Bay Area Scientists in Schools Presentation Plan

Lesson Name: Synesthesia and You
Presenter(s): Synesthesia Association at Berkeley

California Standards Connection(s): 3rd Grade Life & Physical Science

3-PS-2. Light has a source and travels in a direction. As a basis for understanding this concept:
   d. Students know an object is seen when light traveling from the object enters the eye.

3-LS-3. Adaptations in physical structure or behavior may improve an organism’s chance for survival. As a basis for understanding this concept:
   a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3-IE-5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
   a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
   b. Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
   d. Predict the outcome of a simple investigation and compare the result with the prediction.

Next Generation Science Standards:

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.

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
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<td>Developing and Using Models</td>
<td>LS1.A: Structure and Function</td>
<td>Cause and Effect</td>
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<tr>
<td>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</td>
<td>Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)</td>
<td>Cause and effect relationships are routinely identified. (4-PS4-2)</td>
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<td>☐ Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2)</td>
<td>LS1.D: Information Processing</td>
<td>Systems and System Models</td>
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<td>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).</td>
<td>☐ Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal’s brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)</td>
<td>A system can be described in terms of its components and their interactions. (4-LS1-1), (LS1-2)</td>
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<td>☐ Construct an argument with evidence, data, and/or a model. (4-LS1-1)</td>
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FOSS Connections:
Grade 4-6 Module: Living Systems

Teaser:
In this lesson we will learn about the brain, the five senses, and the special sensation called Synesthesia. We will learn about the different areas of the brain and the different types of Synesthesia. You will then get a chance to touch a real brain!

Objective:
Students will learn about the specialized areas of the brain that encode the senses through hands-on activities. Students will be introduced to/understand the topic of Synesthesia.

Vocabulary/Definitions: 3 - 6 important (new) words

Neuroscience: the study of the brain (neurology, neurologists)
Synesthesia: A neurological condition where the senses mix
Cerebral Cortex: Part of the brain where thought, voluntary movement, language, reasoning, perception occur.
Cerebellum: Helps with balance, posture, and some movement

Some Regions of the Brain:
Visual Cortex: brain area responsible for vision
Somatosensory Cortex: brain area responsible for touch
Auditory Cortex: brain area responsible for hearing
Olfactory Bulb: brain area responsible for smell
Gustatory (thalamus): taste (brain area responsible for taste)
Corpus Callosum: connects the left and right hemispheres
Spinal Cord: Transmits signals from brain to the rest of the body and vice versa

Materials:
What will you bring with you?
- gloves for handling brains
- preserved brains (Human)
- laptop
- printouts and brain maps
- Q-tips
- cups
- salt
- lemon juice
- sugar
- water

What should students have ready (pencils, paper, scissors)?
- Pencils/Writing Tools
- Colored Pencils, Markers, or Crayons
**Classroom Set-up:**
- Projector and screen
- Whiteboard with markers/ chalkboard with chalk
- Sink or place for students to wash hands.
- At the beginning of presentation: Students should be seated all together for the introduction.
- During the hands-on portion, they will be split up into 3 smaller stations (need tables/areas for each station)
- One table to present brains (can be reused from the station activities)

**Classroom Visit**

1. **Personal Introduction:** _______ 5 _____ Minutes
   Introduce each member and interests... We're all studying at UC Berkeley and we're all interested in studying the brain and how it works. Today we're going to talk about the brain and at the end you'll have the chance to look at the real brains that we've brought with us.

**Topic Introduction:** _______ 10 _____ Minutes
   Today we're going to talk about neuroscience or the study of the brain. Write on the board.
   Can anyone tell me some things that the brain does or helps you do? Write on the board.
   Your brain is very important because it does a lot of these things that you all mentioned earlier. [Mention some of the things that the students said using their own words. Some of those things might be: thinking, remembering, movement, talking, etc]
   Did you know that your brain is actually made up of smaller regions that do different things? Scientists have been studying this for a long time and so now we have some idea of which regions so what things but there's still a lot that we don't know about how the brain works.
   How do you think that neurologists would find out what the different regions of the brain do? [Pause here to allow students to think and suggest possibilities.]
   One way is to look at people who have brain damage or are missing parts of their brain. People can lose parts of their brain in accidents or when they get older some of their brain cells can die. Sometimes the damage is so small that these people are still able to walk around and do normal things but they might be missing one specific function (i.e. the ability to smell, lose certain memories, read, etc). Neurologists can often recognize this and now we can figure out what part of the brain has been damaged.
   Another way that neurologists study the brain is to look at what part of the brain is being used when you do a certain thing. Using special machines they can see inside your brain while you're completing a task of thinking about something. [Some kids might know fMRI but it's best not to go into too much depth. If a few students are interested in this topic it's best to talk to them during smaller groups.]
Can anyone tell me how many sense we have and what they are? [volunteers answer, go over answers] You use all of these senses everyday, even when you don’t think about it. But who does think about it when you forget to…your brain! For some people these senses can mix and this is called Synesthesia. There are three main types of synesthesia:
1. Grapheme-color
   - Personalities for numbers and letters
2. Color-sound
3. Tasting sounds
   - What do you think your name tastes like?

