of a bottle nose dolphin is truly a thing of beauty. In some ways, it is even more specialized than a human brain. Dolphins are able to see with sound!
Echolocation requires some special wiring indeed but the dolphins we know are up to the call.

That would be notable enough to make our list, but these miraculous mammals also sleep with one eye open. Half their brain is always awake keeping them alert and alive!

12. **AB050 AMAZING BRAINS: JUMPING SPIDER** 12

NARRATOR

Now there's one more brain that just has my skin crawling to tell you about. Jumping spiders are as cute as they come, but if you're an insect, they're not so good for a cuddle!

The spider’s tiny but mighty brain helps all of its EIGHT eyes work together to detect motion and zero in for the kill in a split second. These active arachnids stalk and hunt prey with the skill of a lion on the savanna, but in this case, the savanna may be your sofa.

13. **AB060 AMAZING BRAINS: WRAPPING IT ALL UP** 13

Rotifers, elephants, dolphins and spiders are just four notable noggins on this prodigious planet. Brains come in many shapes and sizes, but at the cellular level they're all the same. Neurons are there, sending signals and making these AMAZING BRAINS OF NATURE!!!

14. **MF040 MIND FOREST: SMOOTH AND FOLDED** 14

Back in the floating world. The GIRL has been watching the show.

GIRL

Oh, wow. Those are some amazing brains.

CROW appears.

CROW

Ah-ha, but wait! He neglected to tell you about the incredible, stupendous, outrageous crow brain! We solve problems, and play, and copy and ...

GIRL

Stop! Of course. I know. Crows are great. You're my imaginary instructor after all! But why aren't elephants smarter than us with brains that are so much bigger? How can humans write stories and predict the weather? I mean, we can even make spaceships to explore the solar system. Can you explain how our brains do all that?

CROW

Well, of course! That's why I came back! Heh-he-heh-emm.

CROW clears throat, professorially.

15. **BR030 BRAIN INSIDES: SMOOTH VS FOLDED** 15

We see a silhouette of a human and a crow with their brains highlighted. We fly in low and close to the smooth crow brain. As CROW gets to human brain, we fly across to zoom along the bumpy surface of the human brain.

CROW

You see, many animals have smooth brains, but the surface of the human brain has ridges and bumps, hills and valleys. You can fit a lot of power in a small space.

GIRL

What do you mean? How does it get more power?

The camera pulls back to see the human brain and crow brains again.

CROW

From the neurons! You remember the neurons, right? Compared to mine, there's a whole lot more brain folded up in your head, and all that extra surface can hold a lot more neurons and synapses.

Both brains unfold on screen showing a dramatic size difference in surface area.

GIRL

Ah, so more neurons mean more messages, which means my brain is bigger than you'd expect and can do a lot more at the same time!

CROW

Yes, but those aren't the only differences in brains. Even though the elephant's brain is big and wrinkly, it's evolved for different jobs. Its neurons need to finely control those trunk muscles and massive legs to survive.

GIRL

Umm-hmm. More neurons, different connections...kind of like a new computer?

The spread out human brain lines glow and spread to cover the dome. The prediction machine rises up in front of the brain line background.

A new, low female voice joins in, the PREDICTION MACHINE - a capable illustrator of the brain's computational abilities.

PREDICTION MACHINE

Exactly. The human brain excels at identifying patterns and making predictions.
(MORE)

PREDICTION MACHINE (CONT'D)

In fact your brain is a three-pound prediction machine.

Under the following dialogue, an image goes in one side of the prediction machine and a different image comes out the other: A cat face changes to a human eye (sight) then changes to a full cat. Smell lines change to a human nose (smell) then changes to a plate of cookies. A waveform of a thunder changes into a human ear (head) then changes into a thunder cloud. Finally a whole scene of a videogame forest fill the room. Close to the camera there is a "BEWARE OF BEARS" sign

PREDICTION MACHINE (CONT'D)

Say you are on a trail deep in the woods, and you hear this.

[A bear GROWLS.]

PREDICTION MACHINE (CONT'D)

What do you think?

The "information" elements are highlighted in progression. First the waveform of the sound, then the trees, finally the sign.

