

# Experimental Design and Sensory Analysis

# Hypothesis

*hypothesis* = tentative assumption to test logical or empirical consequences of applying a variable in a research project

*null hypothesis* = statement that applying a research variable will not make a significant difference in a research project

Some examples...

# Planning an experiment

- Idea
- Justification – Develop hypothesis
- Literature review
- Designing Experiment – work from hypothesis
  - Must have controls
  - Verified methods
  - Weights and measures

# Planning an experiment

- Results
  - Compare treatments using objective measurements
  - Physical and sensory tests
- Discussion
  - Compare your results with those of others
  - Did your results support your hypothesis or not?
  - Rationale
- Conclusion
  - Summary of results
  - Impact of study

# Controlling Experimental Variables

- **Variable** = quantity that has no fixed value
- **Independent variable**=defined by researcher (*e.g.* type of sweetner used)
- **Dependent variable**=will be a measured result from the experiment (*e.g.* affect of sweetner on color, volume,etc.)
- **Extraneous variable** = added variation that is not controlled that affects experimental outcome

# Conducting an Experiment

- Objective and subjective observations
- Recording data – all information when observed
- Statistical analysis
  - Descriptive statistics – frequency, distribution (mean, variance, standard deviation)
  - Inferential statistics – probability of predicting an occurrence by use of a statistical test (t-test, ANOVA).  
Use significance level  $P < 0.05$
- Report

# Sensory Tests

- Can be very objective when terms are clearly defined (consumer panel – 100s of people) or a panel that is highly trained (quantitative descriptive analysis)

# Sensory Tests

- Involves use of senses – physiological response
  - **Olfactory** receptors in nose
    - Odor and taste receptors blend to give flavor
  - **Taste receptors** –tongue, taste buds (gungiforms and circumvallate)
  - Sweet, sour, bitter, salt
  - Thresholds – concentration of taste compound at barely detectable level
  - Subthreshold – concentration of taste compound at a level that is not detectable, but is capable of influencing other taste perception (e.g. salt on sweetness)

# Sensory Tests

- Visual receptors – shape, color, texture
- Appearance can affect perceived flavor or texture (example)
- Lighting is important – must not mask or accentuate irrelevant traits during sensory testing

# Sensory Characteristics

- Appearance-color being most important (kids)
- Color is exterior surface
- Interior appearance –lumps, air cells, etc.
- Appearance and color features should be included on sensory testing forms

# Sensory Characteristics

- Aroma – second most characteristic
- Aroma ‘advertises’ food
- Consider proper temperature when evaluating food aroma

# Sensory Characteristics

- Flavor – taste and aroma mix to form flavor
- Temperature is critical to extract flavor and aroma
- Flavor potentiator – compound that enhances flavor without adding a flavor of its own (MSG)
- Flavor inhibitors – substance that blocks perception of a taste (milk protein or starch on hot pepper)

# Sensory Characteristics

- Texture – mouthfeel – how a food feels in your mouth
  - Mouthfeel –must clearly define what panelist is to evaluate (sticky, smooth, astringent)
- Tenderness – amount of chewing action to reach a certain consistency

# Sensory Tests

- Appearance, Aroma, Flavor, Texture
  - Train panel how attribute is defined so all are using same criteria
  - Standardized and consistent experimental protocol
    - examples

## Selecting a Panel

- Ability to discriminate differences you are looking for
  - Depending on test, may or may not want highly sensitive people
  - Screen using preliminary tests
  - Interest in project and serving on a panel
  - Clarity of nasal passages and ability to taste and smell
  - Demographic characteristics

# Training a Panel

- Trained panelists- varies with complexity of test
- Review scorecards, clarify questions, assure that panelists are using same word definitions for scoring

# Training a Panel

- Untrained panelists – need larger number for tests. Consumer panels.
- Panelist has no preparation for evaluation of product (outside of own personal experience)

