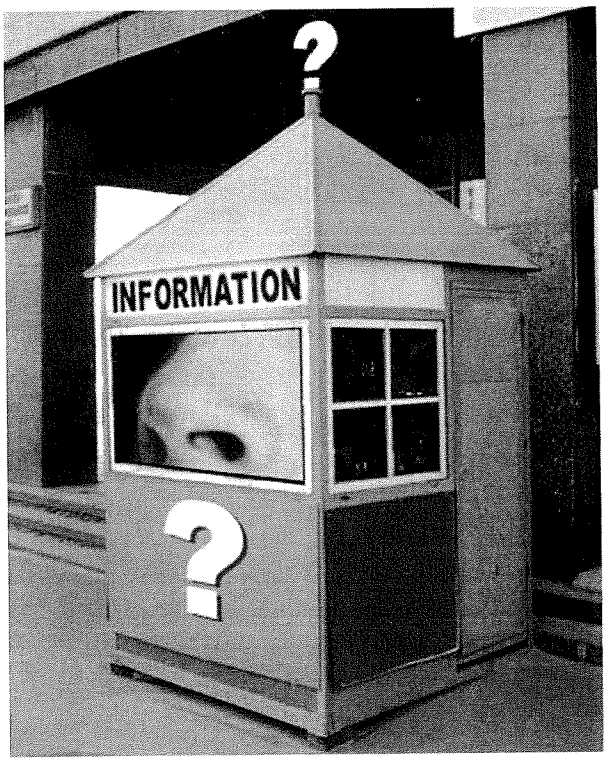
Explorer's Guide

The Nose Knows

Discover the difference between taste and smell



Think of all the wonderful sensations provided by your sense of taste—the sweetness of a perfectly ripe peach, the saltiness of a dill pickle. You can use your sense of taste to tell the difference between two kinds of apples or two kinds of chocolate. How does this powerful sense actually work? How does your body "taste" things?

Things You Will Need

- ▲ several different flavors of hard candies (or lollipops)
- ▲ a stopwatch or clock with a second hand
- ▲ paper for recording observations

To Do and Notice

Work with a partner in this activity. Choose who will be the first volunteer and who will be the first assistant. You'll reverse roles after you've gone through the activity once.

You may find it helpful to read through the activity and create a data table before you take on the assistant role. You'll be recording the volunteer's experiences and flavor-guesses at three separate times during the activity, and it will be handy to have a prelabeled place to put each observation.

❶ Volunteer: Close your eyes and pinch your nose shut with your fingers.

❷ Assistant: Select a candy, but do not tell the subject the flavor. Unwrap it and place it in the subject's hand. Try not to touch the candy with your fingers.

❸ Volunteer: Place the candy in your mouth. Open your eyes—but keep your nose pinched shut! You may breathe through your mouth, but be careful not to inhale the candy into your throat. Focus on the tastes and sensations in your mouth.

❹ Assistant: When the volunteer places the candy in his or her mouth, begin a 60-second countdown. At the same time, ask the volunteer to describe the sensations he or she is experiencing. Quickly record the volunteer's observations in your data table and go to the next step.

❺ Assistant: Ask the volunteer to identify the flavor of the candy. If the volunteer can't do this, record a question mark. If the volunteer is guessing, say so.

❻ Assistant: When the candy has been in the volunteer's mouth for about 60 seconds, again ask the volunteer about the sensations in his or her mouth, and again ask him or her to identify the flavor of the candy. Record both sets of observations.

❼ Assistant: After you've finished recording the information for step 6, tell the volunteer to open his or her nose and immediately describe any differences in the sensations in his or her mouth. Record these observations in your data table, and then ask the volunteer to identify the flavor of the candy.

❽ Assistant: You may now reveal the true flavor of the candy. Record it on the sheet of paper below your data table.

❾ Change roles and repeat the activity.

Interpreting Observations

What sensations did you experience in your mouth? How did these sensations change over time? Could you determine the true flavor of the candy? If so, when? Did your taste sensations change when you opened your nose? What does this tell you about your sense of taste?

Facilitator's Guide

The Nose Knows

Materials

for each small group

- several different flavors of individually-wrapped, flavored hard candies (lollipops, which some people find easier to handle, may be used instead)
- stopwatch or access to a clock with a second hand
- paper for recording observations

Management

- Amount of time for the activity: 20–30 minutes
- Preparation time: 10 minutes to set out materials
- Group size: 2

Preparation and Setup

Activity Overview

Discover the connection between taste and smell by trying to identify the flavors of hard candies through taste alone.

Concepts

› There are five tastes that can be recognized by the tongue: sweet, sour, bitter, salty, and *umami*.

› Most of what we experience as taste is actually from our sense of smell.

› Particular scents and tastes are due to different molecules that bind to smell and taste receptors.

› Our smell receptors can recognize thousands of different scent molecules.

Preparation

None, except for obtaining materials.

Questions for Getting Started

› How many different tastes are there? Give examples.

› What's the difference between a taste and a particular flavor? (For example, honey: the taste is sweet; the flavor is honey.)

› How does food taste when you have a cold or a stuffy nose?

TIPS!