PREDICTION MACHINE (CONT'D)

You didn't see a bear, but your brain predicted that the sound was most likely made by a bear based on the information it was given and your previous experiences. And most of these calculations were done automatically without you even thinking about it.

Bear scenario fades then a holographic ball is launched into the scene and bounces around.

Here’s another example. Think about catching a ball. If your brain wasn't able to make predictions, you'd try to grab the ball where you see it and the ball would zoom right past you every time.

However, since your brain is a prediction machine, when you glimpse the ball coming toward you, your brain begins to calculate where the ball is going to be just in time for you to catch it.

17. **PM020 PREDICTION MACHINE: OPTICAL ILLUSIONS** 17

CROW caws and interjects appearing at the controls.

CROW

Squwak! Whoa whoa whoa, not so fast. Sometimes your brain is so eager to jump ahead, it makes mistakes.

GIRL (O.S.)

What do you mean?

CROW

I mean: optical illusions. Take a look at this.

CROW presses a switch and a blurred line illusion fills the screen, circular, multicolored. Not a hologram and the prediction machine is gone. CROW and GIRL are offscreen

GIRL

Woooaaahhhh...It's swirling...

CROW

Ah, it LOOKS like it is. Your brain sees some patterns and colors and can be tricked. It keeps trying to predict where the lines are going to be. Even if they're not moving at all.

18. **AN010 ANIMATION FUN: FLIPBOOKS AND MOVIES** 18

CROW

Or have a look at this.

A drawing pad flops down onto the dome one page at a time. We see line drawings of the CROW put on a space helmet and a simple moon with craters draws on.

CROW (CONT'D)

In a simple flip book, each page shows a drawing. Flip them fast enough, and your brain fills in the blanks between with images that aren’t there. Your brain creates the illusion of movement.

CROW has started doing weightless flips and spins in space.

GIRL

Ha ha! That looks like fun!

With simple puff of smoke the girl is on the page as well.

CROW

Animated movies work the same way.

The line drawings get colorized and more graphical. They continue to float around the dome and spin weightlessly.

CROW (CONT'D)

When you're all watching us...it looks like we're moving but we really aren't.

Crow and Girl break down into stepped movement.

CROW (CONT'D)

Ha-ha! A trick of the brain!

Film burns out. Transition to new scene.

19. **MF050 MIND FOREST: HOW IS MY BRAIN DIFFERENT?** 19

Girl and crow are in a dark vast space.

GIRL

I get it now. Our brains are great at filling in what's missing and making predictions.

But you said my brain is unique. How's it different from someone else's? I still don't understand how all those linked neurons make me into me.

CROW

(thinks for a moment) Well, I've got an idea. Imagine you smell chocolate.

20. **DI010 DIORAMA: CHOCOLATE MEMORIES** 20

What's the first thing that pops into your head?

A paper diorama of a colorful birthday scene pops up. In the center is a delicious looking chocolate cake and a bright sparkling trail of scent wafts through the scene.

GIRL

My birthday cake! I loooove chocolate. I have it every year.

CROW

Ahhh, but your friend doesn't like it at all, right?

Another diorama scene comes into view of a cup of coco on a table next to an empty dog bed under pictures of a cute dog. A sad blue trail of scent rises from the cup of coco.

GIRL

Yeah, she hates it. Every time she smells chocolate, she remembers the day her dog ran away. Her mom made her hot chocolate to try to make her feel better.

CROW

You see, You like the taste of chocolate because you love your birthday but your friend connects it to something really sad.
Your eyes, ears, and nose take in information, but your brain makes sense of all those sights, sounds and smells.

The different smell trails drift around together.

CROW (CONT'D)

So when you breathe in chocolate, neurons race to spread the news. One neuron connects to the next and the next.

The signal travels its own path, creating a whole network of neurons.

Each smell trail forms a distinct shape that evokes a neural network.

CROW (CONT'D)

Your unique networks give chocolate a meaning. And presto! You love it; your friend hates it. Your brain tells you a story about who you are.

GIRL

Ahhh, that explains why our brains are different.

21. **DI020 DIORAMA: EMPATHY/EMOTION** 21

A bunch of colorful paper faces fill the dome.

CROW

Yes! Your brain is one of a kind, but humans, like crows, are very social.

