Pangborn 2019 | 13th Pangborn Sensory Science Symposium

28 July – 1 August 2019 • Edinburgh International Conference Centre (EICC) • Edinburgh, Scotland

Wednesday July 31, 2019

Learnshop # 5

Consumer Relevance of Sensory Measurements

Presented by

Dr. Benoît Rousseau
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Learnshop Agenda

- Introduction
- Activity 1
- Presentation 1: Prof. J. Prescott: *Principles and Applications of Consumer Rejection Thresholds*
- Activity 2
- Presentation 2: Dr. C. Kasamatsu: *Using the same-different method to establish consumer relevance at Ajinomoto Co.*
- Results of activity 1
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- Review of all activity results
- Discussion
- Conclusions

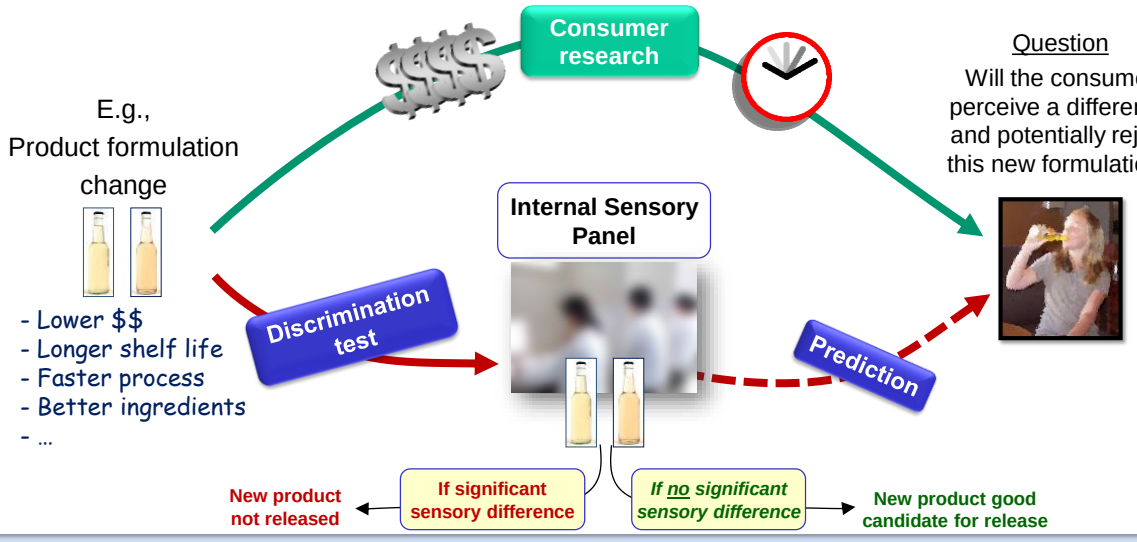
Introduction

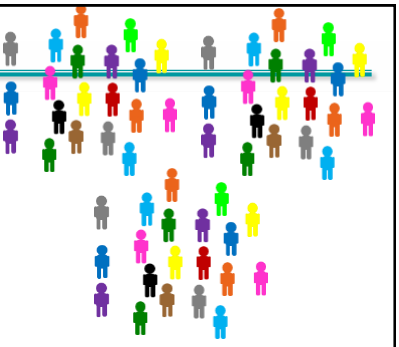
Why Estimate Consumer Relevance?

Dr. Benoît Rousseau
The Institute for Perception
USA

The Institute for Perception

Product Similarities and Consumer Relevance

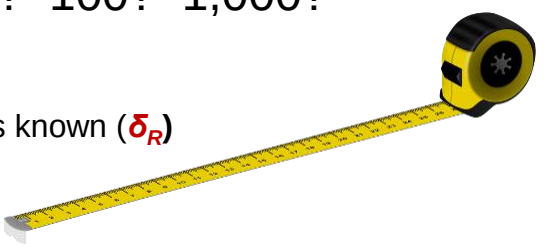




- Chew (1977)

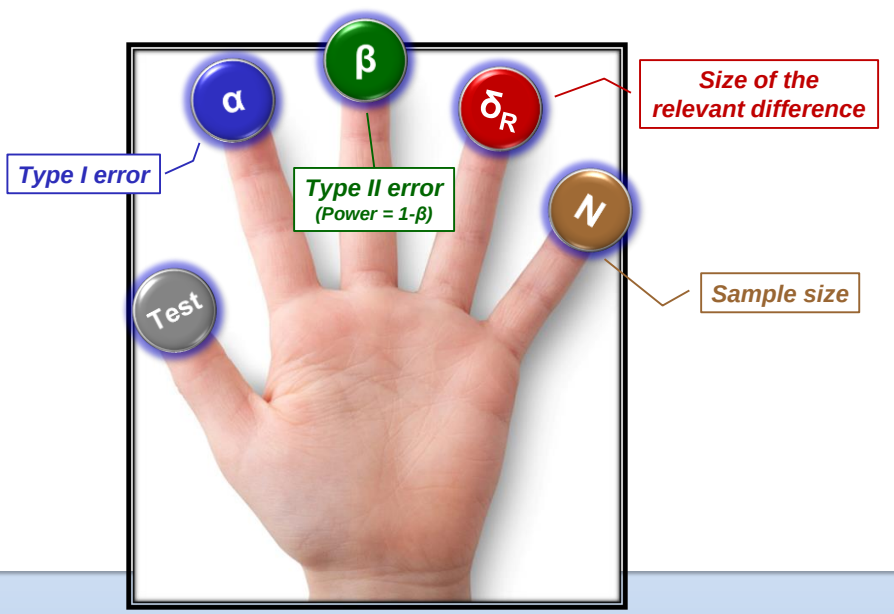
> ***Provided two putatively different products and a test sample size that is large enough, a statistically significant difference will always be found***

- What is the optimal sample size? 12? 20? 100? 1,000?



- An optimal sample size can only be set if the size of the relevant difference is known (δ_R)

How Does Consumer Relevance Fit in a Sensory Program?



Introduction
Why Estimate Consumer Relevance?

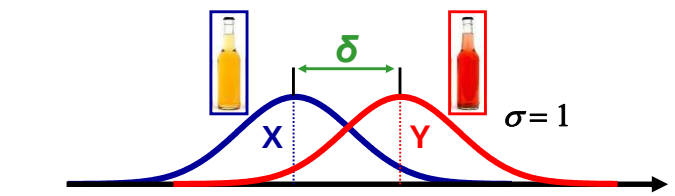
Thurstonian Theory:

Quantifying the Size of Sensory Differences

Thurstonian Models

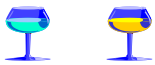
δ = Standardized measure of sensory difference

d' = Experimental estimate of δ



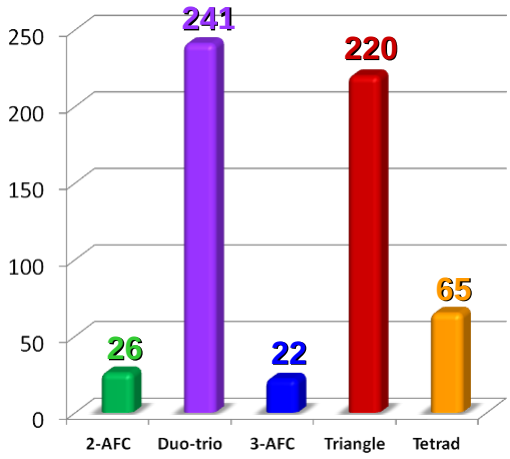
- In sensory testing, δ typically varies between 0 and 2

Business Impact: The Cost of Decision Rules



Scenario 1

- **Size of the difference:** 76% correct in a 2-AFC (*δ_R of 1)*
- **Power:** 80% chance of detecting the difference
- **α level:** 5%
- ***Sample size needed*** ➡



