Sweet and powerful

A two-attribute time-intensity study of fruit liqueur

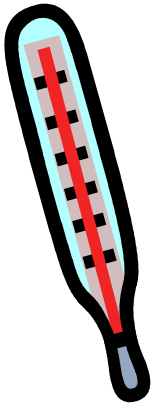
J. C. Castura

COMPUSENSE®

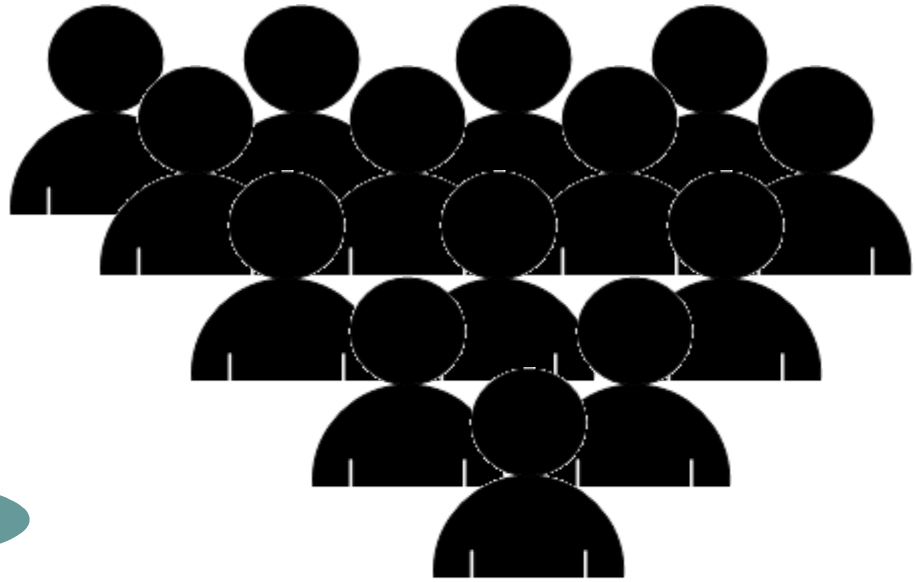
Statistical Society of Canada
Société statistique du Canada

Orange Juice

What is its temperature?



How intense is the fresh orange flavour?



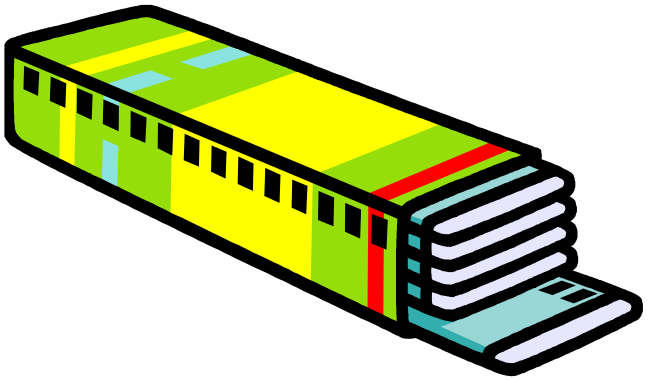
Sensory Science

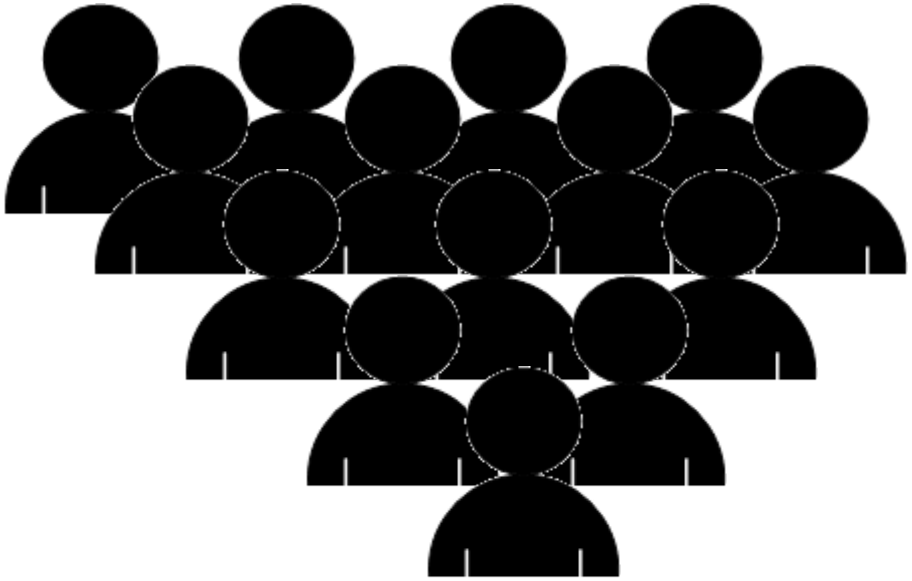
A scientific discipline used to evoke, measure, analyze and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing.

From Stone, H. & Sidel, J.L. *Sensory Evaluation Practices.* 2nd ed. San Diego: Academic Press, 1983.

Chewing Gum

What is the sweetness of gum?





Study Objectives

Typically the aim is to understand temporal properties of products

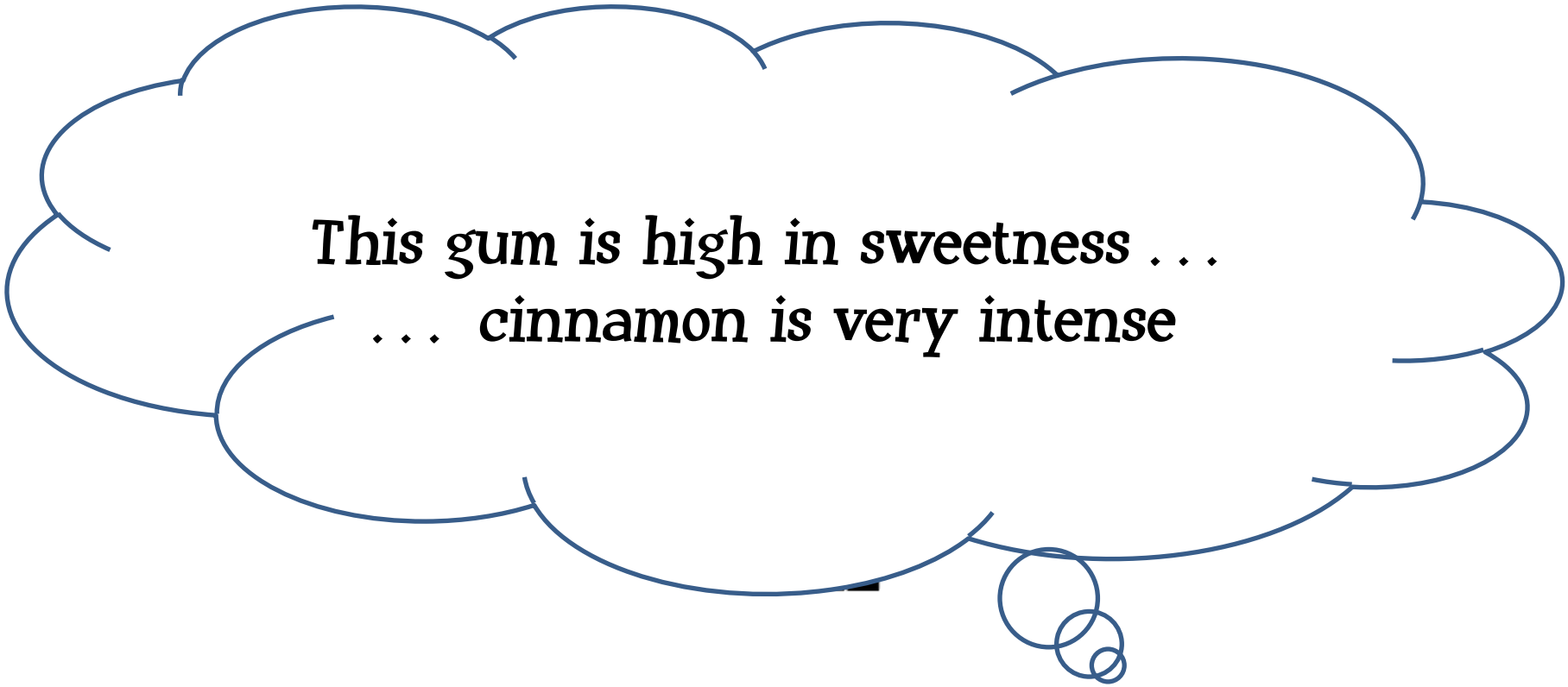
e.g. Ingredient substitution (high-intensity sweeteners for sugar, NaCl alternatives, etc.)

