ND EPSCoR Lesson Plan

Senses and Perception in Nature

Lesson Title: Senses and Perception in Nature

Lesson Overview:
A sense is a physiological capacity organism's use to acquire data for perception. The senses and their operation, classification, and theory are overlapping topics studied by a variety of fields. The stimuli perceived by senses are controlled by a specific sensory nervous system, and a sense organ, or sensor, dedicated to each sense. Humans have a multitude of sensors but Sight (vision), Hearing (audition), Taste (gustation), Smell (olfaction), and Touch (somatosensation), are the five traditionally recognized senses. The ability to detect other stimuli beyond those governed by these broadly recognized senses also exist. These include: Temperature (thermoception), Kinesthetic sense (proprioception), Pain (nociception), Balance (equilibrioception), Vibration (mechanoreception), and various internal stimuli (e.g. the different chemoreceptors for detecting salt and carbon dioxide concentrations in the blood, or sense of hunger and sense of thirst).
Non-human animals may possess senses that are absent in humans and some of these are more advanced. Plants also have a whole set of senses that closely mirror what animals have. These senses help them interact with the environment around them.
Some senses also originate from a complex interaction of two or more sensors to provide a unique perception to our brains. From a sociological angle, the literal use of concepts associated with perception have had a great impact on our ability to communicate, understand, and empathize with other people. In other words, perception leads to understanding, which should eventually create empathy. This flow in the process of information is central to how we interact with our environment, and other people around us.

Topic(s): Information Processing in Life Sciences

Grade or Grade Band: Middle School Life Science

Lesson Objectives:
-Develop an explanation of how traditional and nontraditional senses work.
-Demonstrate how sense are used by animals to survive in nature.
- Engage in and discuss perception activities that shape our own point of view.

Next Generation Science Standards:
MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

North Dakota Standards:
4-LS1-2 Form an explanation 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.

Time Needed (estimate): 3, 50-minute class periods

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Scientist/K12 Collaborator & University:
This lesson was developed by a team of individuals from Tribal Colleges and Universities with input from high school teachers for the ND EPSCoR NATURE Sunday Academy program. Sunday Academy is a program designed to generate interest in science, technology, engineering, and math (STEM), among the American Indian students. Once a month during the academic year, middle- and high-school students are brought together on a Sunday. They are presented with practical day-to-day problems involving STEM in an informal and friendly atmosphere, requiring them to think, analyze and seek solutions. Typically, seven academy sessions are held at each of the five tribal colleges, beginning in September and ending in March. Professors travel to share their research across the state, and the sessions are hosted by the Tribal College/ University (TCU) NATURE Coordinator at each site. Cultural relevance and hands-on activities are emphasized in all topics.

Preparation/Materials

Background knowledge students must have to be successful:
A sense is "A system that consists of a group of sensory cell types that responds to a specific physical phenomenon, and that corresponds to a particular group of regions within the brain where the signals are received and interpreted." There is no firm agreement as to the number of senses because of differing definitions of what constitutes a sense.

Differentiation and accommodation to support learning for all students:

Essential terminology:

- Exteroceptive senses are senses that perceive the body's own position, motion, and state, known as proprioceptive senses. External senses include the traditional five: sight, hearing, touch, smell and taste, as well as thermoception (temperature differences) and possibly an additional weak magnetoception (direction). Proprioceptive senses include nociception (pain); equilibrioception (balance); proprioception (a sense of the position and movement of the parts of one's own body).
- Interoceptive senses are senses that perceive sensations in internal organs.
- Umami-a category of taste in food corresponding to the flavor of glutamates. Naturally brewed soy sauce, Marmite, anchovy relish, miso, tomato puree, fish sauce and Worcestershire sauce are all great sources of umami.

Resources:
Complex Human Perceptions Recording Sheet
How the Senses have shaped our languages Scenarios
Senses Activity Recording Sheet
Senses Activity Directions

Websites:
https://www.youtube.com/watch?v=hGj0lgfbik8

Materials needed:

Lesson 1 Activities

Activity 1: Touch of Genius

- Blindfold (one per group)
- Earplugs (one set per student)
- Respiratory mask (one per student)

Activity 2: I see the Light

- Blindfold
- Dark room
- Light sources (such as 4 or 5 flashlights)

Activity 3: Tasty Treats

- Treats
- Bowls
- Blindfolds

Activity 4: Bells and Whistles

- Blindfold (one per group)
- Bells and whistles

Activity 5: Fee-Fi-fo-fum

- Blindfold (one per group)
- Various natural and man-made fragrances and scents (or objects with distinct fragrances)

Lesson 2 Activities

Activity 1: Flavor Test

- Treats and natural food products
- Bowls
- Nose pincers or nose clamps or other forms of clamps to secure the nasal passages.

