“How hot is it?”

How the body senses changes in temperature

In this lesson, students experience how the body senses changes in temperature. Students will understand the importance of previous experience in how the body senses how hot or cold water is. Students will also see that there is variation in how hot or cold we perceive water to be, even though we all sense the same water. This lesson will also cover the idea of adaptation as students experience the temperature receptors in their fingers adapting to various water temperatures. *The overarching theme of this lesson is that previous experience affects how you perceive the world.*

Grade Level: 9-12

Presentation time: 50 minutes

Lesson plan organization:

Each lesson plan is divided into three sections: *Introducing the lesson*, *Conducting the lesson*, and *Concluding the lesson*. Each lesson has specific principles with associated figures, class discussion (D), and learning activities (A). Resources for additional advanced information are indicated by ◊**.**

Materials:

3 paper, Styrofoam, or plastic cups for each group
ice
room temperature water
hot water
thermometer
worksheet entitled “How hot is it” (included on pgs. 5-7)

This lesson plan is provided by the Neurobiology and Behavior Community Outreach Team at the University of Washington: http://students.washington.edu/watari/neuroscience/k12/LessonPlans.html

Introducing the lesson

D: Introduction

Have a discussion about how previous experience influences our behavior, likes/dislikes, and perception.

1. Ask students: Who doesn't like brussels sprouts, broccoli, squash? How did they know they didn't like it? *(smell, tried it once)*

2. Ask students: Who likes science? How did they know they liked/didn't like it? *(tried it and were good at it)*

3. Ask students: Who likes orange juice? What happens when they drink orange juice right after brushing their teeth. What changed? Did the molecules in the orange juice change or did the way we perceive them change? *(orange juice didn't change, the way we perceive it did)*

4. Ask students: Have you ever been in a hot tub and then jumped into the pool? What did it feel like? Do you think the temperature was really that extreme?

5. Explain to students that this lesson will help answer the question of how we sense temperature.

Conducting the lesson

Principle 1: **What we feel is influenced by what we felt before**

A: Temperature experiment

1. Group students in pairs or groups of three. Give them the worksheet entitled How hot is it?. Explain to students that they will conduct an experiment using their temperature receptors and they will work collaboratively to collect the data from this experiment.

2. Have students go through the activity, following the procedures outlined in their worksheets. You can have them answer the questions in the worksheet individually during class or individually as homework. Or you can use them as questions for a discussion during class.

D: Temperature discussion

1. Ask students what they experienced in the experiment. Ask them why that might have happened.

2. Ask students why sometimes when you go to a pool and stick your toe into the water, the water seems pretty warm, but when you jump in, it seems much cooler? *(When you just stick your toe in the water, only a few temperature receptors are telling you how hot or cold the water is. When you jump all the way in, you have many, many more receptors telling you the temperature, so it seems much more intense.)*

3. Ask students to hypothesize how you might feel if you stuck your finger in hot water vs. your elbow. *(Finger has more temperature receptors than your elbow, so you are able to feel temperatures better with your finger.)*

4. Ask students what happens when you jump into really cold water and then stay there for awhile. Does the water seem to stay cold to you? *(Temperature of the water does not change even though the water seems to get warmer. Your temperature receptors adapt to the constant temperature and stop telling the brain what the temperature is.)*

5. Explain to students that scientists call this sensory adaptation. Sensory adaptation is when our receptors stop telling us what they are sensing because what they are sensing does not change.