Definition

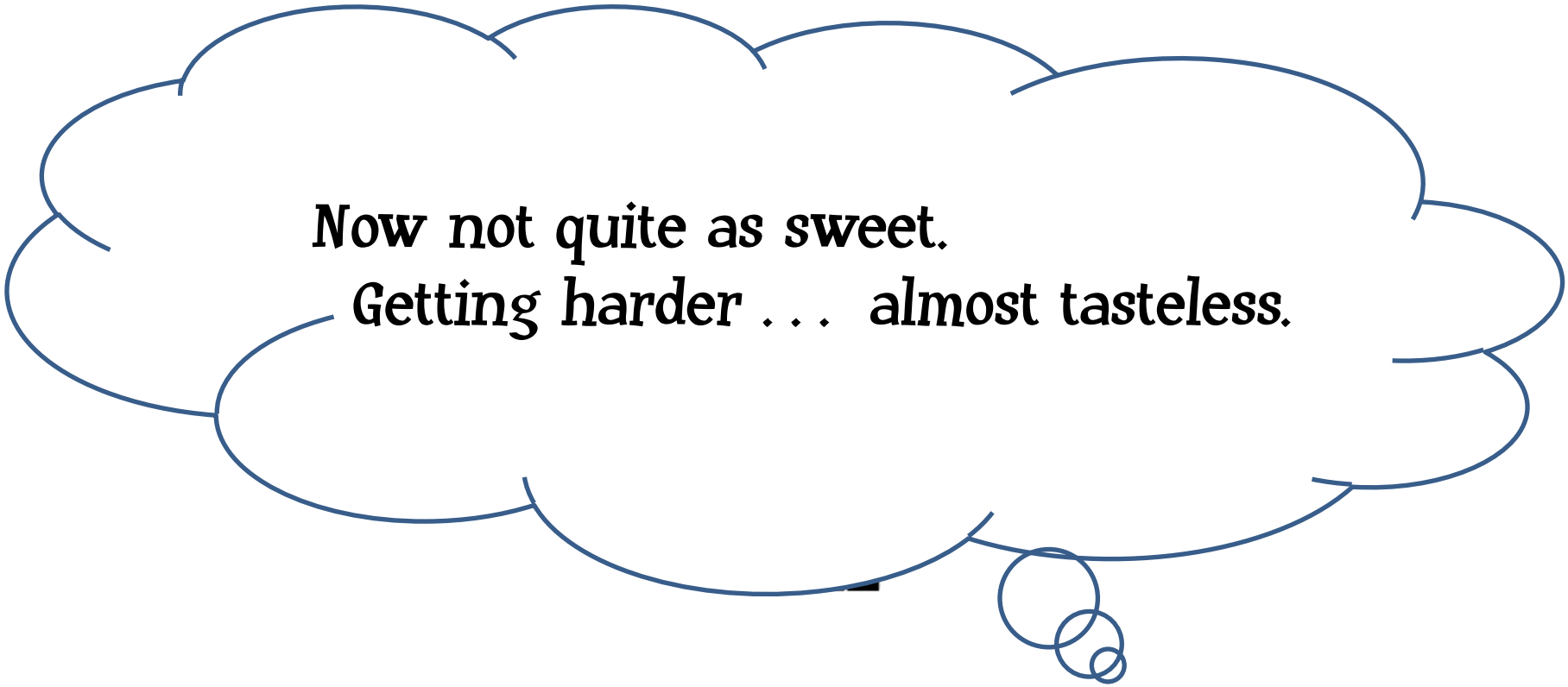
Time-intensity is the measurement of the intensity of a single sensory sensation over time in response to a product or other sensory stimulus.

From ASTM. 2011. *Standard Guide for the Time-Intensity Evaluation of Sensory Attributes.* ASTM Standard Guide E1909-11.

