Sensory Evaluation of Foods for Product Development

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Goals

- By the end of this class, students will be able to:
  - Define sensory science and give examples of common applications to food product development
  - Determine the appropriate category of sensory test for a given research question
  - Identify sources of potential bias that will need to be controlled when given a sensory testing scenario

Intro to Sensory Science

What is Sensory Science?

- The goals of Sensory Evaluation are "…to **evoke**, **measure**, **analyze**, and **interpret** [human] responses to products as perceived through the senses…" (Lawless & Heymann, 2010)
- The senses:
  - Smell
  - Taste
  - Touch
  - Sight
  - Hearing
- Using people as **instruments** to measure something true about a **product**

Common Applications to PD

How are changes to a food perceived and liked?

How much is a food liked overall?

Is one product preferred over another?

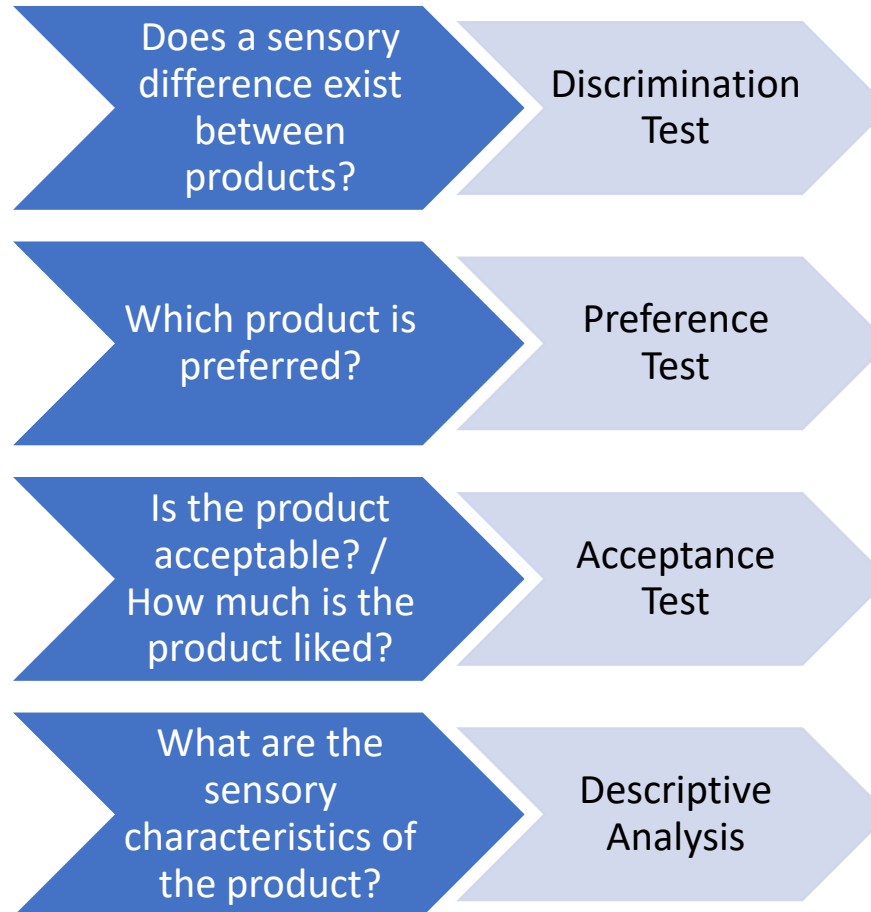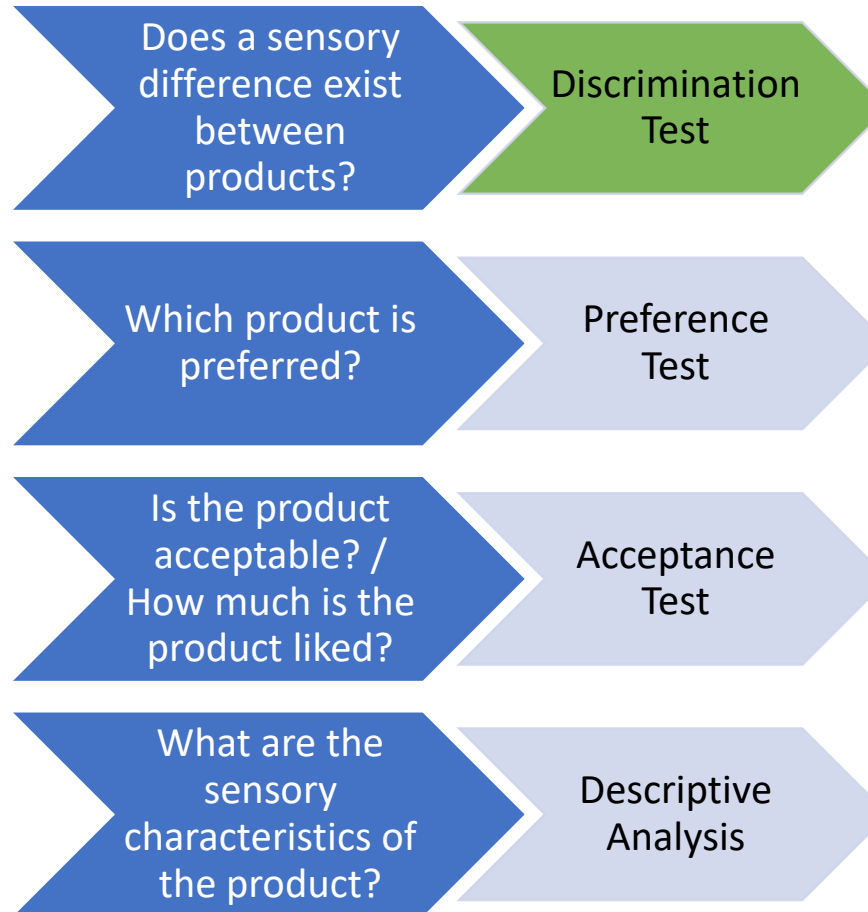Product vs. competitor

