

Teacher Institute for Neuroscience and Society

LESSON PLAN

Our Sense of Touch

 Suggested Duration

75-90 min

 Grade Level

Middle School (Grades 6-8)

 Topic

Statistics & Neurodiversity

Summary

The focus of this lesson is to have students engage in a **two-point touch discrimination experiment** using calipers to explore how the **brain receives and interprets information through touch**. They will collect and analyze class data to investigate which body parts are most **sensitive** and how **diverse** touch perception is. Students will write a reflection allowing them to connect their findings to **neurodiversity**.

Prerequisites

- Familiarity with the concept of the senses.
- Ability to work collaboratively in small groups.
- Basic writing skills for reflection and response tasks.
- Understanding of how to calculate an average (mean).
- Familiarity with reading and constructing bar graphs and dot plots.

With support from  Dana Foundation

For more, visit <https://zuckermaninstitute.columbia.edu/teacher-institute-lessons>

NGSS Science Standards

MS-LS1-3: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

MS-LS1-8: Gather and synthesize information to describe that the brain is part of the body system that affects behavior.

MS-ETS1-1: Define the criteria and constraints of a design problem.

MS-ETS1-3: Analyze data to determine similarities and differences among several design solutions.

MS-LS1-8: Gather and synthesize information to communicate solutions about how organisms are affected by their environment.

NGSS Writing Standards

WHST1a: Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

WHST1b: Support claim(s) with logical reasoning and relevant, accurate data and evidence by identifying and using credible sources.

WHST1c: Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, and evidence.

WHST1d: Establish and maintain a formal style appropriate to the academic discipline, purpose, and audience.

WHST1e: Provide a concluding statement or section that follows from and supports the argument presented.

NGSS Practices

Constructing Explanations

Engaging in Argument from Evidence

Asking Questions and Defining Problems

Q Essential Questions

- Which part of our body is the most sensitive to touch, and what does that tell us about how our brain is organized?
- What does the variation in our class data tell us about how diverse touch perception is?
- How does understanding neurodiversity help us appreciate the different ways people experience the world around them?

Q Learning Objectives

All students will...

- Identify and debunk common myths about the brain and the senses.
- Conduct a two-point touch discrimination experiment to measure tactile sensitivity across three body parts.
- Collect, organize, and analyze data by calculating averages and constructing a bar graph and dot plot.
- Explain how variation in class data reflects the concept of neurodiversity.

Advanced students will...

- Evaluate how the organization of the somatosensory cortex supports conclusions drawn from their experimental data.

Materials

Downloadable Lesson Components

- Student worksheet
- Powerpoint slides

Supplies

- Calipers (one per group of 3-4)
- Data collection sheet (one per student)
- Pencils
- Graphing paper or pre-printed graph templates (for bar graph or dot plot)
- Device with internet access

References

Videos Used in Lesson

- Senses & The Brain Mini Clip by GenerationGenius
<https://www.youtube.com/watch?v=LTX91k7RFzg>
- Sensory Processing and the Brain by Khan Academy
<http://www.youtube.com/watch?v=fMrz3L9bMsl>
- What are Calipers Used For? by One Minute Workbench
<https://www.youtube.com/watch?v=A1DNh2jSowE>

Additional Background

- “Neurodiversity Can Explain Differences in How People Experience Everyday Life” article from Frontiers for Young Minds <https://kids.frontiersin.org/articles/10.3389/frym.2024.1434143>
- “Measure touch sensitivity!” Two-point touch discrimination test how-to video from BioBus <https://www.youtube.com/watch?v=N5eeUYxQ2IA>

INSTRUCTIONAL ACTIVITIES

Part 1 (Engage) • 10-15 MIN

Note: Though it is at the educator’s discretion, it is suggested that this lesson takes place offline. Offline learning offers several benefits for middle school students, such as enhanced face-to-face interaction, development of essential social skills, reduced distractions, and a structured learning environment. It fosters a sense of community, encourages teamwork, and allows for immediate feedback from teachers.

The purpose of this task to activate prior knowledge about the **brain and senses** by having students engage with common **myths and misconceptions** they may already hold. The goal is to establish our understanding of the brain and senses is often incomplete or incorrect, and that **data and science** can help us see more clearly.

 Student worksheet

 Powerpoint slides

- Display Warm Up True/False Myths Activity and set a timer while students indicate true or false on their worksheet.
- Facilitate whole-class discussion as answers are revealed one by one.
- Promise to reveal the purpose of this activity later in the lesson sequence (creating anticipation).