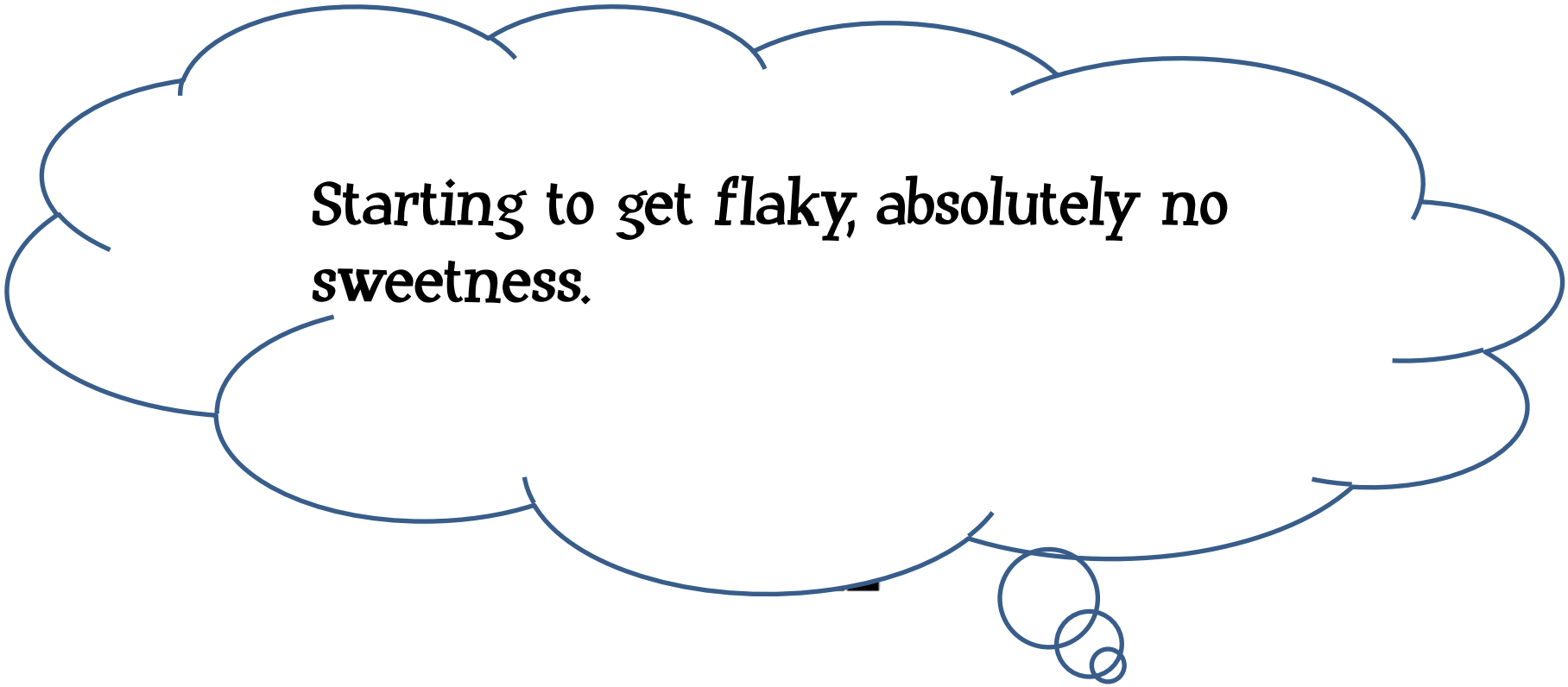
A Person



A Person



A Person



A Panelist

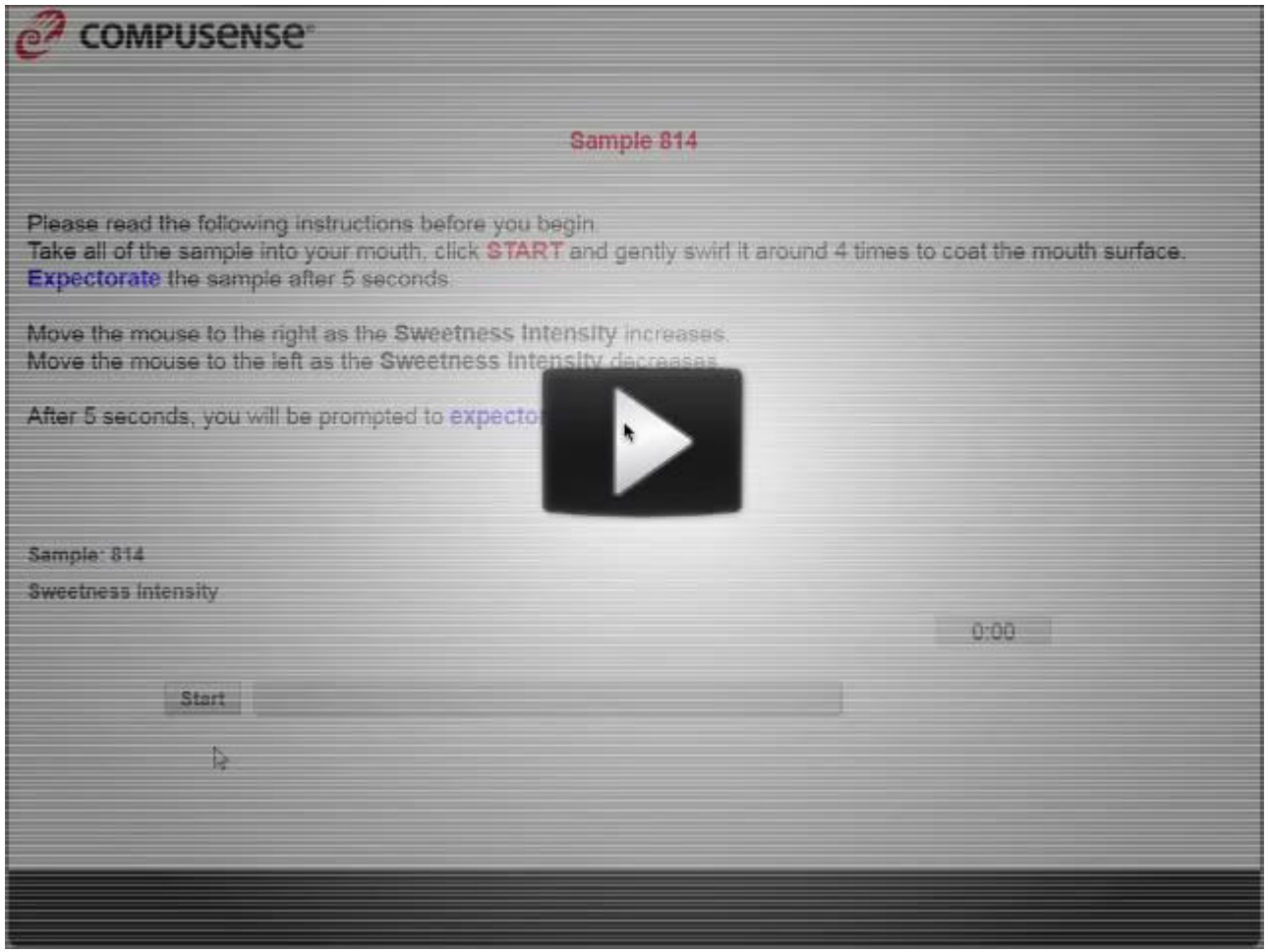
- Selection
- Training
  - identify sensory attributes
  - scale intensities
  - follow evaluation protocols
  - acquire product category familiarity

Please do not touch the Monitor!
Sample 548
Please read the following instructions before you begin.
Take all of the sample into your mouth, click START and gently swirl it around it times to coat the mouth surface.
Move the mouse to the right as the Sweetness Intensity increases.
Move the mouse to the left as the Sweetness Intensity decreases.
After 5 seconds, you will be prompted to expectorate the sample.
If you no longer perceive Sweetness in your mouth, the mouse should return to the starting point.
Start
Sweetness Intensity
Review Instructions
SAMSUNG
SyncMaster 153v
Compusense 2012

Please do not touch the Monitor!
Sample 549
00:01
Please read the following instructions before you begin.
Take all of the sample into your mouth, click START and gently swirl it around 4 times to coat the mouth surface.
Move the mouse to the right as the Sweetness Intensity increases.
Move the mouse to the left as the Sweetness Intensity decreases.
After 5 seconds, you will be prompted to expectorate the sample.
If you no longer perceive Sweetness in your mouth, the mouse should return to the starting point.
Sweetness Intensity
Review Instructions
SAMSUNG
SyncMaster 152v
Compusense 2012

Sample 549
00 05
Please read the following instructions before you begin.
Take all of the sample into your mouth, click START and gently swirl it around it times to coat the mouth surface.
Move the mouse to the right as the Sweetness Intensity increases.
Move the mouse to the left as the Sweetness Intensity decreases.
After 5 seconds, you will be prompted to expectorate the sample.
If you no longer perceive Sweetness in your mouth, the mouse should return to the starting point.
Expectorate Sample NOW
Sweetness Intensity
Review Instructions
SAMSUNG
SyncMaster 932
Compusense 2012

