Teacher Guide

Cool Tool

Grade Level 9-12
Lesson Length **1 class period**

Lesson Summary: Using pencils, students explore touch and temperature sensitivity by finding cool receptors on their skin.

Objectives—Students will be able to

- Describe important pathways in the peripheral nervous system for thermal sensation
- Describe the neural process of sensory adaptation
- Collect and interpret data

Assessment Options

- Explain how the sensations of the external environment can change over time
- Provide an example of how information travels from the skin to the peripheral nervous system to the central nervous system

Procedures

Engage - Part 1: Experiment

1. Place index finger in the middle container and leave in the water for 15 seconds.
2. Place the finger from the middle container to the container with cooler water. How does that finger feel? Warmer or colder?
3. Move finger from cooler water into the middle container wait 30 seconds. How does that finger feel? Does it change over the course of 30 seconds? Does it feel warmer or colder then it did originally?
4. Place the finger from the middle container into the warmer water. How does that finger feel? Warmer or colder?

Engage - Part 1: Experiment expanded: Optional procedures

1. Work in teams of two and have one team member document observations of the other team member running the trial.
2. Try the experiment moving between the containers in different orders. How many different orders are there? Document changes in how the temperature feels for each different order.
3. Use the written observations to find a pattern among the sensations. Write a lab report.

Explain

Question 1. How is temperature sensed in the skin though thermoreceptors?

Human skin is full of different receptors that sense heat, cold, pressure, pain etc. See http://faculty.washington.edu/chudler/receptor.html for some information on skin receptors.

Within the dermis of the skin, free nerve endings that sense non-painful warmth or cold are called thermoreceptors. Thermoreceptors have ion channels that change the voltage across the nerves in relation to temperature.

Nerves fire action potentials in response to activation of these thermoreceptors by either warmth or cold.

Warmth receptors respond to warming, which results in an increase in the rate they fire action potentials. Nerve fibers with warmth receptors begin firing at ~30°C, show maximum firing rate at ~40°C, and stop firing at ~ 45°C. Cold fibers show a maximum firing rate at ~ 32°C cease firing at 38°C. Cold receptors start firing again at 45°C and have 2nd peak at 48°C. This is called **paradoxical heat** and explains why hot tap water can *feel* cold.

Warmth and cold receptors show differences in their response to temperature. In nerves with warmth receptors, the firing rate signals how warm the skin is. In contrast, in nerves with cold receptors, the pattern of action potentials changes with the rate of change in temperature across the skin.

Question 3. How does thermosensation keep us alive?

The main function of thermosensation is to help our bodies to maintain homeostatic balance. Homeostasis literally means “same state” and it refers to the process of keeping the internal body environment in a steady state when the external environment is changed.

One of the most important examples of homeostasis is the regulation of body temperature, controlled by the specific areas in the hypothalamus that receive information from thermoreceptors in the skin and in some of the major blood vessels.

If the outside air is too cold, the body will act to keep heat in. Such actions include reducing blood flow to the skin surface, getting goose bumps, shivering, and prompting behaviors such as putting on a coat. Conversely, if the outside air is warm, the body will work to release heat by dilating blood vessels near the skin, sweating, and slowing down physical movement.

Explore - Questions

1. If you walked into a 72-degree F room from outdoors when the temperature outside was 90 degrees F, how would it feel? Why?
2. If you walked into a 72-degree F room from outdoors when the temperature outside was 20 degrees F below zero, how would it feel? Why?
3. What does this tell you about the nerves that are responsible for detecting heat or cold?
4. Can you think of a way to activate these nerves without using extreme temperatures? (hint, think about things that you can eat.)

Engage - Part 2: Your Own Test

You have a friend that can build any device you want. Brainstorm with your group and briefly describe a device that could test this phenomenon more accurately. Make a list of things you need to consider before testing. Try to be as complete as possible. How does your device relate to brain function?