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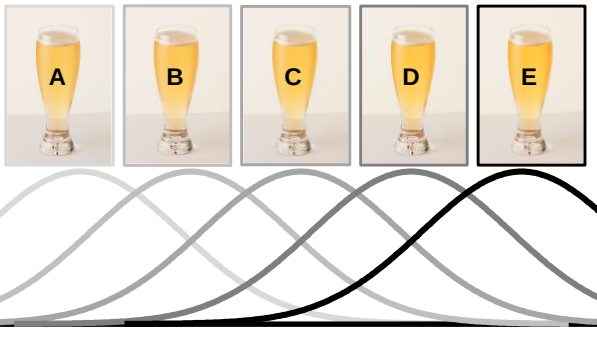
ACTIVITY # 1

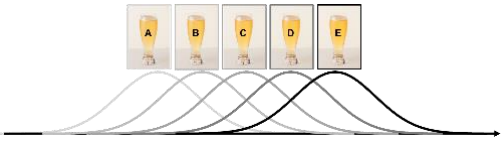
Background

- 5 beer images differing –slightly – in color saturation: A, B, C, D, E
- Two activities
  - Paired preference – Activity 1
  - Same-different – Activity 2



Color saturation

Activity # 1 *(Cont.)*



Preference test
www.ifpress.com/survey1

- Perform 10 paired preference tests
- Indicate which of the two samples' appearance you prefer
- Forced choice (no 'No preference' option)

Please click on the beer image you prefer

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Principles and Applications of Consumer Rejection Thresholds

Prof. John Prescott
TasteMatters Research and Consulting, Australia
Università degli Studi di Firenze, Italy

Harnessing consumer emotions to make decisions

A typical sensory process:

- How do you know if a change in product formulation affects acceptability?
  Paired preference test
- How do you know if a change ~ threshold affects acceptability?
  Determine threshold
- How do you quantify the amount of change that is crucial for product acceptability?
  Trained panel … but need to link to consumers

Based on implicit recognition of “correct” levels of sensory qualities …. but not typically on hedonic response to those qualities

The problem of trichloroanisole (TCA) in wine

- Cork taint costs the wine industry ~ $10B/year
  - Trained panellists are – by definition – very sensitive to TCA
  - Consumers may not object to low levels
- *Question is not how sensitive consumers are …. but at what point do they reject TCA in wine?*
  - The RjT was developed to provide an ecologically valid answer to the question of when does cork taint actually become a problem for consumers
- How would it help?
  - CRT may allow a more accurate calculation of that percentage of wines that could be rejected, if the average TCA content is known through analytical testing

Development of the (consumer) Rejection Threshold

- The approach combines 2 standard sensory methodologies: the paired preference test (ISO 5495, 1983) conducted at each step of a constant stimuli threshold measure (ISO 13301, 2002)
  - White wine (screw cap - no natural TCA present)
    - Spiked with TCA @ following concentrations:

      0 0.5 1 2 4 8 16 32 ppt

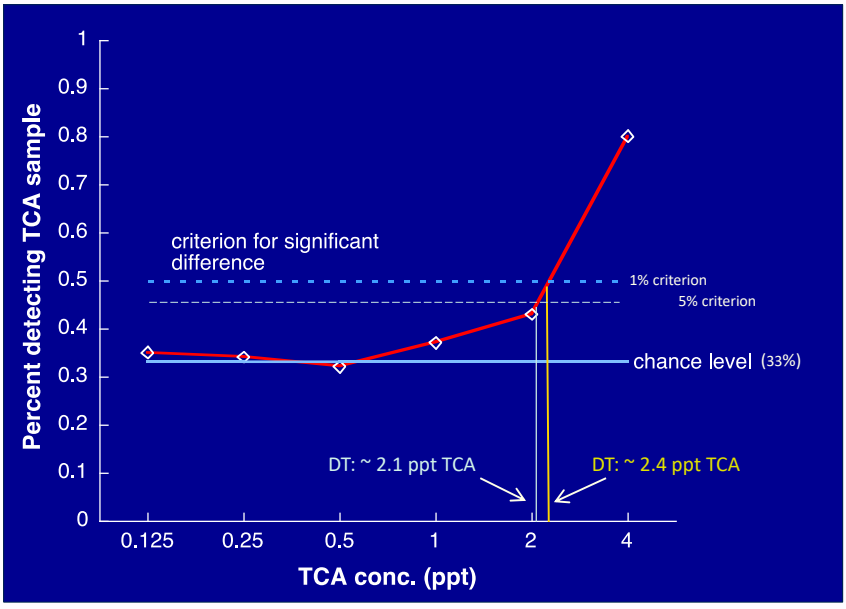
    - Regular wine drinkers presented with pairs (TCA^+ + TCA^-)

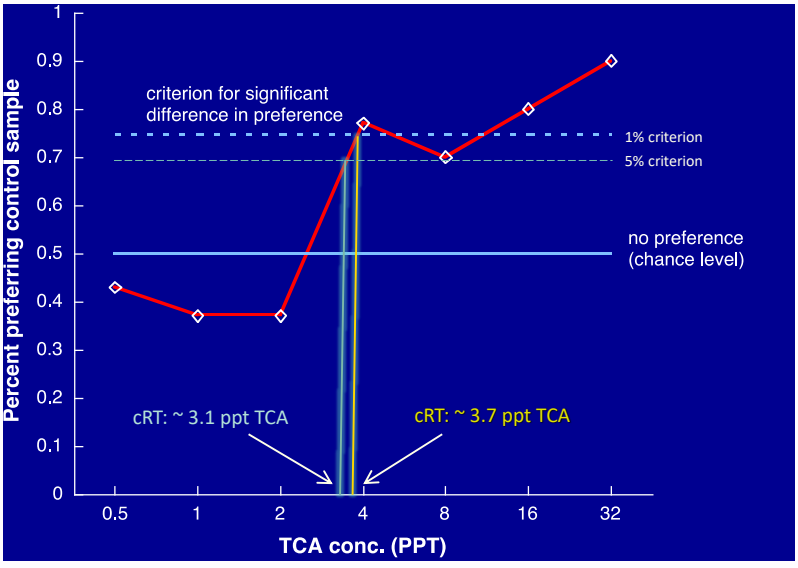
      Which do you prefer?

    - Sample pairs presented in a balanced order over 2 sessions, a day apart

Detection Threshold for TCA in White Wine

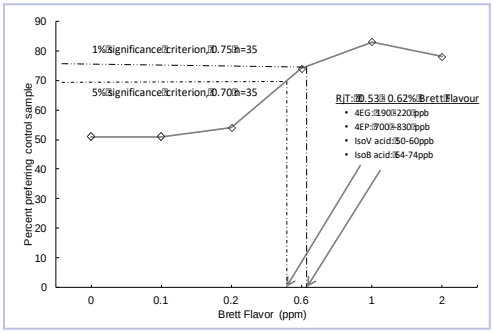


(consumer) Rejection Threshold

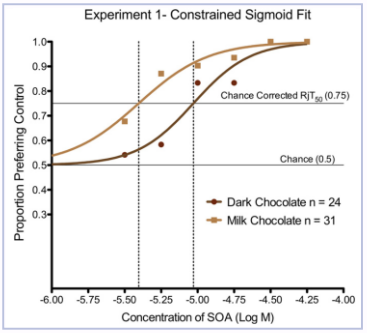


Applications of the cRT

Impact of potentially unacceptable ingredients



Brettanomyces added to wine
(Norris, 2005)