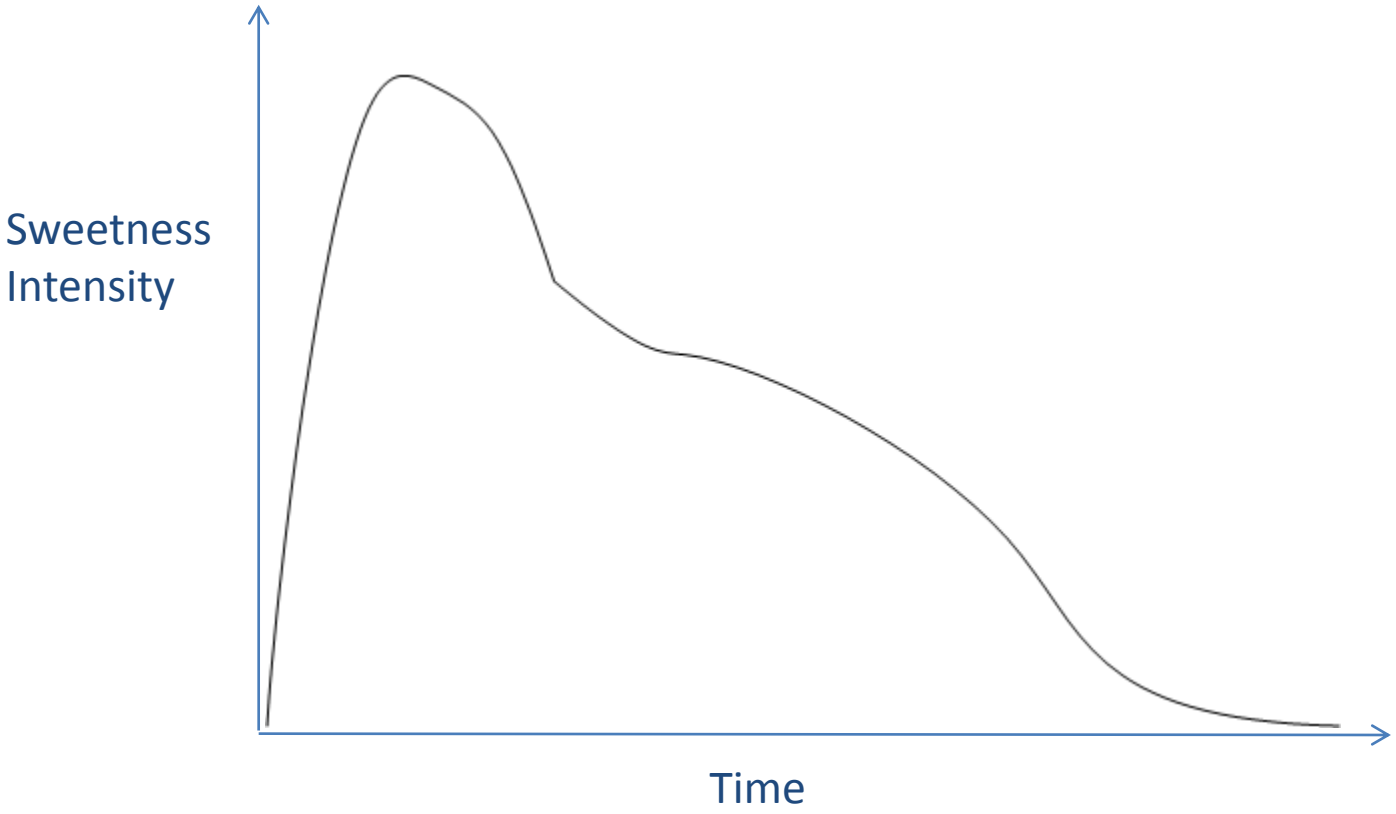
A Trained Panelist



COMPUSENSE®

Statistical Society of Canada
Société statistique du Canada

TI Curve



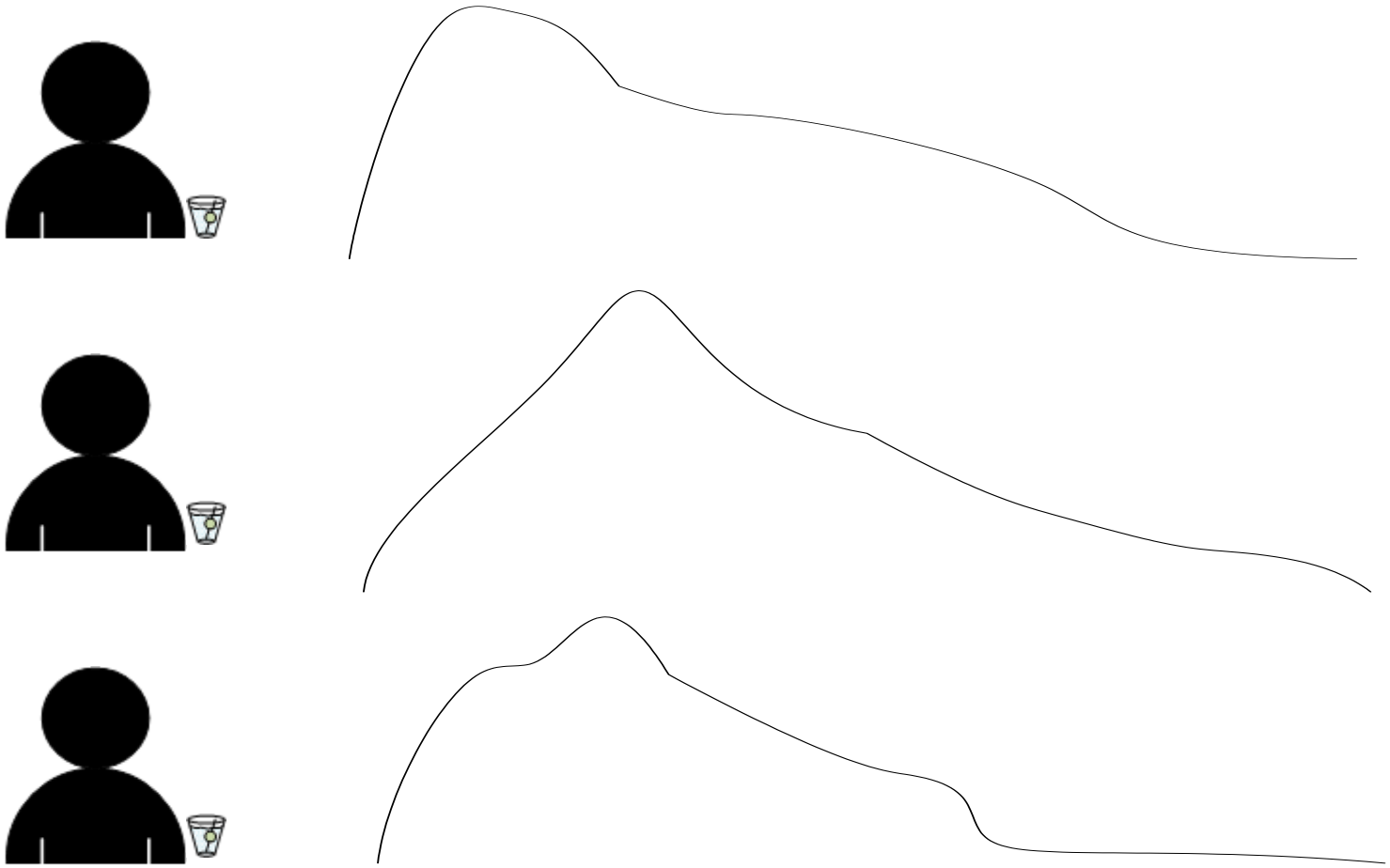
TI data

Response on line captured continuously

No interval censoring

Interval data

Signature TI Curves



Signature TI Curves

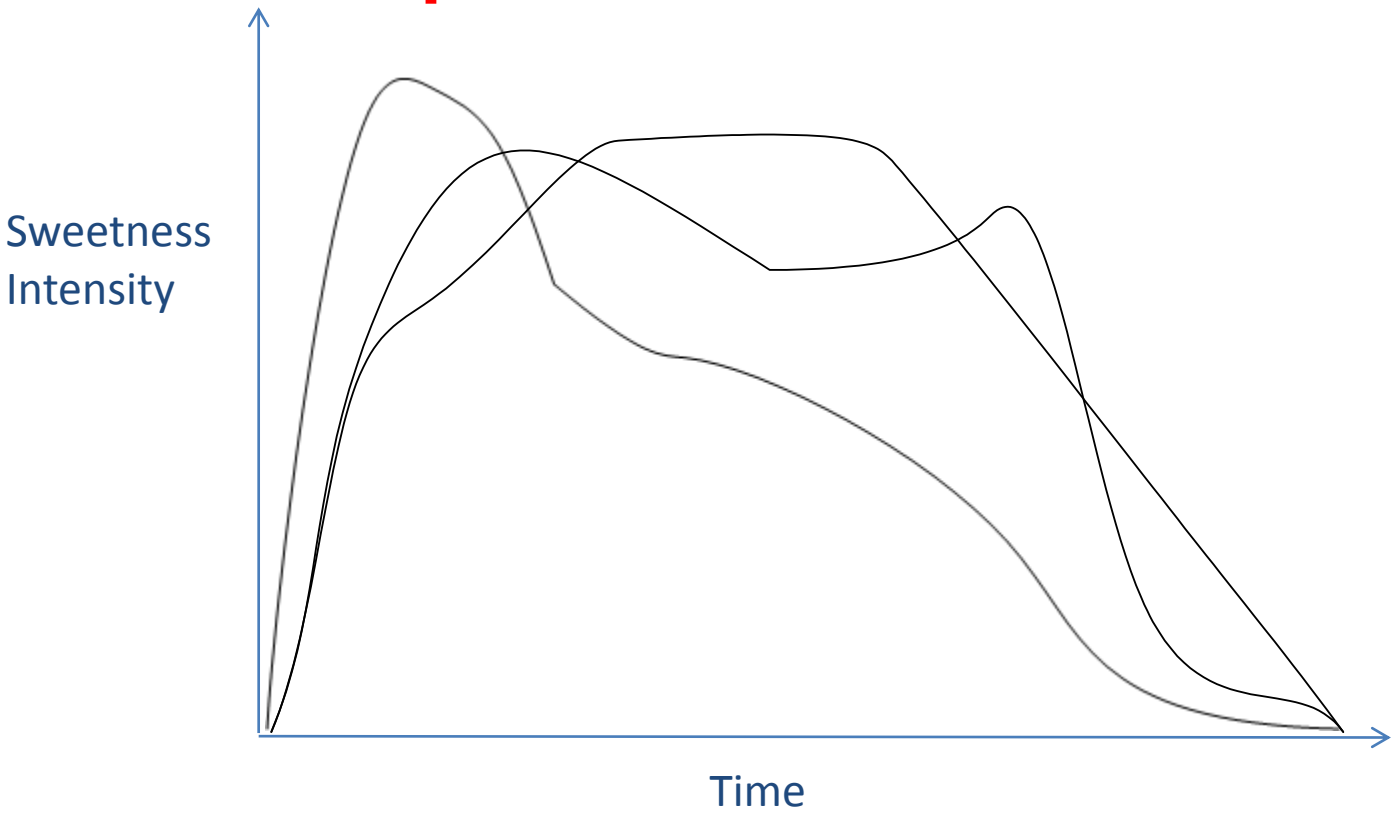
Scale usage

Treatment of food in mouth
(e.g. tongue movement, chewing efficiency)

Individual differences