New formulation vs. existing product line

Multiple potential formulations

Types of Sensory Tests

Types of Sensory Tests

Does a sensory difference exist between products? → Discrimination Test

Which product is preferred? → Preference Test

Is the product acceptable? / How much is the product liked? → Acceptance Test

What are the sensory characteristics of the product? → Descriptive Analysis

Discrimination Testing

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There are many discrimination tests…

Table 4.1 Types of available discrimination tests

Class of test	Test	Samples: inspection phase	Samples: test phase	Task/instructions	Chance probability
Oddity	Triangle	(None)	A, A′, B (or A, B, B′)	Choose the most different sample	1/3
Matching	Constant reference duo–trio	Ref-A	A, B	Match sample to reference	1/2
	Balanced reference duo–trio	Ref-A, Ref-B	A, B	Match sample to reference	1/2
	ABX	Ref-A, Ref-B	A (or B)	Match sample to reference	1/2
	Dual standard	Ref-A, Ref-B	A, B	Match both pairs	1/2
Forced choice	Paired comparison	(None)	A, B	Choose sample with most of specified attribute	1/2
	3-AFC	(None)	A, A′, B	(Same)	1/3
	n-AFC	(None)	$A_1 - A_{n-1}$, B	(Same)	$1/n$
	Dual pair	(None)	A, B and A, A′	Choose A, B (different pair)	1/2
Sorting	Two out of five	(None)	A, A′, B, B′, B″	Sort into two groups	1/10
	4/8 "Harris–Kalmus"	(None)	$A_1 - A_4$, $B_1 - B_4$	Sort into two groups	1/70
Yes/no	Same–different	(None)	Pairs: A, A′ or A, B	Choose response: "Same" or "different"	N/A[a]
(Response choice)	A, not-A	Ref-A	A or B	Choose response: "A" or "not-A"	N/A[a]

Lawless and Heymann, 2010

…but they all answer the same question

- Does a sensory difference exist between products?

- Or, more accurately: How likely is it that a random consumer will notice any difference?

- Discrimination tests only tell us if there is variation, **not the nature or magnitude** of any differences
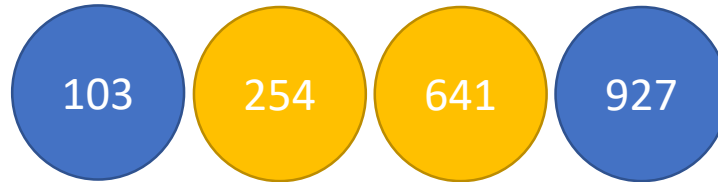
Common Discrimination Tests

Triangle

103 254 927

- "Pick the sample which is unlike the other two."
- 1/3 guessing chance
- Undirected (test measures overall difference)

