Teacher Version: Taste This!

This activity was developed by Dr. Susan Hershberger for the Fighting with Food project, a partnership between Miami University, the University of Cincinnati, and the University of Kentucky. The project is funded through the National Center for Research Resources and the Division of Program Coordination, Planning, and Strategic Initiatives of the National Institutes of Health through Grant Number R25 ODO01190-02. These materials have been developed and reviewed upon the advice of for the following research scientists at partnering institutions: University of Kentucky—Dr. Bernhard Hennig, Dr. Lisa Gaetke, and Dr. Lindell Ormsbee; University of Cincinnati: Dr. Kim Dietrich and Dr. Mary Beth Genter. Pedagogical review has been provided by Dr. Aeran Choi, Kent State University

Background

One important goal of the Fighting with Food project is expanding students' experience with nutrient rich "fighting foods" that they may not have been exposed to (or been receptive to) in the past. Ideally, as students discover "fighting foods" that they enjoy, their consumption of these foods will increase. This exposure to new foods is one purpose for the cooking and tasting experiences included in the Fighting with Food materials.

In addition to expanding student exposure, experience, and knowledge of nutrient rich foods, food tasting can introduce students to the rigor and science of sensory evaluation—a scientific discipline in which human senses are used to evaluate consumer products. Sensory evaluation is central to food science and essential to the development and marketing of food brands. The most common type of consumer test shown in popular culture is a food tasting challenge featuring the preference by a savvy consumer for one product, such as the preference of one brand of cola over another brand of cola. Since colas have similar color and mouth feel, consumers must choose their preferred product based on detecting difference in the flavor characteristics of aroma and taste (mostly sweet and sour, with lesser amount of bitter and salt.) In the case of a famous cola taste challenge, one cola brand knew from many previous preference tests that for a first sip many tasters prefer a sweeter sample so they were able to tip the "challenge" in their favor on the basis of the first sip, although consumers might actually like a whole bottle of another product better. This example raises some important questions about experimental design. How large of a sample should testers taste? Can they taste samples more than once?

A taste test might show that one product is preferred, but how do researchers know that consumers were actually able to tell the samples apart? Testing to determine whether there is a detectable difference among two or more products (called discrimination testing) is an important area of sensory evaluation. Students with a strong loyalty to a particular brand might be very surprised to find out in a discrimination test that they can't actually tell the difference between their favorite product and a rival.

Another important area of sensory evaluation is descriptive analysis. Rather than answering the question "Are products different?" as a discrimination test does, this type of evaluation answers the question "If products are different, how are they different?" A ballot or questionnaire lists the characteristics to be evaluated, typically appearance, aroma, flavor and texture. The result is a sensory profile outlining the attributes of the product and the intensity for each attribute.

By exposing students to "fighting foods" in the context of conducting sensory evaluations, food tasting becomes highly relevant to the science classroom. Inquiry, experimental design, and data analysis are

naturally incorporated as teachers and students approach these investigations together as a research team and use mathematics and statistics to determine the significance of data collected. The results will be different depending upon the foods being tasted, the type of sensory evaluation chosen, and the test audience. Each Fighting with Food unit provides suggestions for at least one cooking and tasting experience. The nature of the foods being cooked and tasted and the questions students want to answer will guide whether preference testing, discrimination testing, descriptive analysis, or a combination of these are the best sensory evaluation for a given cooking/tasting experience. We suggest that students have the opportunity to design and conduct at least one of each type of evaluation.

In the food industry, sensory evaluation follows standardized methods with explicitly described procedures included in compendiums of methods such as the America Society for Testing and Materials (ASTM). While other education resources may emphasize teaching students how to follow these published methods, our goal is to help students learn the important "what" and "why" behind the tests and to make the tests easier to conduct in a classroom.

Concept checklist

To help you plan for using this lesson in your classroom and potentially modify it to meet your needs, consider the following list of targeted concepts and note whether your students will be introduced to them for the first time or will be revisiting concepts they have been exposed to previously.

Targeted concept	Introducing	Revisiting
experimental design		
communication of results		
significance of results		
statistical significance		

Part A: Preference Test

A preference test is designed to answer the question "Is one product preferred over another?" The procedure often involves presenting a tester or judge with two or more items and asking which one they prefer.

Part A Materials

- non-laboratory space to taste a food sample
- two or more versions of a food choice that students may want to taste connected with a nutrient rich food being studied
  Note: Unlike a discrimination test, a preference test does not require that the samples be as identical as possible.
- slips of paper reading either AB or BA, one slip per student with equal numbers of each type
- bowl or other container for slips
- utensils necessary to hygienically taste two different food samples such as cups, spoons, plates, napkins etc.