(e.g. perception of flavours, saliva composition)

Replicated Data

Is the panelist consistent?



Monitoring Panelists

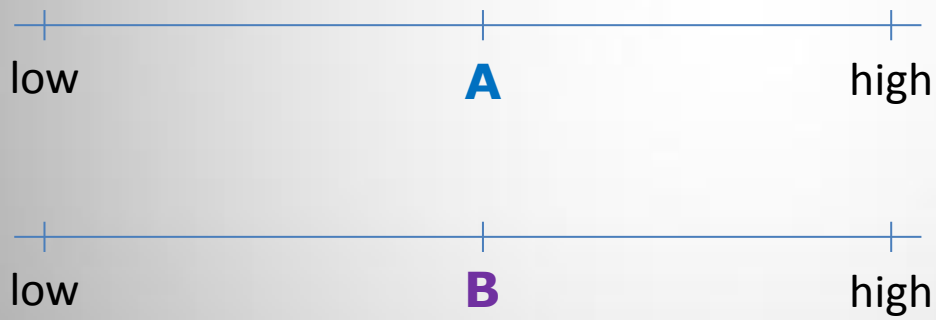
Review data

Assess reliability

Drop panelists

Comparison of Products

Two products might be characterized as equally intense.



A = B ?

Comparison of Products

Yet panelists might easily discriminate the products in a difference test

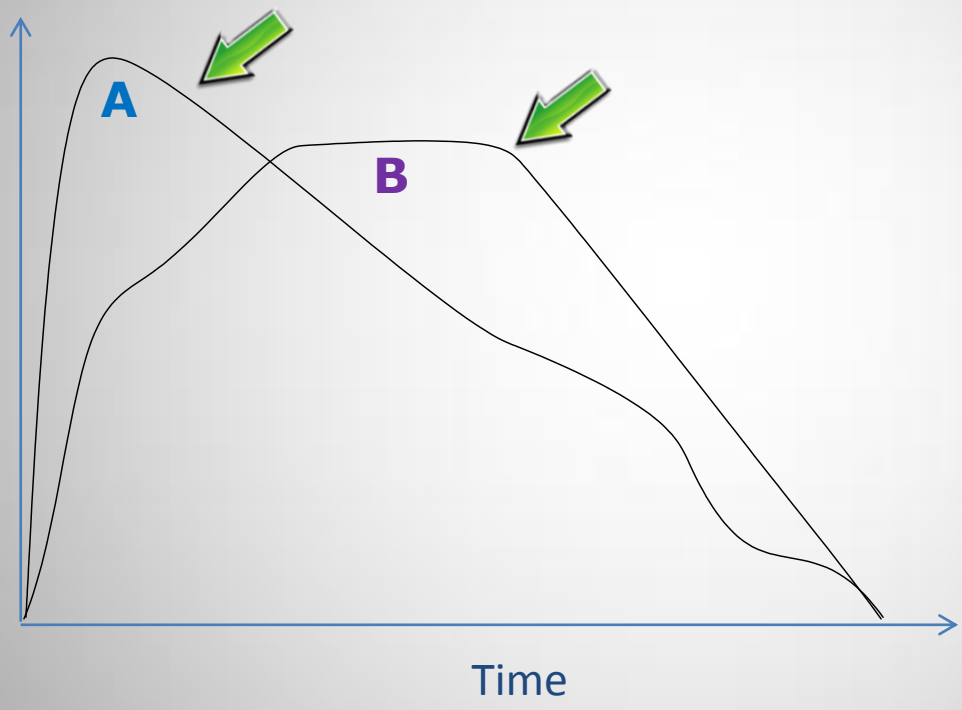
Same

Different

A ≠ B ?