Tetrad

103 254 641 927

- "Make two groups of two samples each based on similarity."
- 1/3 guessing chance
- Can be directed or undirected

Paired Comparison

103 641

- "Pick the sample which is sweeter."
- 1/2 guessing chance
- Directed (test names a specific difference)

Directed (Attribute-Specific) Tests

- When a **specific difference** is known or expected, **attribute-specific** tests may be more appropriate
- Pro – Panelists become more sensitive to small differences
- Con – Only useful in specific circumstances
    - Must know how the samples are expected to differ
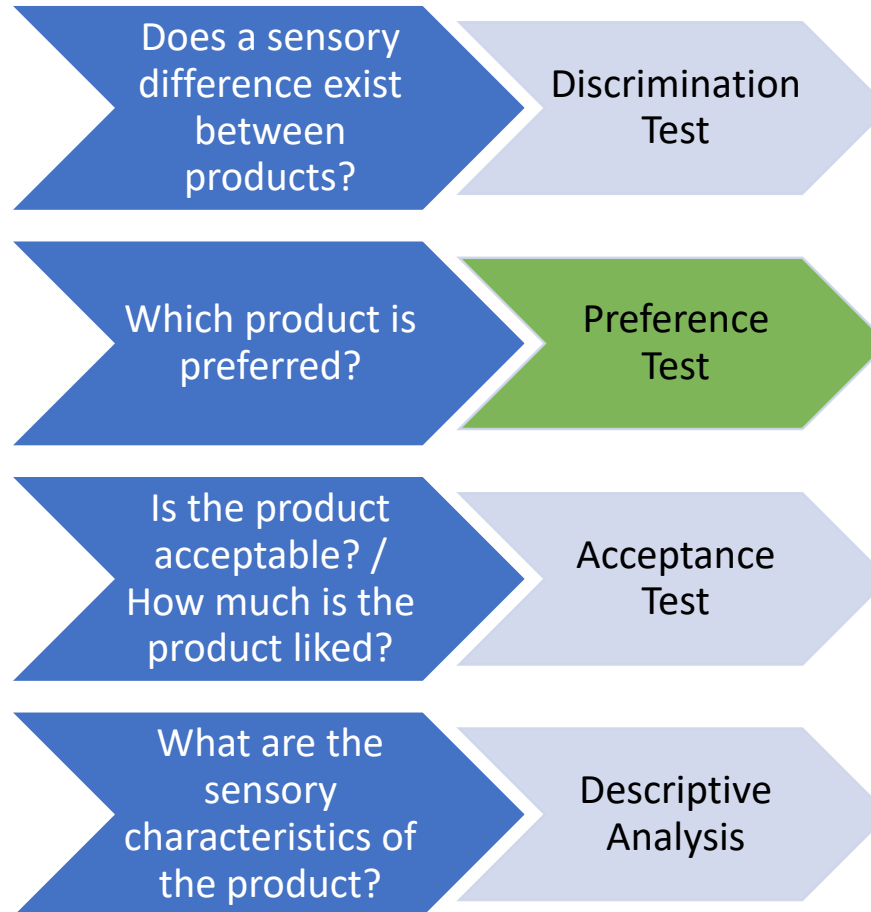   - Panelists must be familiar with the expected difference

The Trouble with "Proving" Similarity

| $p \leq 0.05$ "Reject"	$p > 0.05$ "Fail to reject"	?
~~H_0: The samples are the same~~	H_0: The samples are the same	
H_a: There is a perceptible difference between samples	H_a: There is a perceptible difference between samples	

- We <u>cannot</u> prove that the samples are the same with a normal hypothesis test
- Easy ways to minimize the chance of missing a difference:
  - Increase number of participants
  - Use a more sensitive test

Types of Sensory Tests

|	
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Preference Testing

- You already know that there's a difference, so...

- Do consumers like one product more than another?

- Tells you about <u>preference</u>, but not how well-liked any single product is.