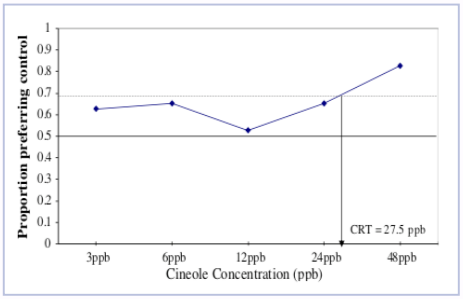


SOA added to chocolate milk
(Harwood et., 2012)

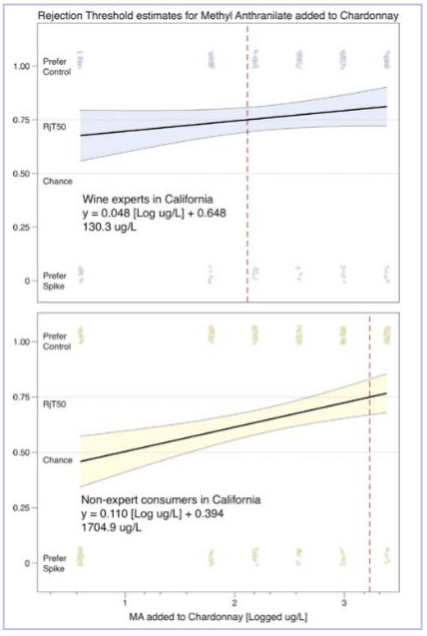
Applications of the cRT

Unacceptable or not?

Labrusca-type aromas
(methyl anthranilate/MA; 2-aminoacetophenone/2AAP) in wine
(Perry et al., 2019)

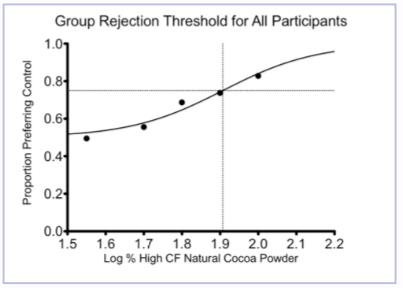


Is eucalyptol in red wine a taint?
(Saliba et al., 2009)



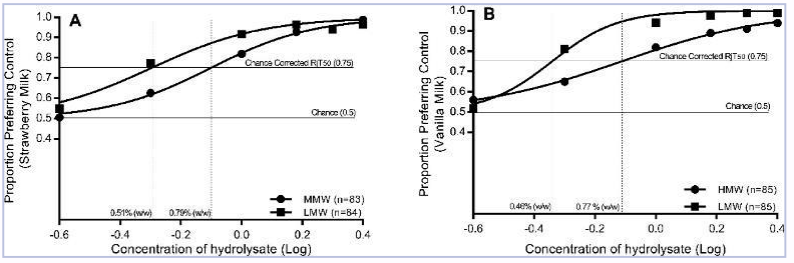
Applications of the cRT

Studying the impact of functional ingredients



High Flavanol Cocoa Powder in Semisweet Chocolate (Harwood, 2013)

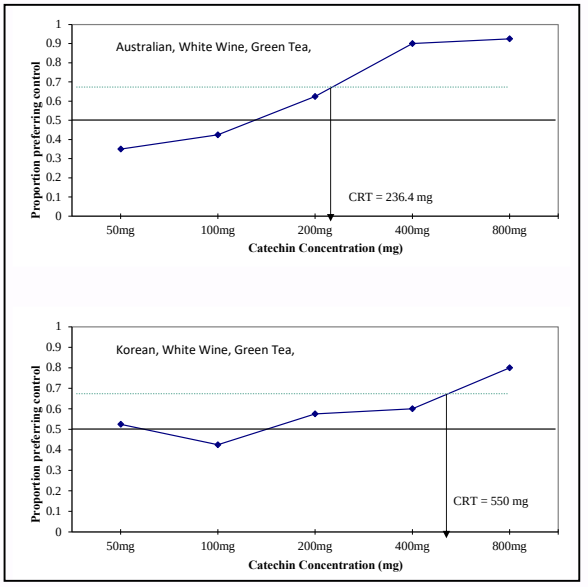
Novel bioactive compounds (casein hydrolysates) added to milk beverages (Murray et al., 2019)



Applications of the cRT

Exploring cultural differences

Cross-cultural comparison of effects of green tea catechin (polyphenol antioxidants) in white wine (Yoo et al., 2012)



Applications of the cRT

Exploring individual differences in perception

Casein hydrolysates added to milk beverages as a function of bitterness of these compounds

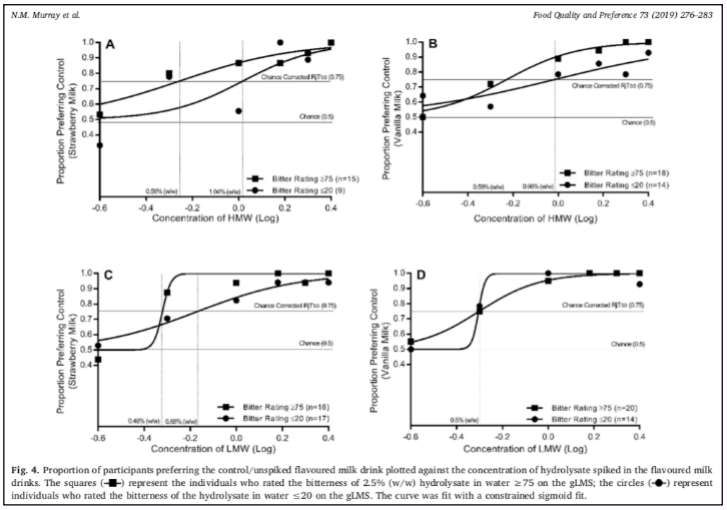
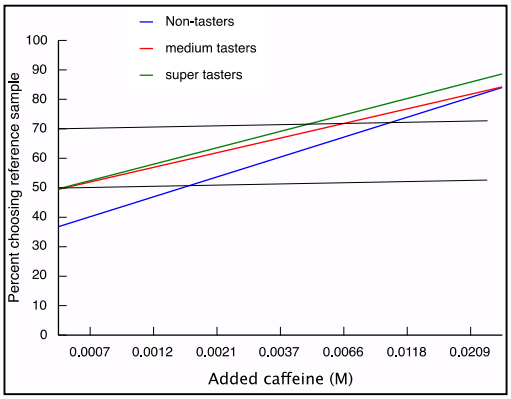


Fig. 4. Proportion of participants preferring the control/unspiked flavoured milk drink plotted against the concentration of hydrolysate spiked in the flavoured milk drinks. The squares (■) represent the individuals who rated the bitterness of 2.5% (w/w) hydrolysate in water ≥75 on the gLMS; the circles (●) represent individuals who rated the bitterness of the hydrolysate in water ≤20 on the gLMS. The curve was fit with a constrained sigmoid fit.

