CRS WWW.CRSCIENCE.ORG
COMMUNITY RESOURCES FOR SCIENCE

BASIS Lesson Plan

Lesson Name: Feel Dead Brains

Grade Level Connection(s)

NGSS Standards: Grade 4, Life Science (4-LS1)
FOSS CA Edition: Grade 5, Life Science: Living Systems

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

This hands-on lesson guides students to explore the human brain and all the extraordinary things that it does for us, including thinking, our five senses, and remembering. Students will learn about the different regions of the brain and how those different regions need to communicate with one another. Students will participate in two experiments designed to trick our brains, illustrating some of the ways that neuroscientists conduct experiments so that they can learn more about the brain. Students will also have the opportunity to see, touch, and hold real preserved brains!

Lesson Objectives

- Students will learn about the different lobs of the brain (and other parts) and their specific functions
- Students will compare the brains of different species (sheep and human), and relate the structural differences to the functional differences that they learned about
- Students will learn from visual/linguistic illusions how we can run experiments on people based on their behaviors

Vocabulary Words

- **Neuroscience:** the study of the system in the body that includes the brain.
- **Frontal Lobe**: the part of your brain just behind your forehead that helps control things like planning, reasoning, social behavior, and movement.
- **Parietal Lobe**: the part of your brain directly under the top of your skull that helps control things like perception of touch and pain.

- **Occipital Lobe**: the part of your brain on the back of your head that helps process visual information that comes in from the eyes.
- **Temporal Lobe**: the part of your brain on the sides of your head that helps process sound information that comes in from the ears, helps you speak, and helps you make memories.
- **Cerebellum**: the part of your brain just above the nape of your neck that helps control things like movement, posture, and balance.
- **Brainstem**: the part of your brain that connects to the spinal cord, that helps control autonomic body functions like breathing and heartbeats, as well as reflexes like vomiting, coughing, sneezing, and swallowing.
- **Spinal Cord**: the bundle of nerves protected by the spine that transmits signals from the brain to the rest of the body, and vice-a-versa.

Materials

Scientist Volunteers will bring:

- Preserved brain, human (1)
- Preserved brains, sheep (8-16, if possible)
- Trays (8)
- Gloves for handling brains (32, one per student)
- Parts of the brain worksheet (32, one per student)
- Stroop test cards (16, one for each pair of students)
- Visual Illusion slides (or printouts if projector is unavailable)

Materials teachers should provide:

- Pens/pencils for filling out worksheet
- Projector or document camera for showing visual illusions
- Access to a sink for washing hands and trays

Classroom Set-Up

Please have students paired prior to our arrival. Ideally, these pairs will be sitting in groups of 4 or 6 so that we can easily transition into the preserved brain observations. We will need a large amount of board space for drawing a brain diagram that the students will fill in with us on their worksheets. We will also need access to a projector or document camera for projecting visual illusion images to the whole class. For clean-up, we will need access to a sink for washing hands and our specimen trays. Nametags for students are always helpful.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
Being a role model is an important part of being a BASIS volunteer! Begin your lesson by explaining who you are and what you do as a scientist. Feel free to tell your "story" as if giving an elevator pitch to elementary school students: Why did you become a scientist? What questions are you trying to figure out? What do you do in your job? Why should students relate to you? Feel free to bring in photos, specimens, and other props. Let your personality shine through!

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: *the different regions of the brain and their specific functions*. It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **The brain has specific regions that are responsible for processing different types of information. We can study the physical structure of the brain and understand how it works through experiments.**

Your topic introduction should introduce students to the phenomena they will explore. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitates student-guided conversation.

1. Introduce the phenomenon that the class will explore: *the brain has specific parts that are responsible for specific functions*.
    - Does anyone know what **neuroscience** is? [Write and define neuroscience on board]
    - Neuroscience is the study of the system of the body that includes the brain. Today we're going to talk about the brain, what it does, and explore that there are different parts of the brain.
    - The brain is really cool and is a really important organ in your body! Who can tell me some things that the brain does or helps you do? [Gather list of student responses on the board]
    - Your brain is very important because it does all of these things you just mentioned. It helps you think, remember, move, talk, eat, and almost anything else you can think of! Your brain is working hard every second of the day, every day.
    - Your brain is responsible for all of these tasks, but I have a question for you. Do you think that your brain has specific areas that are responsible for specific things? Or is it one organ in your head with all the tasks mixed together? Let's think about it this way – does your body have specific areas to process things like sound and smell and taste? [Yes!] Guess what? Your brain has specific areas that do certain jobs too!