- Good when you're interested in a limited set of products or you have a "gold standard"
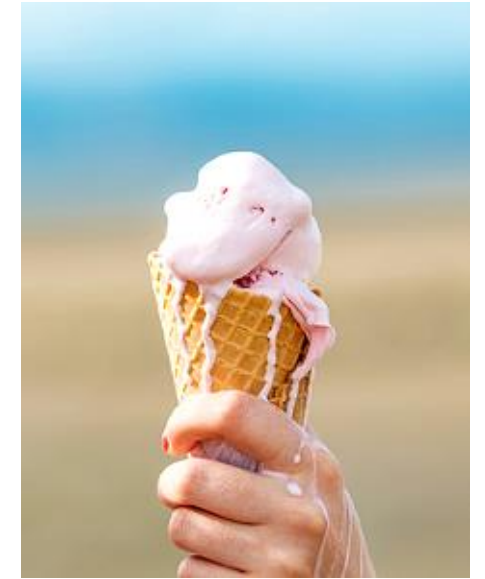
Types of Preference Tests

- Very similar to discrimination testing

- Paired Preference
    - The same setup as a paired comparison test
    - "Which sample do you like more?"

- Ranking
    - Preference test for more than 2 samples.
    - "Rank the n samples from most liked (1) to least liked (n)."
    - All samples must be presented to the panelist at once
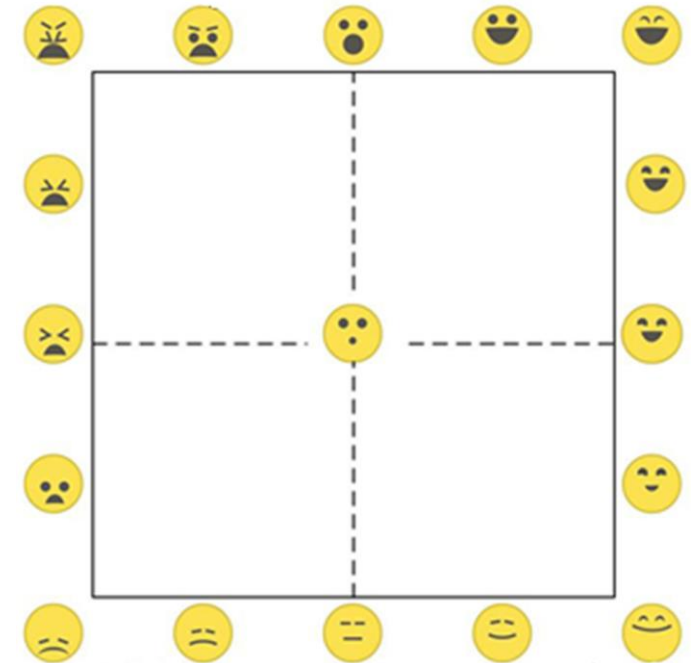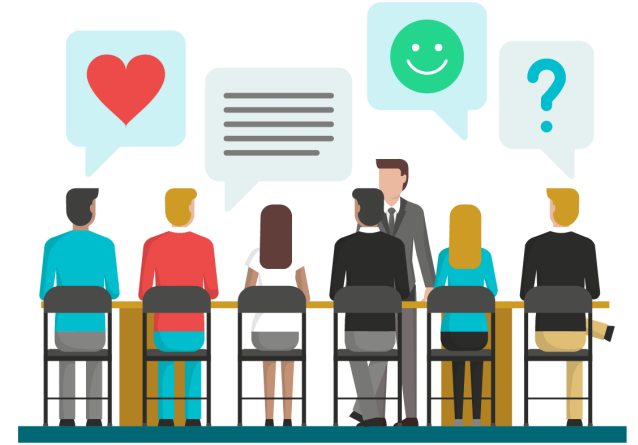
Types of Sensory Tests
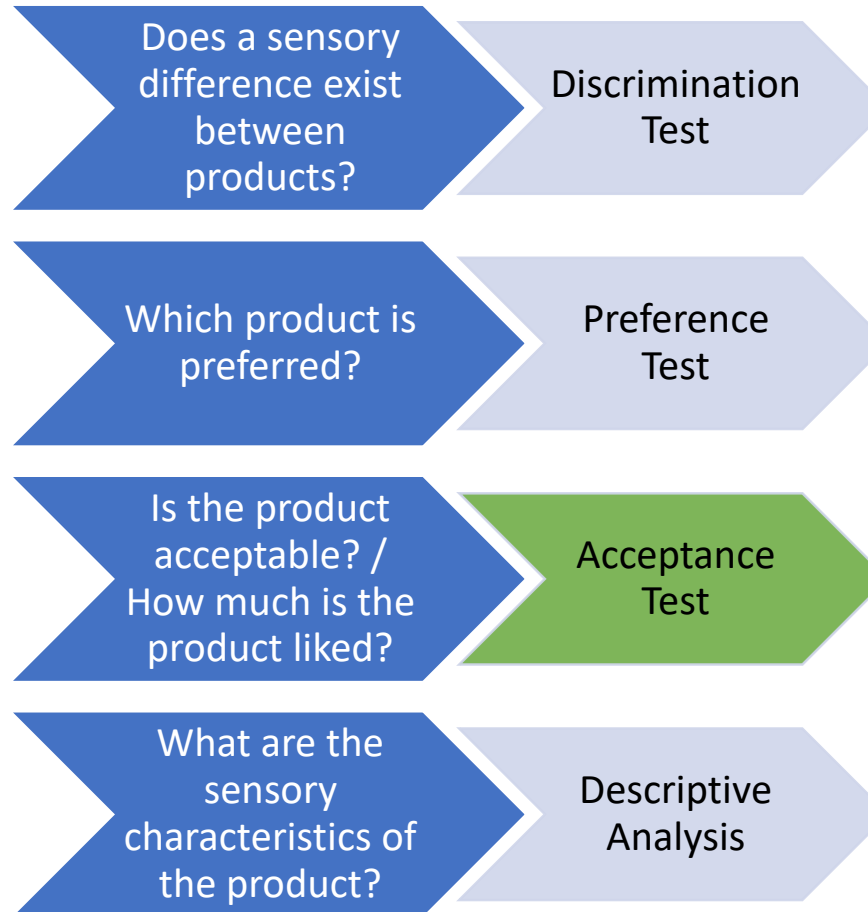
Acceptance or Hedonic testing