Principle 2: **Adaptation**

D: Adaptation discussion

1. Ask students if they can think of other examples of receptors adapting. *(feel of a shirt on our back, smell of cookies in a room)*

2. After querying the class, show the disappearing dots (page 8). Have students fixate on the small black dot in the center and see what happens to the bigger colored circles. This is an example of how the photoreceptors in our eyes adapt. They fatigue with a constant stimulus. Why doesn't this happen all the time? Why is it a good thing that our eyes adapt quickly? (*It doesn't happen all the time because we are constantly shifting our gaze. It is good that our eyes adapt quickly, because it gets our eyes ready to sense a change in stimulus.)*

Concluding the lesson

1. There are two important points to bring up as you conclude this lesson:
   (1) What we feel is influenced by what we felt before
   (2) Our bodies adapt to a constant stimulus

The first point is the idea that what we feel is influenced by what we felt before. This can be generalized to talk about how previous experience influences how we perceive things. You can return to the example of how orange juice tastes after brushing your teeth. Then you can talk about the experiences of the temperature experiment. In addition, you could extend the discussion by asking:

a. Would you rather know exactly what temperature it was outside or whether the temperature was changing? *(Often knowing that something is changing is more important to us. If something is constant we can forget about it.)*

The second is the idea of *adaptation* and why it might or might not be beneficial. Review the findings of the lesson with regard to adaptation. What are examples of adaptation? You could extend the discussion by asking questions such as:

a. Is it beneficial or not that our senses adapt? (*yes)*
b. What would happen if our skin receptors never adapted to pressure of the shirt we are wearing? *(We might not be able to focus on important information because we would be constantly thinking about the shirt on our backs.)*
c. What would happen if we would move to a cold climate? (we might only be able to focus on the feeling of cold)

Name _____ Date _____
Period _____

How hot is it?

Purpose:
In this lesson you will be learning about how your body senses temperature. Some of the concepts learned in this activity on temperature will be applicable to how your other senses work.

Procedure and data collection:
1. You and your other group members will each receive 3 cups with hot water, ice water, and room temperature water. In addition you will get a thermometer.

2. Use the thermometer to record the temperature of the hot water and write it in the space here.
   Initial hot water temperature:_____

3. Put each pointer finger into the room temperature water at the same time. Notice if each finger feels the same temperature or not.

4. Put one pointer finger into the hot water and one pointer finger into the cold water. Keep fingers in the water for approximately a minute. Notice what happens to the feeling of the water during that time.

5. Keeping your fingers in the two cups, have a group member record the temperature of the hot water again and write it in the space here.
   Hot water temperature after a minute:_____

6. Put both pointer fingers back into the room temperature water at the same time. Notice the temperature that each finger feels even though they are in the same water.

Data Clarification Questions:
1. What happened when you put your finger in the hot water for approximately a minute? What did you feel initially versus what did you feel after a minute?

2. What happened when you put both of your fingers back into the room temperature water in step 6? Did each finger feel the same? Explain how each finger felt.

Data Interpretation Questions:

3. When you put your finger in the hot water, why did it feel like the water got cooler after a minute, yet the actual temperature of the water stayed the same?

4. When you put your fingers back into the room temperature water, why did if feel like the water was two different temperatures?

5. Given the results of this experiment, do you feel your brain senses temperature as an absolute value or as relative value? Explain.

Conclusion Questions:

6. What are 2 examples of our senses adapting with time?

7. Is it beneficial or not that our senses adapt? What would happen if they could not adapt? Explain with a specific example.

8. Have you ever gone to a pool and checked the temperature of the water with your toe before you jumped in? Did it feel the same when you plunged in? Often people are surprised when the water feels much colder when they jump in than they initially felt with their toes. Why do you think this happens?

9. Why don't we have as many temperature receptors in the skin over our elbow versus our lips?

10. What would happen if we had the same density of receptors everywhere?

11. The Robotech Company has hired you to design a temperature detection system for a robot's fingertip. Here are your instructions:
    1. Make it as human as possible
    2. It needs to be able to sense temperatures between 0 and 100 degrees.

    Question: Would you want to have a different receptor that would signal for each temperature (for example, a receptor for 70 degrees and another receptor for 75 degrees?) or would you want to have one receptor that would signal to the brain when it got hotter and one that would signal to the brain when it got cooler? Explain your answer.

Can you make the hazy colored circle disapper?