- Now we're going to talk about the different parts of the brain. [Draw diagram on the board and pass out worksheets to students that has the same diagram on it.]
- Do you recognize any parts of the brain on the worksheet? If not, that's okay. Let's fill it out together and learn more about the brain and its different parts! [Fill in parts of the brain on the diagram on the board. Explain a little bit about what each part of the brain does.]
    - **Frontal Lobe:** the part of your brain just behind your forehead that helps control things like planning, reasoning, social behavior, and movement.
    - **Parietal Lobe:** the part of your brain directly under the top of your skull that helps control things like perception of touch and pain.
    - **Occipital Lobe:** the part of your brain on the back of your head that helps process visual information that comes in from the eyes.
    - **Temporal Lobe:** the part of your brain on the sides of your head that helps process sound information that comes in from the ears, helps you speak, and helps you make memories.
    - **Cerebellum:** the part of your brain just above the nape of your neck that helps control things like movement, posture, and balance.
    - **Brainstem:** the part of your brain that connects it to the spinal cord, that helps control autonomic body functions like breathing and heartbeats, as well as reflexes like vomiting, coughing, sneezing, and swallowing.
    - **Spinal Cord:** the bundle of nerves protected by the spine that transmits signals from the brain to the rest of the body, and vice versa.
- Let's explore these different parts of the brain further to understand how they're communicating with each other!

Teaching Tip: Say, Write, Show

- Bring in photos and props to illustrate the topic intro
- Write new vocabulary words, key terms, and brainstorm lists on the board
- Help students make sense of vocab through root words, eg neuro+science
- Refer back to the board to engage visual learners and English Language Learners

2. Learning Experience (40 minutes)

Students should be paired with a partner and placed in table groups of 4 or 6 with these pairs. Remember that all activities are designed to address the take-away in a particular way: **The brain has specific regions that are responsible for processing different types of information. We can study the physical structure of the brain and understand how it works through experiments.**

Activity 1: Stroop Test (10 minutes)

- Now that we know your brain has different regions/areas that do different things. Do you think those regions communicate with each other? [Yes!] [Provide a specific example: If you see some candy sitting in a bowl across the room, your **occipital lobe** would process that information. It would need to communicate with the **frontal lobe** so that you would get up and walk across the room to get to the candy!]
- We're going to play a game to explore how these different regions of your brain communicate with each other. The game is supposed to trick your brain! The game involves the regions of the brain responsible for vision and language [Point out the **occipital lobe** and **temporal/frontal lobes** on the board to remind students of these regions and the vocabulary words]
- You are going to take turns playing this game with your partner sitting next to you. On these cards, you will see lists of color words written in different colors of ink. The trick is that the word does NOT match the color that it's written in. For example, the word might be "green", but it's written in purple-colored ink. [If possible, draw a couple examples on the board using the available colored markers in the classroom.] We're going to play a game with these where sometimes we're going to ask you to read the WORDS and sometimes we're going to ask you to say the COLORS. We'll time you for 1 minute each while your partner counts how many words you get through. Then you'll switch so everyone will get a chance to play the game.
- Pass out Stroop cards to one student in each partner pair FACE DOWN. Don't begin until we say the magic word, which will be "Neuroscience". Ready? Neuroscience!
- Start by having the students read the WORDS and time them. Once one minute passes, have partners raise their hands and call out how many they got through in the allotted time. Draw a number line on the board from 0 to [total words on stroop sheet]. Plot each person's data on that number line with a point and explain what it means.
- Switch to the other partner and have the other half of the class go, then repeat drawing their points on the number line on the board.
- Ask students if they thought this was an easy or a hard task. [Hopefully this was easy]
- Now change to the other task where they say the COLORS the words are written in. When one minute is up, draw those data points on the number line in a different color marker [avoid red/green]. Point out how they seem to be in a different place on the number line, and then say that we need more data.
- Switch to the other partner and have the other group go, then draw their points on the number line. Talk to the students about the differences between the groups and how we can see that in our data.
- This task is difficult because there are different parts of your brain that are doing different jobs. Instead of working together, they are actually working against each other in this task. The visual part of your brain (**occipital lobe**) is trying to say the color and the language part of your brain is trying to say the word. It's really hard to separate the two streams of thought!
- This is basically how we would run this actual experiment in the lab! The last thing we would do as scientists is something called statistics. We would use the numbers here

and apply statistics to decide if the groups are different or not. Congratulations, you just ran your first **psychology** experiment!