- The *other* method to determine liking is to scale it ("on a scale from 1 to 10...")
- Advantages over preference testing
  - You can compare to products tested at other times
  - Provides information about <u>absolute</u> liking or disliking
  - More samples can be tested easily

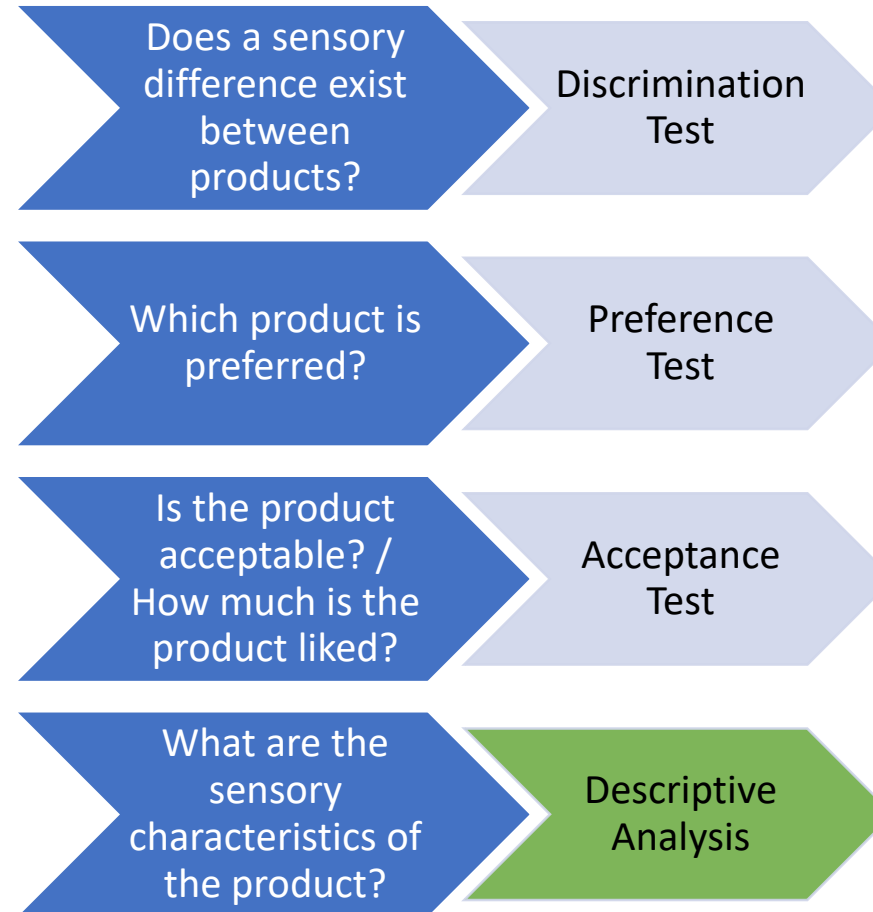| 1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Somewhat	Neither Like Or Dislike	Like Somewhat	Like Moderately	Like Very Much	Like Extremely