Part A Pre-Activity Discussion

The pre-activity brainstorming discussion outlined below is designed for instructors to engage students in

understanding the goals of the investigation and possible approaches to doing the investigation. In cases where teachers use inquiry and facilitate student proposed and designed investigations, this discussion provides a starting point for that process. In cases where teachers supply students with a procedure for the investigation, this discussion incorporates some elements of student inquiry into the activity.

Discuss with students what they know about a specific type of nutrient (such as an antioxidant, Vitamin C, or calcium rich foods), what foods may be high in that nutrient, and how they expect those foods to taste. Examples include different types of fresh fruit, fresh vegetables, salad greens, yogurts, and non-dairy milks such as soy, coconut, or rice milk. (Use nut milks such as almond milk with caution, and only if you know that students do not have tree nut allergies.) Student can additionally discuss whether a specific brand, style, or preparation of a nutrient rich food may be preferred such as raw versus cooked, fresh versus frozen, and frozen versus canned.

Ask how students' preference for a type of food, brand, style, or preparation could be measured. Students will probably describe some version of "give a student two samples, tell students to taste each sample, and ask students which sample they prefer." Students may need to be prompted to include steps like recording the result of each student's preference and whether they think a student should include a reason why they preferred that sample. If needed, prompt students to consider experimental procedures such as tasting order (Do all students taste sample A first and sample B second, or do some students taste sample B first followed by sample A?), whether students should be allowed to re-taste, how large samples should be, and whether "no preference" should be offered as a choice.

Part A Procedure

The procedure outlined below is written to the teacher. In cases where teachers have students propose and design their own investigations, this procedure serves as an example for the teacher of a tested procedure that produces observable outcomes. While finding no observable outcome is a viable result in itself, and certainly may happen in student-directed investigations, having a tested procedure as a reference point can help teachers facilitate discussions with students as they propose their own procedures. In cases where teachers supply students with a procedure for the investigation, the written procedure can be adapted for students to read directly.

1. Put slips of paper reading either AB or BA into a container.
2. Have each student draw a slip.
3. Have each student place a small sample of each food on a plate (or cups on a tray) in the order stated on his or her slip and record the position and identity of the samples with a labeled diagram. Students should not reveal the sample order to their partners.
4. Have students take turns offering samples to a partner to taste (asking if they prefer the left or right sample), and recording results, possibly in a large data table similar to the one on the next page.

Sample Number	**Result of Tasting** Does the student prefer sample on the left or on the right?	**Pattern on paper slip** 1: Left = A and right = B or 2: Left = B and right = A	**Student Preference** Read from previous 2 columns	**Student Preference** Read from previous 2 columns
			A	B

1	left	2		X
2	right	1		X
3	right	2	X	
Sample size			Total number of B choices	Total number of A choices

Part A: Post-Activity Discussion

The post-activity discussion is designed to help the teacher facilitate student learning as students summarize their observations and make claims about the outcome of the investigation using their data as evidence. Whether students use a provided procedure or have designed one of their own, this discussion incorporates key components of inquiry-based learning into the lesson.

So, does the classroom data indicate that one food is clearly preferred over another food? Help your students understand by leading a discussion that might go as follows.

You might pose to students the question "If you conduct a preference test with one person, can you generalize that the product he or she prefers is likely to be preferred by the public as a whole?" Students are likely to recognize that in one test there is a 50% chance that either product is preferred. More people need to take the preference test in order to draw a conclusion. What if two people do the test, and they both prefer the same food? If three out of three people choose the same food, is there a clear preference? What if only two of three people choose the same?

You can follow with the question "If 100 people participated in a preference test, how many would need to choose one product over another for you to feel confident that most people in the public would prefer the same product?" Obviously, if 100 people make the same choice, the conclusion is clear. But what if 75 people make the same choice? What if 55% do? This discussion leads to the topic of statistical significance and the idea that scientists use mathematical rules to decide whether the results from preference tests, or any experiment, are considered to provide a conclusive answer.

Typically, scientists are satisfied with a conclusion that they are sure of about 95 out of 100 times. In the language of statistics, the conclusion has 95% significance. When the number of people (called the sample size) taking the preference test is small, nearly everyone needs to choose the same answer for it to be statistically significant. For example, with 10 testers, 9 need to make the same choice for 95% significance. As the sample size gets larger, the answers can be more divided between the two choices and still produce a statistically significant result. For example, with 40 testers, 27 need to make the same choice for 95% significance. You may want to point out that the use of statistics to understand how consumers taste and respond to sensory stimuli is related to the use of statistics in determining whether a medicine is effective in relieving symptoms of a disease, for either laboratory test animals or people.