Activity 2: Visual Illusions (10 minutes)

- Did we trick your brain before? [Yes! Good!] Now we're going to trick your brain again, but this time we are going to experiment only with the vision portion of your brain. Who remembers what part of the brain is for vision? [Point to the **occipital lobe** to remind students again]
- Depending on the classroom equipment, this activity will either involve a PowerPoint slideshow of some images/gifs or a series of images that are printed out and projected using a document camera.
- We are going to start with some very basic illusions that some of you may have seen before! [The first one is two orange circles that appear to be different sizes, one is surrounded by small grey circles and one is surrounded by large grey circles. Which one of these circles is bigger? [Students may answer the one with the small grey circles] What if I told you they are actually the same size? This is because the visual part of your brain looks at the whole picture of what you are seeing instead of just small points, so it takes into account the context of the grey circles. Since one of the orange circles is surrounded by small grey circles, it looks bigger by comparison, and the opposite is happening for the other orange circle. (If powerpoint, show the other side with isolated orange circles to prove it to them.) (The second one is two lines with arrows on the ends pointing in opposite directions.) Which of these lines looks longer to you? Again, they are actually exactly the same! Does anyone think they know why this is? (It's basically the same reason as above, the context of the whole scene, the arrowheads on the end make us think the line is stretched or shrunk.)
- Okay, now we're going to look at something a little more complicated. (This is one is an image with a checkerboard ground and a shadow created by a large cylinder.) There are two squares here labeled A and B, which one looks darker and which one looks lighter? (By now they have probably figured out that you're trying to trick them and they will likely guess that they're the same. You can tell them that they're just too smart for you, but then ask them if they think they know why the colors look different, even if they know the answer.)
    i. **Explanation:** Your brain is trying to make assumptions based on the shadow in the image. You know that when a shadow is cast on an object, it looks darker than it would be in a full-light situation, so you assume that the object is "actually lighter". This is what's happening with square B, and why we think it's lighter than A. Because they have the same pixel value in the image, but B has that value in the shadows, we think that if the two squares had the same light on them, B would be lighter, and that's the comparison that our brain is trying to make.

- Here's another one with color! (This one looks like an American flag but the colors are wrong: yellow with black stars, and cyan and black stripes.) What I want you to do is stare at the center of the cross for 30 seconds, and then something is going to happen when I take it away. Make sure you stare at the exact same spot the whole time or it won't work! Time them for 30 seconds and then take the image away (either by going to the next slide or putting a blank piece of paper over the flag image to cover it up). Ask them if they saw anything happen. (They should see a regular colored American flag as an after-effect.) Try it again to make sure that everyone sees it and then have them guess what's going on.
    i. **Explanation:** You have different cells in your eyes for perceiving different colors (ask if they've heard of rods and cones). Cones are for perceiving color, and there are different ones for each color. So after staring at the greenish-blue stripes on the flag, the green-blue cells get very tired, so when there is no stimulation in that location later, you see the opposite of that color. In the visual system, this shows up as red. A similar thing is happening with the yellow area in the upper-left part of the image, and it turns blue when the cones responding to the yellow color get tired. Rods are the cells for perceiving dark vs. light and they are controlling what's happening in the black areas that then appear more light in the afterimage.
    ii. (Ask why they needed to keep their eyes in the same spot for 30 seconds)
    iii. It's important that you keep your eyes in the same place the whole time because each spot inside your eye is looking at just one location in the world. So in order for those cells to get "tired" of the color that they're looking at, they need to keep looking at that color at the same place in space. If you move your eyes from the yellow area to the blue-green area, different cells in that location are being used for each of those colors, and none are going to get as tired, so you won't get the afterimage at all.
- (The next image will only work on a projector because it's a gif, not a static image, so skip it if there is no projector in the classroom.) Here's another one with interesting color effects. (This one has multiple purple dots in a circle that disappear in a rotating pattern.) Watch this one for a while and tell me what you see. Try it both following the location of the disappearing circle, and also by just staring at the cross in the middle.
    i. **Explanation:** If you follow the disappearing dot around the screen, you just see a blank space. But if you focus on the cross at the center, the disappearing dot will actually look green. Again, this is a color after-effect, since green and purple are "opposites" to the cells in your eyes.