Applications of the cRT

Exploring individual differences in perception

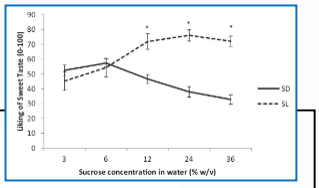
Added caffeine in coffee in PROP taster groups
(Lee et al., 2008)



Applications of the cRT

Exploring individual differences in preference

Acceptability of increases in sweetness in OJ as a function of sweet-liker status
(Methven et al., 2016)



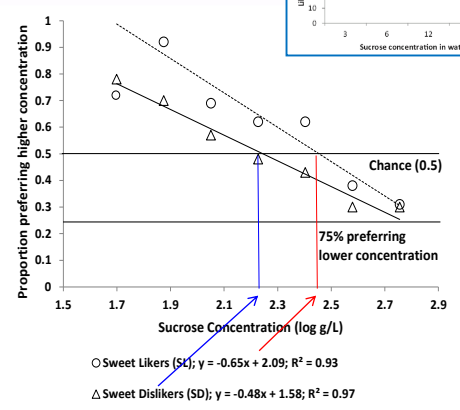
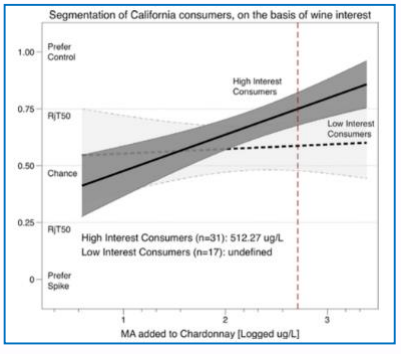


Figure 2. Proportion of participants preferring the orange juice containing the higher concentration of sucrose (note : the first value for SL was removed in order to fit the regression line)

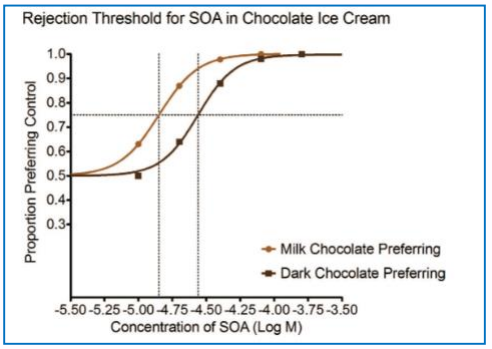
Applications of the cRT

Exploring differences in consumer segments



Impact of Labrusca-type aromas in wine as a function of wine interest
(Perry et al., 2019)

cRT significantly correlated (-0.38) with knowledge of TCA
(Prescott et al., 2005)



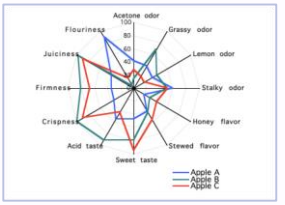
Explaining tolerance for bitterness in chocolate ice cream using solid chocolate preferences
(Harwood et al., 2013)

Consumers respond globally to products

Why assume that they are less sensitive when a global response is called for?

- Can affective responses of consumers can be harnessed?
- Evidence that consumers respond more sensitively if asked about their global affective response to products

"emotions … exist for the sake of signalling states of the world that have to be responded to, or that no longer need response"



Sensitivity incorrectly seen only in terms of analysis of attributes

- Emotions may be useful heuristics, summarizing large amounts of information

Affective biases in perception

How can emotion improve sensitivity?

Brain allocates attention as function of the emotional significance of sensory stimuli

- → Attention drawn faster to emotional stimuli (e.g. facial expressions)
- → emotional priming leads to better subsequent target detection
- → emotional stimuli produce greater activation in relevant sensory areas than do neutral stimuli
- → ignored stimuli are emotionally devalued

- Positive emotions signal "no problem": no action required
- Negative emotions trigger slower, more detailed & systematic processing of stimuli (see: *Authenticity Test*)

Discrimination as an hedonic process

Why consumers are appropriate for decision making

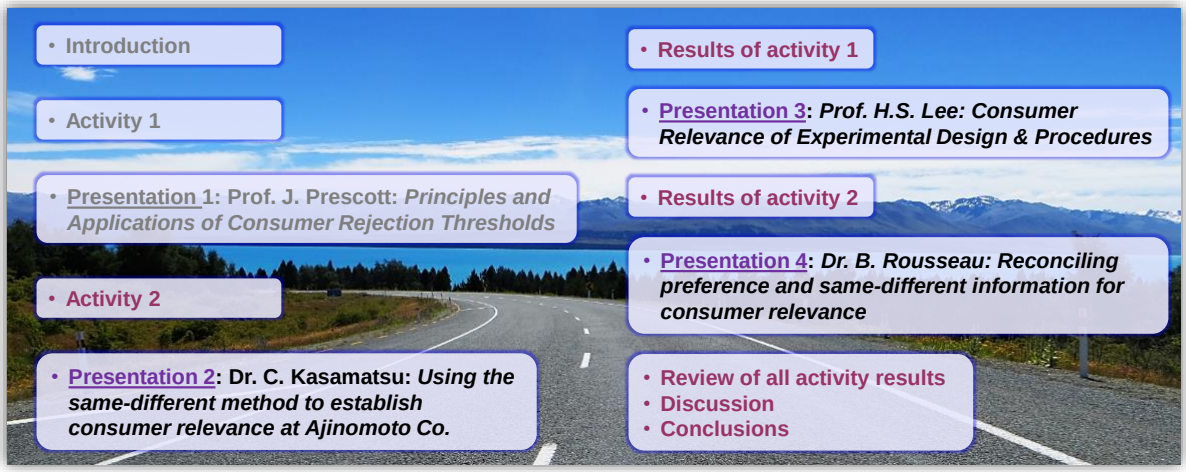
- Preference does not even require an ability to distinguish stimuli
  - Adolphs et al (2005): a heavily brain damaged man w/o a functioning taste cortex showed no difference in affective responses when asked to (separately) drink strong NaCl sol^{n} or sucrose sol^{n} consistently picked sucrose in paired preference test
    - → thus, despite no basis on which to distinguish the tastes, he could still state a reliable preference
- Evidence that preferences operate using non-conscious information/processing – e.g., subliminal mere exposure effects

Principles and Applications of Consumer Rejection Thresholds

Thank you for your attention

Prof. John Prescott
TasteMatters Research and Consulting, Australia
Università degli Studi di Firenze, Italy

Learnshop Agenda



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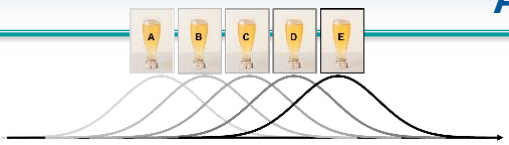
ACTIVITY # 2

Activity # 2



Same-different test
www.ifpress.com/survey2

- Perform 20 same-different trials
- Some pairs have identical samples, other have different samples
- Indicate whether you would consider the two samples to look the same or different (in terms of color saturation)

Please indicate if you'd consider the two beers to look the same or different.

Different

Same

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Using the same-different method to establish consumer relevance at Ajinomoto Co.

Dr. Chinatsu Kasamatsu
Executive Specialist
Institute of Food Sciences and Technologies
Ajinomoto Co. Inc., Japan

Eat Well, Live Well.
AJINOMOTO

Presentation Outline

1. About Ajinomoto Co.
2. Research background and objectives
3. Materials and Methods
4. Results
5. Conclusions

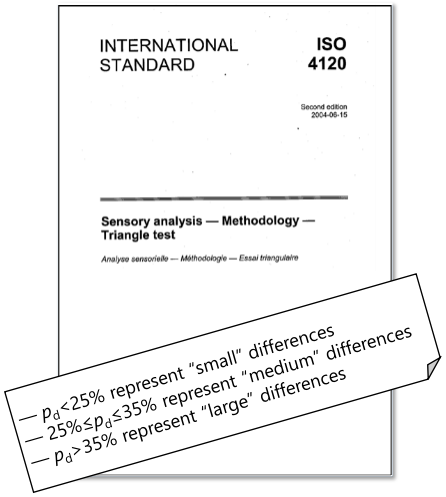
Using the same-different method to establish consumer relevance at Ajinomoto Co.

About Ajinomoto Co.

Using the same-different method to establish consumer relevance at Ajinomoto Co.

Research Background and Objectives

Background



Similarity test @Ajinomoto Co.

Triangle test

α=xx
β=xxx
P_d =25-35%
"Medium difference"

N≧n (in-house panel)

Table A.2 Similarity test

#Correct ≤ n

"The products can be used interchangeably."