Other Affective Tests

- Self-reported liking (e.g. on the 9-point hedonic scale) doesn't predict success of new products very well

- So what else can we measure? – Vast area of research in consumer sciences
  - Focus groups (Qualitative data – record a few hours of moderator talking with consumers about the product category, interacting with example products)
  - Willingness to pay ("How much would you pay for this product" / "Would you purchase this product at this price point?")
  - Experimental auctions
 - Measure emotional response (self-reported, using facial recognition, etc)

Toet et. al, 2018

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Descriptive Analysis

- <u>Describes</u> and <u>quantifies</u> the distinct attributes of a product

- Attributes - Specific, distinct, named flavors, textures, aromas, etc.

- Phase 1 – Identify the attributes to be measured

- Phase 2 – Measure the attributes
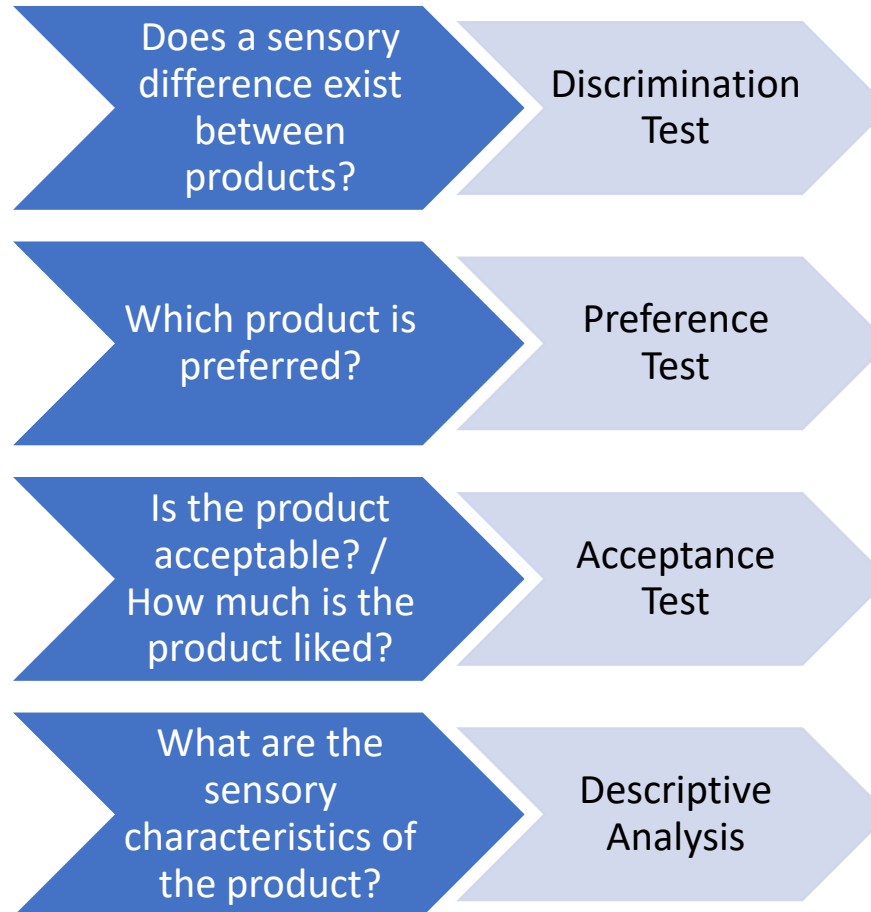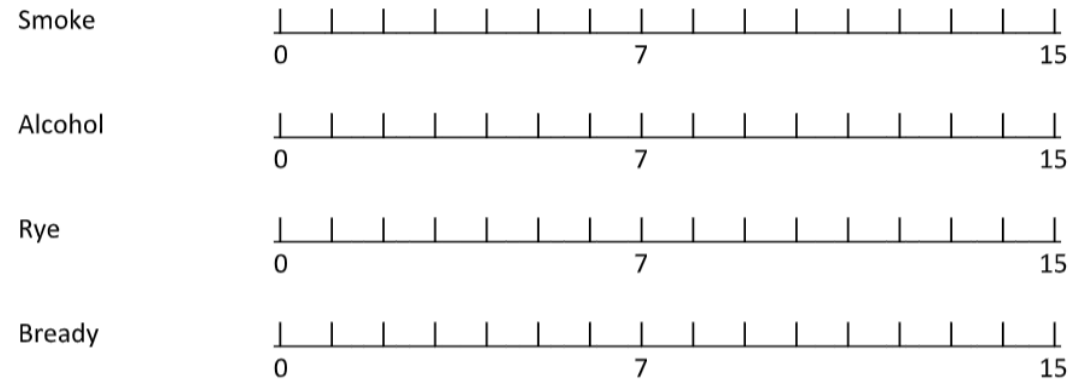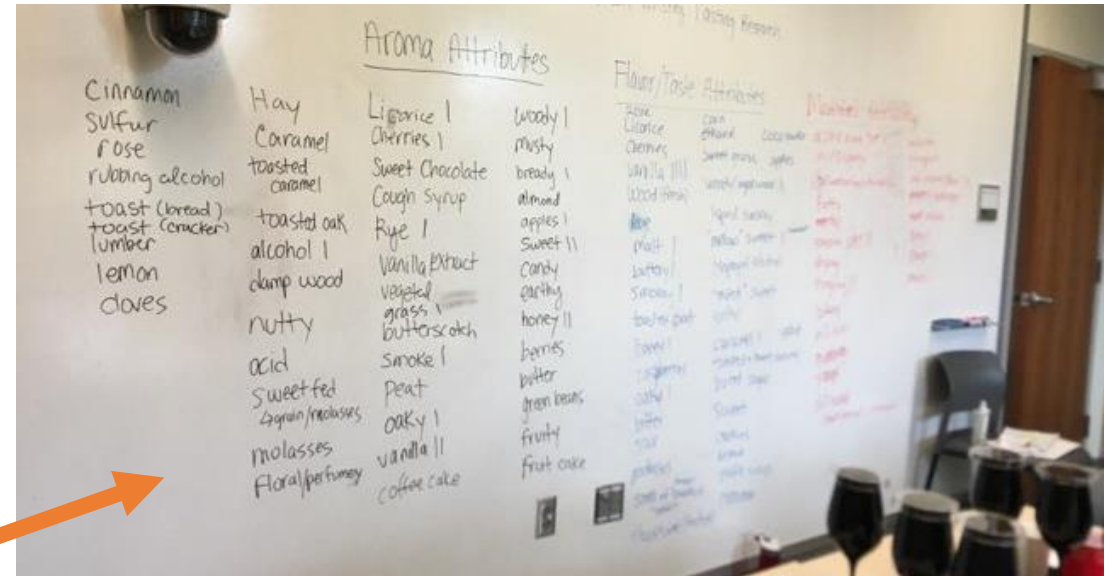
Descriptive Analysis