Activity 3: Sheep Brains (10 minutes)

- We're going to hand out one glove to each of you now so that you can touch brains that we have brought in to show you today. Please keep the glove on until we tell you that we're all done with the brains.

- Make sure to tell the students that they **DO NOT** have to touch the brains if they don't want to (some students are not comfortable participating).
- We have real, preserved brains here for you to observe and touch. We have three rules for touching the brains: **be respectful, be safe, and be gentle.**
    i. *Be respectful. When you are an adult, you can choose to donate your body to science*. This allows scientists to study real specimens, with permission. These brains belonged to people to chose, before they died, to donate their bodies to science. We have to be respectful of this. These brains belonged to real people just like you and me. That being said, we need to be doubly respectful of the animal brains. These animals did not elect to have their brains donated, and we need to be thankful for their sacrifice. (Note: sometimes kids ask… sheep brains usually come from slaughterhouses where their bodies are harvested for meat, etc.)
    ii. *Be safe. We all have to wear gloves* when touching the brains, no questions asked. This protects us from any germs or pathogens that might still be on the brain, and protects the brain from any germs that might be on your hands. These brains were preserved using special chemicals so that we can study them for a long time. They may smell a little funny, but it is safe.
    iii. Be gentle. Although they are preserved, the brains are still very fragile and can be damaged very easily if you are not careful.
- Some ideas for discussion:
    i. What kind of animal do you think this brain belonged to?
        1. Sometimes kids guess things like guinea pig or even elephant. Encourage thought about size of body vs size of brain.
    ii. Let's find some of the regions! Are some of them smaller or larger?
    iii. Sheep brains and dog brains have much bigger olfactory bulbs than humans. Think about what having a bigger smelling region of the brain might mean.
    iv. Dolphins have really big motor cortex and cerebellum, as well as very developed areas for finding themselves in 3D space. Why do you think this is?
    v. More advanced: Humans are capable of language and other complex things, yet our brains look very similar. What do you think separates us from animals?

Activity 4: Human Brain (10 minutes)

- Some ideas for discussion:
    i. Every memory, experience, hobby, love, etc. of this brains owner was contained by this brain. Their entire life!
    ii. Find some of the regions that we talked about earlier.
    iii. Why is the brain wrinkled like this? Our brains are too big for our heads. If you unfolded the entire cortex, it would be the size of a newspaper or a school desk.

iv. Notice the brainstem and how it exits vertically down towards the spine.
v. Notice the texture and hardness. It seems so easy to damage this brain, but this is much more firm than what is in your head! Your living brain, unpreserved, would feel a lot more like soft tofu, and even leave a fingerprint for a while if you touched it, like a memory foam mattress!
vi. Compare them to sheep brains. What's similar and what's different? Think about the brainstem direction and bipedalism vs quadupedalism.

- Okay, it's time to take your gloves off and wash your hands now!
- Make sure students throw away of gloves properly and wash their hands.

Classroom Management Tips: Encourage Participation

- Wait 3 seconds before calling on students to answer a question. You'll be impressed with how many more (and often, more diverse) hands go up.
- It's tempting to call on eager students, but give everyone a chance!
- Be flexible in how you communicate questions and responses, reiterating information in different ways if needed.
- For more classroom management tips, visit www.crscience.org/volunteers/volunteertools

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

*This is the "discussion and conclusions" part of the lesson

- Review. Tell me some things that you observed and learned today.
  - What are some functions of the brain?
  - What are some of the parts of the brain?
  - How do experiments test your brain? [Stroop task]
  - What are some differences between human and animal brains

4. Connections & Close (5 minutes)

Wrap up as a role model by leaving a few minutes for students to ask questions about science, about being a neuroscientist, and about becoming a scientist. Then, thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  Life Science: 4. Structure and Function.
- Connections by disciplinary core ideas:
  Life Science: 4-LS1 From Molecules to Organisms: Structure and Processes
- Connections by scientific & engineering practices
  1. Asking questions and defining problems
  6. Constructing explanations and designing solutions
- Connections by crosscutting concepts
  4. Systems and system models
  6. Structure and function
- Connections by performance expectation:
  4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
  4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

FOSS CA Edition kit: Grade 5 Life Science.