Background *(Cont.)*

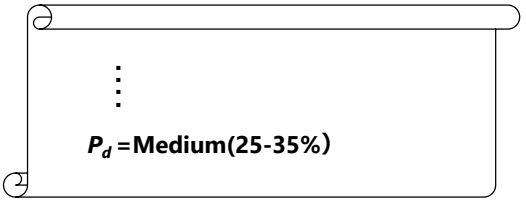
AJINOMOTO CO. has a standard

However, we don't know

- **underlying reasoning behind**

p_d=25-35%（"medium" sized difference)

- **whether this sensory difference is relevant for consumer**
- **whether this sensory difference is common across product categories**
- **how this sensory difference relates to the sensitivity of our in-house panel**



Objectives

Investigate consumer's same/different decision criterion using a Thurstonian approach

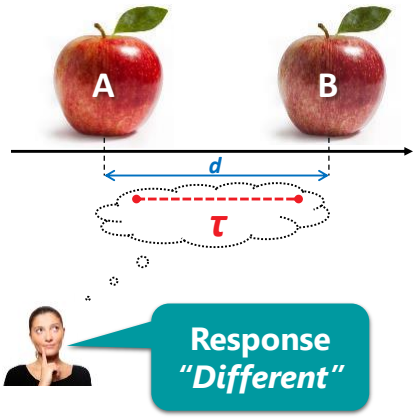
- **Estimate the size of the criterion and relate it to *Pd***
- **Study the criterion across a few food types**
- **Relate the consumer criterion to our in-house panel sensitivity**
- **Use this information to update our programs' risk profile**

Using the same-different method to establish consumer relevance at Ajinomoto Co.

Materials and Methods

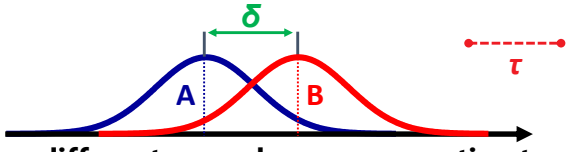
Methodological Approach

Use an approach providing a measure of consumers' "different" decision criterion: Same-different method



If	Answer
$d \leq \tau$	"Same"
$d > \tau$	"Different"

- **τ has the same unit as the Thurstonian δ**

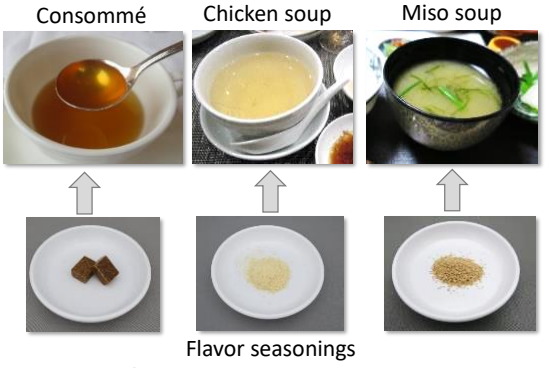


- **From a same-different procedure, we can estimate both τ and δ**
- **τ is a measure of a meaningful degree of difference**
- **We used the same-different method in this research**

Stimuli and Respondents

- **Stimuli: Soup samples**

Stimulus	Number of pairs
Consommé	5
Chicken soup	2
Miso soup	8



- **Differences created using salt, sugar, flavor ingredients, and concentrations of the seasonings**
- **Study sample sizes: 82 to 88 category consumers**

Procedures

Present pairs of samples

- P1:P1, P2:P2, Q1:Q1, ・・・ Identical pair
- P1:P2, Q1:Q2, ・・・ Different pair

Same-different test

You are going to be presented with 6 pairs of miso soups. Some pairs might be made of identical soups while others might be made of different soups.
Kindly taste the first pair of two miso soups and indicate your answer below

Codes 225 & 709

Q. The two soups are

Same **Different**

Using the same-different method to establish consumer relevance at Ajinomoto Co.

Results

Estimating τ (δ_R) from Same-Different Test

Results

Same-different test data

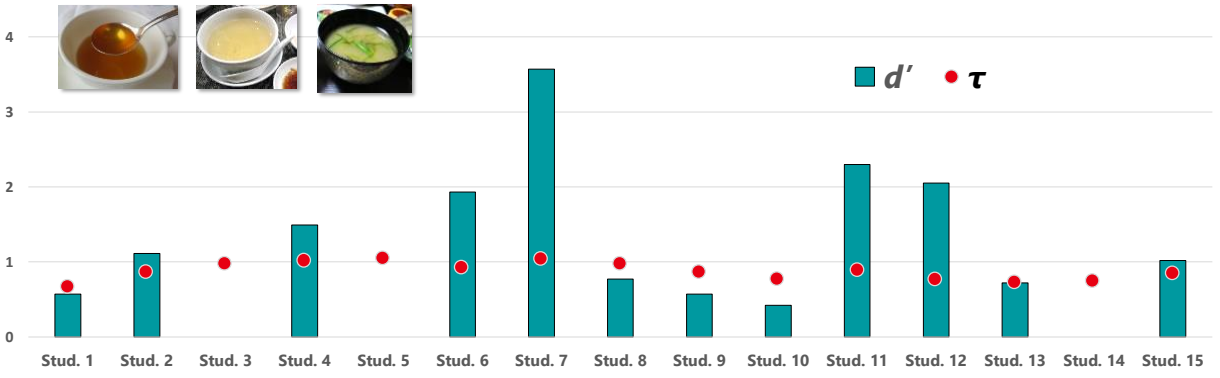
Pair	"Same"	"Different"	N
P1 : P1	12	19	31
P2 : P2	12	18	30
P1 : P2	19	33	52
Q1 : Q1	18	12	30
Q2 : Q2	16	15	31
Q1 : Q2	29	22	51
⋮			
R2 : R4	9	43	52
R3 : R4	19	32	51

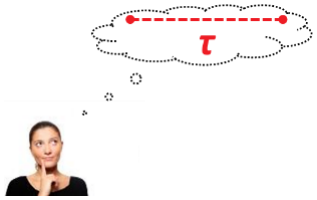
: Identical pair

: Different pair

- **Analyses conducted with**
  - IFPrograms® *(The Institute for Perception)*
  - V-Power *(by V. Jesionka, XLS add-in)*
  - sensR
- **Used to estimate**
  - **δ values (δ estimates = *d'*)**
  - **τ values**
  - **P_d**
  - **Power and sample sizes**

Results *(Cont.)*

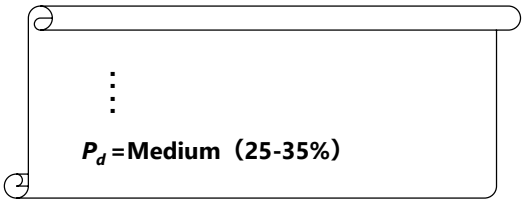




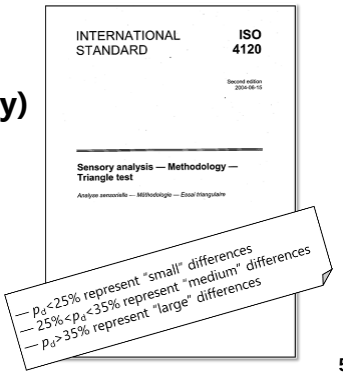
- **Average τ value: 0.93**
- **To set risk profile, use τ value (0.93) as δ_R**

Results *(Cont.)*

- **Current Ajinomoto risk profile:**



- **Result of current research: δ_R=0.93**
- **δ_R of 0.93 is equivalent to P_d =11% (high sensitivity) in the triangle test**
- **According to ISO4120, over 387 panelists are required in the triangle test (if α=0.10, β＝0.05)**



Using the same-different method to establish consumer relevance at Ajinomoto Co.