Activity 2: Coke or Pepsi

- Blindfold
- Red Solo cups
- Original Coca Cola and Pepsi Cola products

Activity 3: Balance and Direction

- Earplugs
- Blindfolds

Lesson sequence:

Lesson 1: Simple Human Perception

Lesson 2: Complex Human Perception

Lesson 3: Applied aspects of the senses in our daily lives

Procedure/Activities

Lesson 1: Simple Human Perception

Engage:

Present slide 2 to give students the scientific terminology for the five senses we typically learn about.

Write the following words on the board:

Thermoception

Proprioception

Nociception

Equilibrioception

Mechanoreception

Inform students that each of the words listed is considered a nontraditional sense. Allow students time to use the root words from each of the senses listed and attempt to identify the stimuli our bodies can detect using these senses. Ask students to write down their guesses.

Present slide 3. Allow students to compare their answers to the ones presented on slide three. Survey the class by asking "Show me a thumbs up if you guess for thermoception had something to do with temperature?" Continue down the list and discuss why some where easy to guess and others may have been more difficult.

Present slides 4 and 5 and explain that Non-human animals may possess senses that are absent in humans, such as electroreception and detection of polarized light. Most animals have advanced senses of smell, taste, sight, touch, echolocation, balance, magnetic alignment, and many other senses they use in nature.

Plants also have a whole set of senses that closely mirror what animals have. Plants sense light, gravity, temperature, humidity, chemical substances, chemical gradients, reorientation, magnetic fields, infections, tissue damage and mechanical pressure. These senses help them interact with the environment around them.

It is possible to lose a sense due to disease, an accident, or deterioration over time. It is also possible to be born without the capacity to use a sense. Some people have the ability to have one sense that is highly developed; some people without the ability to use a sense can compensate by highly developing another sense.

Explore:

Students will spend the remainder of the period rotating through 5 activities to help demonstrate how the impairment to one or more of our senses effects our ability to familiarize ourselves with objects and our surroundings.

Start my splitting up the class into pairs or small groups. Give each group a copy of the **Senses Activities Recording Sheet**.

Print off the directions for each activity and set up each station according to the directions on the **Senses**

Activity Directions sheet. A set of the directions should stay at each station.

Instruct students to read the introduction and procedures for each activity. Students will use their Senses Activities Recording Sheet to answer questions after each activity.

Explain:

Once all groups have had the opportunity to rotate through all of the stations, bring the class back together to review what was learned. Allow students time to discuss the follow up questions from their recording sheets. Use the explanations below to guide the class discussion.

Touch of Genius: The sense of touch is very important for how living things interact with the outside world. Touch or somatosensation (also called tactition), is a perception resulting from activation of neural receptors, generally in the skin including hair follicles, tongue, throat, and internal skin linings. A variety of pressure receptors respond to variations in pressure (firm, brushing, sustained, etc.). The touch sense of itching caused by insect bites or allergies involves special itch-specific receptors in the skin and spinal cord.
The loss or impairment of the ability to feel anything touched is called ***tactile anesthesia***. Paresthesia is a sensation of tingling, pricking, or numbness of the skin that may result from nerve damage and may be permanent or temporary.

I See the Light: Sight or vision is the capability of the eye(s) to focus and detect images of visible light on photoreceptors in the retina of each eye that generates electrical nerve impulses for varying colors, hues, and brightness. There are two types of photoreceptors: rods and cones. Rods are very sensitive to light but do not distinguish colors. Cones distinguish colors but are less sensitive to dim light.
The inability to see is called ***blindness***. Blindness may result from damage to the eyeball, especially to the retina, damage to the optic nerve that connects each eye to the brain, and/or from stroke. Temporary or permanent blindness can be caused by poisons or medications.
People who are blind from degradation or damage to the visual cortex, but still have functional eyes, are actually capable of some level of vision and reaction to visual stimuli but not a conscious perception; this is known as blindsight.