- Pros
  - Can link flavors to ingredients or processes
  - Once a panel is trained, relatively easy to analyze new samples
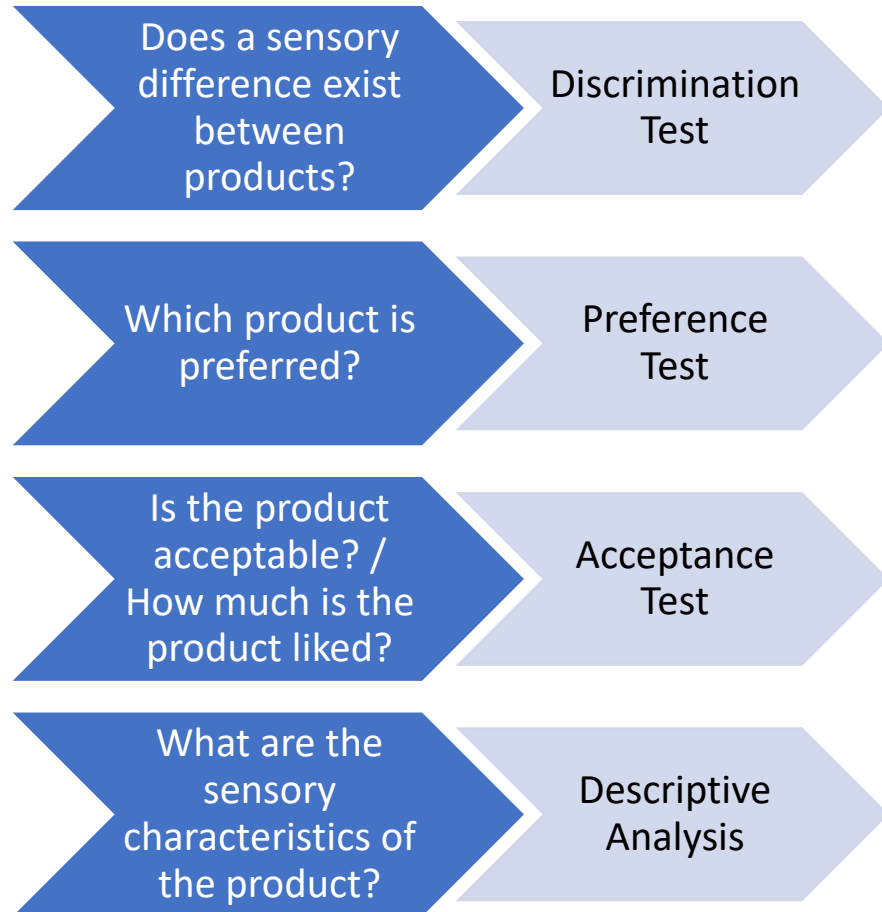 - Attribute vocabulary – good for marketing