Ask students, "From the group data, is there a clear preference for one sample over the other sample? How do you know? Should you run the taste test with more testers? What other taste tests would you like to run?"

Number of Testers	Number of preferences for a specific sample needed for 95% significance
6	6
8	8
10	9
12	10
15	12
20	15
25	18
30	21
35	24
40	27
45	30
50	32
55	35
60	38

Part B: Triangle Taste Test

The Triangle Taste Test is a discrimination test designed to answer the question, "Can the differences between products be distinguished" In a triangle taste test, each tester is presented with three samples to taste, where two of the samples are the same, and one sample is different. The job of the tester is to pick which sample is different.

Part B Materials:

- food safe room for food tasting
- slips of paper with the combinations of AAB, ABA, BAA, BBA, BAB, ABB; one slip per student, with equal numbers of each type
- bowl or other container for slips
- two similar food samples, such as two varieties of apples or two brands of the same food, one designated A and one designated B,
  Note: Unlike a preference test, a discrimination test requires that the samples look as identical as possible, unless blindfolds are used.
- (optional) blindfolds
  Note: if the foods to be tested have different appearances and your students want to test whether they taste different without being able to see the difference, you could ask testers to wear a blindfold during the tasting.
- trays and utensils appropriate for the hygienic tasting of food, such as cups, spoons, napkins etc.

Part B Pre-Activity Discussion

The pre-activity brainstorming discussion outlined below is designed for instructors to engage students in understanding the goals of the investigation and possible approaches to doing the investigation. In cases where teachers use inquiry and facilitate student proposed and designed investigations, this discussion provides a starting point for that process. In cases where teachers supply students with a procedure for the investigation, this discussion incorporates some elements of student inquiry into the activity.

Discuss with students what could be done about the case of a preference test that failed to indicate a statistically significant preference of one food over another food. Ask students why this might be. Did tasters did not clearly prefer one food over another? Is it possible that tasters could not tell the difference between the two samples? Ask students to consider how this question could be answered with a food tasting test. Since discrimination tests are probably less familiar to students than preference tests, you may have to pose the question, "What would you find out if you presented a tester with three samples, two of the same food and one different?" Students may agree that you would be testing whether the tester could taste which of the three samples was different.

As in the preference testing discussion, ask students to consider different experimental procedures such as tasting order (Should the samples be in the same order for all tests?), whether students should be allowed to re-taste, how large samples should be, and whether you want testers to describe the nature of the difference.

Part B Procedure

The procedure outlined below is written to the teacher. In cases where teachers have students propose and design their own investigations, this procedure serves as an example for the teacher of a tested procedure that produces observable outcomes. While finding no observable outcome is a viable result in itself, and certainly may happen in student-directed investigations, having a tested procedure as a reference point can help teachers facilitate discussions with students as they propose their own procedures. In cases where teachers supply students with a procedure for the investigation, the written procedure can be adapted for students to read directly.

1. Put slips of paper reading AAB, ABA, BAA, BBA, BAB, or ABB into a container.
2. Have each student draw a slip.
3. Have each student place a small sample of each food on a plate (or cups on a tray) in the order stated on his or her slip and record the position and identity of the samples with a labeled diagram. Students should not reveal the sample order to their partners.
4. Have students take turns offering samples to a partner to taste (asking which sample tastes different, from left to right, first, second, or third), and recording results.

Sample table for tabulating the group or class responses

Sample Number	**Result of Tasting** Which sample (from left to right) tastes different? first, second, or third	**Pattern on bottom of tray or sample paper** AAB, ABA, BAA, BBA, BAB, ABB (Revealed only after tester identifies the different sample.)	Did tester pick the sample that is different? (Decided from the previous 2 columns)	Did tester pick the sample that is different? (Decided from the previous 2 columns)
			YES	NO
1	first	AAB		X
2	first	ABA	X	
3	third	BBA	X	
Sample size			Total number of YES	Total number of NO

Part B: Post-Activity Discussion

The post-activity discussion is designed to help the teacher facilitate student learning as students summarize their observations and make claims about the outcome of the investigation using their data as evidence. Whether students use a provided procedure or have designed one of their own, this discussion incorporates key components of inquiry-based learning into the lesson.

So, does the classroom data indicate that testers could distinguish the "odd" sample?