Tasty Treats: The sense of taste is very important for how living things survive. It relies mainly on chemical interaction and is strongly correlated with our perception of like or dislike. Taste or gustation is one of the traditional five senses. It refers to the capability to detect the taste of substances such as food, certain minerals, and poisons, etc.
The sense of taste is often confused with the "sense" of flavor, which is a combination of taste and smell perception.
Flavor depends on odor, texture, and temperature as well as on taste. Humans receive tastes through sensory organs called taste buds, or gustatory calyculi, concentrated on the upper surface of the tongue.
There are five basic tastes: ***sweet, bitter, sour, salty and umami***. There are other tastes but these have yet to receive widespread acceptance. The inability to taste is called ***ageusia***.

Bells and Whistles: Hearing, or auditory perception, is the ability to perceive sounds by detecting vibrations and changes in the pressure of a medium through time. The ear is the main sensory organ for audition. Sound may be heard through all 3 forms of matter. It is one of the traditional five senses; In humans and other

vertebrates, hearing is performed primarily by the auditory system and involves the detection of mechanical waves which are transduced into nerve impulses that are perceived by the brain's temporal lobe. Hearing and touch essential have similar mechanisms.
The swimming pool game, Marco Polo, demonstrates our ability to localize sound. With eyes closed we hear "Marco" then swim towards its direction. This ability is only possible with two ears. Although we can hear with just one ear we can't distinguish the location of its source. A single ear can process the amplitude (loudness) and frequency (pitch) of a sound wave. But, together, both ears detect sound location through minute differences in timing.
Partial or total inability to hear is called ***hearing loss***. There are several different types of hearing loss based on severity: Conductive hearing loss, sensorineural hearing loss and mixed types.

Fee-fi-fo-fum: The sense of smell is also known as olfaction. It has many purposes and plays a major role in our ability to perceive and detect hazards, pheromones, and food. It is one of the senses involved in our perception of flavor. It occurs when odorants bind to specific sites on olfactory receptors located in the nasal cavity. The signals from these receptors are transmitted to the olfactory bulb, where the sensory input interacts with portions of the brain responsible for smell identification, memory, and emotion. Thus, emotions are closely tied to our abilities to smell. Some organisms rely on this sense more than others. Pets such as dogs and cats use their sense of smell to create emotional attachments to their owners, In the wild, social structures and belonging to a group is dependent on this sense for many animals.
The inability to smell is known as Anosmia. There are several other olfactory such as: hyperosmia (abnormally acute sense of smell), hyposmia (decreased ability to smell), presbyosmia (decline in the sense of smell with aging), dysosmia (distortion in the sense of smell), parosmia (distortion in the perception of an odor), phantosmia (hallucinated smell), and heterosmia (inability to distinguish odors).
Terminology used to describe smells vary but usually are associated with emotional interpretation of the stimuli. Words such as: soft, strong, weak, hard, gross, putrid, bitter, noxious, sweet, euphoric, etc., are typically used.

Extensions for learning more about this topic:

Students have been introduced to several nontraditional senses used by humans and other animals. Allow students time to further research one of the nontraditional senses that interests them. Allow students to present their research in by creating a magazine article or recording a news broadcast introducing the nontraditional sense.

Evaluation of learning:

Teachers should collect each students' **Senses Activities Recording Sheet** as evidence of learning. Teachers should also observe as the class discusses each activity during the follow-up portion of the lesson.

Lesson 2: Complex Human Perception

Engage:

Tell students that we are going to continue to study the senses with another set of activities similar to those in the first lesson. Today's set of activities look at sensory perceptions that require more than one sense for the brain to form an idea of what it is we are interacting with. More often than not, we confuse these with the simple and traditional senses. Examples of complex perceptions involving a combination of multiple senses include: flavor, balance, hunger, homeostasis, pain, and many others.

Explore:

As a class, students will complete the three activities described below. After each activity, students should be directed to record their answers to the accompanying questions on the **Complex Human Perceptions** recording sheet.

Activity 1: Flavor Test

In this experiment students will demonstrate how the limiting one sense can impact our ability to determine flavor.

Procedure:

1. This activity will be performed in 2 rounds. It may be helpful to split the class into 2 general groups; one group starting the experiment with clamped noses, and the other with unclamped noses.
2. Students are provided each with a nose clamp. This eliminates the senses of smell.
3. First, the students will be provided with several foods spread out. The student is expected to eat them without clamped noses.
4. The student should determine the flavor of each food provided to them.
5. If need be, the student will be provided with water to rinse their mouths after every food eaten.
6. Then the activity will be repeated, but this time with their noses clamped.
7. Each student will write down the possible differences in the flavor when their noses are clamped and unclamped.