# Training a Panel

- Descriptive Flavor Analysis Panel and Quantitative Descriptive Analysis
- -trained panel to analyze flavor, texture, appearance of product in great detail
- Describe product characteristics and quantify intensity of traits
- Verify flavor and determine quality
- Great amount of work (9 week or so to train panel)
- Must use same ‘calibrated’ panel over and over again. Needs long term commitment

# Types of Tests

- Descriptive – provide information on selected characteristics
- Affective - subjective attitude to a product. Acceptability or preference. Follows discriminative or descriptive testing
- Difference – determine whether there are detectable differences between products

# Types of Tests

- Descriptive – provide selective information on characteristics of food
  - Selective scoring of critical attributes. These are developed by researcher, through focus group or preliminary panels
  - Each characteristic to be evaluated is described over entire range (min amount to excessive amount of trait x)
  - Score card with rating scales (hedonic scales – e.g. extremely sweet to not sweet). These must be carefully worded

## Descriptive Tests, cont.

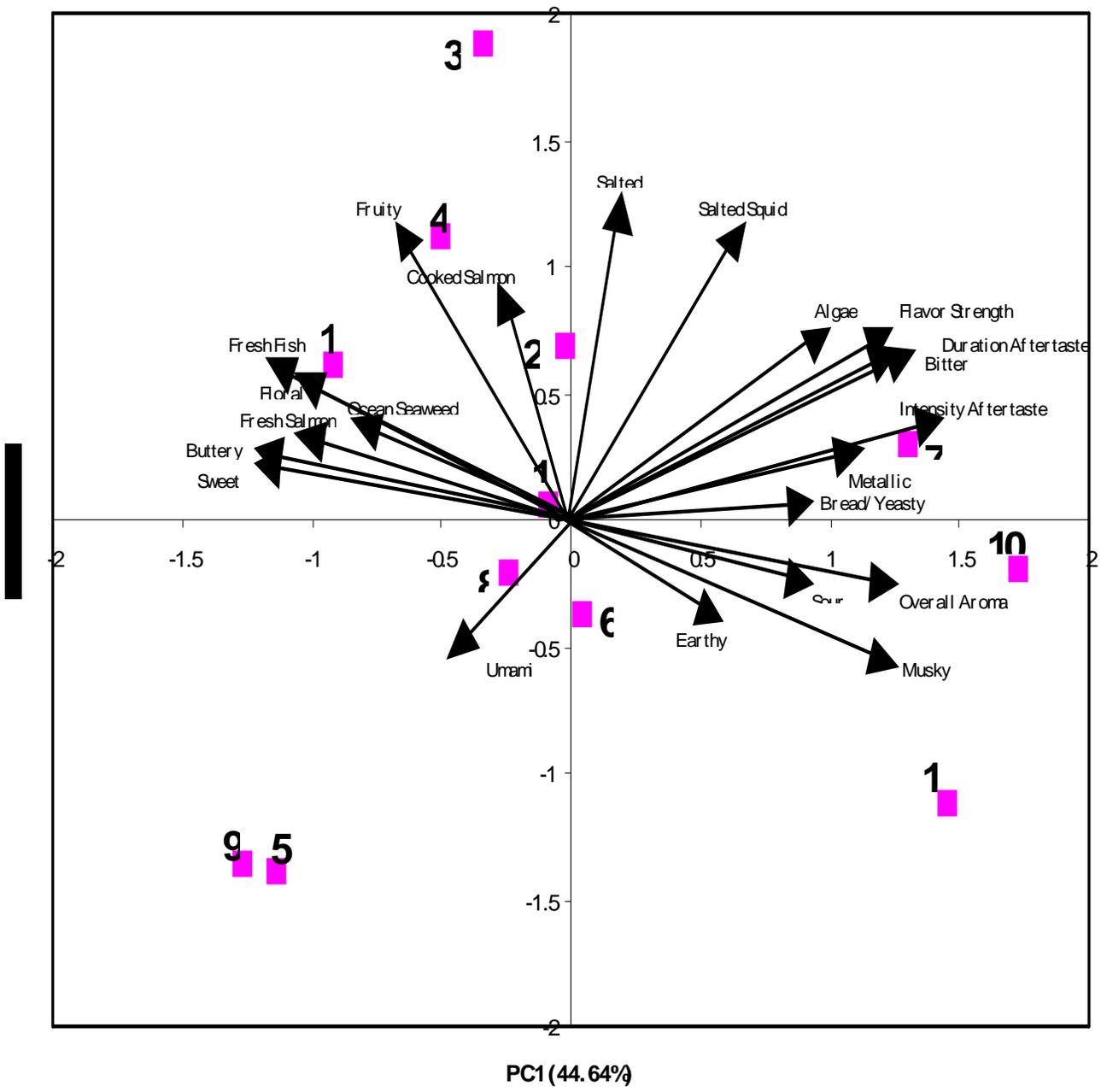
- Score cards with comparisons - ‘the more X sample is #’
- Trained or semi-trained panel
- Profile methods (flavor and texture profiling) - Individual judgments, or ratings by a group. Develop accurate word for each characteristic to be measured
- Can be a single sample