- Cons
  - Panelists must be trained extensively
  - Need diverse examples of product category to develop a list of attributes

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Practice Activity: Match the test type

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1. Your spice company is developing a new MSG-free Cajun seasoning and wants to know if consumers think the new product tastes worse than your existing Cajun seasoning.

2. You work for a premium potato chip producer and want to understand what differences there are between existing commercial potato chips to make a line extension that is new and unique.

3. The marketing department has told you that a wasabi-flavored ice cream will sell well, and you want to know if potential consumers like the flavor of the prototype.

Good Sensory Practices

Sources of Unwanted Variation

- Inter-subject variability
- Irrelevant product variation
- Environmental variability
- Survey design

Inter-Subject Variability

- People are different!
  - Genetics, experience, personal preferences, degree of training
- Appropriate controls
  - Big sample size (i.e. number of participants), especially for affective testing (preference/acceptability)
  - Panelist training for analytic testing (discrimination/descriptive)
  - Sample panelists randomly from your product's target demographic for affective testing

Irrelevant Product Variation

- People aren't good at ignoring differences that aren't relevant to what they're measuring

- If we're testing the effect of X on Y, we want all the samples with the same level of X to be the same!
  - Product color, texture, appearance – may or may not matter depending on the research question
  - Changes in product over time (e.g. temperature, volatile loss, staling)
  - Batch-to-batch or sample-to-sample variability

Irrelevant Product Variation

- Appropriate Controls
  - Standardize the presentation of all samples
  - Have a written sample preparation protocol that covers preparation, serving amounts, temperature, timeline, etc.
  - Use red lights or opaque serving containers to mask irrelevant differences in appearance
  - Do not use a directed discrimination test for products with complex differences

Environmental Variability

- The environment someone eats in isn't a part of the product!
    - Extraneous smells, sounds, differences in lighting, etc affect the sensory experience
- Branding or information about how the samples differ primes people to respond in certain (biased) ways
- Appropriate Controls
    - Hide branding and other info using blinding codes
    - Use booths or dividers to isolate panelists from distractions
    - Avoid strong-smelling cleaners, foods, etc near the sensory testing area

Survey Design

- The answers people give depend on what you ask!
  - The wording of each question affects the answers to that question and all subsequent questions
  - The panelists will not read instructions the same way you do
  - Panelists may become bored or tired
  - Product expectations (e.g. neutral liking) differ based on previous samples
- Appropriate Controls
  - Randomize your serving orders using an experimental design
  - Defer to existing resources for the wording of questions, like published papers or textbooks (Lawless and Heymann, 2010)

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References

- Lawless, H. T., & Heymann, H. (2010). *Sensory Evaluation of Food: Principles and Practices*. *Elementary Food Science* (2nd Editio). Springer. https://doi.org/10.1007/978-1-4419-6488-5

- Toet, A., Kaneko, D., Ushiama, S., Hoving, S., de Kruijf, I., Brouwer, A., Kallen, V., & van Erp J. B. F. (2018). EmojiGrid: A 2D Pictorial Scale for the Assessment of Food Elicited Emotions. In *Frontiers in Psychology* 9:2396. https://doi.org/10.3389/fpsyg.2018.02396