Neurons in your mirror neuron system help you connect to other people, sharing their experiences.

One face frowns and turns blue and the other faces mirror this change.

GIRL

Oh, so that's why if my friend is feeling sad, I feel sad, too. Even if I don’t have a sad memory.

But then, if I smile, her mirror system neurons could fire too. That happens all the time and we both just start laughing.

A wave of smiles and laughter passes over the faces.

CROW

And since the emotion part of the brain takes cues from your body, the movement of laughter can make you FEEL happy.
But mirror system neurons aren't just about being happy or sad.

22. **DI030 DIORAMA: TREE CLIMBING** 22

CROW

Say you're climbing a tree. Neurons related to tree climbing fire.

The paper faces become the leaves of a tree and diorama of a large tree pops up and we are looking up at it.

CROW (CONT'D)

If your brother watches you, the mirror system neurons in his brain might fire too, even if he hasn’t reached for a branch. This is the start of learning and empathy.

23. **DI040 DIORAMA: I AM UNIQUE** 23

A final cutout of the GIRL covered with a sparkling network of stylized neurons that look interesting and unique

GIRL

So my networks of neurons make me unique and connect me to other people.

My brain really does make me, me!

24. **MF060 MIND FOREST: PRACTICE MAKES CHANGE** 24

This next idea is a new thought for the GIRL. She has moved past her initial question. Interrupting CROW in his moment of triumph.

CROW

And so the Mysteries of Your Brain are solved!

GIRL

Wait a minute, Crow! I'm more than just my memories and emotions. I can learn things, but I need to practice to get better, like playing the violin. Now that I think about it, it feels like I'm changing my brain.

CROW

Yes! Everything you do comes from messages sent by your neurons.
If you do something over and over again, the connections between neurons can get stronger.

CROW

Remember your first violin lesson?
[We hear a badly played violin playing Twinkle Twinkle.]

Flowing visuals illustrate the sound as it crows and improves

CROW (CONT'D)

At first, the neural pathways were hard to follow.
Your fingers struggled to find the right strings.

Violin playing steadily gets better.

But as you practiced, repetition strengthened your synapses.
Neurotransmitters flooded in. Dendrites sprouted more receptors. New synapses grew. The signal
became more and more powerful. And now...
[We hear an exciting and dynamic version of Twinkle Twinkle.]

As the CROW talks, a faint shaky line mimics the sound of the violin. As the sound becomes more confident more lines take shape and weave together to form a tapestry of the music. It is exciting and dynamic.

GIRL

Hey! I changed my brain!

The music starts to fade. A couple lines tear off and disappear.

CROW

You sure did. But beware - synapses that don’t get much use can disappear. Use 'em or lose 'em. So keep practicing!

The music builds again and new lines join the pattern to fill in the gaps.

GIRL

Because what my brain's like tomorrow depends on what happens today.

CROW

Yes! Each experience helps build you, the you of today, of this exact moment.

26. **MU020 MUSIC MAGIC: THE TIP OF THE ICEBERG** 26

We pull out from the lines and we see the girls shape is outlined. Bright and glowing.

GIRL

Now I know how my brain works! All those messages zooming around all the time. And just thinking about it makes my head tingle.

A glow lined version of the crow flashes across the dome leaving a drawn blue print space image behind.

CROW

And that's just the tip of the iceberg! You should use that amazing brain of yours to understand the mysteries of the universe.

GIRL

Yeah, there's so many unanswered questions, I better get started! I could design a new kind of telescope to peer at the furthest object in the universe and then I could create a new kind of spaceship to take us there!

27. **MF070 MIND FOREST: BLAST OFF** 27

Back to the girl and crow talking.

GIRL

I can't imagine what it would be like.

CROW

Well you've imagined a brilliant...and amazingly handsome... talking crow, so a spaceship should be easy!

GIRL

Ha-ha, you're right!

Girl snaps her fingers and she and the crow are in the cockpit of a spacecraft.

CAPCOM (WOMAN)

6...5...4...3...2...1

GIRL

Buckle your seatbelt, Crow! We're go for launch.

CAPCOM

Launch sequence activated.

VIOLIN MUSIC begins again, as the credits roll.