- To create a common foundation for describing observations in this activity, explain the following definitions before you begin. Taste: one of the five perceptions that come from the tongue's taste receptors—sweet, salty, bitter, sour, and *umami*. Flavor: a particular kind of taste/smell experience, such as cherry, orange, honey, mint.
- Carry out this activity in concert with the three others that explore the senses of taste and smell, "The Taste of Color," "Are You a Supertaster?" and "Nose-stalgia."

After the Exploration

Expected Results

Subjects are not likely to identify the flavor of the candy when it is first put it in their mouths; they should, however, recognize a sensation of sweetness or sourness or both. After a minute, some subjects may notice that they can identify the flavor. After opening their noses, most subjects can easily identify the flavor, and the sensations in the mouth become more distinct.

What's Going On?

With your nose closed, you are relying on the taste receptors on your tongue alone. Some of these receptors recognize "sweetness" when the hydroxyl groups (-OH) of the sugars in the candy bind to them. Other receptors recognize "sourness" when they come into contact with the hydrogen ions of the acidic compounds in the candy. In a similar way, the ions in salts stimulate "salty" receptors and nitrogen-containing alkaloids stimulate "bitter" receptors. The amino acid, glutamate, triggers the receptor for *umami*. The perceptions of sweetness and sourness provided by the tongue aren't enough to allow you to identify flavors.

After you have sucked on a candy for awhile, you may be able to identify the flavor because the olfactory receptors may begin to come into play. Scent molecules from the candy volatilize and travel into the nasal passages through a "back door"—a passage at the back of the throat. These molecules arrive at the olfactory bulb, a part of the brain that houses the olfactory receptors. The olfactory bulb contains at least 1,000 different types of receptors that allow the average person to distinguish among about 10,000 different scents. The flavor sensations typical of hard candies—cherry, orange, and so on—are produced by specific "flavor" molecules that are recognized by receptors in the olfactory bulb, and not by the tongue's taste receptors.

After you open your nose, the olfactory bulb can do its job unhindered, and sensing the flavor molecules in the candy is relatively easy.

Discussion Questions

❶ Do you think that vision influences your sense of taste? Can you give an example? How would you design an experiment to test your hypothesis?

❷ How do you think culture might influence how people experience the taste and smell of food? What foods might taste good to someone from one cultural background and bad to someone from a different culture?

Going Further: Ideas for Inquiry

› Place candies on different areas of your tongue. Do you experience different sensations at the different locations? Or does every area of your tongue seem similar?

› Use this activity as the basis of a survey on taste sensitivity. Compare different groups—such as smokers and nonsmokers, or teens and adults—and develop hypotheses to explain any differences between the groups.

The Basics and Beyond

Background

The perception of a food's taste comes from a complex combination of sensory inputs from chemical receptors on the tongue and at the top of the nasal passages. The receptors on the tongue—those responsible for taste per se—are relatively simple: they recognize only sweet, salty, sour, bitter, and *umami*. The olfactory (scent) receptors in the nasal passages, in contrast, are fine-tuned and discriminating. They can recognize thousands of different kinds of smells. When we eat food, our brains combine the olfactory receptors' information with the taste information from the tongue to form what we perceive as the food's "taste." When the brain is deprived of smell information (such as when we have colds), food tastes dull because we are only tasting it, not smelling it, too.

Tidbits

› Olfactory neurons in the epithelium (outer layer) of the olfactory bulb are the only type of brain cells that are continually and rapidly replaced in adults. Each survives for only about 60 days. These neurons are particularly vulnerable to damage as they are directly exposed to the outside environment. As the cells die, new olfactory neurons are generated by a layer of stem cells underneath the olfactory epithelium.

› Alkaloids—the compounds recognized by the tongue's taste sensors as bitter—typically have significant physiological activity. Some examples of alkaloids are nicotine, quinine, morphine, strychnine, and reserpine. Many poisons are alkaloids. Many of the receptors for bitter taste are located at the back of the tongue. This location of the receptors may

help to trigger the vomiting response, which could, in theory, prevent poisoning.

› Scientists who study taste debated for years whether there was a fifth taste, *umami*. In 2000, a receptor for the amino acid, glutamate, was discovered, which confirmed *umami* as a genuine fifth taste. *Umami* is recognized as "savory" often enhanced by the food additive, monosodium glutamate. Most Japanese recognize *umami* as a unique taste and detect it in seaweed, ripe cheeses, and some meats. Interestingly, most non-Japanese do not experience this taste, which suggests that the perception of taste is influenced by culture and language as well as by the functions of the taste and smell sensors.

› "Taste Maps," distinct areas of the tongue that respond most strongly to one particular taste (sweet, sour, bitter, salty, *umami*) do not exist. This pervasive and persistent misconception originated in a mistranslation of a German research paper published in the late 1890s. Most tastes are perceived across the tongue, but variations among individuals exist.

References

Smith, David V. and Robert F. Margolskee. Making Sense of Taste. *Scientific American,* March 2001, 32–39.

Chaudhari, N., A.M. Landin, and S.D. Roper. A metabotropic glutamate receptor variant functions as a taste receptor. Nature Neuroscience, Feb. 2000, 113–119.