Results

Relating Consumer and In-house Panel Sensitivities

Using the same-different method to establish consumer relevance at Ajinomoto Co.

Conclusions

Conclusions

Risk profile can be updated using this new information

	α	β	Panel	P_d	δ_R	Method	N
Current	xx	xxx	In-house	30%	1.64	Triangle	n
Updated	0.10	0.05	Consumer	✗	0.93	Triangle	387
			In-House	✗	1.23	Triangle	**146**

New experimental approach proposed:

- **α=0.10, β=0.05, δ_R=1.23,**

→ Triplicate triangle test ex) N=49x3=147

Conclusions *(Cont.)*

Back to objectives

1. **Estimate the size of the criterion and relate it to *Pd***
   - **Criterion estimated at τ=0.93 → P_d=11%**
   - **Previous P_d of 25-35% might be too large**

2. **Study the criterion across a few food types**
   - **Criterion found to be stable across several soup types**

3. **Relate the consumer criterion to our in-house panel sensitivity**
   - **In-house panel was found to be more sensitive than consumers**
   - **This allows for the use of an overall smaller sample size**

Conclusions *(Cont.)*

- **The same-different method is effective to understand the psychological decision criterion of our consumers for sensory differences**
- **Once we have estimated the criterion, we can design discrimination tests rationally by using it in our research risk profile**

Using the same-different method to establish consumer relevance at Ajinomoto Co.

Thank you for your attention

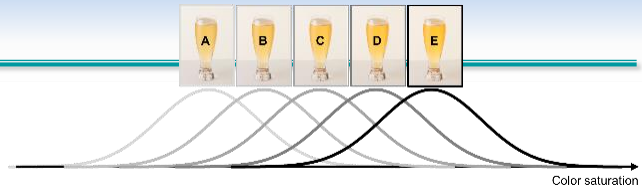
Dr. Chinatsu Kasamatsu
Executive Specialist
Institute of Food Sciences and Technologies
Ajinomoto Co. Inc., Japan

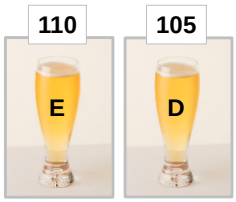
Eat Well, Live Well.
AJINOMOTO

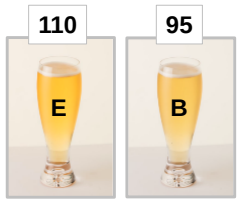
Wednesday July 31, 2019

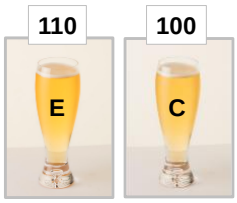
ACTIVITY # 1
Results

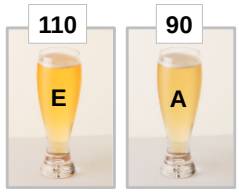
Activity # 1 Results











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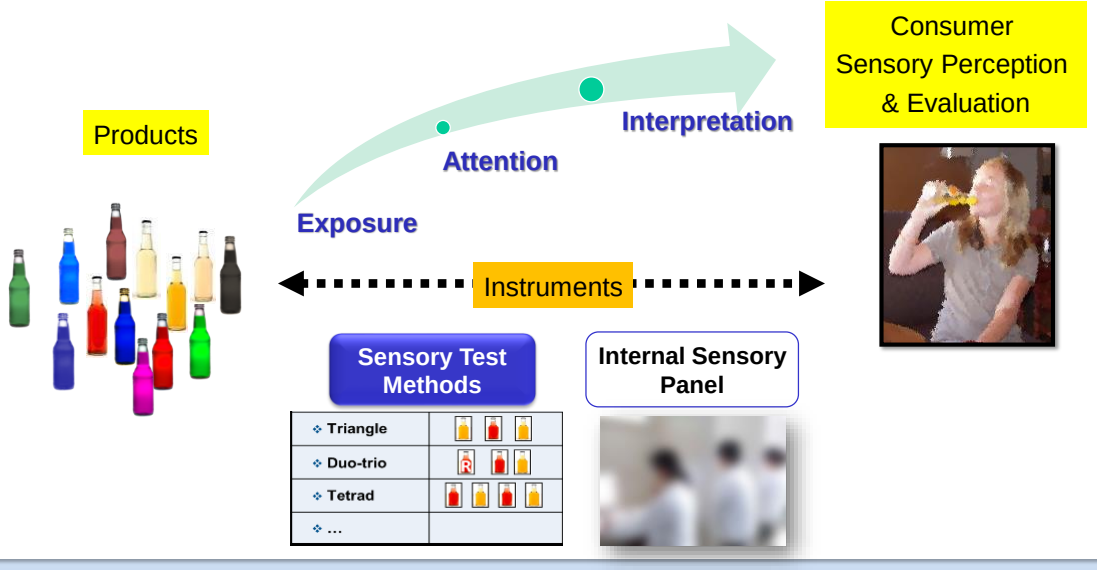
Consumer Relevance of Experimental Design & Procedures

Prof. Hye-Seong Lee
Ewha Womans University
Republic of Korea

EWHA WOMANS UNIVERSITY

Sensory Measurement Issues



Sensory Measurement Issues

How to attain the validity of consumer measurements & prediction?
Beyond the size of sensory difference

1. Do ‘Consumers’ and ‘Internal sensory panel’ experience the same sensory perception?
2. Is the natural cognitive scheme of consumer sensory discrimination well represented in the test methods?

How to measure the accurate size of sensory difference?

1. Difficulties of sensory experiments –theories do not apply exactly. Various experimental factors need to be carefully controlled to minimize the extra noise from experimental procedures

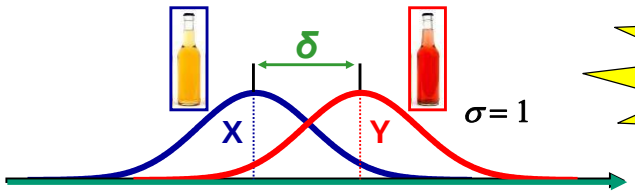
How to attain the validity of consumer measurements & prediction?
Beyond the size of sensory difference

The Importance of Evoking and Studying the Consumer-Relevant Perceptual Dimension

Assumption of Standard Thurstonian Model

δ = Standardized measure of sensory difference

d' = Experimental estimate of δ



Consumer Relevance

One-dimensional Perceptual discrimination

→ Reflecting consumer evaluative criterion

→ Reflecting consumers' familiarity to food samples & sensory expectation

Trained Panelists *vs*. Consumers (Users)

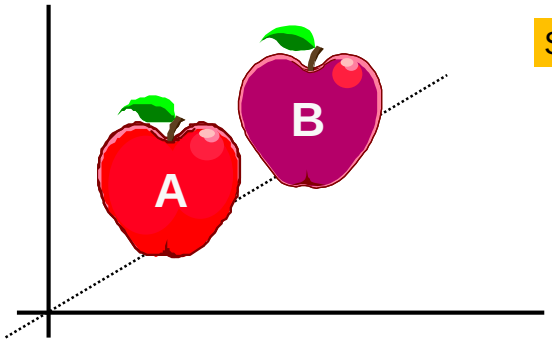
	Perceptual Process	Familiarity & Sensitivity
Trained Sensory Panelists 	• ***Analytic*** strategy: pay selective attention to each trained attribute	• More sensitive to each attribute (each taste modality) • Discriminate products more based on better trained attributes
Consumers (Users) 	• ***Synthetic*** strategy: pay global attention to the overall product flavor	• Less sensitive to each of separable attributes • Could be more familiar and sensitive to overall flavor perception and/or a sets of integrative salient attributes

Heavy Users (loyal consumers)

Marketing effects (stronger identity)

Consumer-Relevant Perceptual Dimension

How to train internal sensory panel to attend to the perceptual dimension that is important to consumers?