Activity 2: Coke or Pepsi

In this activity we will be exploring whether the "average" person can actually differentiate between the 2 products if put within a rigorous scientific testing process. It has been suggested that our abilities to distinguish one from the other, is essentially a visual process. Can you distinguish between the two products? If your visual sense is taken away, can you differentiate between these products?

Procedure:

8. Students will be expected to wear blindfolds. This eliminates the senses of sight.
9. The students will be handed two nondescript cups labelled A and B, containing either the Coca cola or the Pepsi cola product.
10. Instructors assisting with the experiment should be encouraged to vary which product gets poured into cup A and B.

11. The student will be is expected in 3 drawdowns max from each cup, to identify which cup contains the Pepsi cola and which contains the Coca cola. Water will be provided to rinse between drinks from the cups.
12. They will then record what cup they think contains which product.

Activity 3: Balance and Direction

13. In this experiment students will demonstrate how the sense of balance and direction is affected by movement when we inhibit a sense or two. We will play the popular toddler game of merry-go-round, or turning in circles while blindfolded and/or ear plugged.

Procedure:

14. Students stand in the center of an empty or cleared room, wearing a blindfold or ear plugs. This is to eliminate the senses of sight and hearing.
15. The students will be asked to initially spin around for 45 seconds without the blindfold or ear plug. Then the instructor will ask them to move into a specific cardinal direction.
16. After some recovery time, the same process will be repeated with either a blindfold or an ear plug. **CAUTION: Dizziness and motion sickness are possible and care should be taken not to continue if the student feels sick.**
17. After the session, each student will write down their experiences.
18. The students will take turns doing this activity to avoid crowding the room.

Explain:
Once the class has completed the three activities review each activity with the class using the following explanations.

Activity 1: Flavor Test
The perception of flavor involves 3 senses. It is an attribute of a substance produced by the senses of smell, taste, and touch and is perceived within the mouth. Flavor depends on odor, texture, and temperature as well as on taste. Odors are detected only when the material is in gaseous disorders of smell greatly affect the ability to detect flavors. The touch sensations relating to flavor are based on the chemical properties of the substance. Reactions induced by chemical properties include coolness (peppermint), bite (mustard and pepper), and the warmth (cloves). When we consume food, the simultaneous stimulation of these senses creates an immediate impression that causes us to accept or reject the food. This has implications on our decision to continue eating it or to reject it. Many foods such as fruits, nuts, milk, and some vegetables have highly acceptable flavors in their natural, uncooked state. Other foods need to derive flavor through cooking, seasoning, flavoring, or combinations of these. Preference or avoidance of a particular flavor is a learned behavior.

Activity 2: Coke or Pepsi
Begin by revealing which one was Coke and which one was Pepsi.
The debate is real! There is abundant cognitive research out there trying to determine which product, Coca Cola or Pepsi Cola, is better. The market and campaign rivalry between these two beverage products define the American way in so many contexts. An interesting issue raised is whether the “average” person can

actually differentiate between the 2 products if put within a rigorous scientific testing process. It has been suggested that our abilities to distinguish one from the other, is essentially a visual process.

Activity 3: Balance and Direction

The perception of balance is very important for how living things survive. It determines to a greater extent our abilities to move and navigate the world around us. It helps prevent humans and animals from falling over when standing or moving. As humans, our evolution to Homo erectus is greatly tied to this ability. Balance and direction are typically achieved through a combination of multiple sensory organs, skeletal system, and senses: the eyes, ears, and the body's sense of where it is in space all play an important role. Visual signals sent to the brain about the body's position in relation to its surroundings are processed by the brain and compared to information from the vestibular and skeletal systems.

When the sense of balance is interrupted it causes dizziness, disorientation and nausea. Balance can be upset by many diseases, inner ear infections, by a bad common cold affecting the head, and vertigo. The disturbance can be temporary such as quick or prolonged acceleration, turning in circles like riding on a merry-go-round and being weightless in space. Blows the side of the head or directly to the ear can affect balance as well.

Evaluation of Learning:

The teacher should collect the **Complex Human Perceptions** recording sheet as evidence of learning.

Lesson 3: Applied aspects of the senses in our daily lives

Engage:

Beyond the generic and direct use of the concepts of senses to define our perception of the world around us so we can navigate it, there are several applied and colloquial meanings and that can be assigned to these terminologies. Of interest is defining these terms within the framework of understanding different levels of information and cues we get from our surroundings. In this lesson we will do some activities related to how the concepts of perception and understanding are applied in language structure, degree of comprehension, and as a tool for empathy.