Discuss with students that statistics is again very helpful in interpreting the results of the test. For this test the number of correct responses is listed for two different significance levels.

- From the group data, is there a clearly discernible difference between the two different samples? How do you know? Should you run the taste test again with more testers?
- Would you like to run the test again with different protocols? For example, if you did not allow tasters to go back and re-taste a previously tasted sample, would the results be different if you try allowed it? Or, would the results be different if each student randomly selected the order of the samples rather than selecting a slip of paper with an assigned pattern?
- If the results were inconclusive, does looking for patterns in the data add anything to the story? For example, perhaps A is more frequently identified correctly as the odd sample (in patterns BBA, BAB, or ABB) than B (in patterns AAB, ABA, and BAA). Or, maybe there are more correct answers in the patterns where the odd sample is in the middle (ABA and BAB) than in the other patterns.

Number of Testers	Number of correct responses for choosing the odd sample needed for 80% significance	Number of correct responses for choosing the odd sample needed for 95% significance
6	4	5
8	5	6
10	6	7
12	6	8
15	8	9
20	9	11
25	11	13
30	13	15
35	15	17
40	17	19
45	(don't have these numbers)	
50		
55		
60		

Part C: Descriptive Analysis

A descriptive analysis is designed to answer the question "What are the characteristics of this product?" The procedure usually involves trained testers or judges using a questionnaire that usually asks about the

appearance, texture, aroma, and flavor of the food being tested.

Part C Materials

- non-laboratory space to taste a food sample
- food samples
- utensils necessary to hygienically taste two different food samples such as cups, spoons, plates, napkins etc.

Part C Pre-Activity Discussion

The pre-activity brainstorming discussion outlined below is designed for instructors to engage students in understanding the goals of the investigation and possible approaches to doing the investigation. In cases where teachers use inquiry and facilitate student proposed and designed investigations, this discussion provides a starting point for that process. In cases where teachers supply students with a procedure for the investigation, this discussion incorporates some elements of student inquiry into the activity.

To begin, you might ask students if they have ever tried to describe a food they have tasted to another person. Discuss the kinds of attributes foods have, such as appearance, texture, aroma, and flavor. Brainstorm with students words that might be used to describe these attributes. For flavor, they may mention basic tastes such as sweet, salty, sour, and bitter.

Introduce descriptive analysis as another kind of sensory evaluation food tasting. Explain that the method for this type of test depends on everyone using a questionnaire appropriate for the food being tasted so that results can be compared. One way to develop questionnaires is to assign a different food to each of several small groups, give the small groups samples of their assigned food to test, and let them develop a questionnaire based on their observations and perceptions of the food. The rest of the class can then be invited to taste each food and use the questionnaires developed by other groups.

Part C Procedure

The procedure outlined below is written to the teacher. In cases where teachers have students propose and design their own investigations, this procedure serves as an example for the teacher of a tested procedure that produces observable outcomes. While finding no observable outcome is a viable result in itself, and certainly may happen in student-directed investigations, having a tested procedure as a reference point can help teachers facilitate discussions with students as they propose their own procedures. In cases where teachers supply students with a procedure for the investigation, the written procedure can be adapted for students to read directly.

1. Give each group their assigned food samples.
2. If desired, provide students with a sample questionnaire as a guide.
3. Have students work within groups to observe and taste their assigned food and develop a questionnaire that includes attributes of appearance, texture, aroma, and flavor.
4. Give students the opportunity to taste all foods and complete all questionnaires.

Sample questionnaire about strawberry ice cream

Attribute	Intensity (rate on a scale of 1 to 5)	

Appearance	Color	
	Denseness	
	Meltiness	
Flavor	Sweetness	
	Strawberry flavor	
	Candy flavor	
	Cooked sugar flavor	
	Milky flavor	
	Vanilla flavor	
	Buttery flavor	
Texture	Thickness	
	Smoothness	
	Creaminess	
	Mouth Coating	

Part C: Post-Activity Discussion

The post-activity discussion is designed to help the teacher facilitate student learning as students summarize their observations and make claims about the outcome of the investigation using their data as evidence. Whether students use a provided procedure or have designed one of their own, this discussion incorporates key components of inquiry-based learning into the lesson.

Discuss with students ideas for illustrating the results of their descriptive analysis on a graph. You may want to introduce the spider graph as one option. Each spider graph represents one attribute category, such as flavor. The spokes of the "web" each represent one attribute in that category. The intensity is represented along each spoke, with intensity increasing from center outward. Each student in a group could add their results to a common graph using a different color. Students could then look for similar shapes in the results rather than comparing exact values.