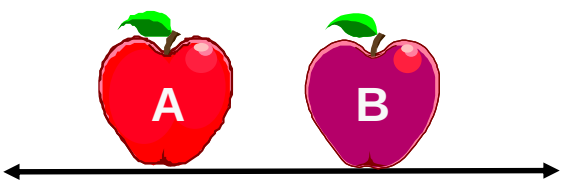


Step 1: Pre-view & Familiarization procedure

- ✓ Accelerate consumption experience up to consumer familiarity of the product category
- ✓ Help sensory panel find an appropriate axis
- ✓ Use VARIOUS products of consumers' fame of reference (comparative products)
- ✓ Facilitate evaluation of un-directional overall sensory difference

Overall Sensory Difference Tests Without Anchor

Test protocol	Sample presentation & Instruction
Balanced Ref. Duo-trio	Which one is the reference? (R)
Triangle	Which one is the odd one?
Unspecified Tetrad	Divide them into two groups of two
Same-different	Is this pair same or different?



Unspecified, non-directional Sensory Difference

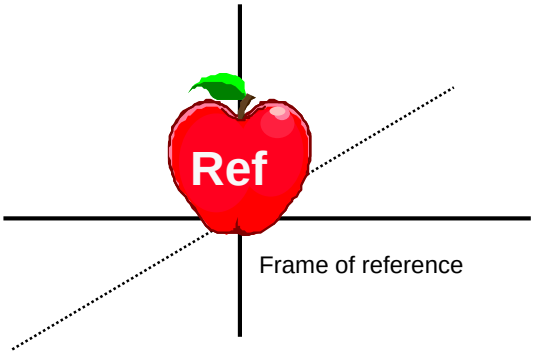
Only Distance

Classification tests:

- ✓ Use non-directional comparisons
- ✓ Assume no difference among samples in terms of familiarity & preference

Consumer-Relevant Perceptual Dimension

How to train internal sensory panel when there is a golden reference that is consumers highly familiar to?



Step 2: Reminder procedure

- ✓ Accelerate consumption experience up to consumer familiarity of a particular product
- ✓ Help sensory panel to learn the inherent variation of sensory perception of the reference
- ✓ Use comparative products against reference to remind the sensory perception of the reference

Overall Sensory Difference Tests With Anchor

Test protocol	Sample presentation & Instruction
A-Not A	Is this the 'A' or not ?
A-Not A with Reminder (A-Not AR)	Is this the 'A' / 'Reference' or not ? Reminder R
Dual-Reminder A-Not A (DR A-Not A)	Reminder R R
2-AFC	Which one is the 'A' ?
2-AFC with Reminder (2-AFCR)	Which one is the 'A' ? Reminder R
Constant Ref. Duo-trio	Which one is the reference? R

Discrimination tests
with a fixed reference (Reminder Scheme)

- ✓ Use directional comparisons
- ✓ Assume subjects (consumers) recognize the sensory identity of the reference
- ✓ Assume the possibility of difference among samples in terms of familiarity & preference

Reminder-Scheme Discrimination Tests

Some Experiments With Multiple Samples, Reported in Literature

Literature	Author Affiliation	Food type	Test method	Subjects	Test samples
Kuesten (2001)	Ocean Spray Cranberries	Beverage	2-AC	Internal	
			Triangle; 2-AFC; Same-different	Untrained/ Consumer	
Lee et al. (2007)	Unilever, Vlaardingen	Margarine	A-Not A with rating	Internal	
Michon & McDonnell (2008)	PepsiCo Ireland	Cola	DOD	Untrained/ Consumer	
Christensen et al. (2011)	Unilever R&D DTU	Soup	A-Not A	Untrained/ Consumer	
Hahn et al (2012)	Kraft Foods RD&Q	Cheese	DOD	Internal	
Kim et al (2012)	Unilever R&D Ewha Womans Univ.	Corn soup	2-AFCR; A-Not A	Untrained/ Consumer	
Kim & Lee (2012)	Ewha Womans Univ.	Tomato juice	Constant Ref. Duo-trio	Untrained/ Consumer	
Jeong et al. (2016)	Ewha Womans Univ. Univ. of Auckland	Soy Milk	A-Not AR; Unspecified Tetrad Constant Ref. Duo-trio; Triangle	Untrained/ Consumer	
Jeong et al. (2017)	Unilever R&D Ewha Womans Univ.	Iced tea	2-AFCR; Unspecified Tetrad	Sensory panel	

How to measure the accurate size of sensory difference?

Operational interferences - Difficulties of sensory experiments

→ theories do not apply exactly.

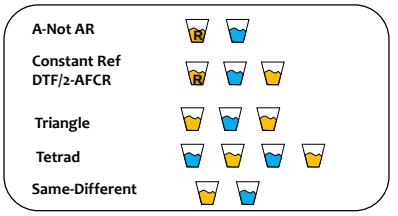
Or we can question differently……..

How to select the test methods to minimize the operational inferences?

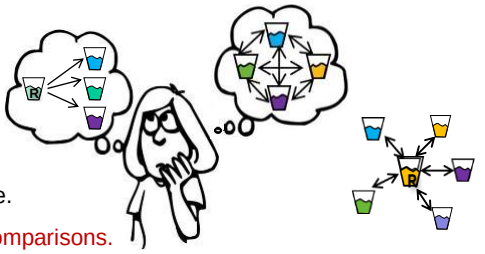
How to best use the theory developed for sensory difference tests?

Experimental factors increasing the noise

- **Effects of the number of test samples in a test**
  - Memory problem
  - Physiological adaptation or carry-over
  - Variations in the cognitive strategies used for comparisons of different samples



- **Effects of the number of test samples in an experiment**
  - Different designs induce different cognitive load
    - ✓Even when using the fixed-ref. discrimination tests, as the number of test samples increases, cognitive load to compare them would increase more!
    - ✓Classification tests require many more comparisons of non-directional differences between samples.
  - High cognitive load would lead to lowering test performance.
    - → If possible, use the model requiring lower number of comparisons.
    - → Plan the larger sample size than what the test power computation predicts.



Summary

- ✓ To guarantee the effectiveness and efficiency of consumer research, the experimental design & test procedure should be carefully selected considering the business situations and target consumers' frame of reference.
- ✓ When considering consumer relevance, not only the size of the sensory difference but also the nature of the sensory difference & the design of the test method are very important. These are the bases to produce the size of sensory difference.
  - Comparisons of samples in the test methods should be based on **consumer evaluative criterion relevant to the natural preference judgement.**
- ✓ When consumers & sensory panel are familiar enough to the overall sensory perception of various products under comparisons, classification tests such as the same-different test and unspecified tetrad tests are good choices.
- ✓ Yet, when there is a golden reference or more familiar (or preferred) sample, discrimination tests using reminder schemes might be more appropriate for consumer research.