Explore:

Activity 1: How the sense has shaped our language.

The use of terminology and phrases related to the implied meaning of the senses is a common theme across languages in the world. Sentences such as:

- I see what you mean.
- You are not listening to me.
- I hear you loud and clear.
- I feel for you in this time of despair.
- This business does not smell right.
- His words were so touching.
- He got a taste of the affluent lifestyle.

Are all instances when we use sensory terminology to communicate specific information to other people. Concepts of the senses are also used to define levels of understanding when presented with specific situations.

The process of understanding is a spectrum. This means we have different levels of understanding. In language application the following is usually true:

Levels of Understanding	Sensory association	Explanation
The beginning of understanding	Taste Smell	The early stages of information processing or gathering
The middle of understanding	Touch/feel Hear/listen	Intermediate. Typically works with situational context
Complete and total understanding	See/look	Getting the clear picture

In this activity we will use these sensory associations to define our level of understanding of various scenarios, riddles, and mathematical equations.

Procedure:

1. Watch the YouTube video on the use of senses in language: https://www.youtube.com/watch?v=hGj0lgfbik8
2. Hand out the **How senses have shaped our languages Scenarios sheet**
   Respond to the following scenarios in column 1 by providing an answer in column 2,
   Then indicate your level of understanding of the scenario by drawing a picture of the sensory organ associated with your level of understanding.

Activity 2: Senses and Understanding

The use of sensory terminology to define levels of understanding is a common trait shared by many languages and cultures. Understanding refers to the ability to grasp or be perceptive of our surrounding. Complete understanding is the end goal of perception. There are several ways in which a complete understanding can be expressed. One of these ways is to be able to communicate what we grasp in multiple ways, with clarity, across diverse platforms, to different audiences and people.

In this activity we will test our complete grasp of understanding by identifying in how many ways we can express information we grasp so that multiple audiences can understand what we mean,

Procedure:

On the backside of the **How senses have shaped our languages,** you will find the **Senses and Understanding** matrix. Identify 5 ways you can express the information listed on the matrix.

Explain:

- Present ppt slide 9: Understanding refers to the ability to grasp or be perceptive of our surrounding. Complete understanding is the end goal of perception. The use of sensory terminology to define levels of understanding is a common trait shared by many languages and cultures.
- Present ppt slide 10: Empathy is the experience of understanding another person's thoughts, feelings, and condition from his or her point of view, rather than from one's own.
- It is the capacity to understand or feel what another person is experiencing from within their frame of reference, or to place oneself in another's position.
- It therefore encompasses a number of emotional states.

- Compassion and sympathy are terms associated with empathy.
- Compassion refers to an emotion we feel when others are in need, and it motivates us to help them.
- Sympathy is a feeling of care and understanding for someone in need.

Extension:
Empathy is the experience of understanding another person's thoughts, feelings, and condition from his or her point of view, rather than from one's own. It is the capacity to understand or feel what another person is experiencing from within their frame of reference, or to place oneself in another's position. Empathy facilitates prosocial or helping behaviors that come from within, rather than being forced, so that people behave in a more compassionate manner. It therefore encompasses a number of emotional states. Compassion and sympathy are terms associated with empathy. Compassion refers to an emotion we feel when others are in need, and it motivates us to help them. Sympathy is a feeling of care and understanding for someone in need.

The absence of empathy is known as ***Alexithymia***. It describes a deficiency in understanding, processing or describing emotions in oneself, as opposed to others.

Several psychological tests have been developed to measure emotional IQ which essentially give the subject an idea of how to be more empathic with others around them. Some of these tests rely on facial cues, while others rely on your behavior towards defined scenarios. In this activity, we are going to do one such tests and determine how empathic each of us can be to others.

Follow the link below to take the Emotional IQ quiz:
https://greatergood.berkeley.edu/quizzes/ei_quiz
This test was developed by the Greater Good Science Center at the University of California at Berkeley.

If you have some more time, you can also try the Emotional IQ test from the following link:
https://www.arealme.com/eq/en/
It is a quick 10 question Emotional Intelligence test that gives a numerical score as a result.

Evaluation:
Wrap up the activities with a class discussion. Use the following prompts to help guide the discussion.
1. How were the concepts of STEM used in today's activity?

2. What was the most successful idea you used in the activity?

3. What did you try in the activity that did not work?

4. Why do think it did not work?

References:

The Greater Good Science Center at the University of California Berkley. (2021). *Quizzes*. Greater Good. https://greatergood.berkeley.edu/quizzes.