# Attribute analysis

- Not a preference test
- Problems with central tendency error
- Scales – 6-10 marks. Use objective terms as anchors (very hard) not subjective ones (much too hard).
- Anchors must be opposites
- Use anchors that are agreed upon during panel training. Each panelist can be calibrated based upon their tendency to use the whole scale. Can be repeated with a control as part of replication.

- Unstructured scales are best. Eliminates problems with unequal psychological intervals between traits.
- Psychological difference between terms are important. E.g ‘extremely sweet’ and ‘very sweet’ do not represent the same difference as ‘trace sweet’ and ‘not sweet’
- Hard to apply to complex traits like texture which must be characterized as individual components

- Train panel on what property IS so all will be looking for the same thing
- Include standards as scale tends to drift with time and panel's familiarity with the product.



# Type of Tests

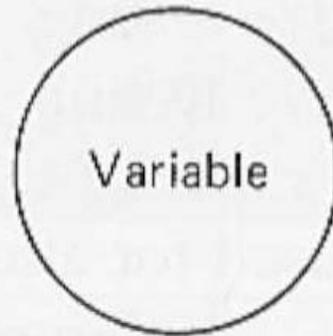
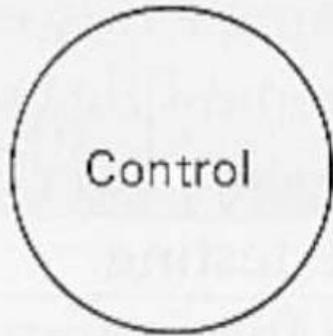
- Affective – subjective attitude to a product. Acceptability or preference. Follows discriminative or descriptive testing
- Ranking – rate by intensity of trait. Can be used to screen one or two samples from a larger group. Must couple with another test to sort out degree of different if this is important.
  - hedonic scales (like extremely/dislike extremely)
  - consumer panels

Difference – detect differences between products

- also called discrimination tests
- Test sensitivity of judges to a certain trait
- Try to match experimental product with control
- New product formulations