INSTRUCTIONAL ACTIVITIES

Part 2 (Explore): Mini Lesson • 15-20 MIN

 Senses & The Brain Mini Clip video

 Sensory Processing and the Brain video

- Introduce experiment questions.
 - Display and view both video clips to build a background on how the **brain receives and interprets touch**.
 - Provide guidance as students complete **predictions** on their worksheet, identifying which body parts they believe are most and least sensitive.
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Part 3: Explain • 10 MIN

 What are Calipers Used For? video

- Introduce the **caliper** with powerpoint slide aid and video for students to observe and take notes from (leave room for clarifying questions).
 - Model **two-point touch discrimination** procedure using a student volunteer.
 - Review the step-by-step procedure with class before beginning.
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Part 4: Elaborate • 20-30 MIN

- Distribute calipers to groups of 3-4 students.
 - Set an 8-minute timer for each body part, then circulate to assist student groups as they **record individual measurements** and **calculate the group average** on their data sheets.
 - Guide students through constructing a **bar graph** of the averages and a **dot plot** of individual data points for each body part as they fill out corresponding 'Data', 'Dot Plots', and 'Averages...' sections on the worksheet.
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Conclusion • 15-20 MIN

- Direct students to completing **Analysis and Reflections** sections of their worksheet using their data and graphs as evidence
- Introduce **neurodiversity** and connect to **variation** observed in whole class results.
- Facilitate a **whole-class discussion** using analysis questions, using the **sensory homunculus** image as a visual aid.
- Collect worksheets for assessment and feedback.

INSTRUCTIONAL ACTIVITIES

Assessment and Deliverables

Formative assessment: evaluated through observation during the experiment, group discussion, and partner work.

Summative assessment: evaluated through the completed worksheet, including data collection, graphs, analysis responses, and reflection. Students should be able to:

- Accurately collect and record two-point touch discrimination measurements across three body parts and calculate the group average for each.
- Represent their data using both a bar graph and a dot plot, with correctly labeled axes and appropriate scale.
- Use their data as evidence to draw conclusions about which body part is most sensitive and explain why, connecting their findings to the concept of receptor density.
- Explain how variation in class data reflects the concept of neurodiversity.

Differentiation or Extension Activities

To extend this activity, students can measure tactile sensitivity across additional relevant (and school-appropriate) body parts to expand their analysis. Students can then apply these findings to their knowledge of the homunculus diagram to gain a deeper understanding of how the somatosensory cortex is organized.

Students can also broaden their reflection on neurodiversity by addressing additional senses beyond touch and how differences in how we perceive other environmental cues like light, sounds, temperature, and smells.

LESSON PLAN CONSIDERATIONS

Possible Student Misconceptions

Misconception that we only have exactly five senses: students may enter the lesson believing humans have exactly five senses. Clarify that while five senses are traditionally taught, humans possess additional senses including those for sensing **balance, proprioception, temperature, and pain**.

Misconception that bigger body parts are more sensitive: students may assume that larger body parts, like the arm compared to the fingertip, are more sensitive because they cover more surface area. Clarify that sensitivity is determined by **density of receptors that sense touch in an area of the body**.

Misconception that everyone experiences touch the same way: students initially may not recognize that **individuals perceive touch differently**. Variation in the class dataset can aid in challenging that assumption and introduce the concept of **neurodiversity**.

Suggested Background Information for the Teacher

Clarification through discussion: Regularly engage students in discussions and encourage them to express their thoughts, addressing misconceptions as they arise.

Neurodiversity: Be prepared to address the idea that people experience and interact with the world around them in many different ways. There is no one “right” way of thinking, learning, and behaving, and differences are not viewed as deficits.

The homunculus diagram of the somatosensory cortex: Gain familiarity with the map of the human body drawn to match the corresponding areas of the brain’s primary sensory cortex, illustrating that body parts with more touch receptors take up more cortical space.

LESSON PLAN CONSIDERATIONS

Glossary

Average (Arithmetic Mean)	A mathematical measure of central tendency representing the “average” of a dataset. It is calculated by adding values in a group together, then dividing that total by the number of values in the set.
Data Visualization	The graphical representation of information and data to highlight trends and patterns.
Bar Graph	A visual tool that compares categorical data using rectangular bars. The length or height of each bar is proportional to the value they represent.
Dot Plot	A simple statistical chart that consists of dots plotted on a number line to display frequency of data points.
Homunculus Diagram	A map of the human body drawn to match the corresponding areas of the brain’s primary sensory cortex. It shows unusual body proportions, such as giant hands and lips and small torso and legs, to illustrate that body parts with more touch receptors take up more cortical space.
Neurodiversity	Idea that people experience and interact with the world around them in many different ways; there is no one “right” way of thinking, learning, and behaving, and differences are not viewed as deficits.
Sensory Processing	How your nervous system receives information from your senses, organizes, it, and responds to it.
Somatosensory Cortex	Key brain region located in the postcentral gyrus of the parietal lobe that processes bodily sensations like touch, pain, temperature, and spatial awareness.

CROSS CUTTING CONCEPTS

Cause and Effect	Understanding how the number of receptors in a body part directly affects how sensitive it is to touch.
Structure and Function	Exploring how different parts of the body (structure) determine functions like detecting touch.
Patterns	Students look for patterns in their two-point touch discrimination data across different body parts and across classmates.

ACKNOWLEDGEMENTS

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Supported by:  Dana Foundation