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Consumer Relevance of Experimental Design & Procedures

Thank you for your attention

Prof. Hye-Seong Lee
Ewha Womans University
Republic of Korea

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Wednesday July 31, 2019

ACTIVITY # 2
Results

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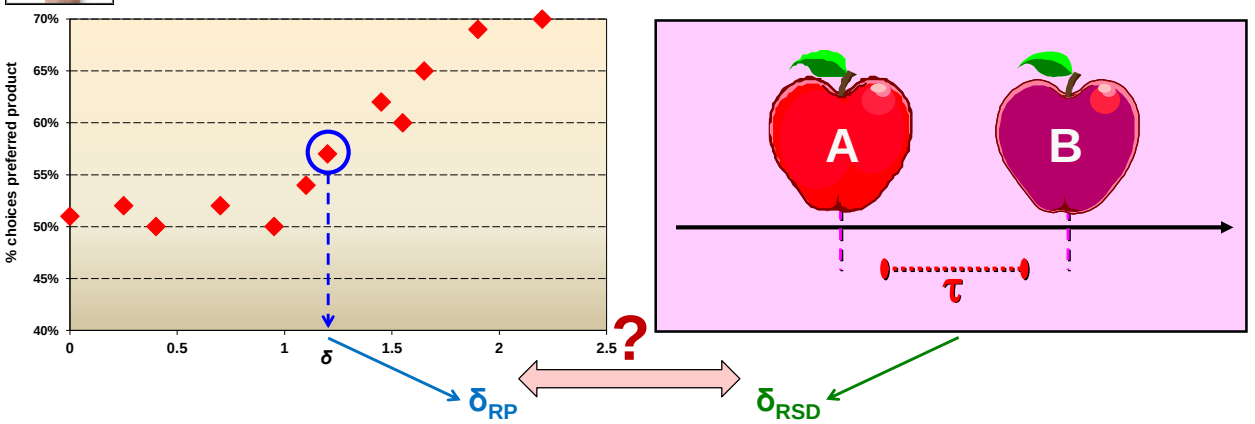
Reconciling preference and same-different information for consumer relevance

Dr. Benoît Rousseau
The Institute for Perception
USA

The Institute for Perception

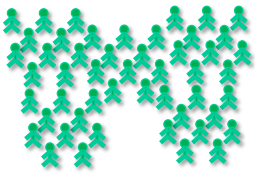
How do Difference and Preference Relate?



- Do the preference and the same-different approaches lead to different predictions?
- If yes, which is more relevant, if either?

Same-Different vs. Preference Investigation

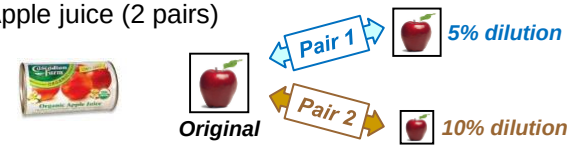
Based on: *Rousseau, Ishii. (2019).* How do Perceived Sensory Differences and Preferences Relate?



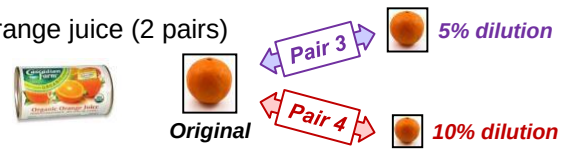
- 256 consumers
  - 126M, 130F
  - Average age 24.8 years old

- Stimuli
  - Fruit juices varying in concentration

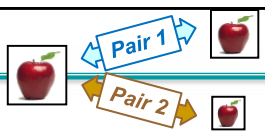
  - Apple juice (2 pairs)

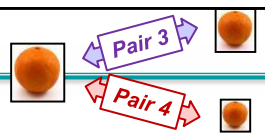


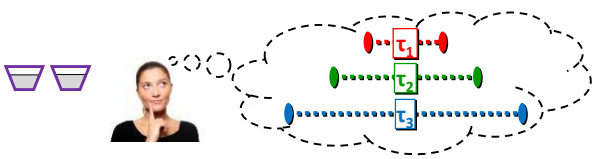
  - Orange juice (2 pairs)



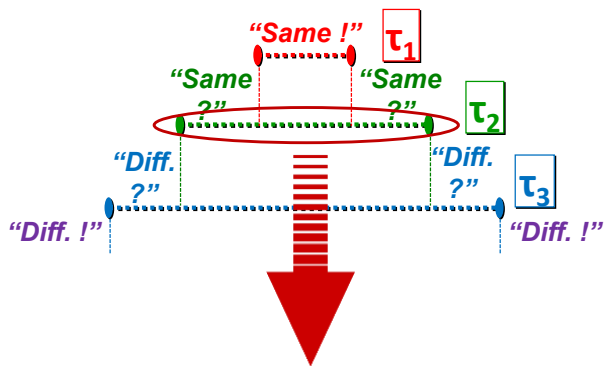
DOD *Results*







Pair	*d'*	τ_1	τ_2	τ_3
Pair 1	0.95	0.4	0.8	1.3
Pair 2	1.41	0.7	1.1	1.5
Pair 3	0	0.6	0.9	1.3
Pair 4	1.14	0.5	0.9	1.5
	Average	*0.55*	*0.93*	*1.40*

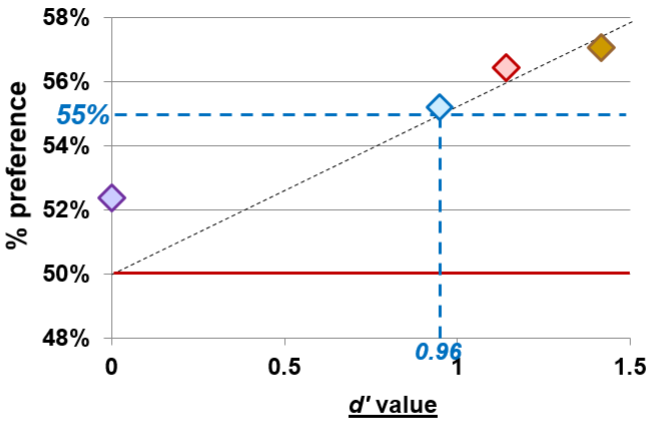


$\delta_{RSD} = 0.93$

Preference Test Results

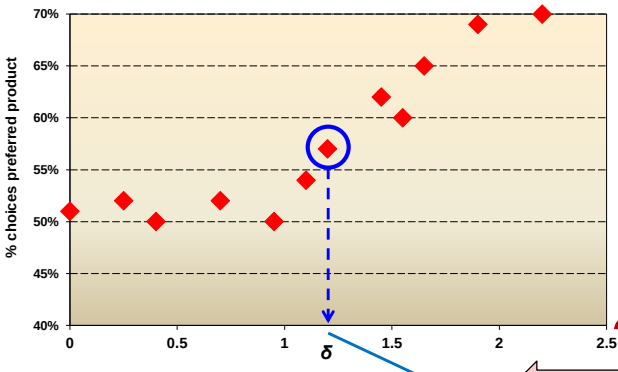
Pair	d'	Pref.
Pair 1	0.95	55.1%
Pair 2	1.41	57.0%
Pair 3	0	52.3%
Pair 4	1.14	56.3%

DOD



$\delta_{RP} = 0.96$

How do Difference and Preference Relate?



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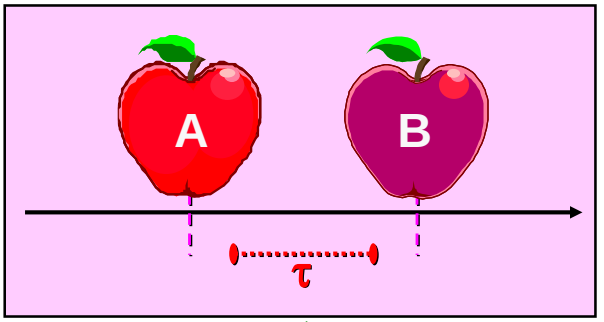

$\delta_{RP}=0.96$ $\delta_{RSD}=0.93$

- The two approaches lead to the same prediction

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Reconciling preference and same-different information for consumer relevance

Thank you for your attention

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Review of Activities' Results
Discussion
Conclusions

Last Thoughts

Wednesday July 31, 2019

Learnshop # 5

Consumer Relevance of Sensory Measurements

Thank you for your attending

Dr. Benoît Rousseau

Prof. John Prescott

Dr. Chinatsu Kasamatsu

Prof. Hye-Seong Lee