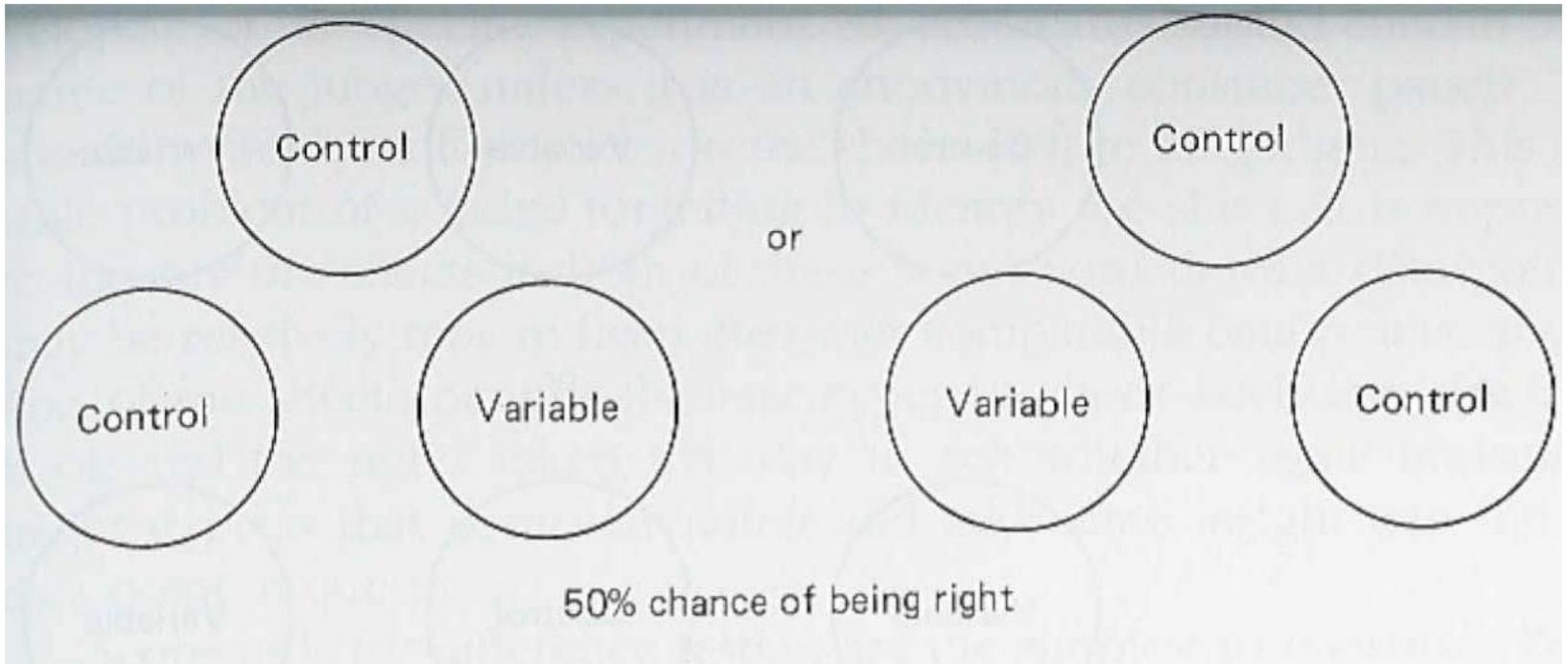
# Difference Tests

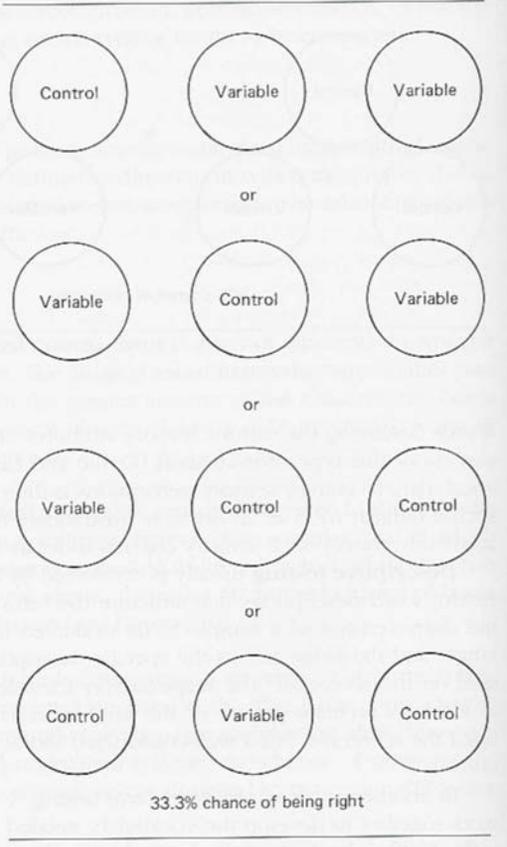
- Paired comparison
- Specific characteristic tested: ‘which sample is more sweet’



50% chance of being right

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# Other discrimination tests

- Triangle
- 2 out of 5
- Ranking- works well when several samples need to be evaluated for a single characteristic. Rank sample in order of intensity of characteristic being measured.