Representative TI Curves

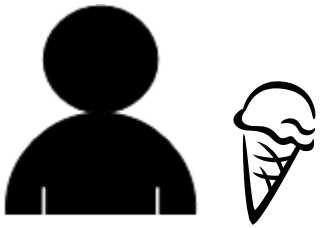
TI curves reveal where differences lay.

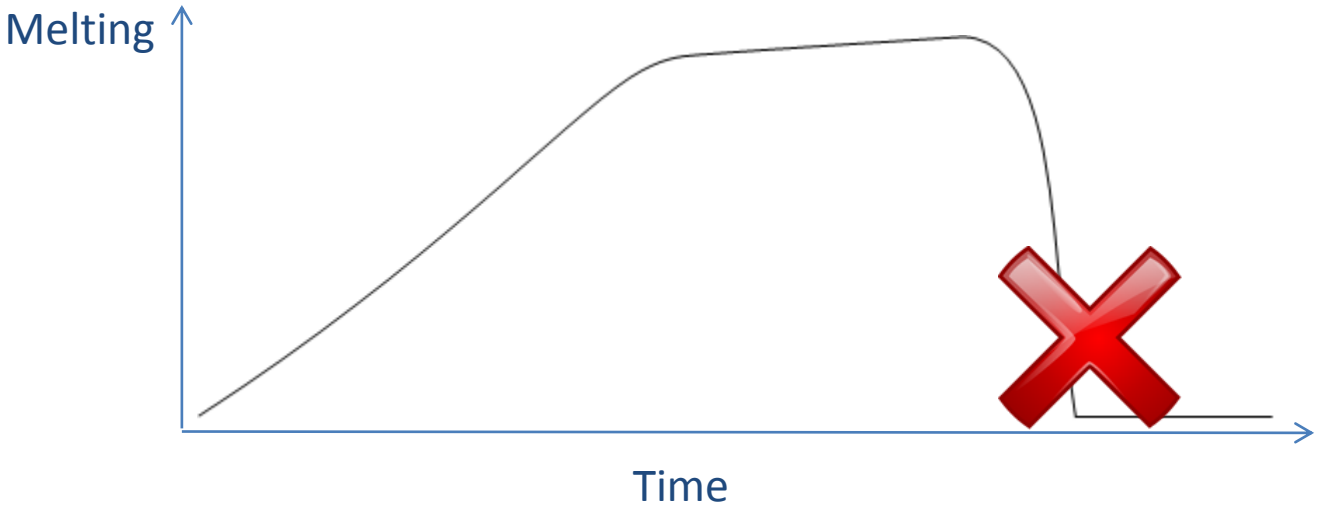


$A \neq B$

Data Artifacts

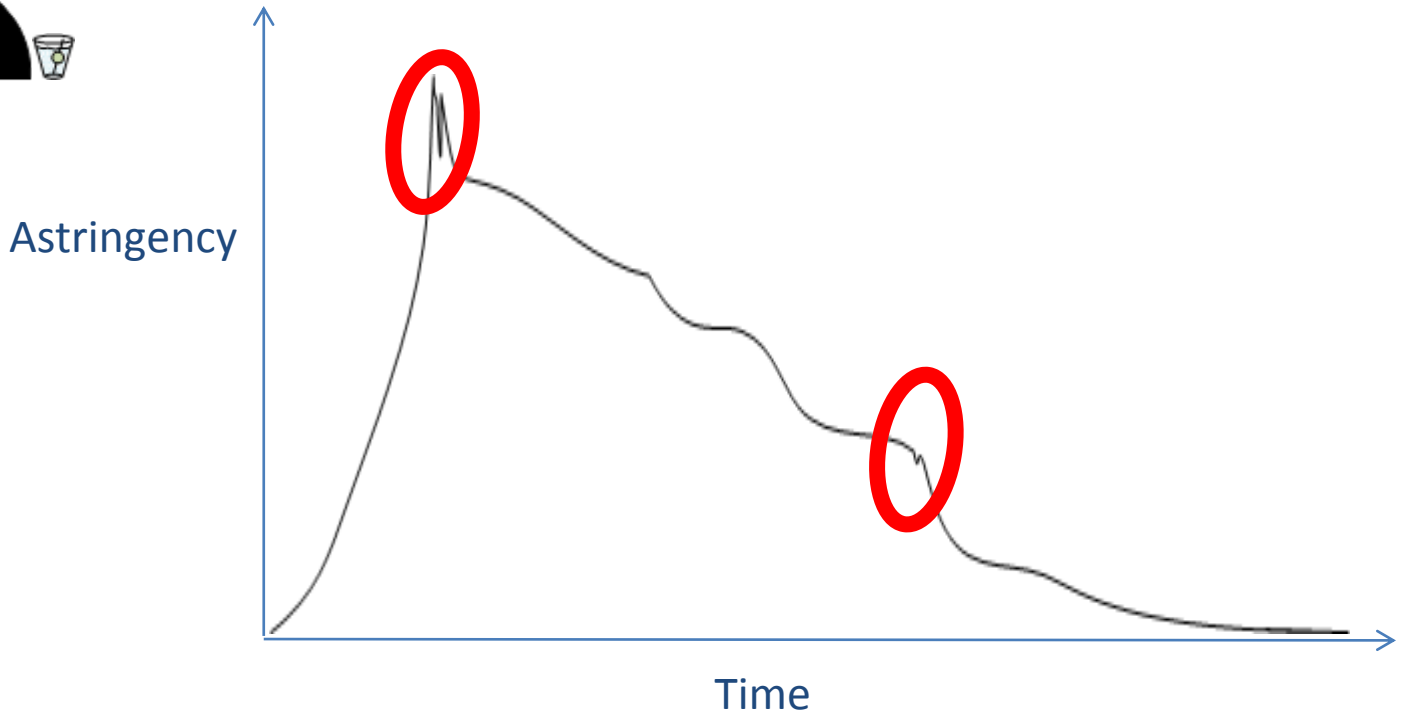
- task understanding





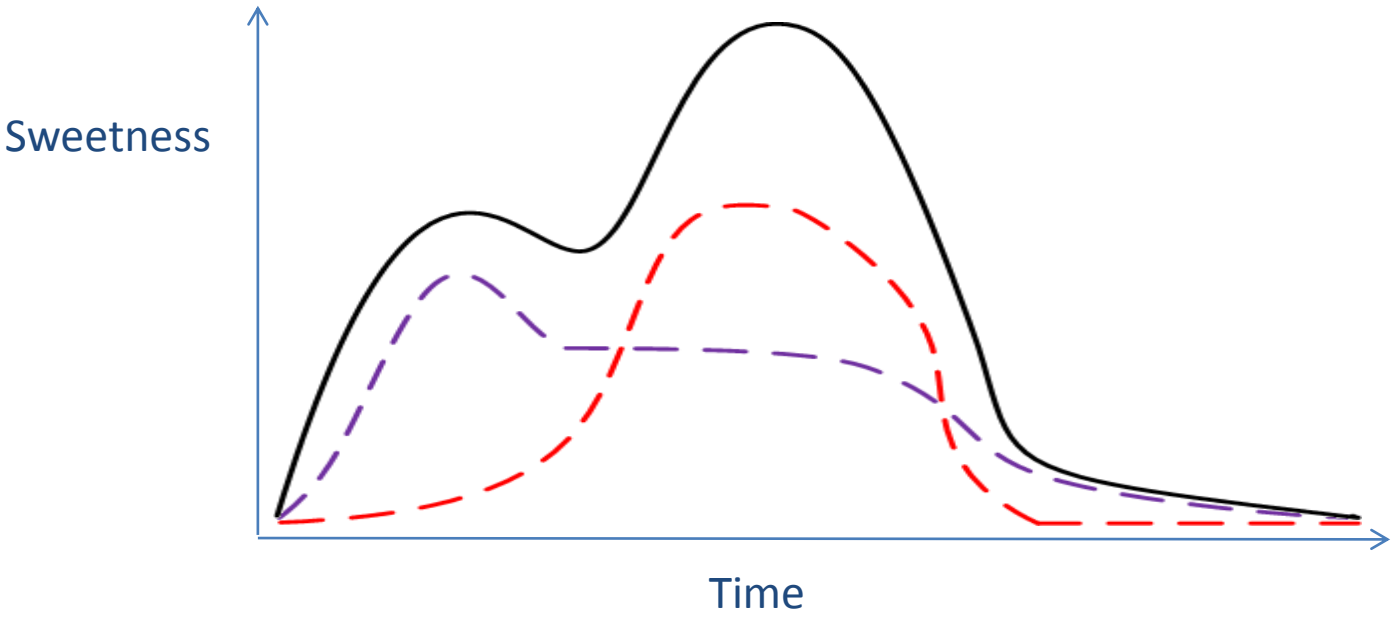
Data Artifacts

- difficulty using pointing device



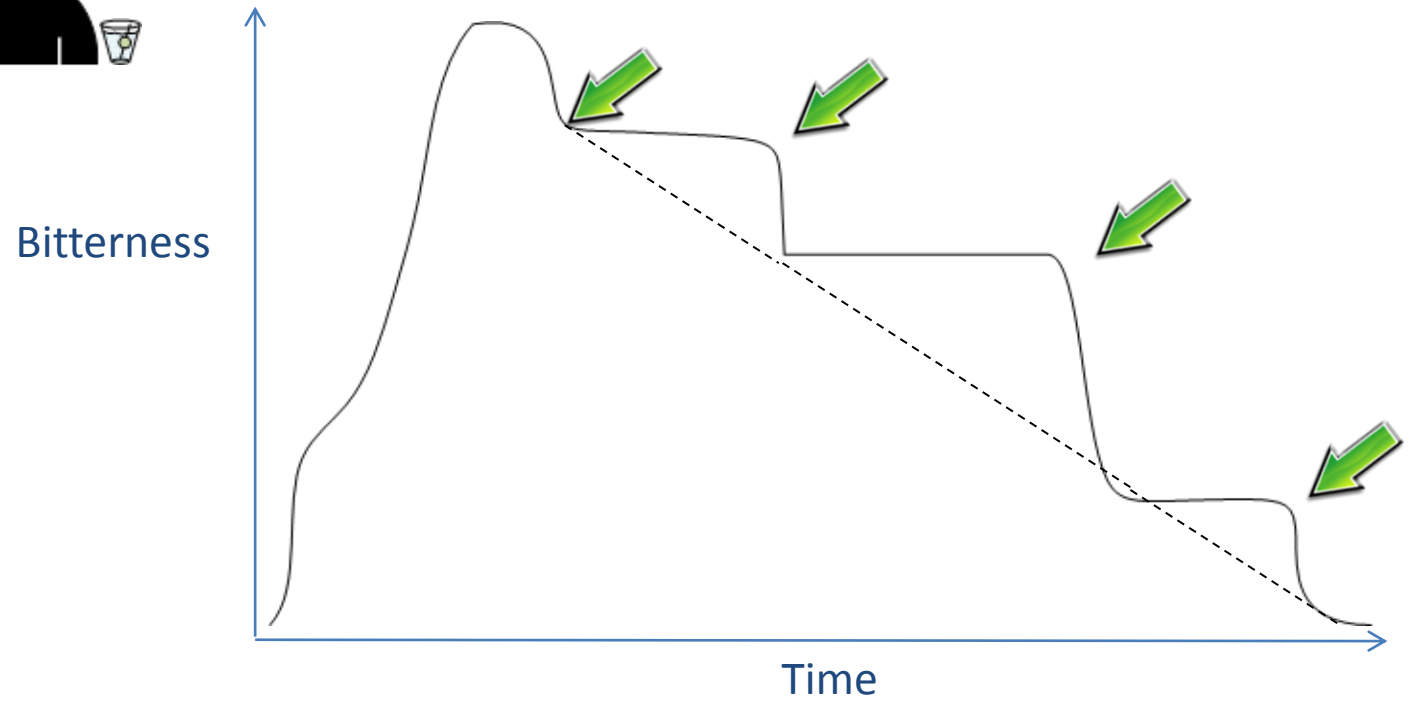
Data Artifacts

- "halo dumping" /
  taste-flavour interactions

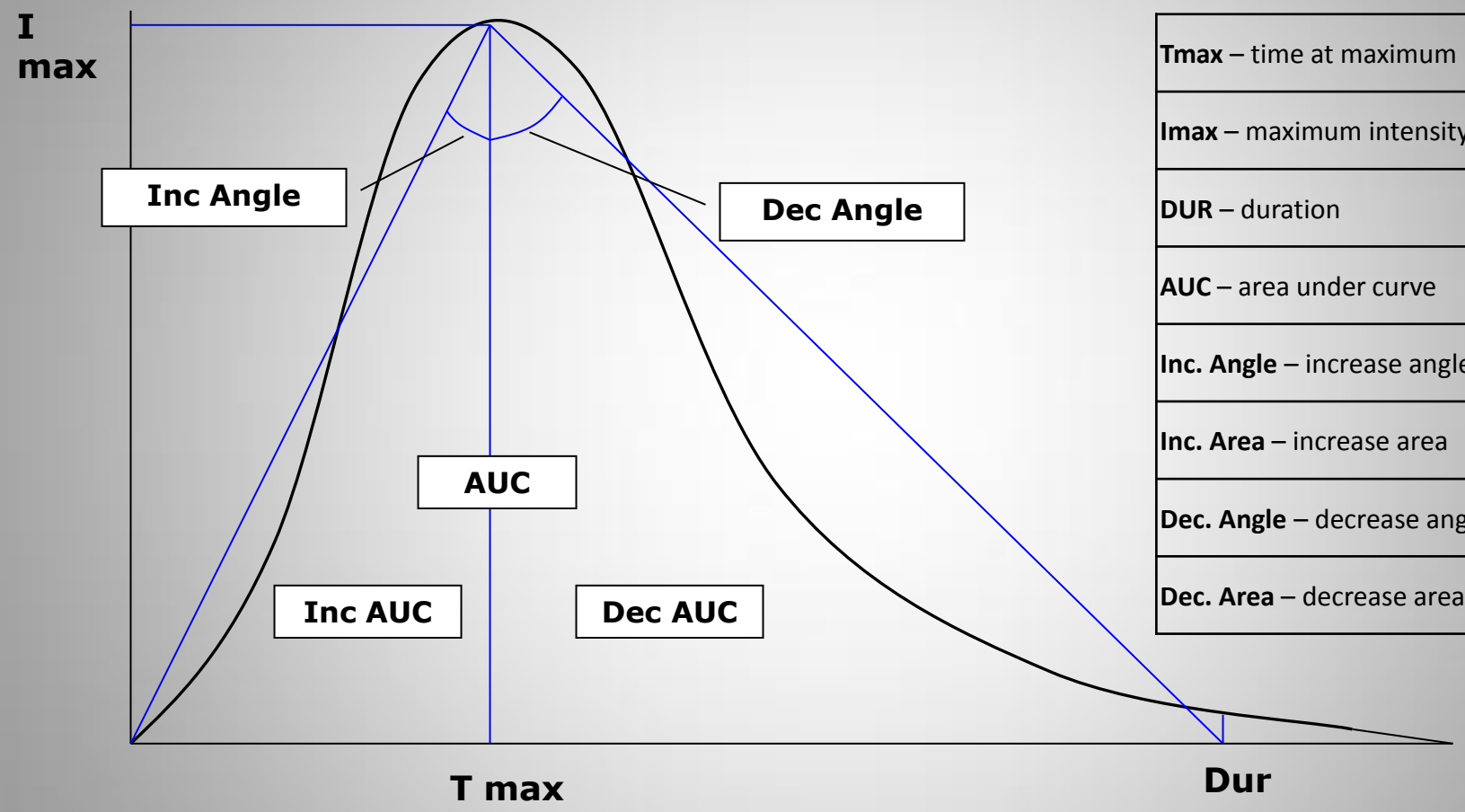


Data Artifacts

- plateaus?



Parameters from a TI Curve



Time Intensity Parameters

Tmax – time at maximum intensity
Imax – maximum intensity
DUR – duration
AUC – area under curve
Inc. Angle – increase angle
Inc. Area – increase area
Dec. Angle – decrease angle
Dec. Area – decrease area

Conventional Analysis

Extracted parameters are treated as the data (e.g. submit AUC for each curve to ANOVA)

Disadvantage: panelist signatures lost

ASTM. 2011. *Standard Guide for the Time-Intensity Evaluation of Sensory Attributes.* ASTM Standard Guide E1909-11.