We will talk more about these kinds of synesthesia when we break up into groups. Now, we’re going to break up into 3 groups. At one station you will get to explore the sense of vision. At the second station you’ll get to explore the sense of taste. At the third station you’ll get to explore the sense of sound. Once you’ve gotten to learn about all three of these senses we’ll regroup to discuss what we already learned and learn even more about them!

2. Learning Experience(s): ___30___ Minutes

Station #1: Vision
- show multiple optical illusion via laptop or print out and explain the basics of how they work
- using printout map of vision (light hitting eye, optic tract, visual cortex) explain basic physiology of vision
- talk about visual synesthesia: show the colored alphabet

Station #2: Taste
- using printout map of taste bud receptor densities on tongue, explain how different areas on tongue are more sensitive to specific tastes
- set up taste experiment:
  - three cups, one salt water, one sugar water, one lemon juice water. Have students dip Q-tips into each cup and put Q-tip on parts of tongue that are specifically receptive for those tastes. They can report where they taste the “strongest”
  - discuss with students taste synesthesia: show picture of ritz cracker artwork

Station #3: Sound
- using printout of ear, ear canal, and auditory cortex, explain basic physiology of audition
- with laptop, show youtube video showing the full range of human auditory capacity
- talk about bad kid deterrent example in UK
- talk about color-sound synesthesia: show painting of a song
3. **Wrap-up: Sharing Experiences**  
___10____ Minutes

- Students share what they thought was most interesting [only a handful of responses].
- hand out brain coloring sheet

**Wrap-up (10 min):**

Finally, you’ll now get to look at brains that have been preserved. They smell a little bit gross because of the chemicals we use to preserve them, so you don’t have to hold them if you don’t want to. But, if you do remember to wear gloves and to wash your hands after you’ve held the brain!

4. **Connections & Close:**  
_____5____ Minutes

- Questions?
- Have battery on hand for kids who are interested [take it home and fill it out with your family]

**Follow-up – After Presentation**

Do you experience synesthesia? Take the Synesthesia Preview Questionnaire (see attached)

**ELA Activity:**
Suggest students write a letter explaining “How we learned about neuroscience?”

**Reading Connections:**
- The Human Brain Book by Rita Carter http://www.amazon.com/Human-Brain-Book-Rita-Carter/dp/0756654416

**Other:**
Draw Your Nervous System:
- http://www.amnh.org/ology/features/nervoussystem/
Stroop Test:
Test Your Reflexes:
- http://faculty.washington.edu/chudler/chreflex.html
Synesthesia Preview Questionnaire

1. Do numbers or letters cause you to have a color experience? Example: Does the letter J "mean" yellow to you? Or does "5" make you perceive purple?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

2. Do weekdays and months have specific colors? Example: Does July always mean Navy Blue to you? Is Wednesday always orange?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

3. Do you imagine or visualize weekdays, months and/or years as having a particular location in space around you? Example: Is September always located two feet in front of you to the left?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

4. Does hearing a sound make you perceive a color? Example: Does a shrill car horn cause you to see the color green? Does C sharp make you see pink?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

5. Do certain words trigger a taste in your mouth? Example: Does the name 'Derek' taste like earwax?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

6. Do you feel a sense of touch when you smell things? Example: Does the smell of coffee make you feel as though you are touching a cold glass surface?
   - Yes, I have had similar experiences
   - No, I have not had such experiences

7. We have described a few types of synesthesia. Many other unusual blendings of the senses have been reported. Do you suspect that you experience an unusual blending that other people do not have (other than the ones listed above)? These could include automatically hearing a sound when you see movement, or the sense of a shape being triggered by a taste, or experiencing a color when feeling pain.
   - Yes, I believe I may have other forms of unusual sensory experiences
   - Not that I know of