# Factors affecting sensory measurements

- Choosing a panel – Best scenario –
  - Panel is an analytical instrument
  - Health, interest, availability, punctual, good verbal and communication skills.

# Training a panel

- Threshold tests for primary tastes not useful to screen individuals for sensitivity to different foods
- Generally screen 2-3x as many people as you will use
- Prepare test samples as you would for 'real experiment'
- Make sure panel understands forms used and the terms used on the forms

- Expectation error – any information a panelist receives influences the outcome
- Panels finds what they are expected to find
- Trick – provide only enough information for panelist to be able to do the test
- Try not to include people already involved in the experiment (single blind)
- Avoid codes that create inherent bias (1,A etc)

- Motivated panelists
- Leniency error – rate products based upon feelings about researcher
- Suggestion effect – response of other panelists to product (need to isolate panelists and keep them quiet)



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# Testing times

- Must not be too tired or hungry
- Late morning or mid afternoon are good
- Early AM bad for testing spicy foods
- Late day – lack of panelist motivation

# Stimulus Error

- Influence of irrelevant questions (e.g piece size, color, uniformity)
- Try to mask unwanted difference (e.g. colored lights)
- Logical error – associated with stimulus error – tendency to rate characteristics that appear to be logically associated (yellow and rancidity).  
Control by masking differences

# Halo and Proximity Effect

- Halo effect – caused by evaluating too many factors at one time. Panelists already have an impression about the product when asked about second trait – will form a logical association (e.g. dry-> tough)
- Best to structure testing so that only one factor is tested at a time (difficult to do)
- Proximity error – rate more characteristics similar when they follow in close proximity.

# Convergence Effect

- Convergence effect – large difference between two samples will mask small differences between others.
- This causes results to converge. So use random order to reduce this.
- Next slide shows how flavor interactions impact this.

**Table 3.1** Effect of Subthreshold Levels

<b>Ingredient Increased</b>	<b>Effect</b>
Salt	Increases sweetness Decreases sourness
Acid	Increases saltiness
Sugar	Reduces saltiness Reduces saltiness Reduces bitterness

# Positional Effect and Contrast Effect

- Positional effect – tendency to rate second product higher or lower
- 2 products very different – panelists will exaggerate differences and rate ‘weaker’ sample lower than would otherwise
- Use random order. Use all possible presentation orders

# Central Tendency Error

- Panelists don't want to use whole scale.
- Mix up scale (don't load one end with all the 'good traits).
- Can also normalize form for each panelist

# Physical Location

- Testing in special rooms. 22C, positive pressure, 45% RH,
- Special lighting
- No fumes
- No smoking

# Sample preparation

- Preliminary preparation – grind, puree to reduce color differences (unless testing for color differences)
- Masking color – lights, glasses, blindfolds, black lined cups, added dye

# Dilutions and carriers

- Spices or hot sauce – dilute in white sauce or syrup
- Hydrocolloids mask flavor
- Test actual food – icing ON cake
- 20-40C easiest range

# Utensils and containers

- Glass is best (inert)
- Container should not have flavor or aroma

# Quantity of sample

- Size limited by amount of product available
- Representative of what is needed to test variation in product as manufactured
- Test dependent (consumer sample or portion would require more sample)
- Discriminative – 16 ml liquid, 28 g solid. Double for preference test
- Market testing – use consumer size serving – what tastes ‘good’ at 20 ml may not at 200!

# Controls

- Include reference sample in test as part of mix
- Use random numbers
- Balanced order of presentation to reduce physiological and psychological effects

- Use same ‘process’ between samples to reduce carry over.
- Neutral tasting room temperature water.
- Matzo crackers between samples
- High fat samples – warm tea, lemon water, apple slices