Multivariate approach

- Principal Component Analysis
  - PCA (van Buuren, 1992)
  - Uncentered PCA (Dijksterhuis, 1993)
  - inferential non-centred principal curve analysis (François *et al.*, 2007)

Representative Curve

- Simple average curve
- Simple median curves (Lawless & Skinner, 1979)
- Procedure including a rescaling to common intensity/time

  e.g. Overbosch *et al.*, 1986; Liu & Macfie, 1990; Macfie & Liu, 1992; Dijksterhuis & Eilers, 1997

Parametric Model

Various attempts have been made to describe a curve with few parameters...

- parameters based on equations associated with events and neurophysiological processes (Garrido *et al.*, 2001)
- parameters based on logistic curves (Janestad, 2000; Eilers & Dijksterhuis, 2004)

Models & Equations

- polynomials and ordinary differential equations (ODE) (Wendin *et al.*, 2003)
- standardize curves and project on basis of B-spline functions (Ledauphin *et al.*, 2006)

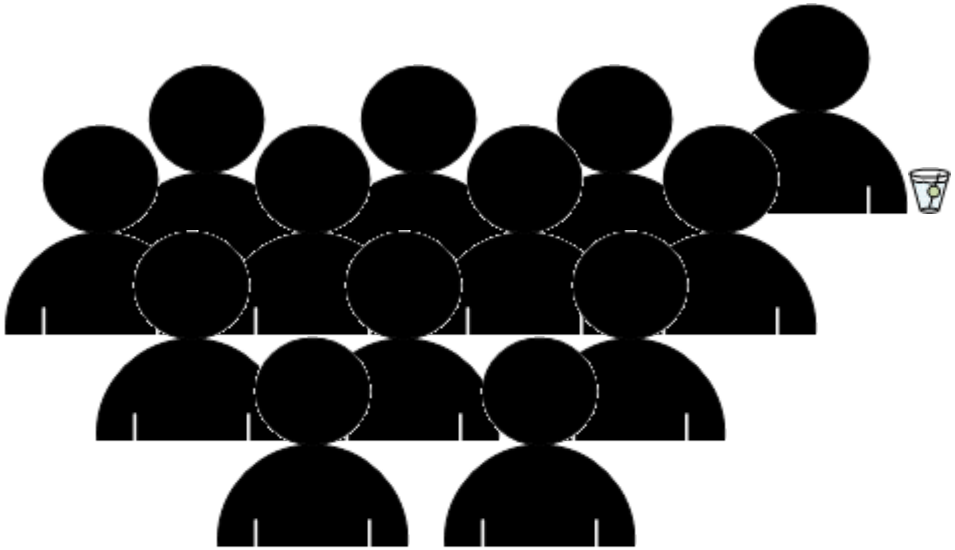
Studies

Moyi Li extends research on TI curves

Her work models the time dependency in TI data explicitly using a Markovian error term

Data used came from time-intensity studies on beverage alcohol

Beverage alcohol studies



Trained panelists

Beverage alcohol studies

Evaluation of 4 fruity liqueurs

An experimental design was chosen to balance sample positions, and protocols used to reduce other biases

Simplified Testing Procedure

1) Present sample
2) Evaluate "Sweetness" (Single attribute time-intensity)
3) Delay between evaluations
4) Evaluate of "Alcohol flavour" (Single attribute time-intensity)
5) Delay between samples

Two additional attributes were discarded.

TI Data

Panelist	Sample	Rep	Time=0	Time=1	Time=2	Time=3	Time=4
1	1	1	0	0	5	12	18
1	1	2	0	13	22	27	32
1	1	3	0	3	10	15	19
1	2	1	0	0	0	4	8
1	2	2	0	4	8	21	35
1	2	3	0	15	24	44	68

Questions

Thank you for your attention!

*Next **Moyi Li** will present*
a novel analysis of TI data…