Comparison of Rapid Sensory Profiling Techniques: Check-all-that-apply (CATA), Sorting, and Polarized Sensory Positioning (PSP)

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Descriptive Analysis: The "Gold Standard"

- Involves the detection, description, and quantification of sensory attributes by a trained panel of judges
- Variations
  - Flavor Profile
  - Texture Profile
  - Quantitative Descriptive Analysis (QDA®)
  - Spectrum™

Descriptive Analysis: The "Gold Standard"

- Advantages
  - Detailed, robust, and consistent, reproducible results (Moussaoui & Varela, 2010).
  - "One of the most powerful, sophisticated, and most extensively used tools in sensory science" (Varela and Ares, 2012).
- Limitations
  - Time consuming
  - Expensive

Solution:
Rapid Sensory Profiling Techniques

Rapid Sensory Profiling Techniques

- Alternative to classic descriptive analysis
- Advantages
  - Less time consuming
  - Greater flexibility
  - Naïve/semi-trained assessors
- Techniques
  - Check-all-that-apply (CATA)
  - Sorting
  - Polarized sensory positioning (PSP)
  - Many others…

} Scope of this presentation

Objectives:

- Determine the relative **efficacy** of three rapid sensory profiling techniques:

Criterion	Definition
1. Configurational Congruence	Relative consistency of visual representations
2. Descriptive Ability	Degree to which method characterizes sensory attributes
3. Practicality	Time required to complete the experiment

All studies were conducted using identical astringent stimuli

Stimuli

Compound	Concentration (g/L)	Class
Ammonium Aluminum Sulfate ("Alum")	2.75	MS
Zinc Chloride	4.00	MS
Lactic Acid	3.00	OA
Malic Acid	2.20	OA
Tartaric Acid	1.60	OA
Biotan®[1]	5.00	P
CocoaVia®[2]	32.50	P
Cranberry Extract	1.50	P
Epigallocatechin Gallate (EGCG)	2.20	P
Tannic Acid	2.00	P

"MS"= Multivalent salt; "OA"= Organic Acid; "P"= Polyphenol

[1]Commercial grape tannin extract used in the wine industry

[2]Cocoa extract supplement; "Dark Chocolate Unsweetened" flavor

Check-All-That-Apply (CATA)

Check all attributes which describe the sample

- [x] Drying
- [ ] Bitter
- [ ] Burning
- [ ] Puckery
- [x] Roughing
- [ ] Salty
- [x] Sour
- [ ] Stinging/pricking
- [ ] Sweet
- [ ] Tickle
- [ ] Tingling
- [ ] Umami/Savory
- [ ] Velvety
- [ ] "Other"

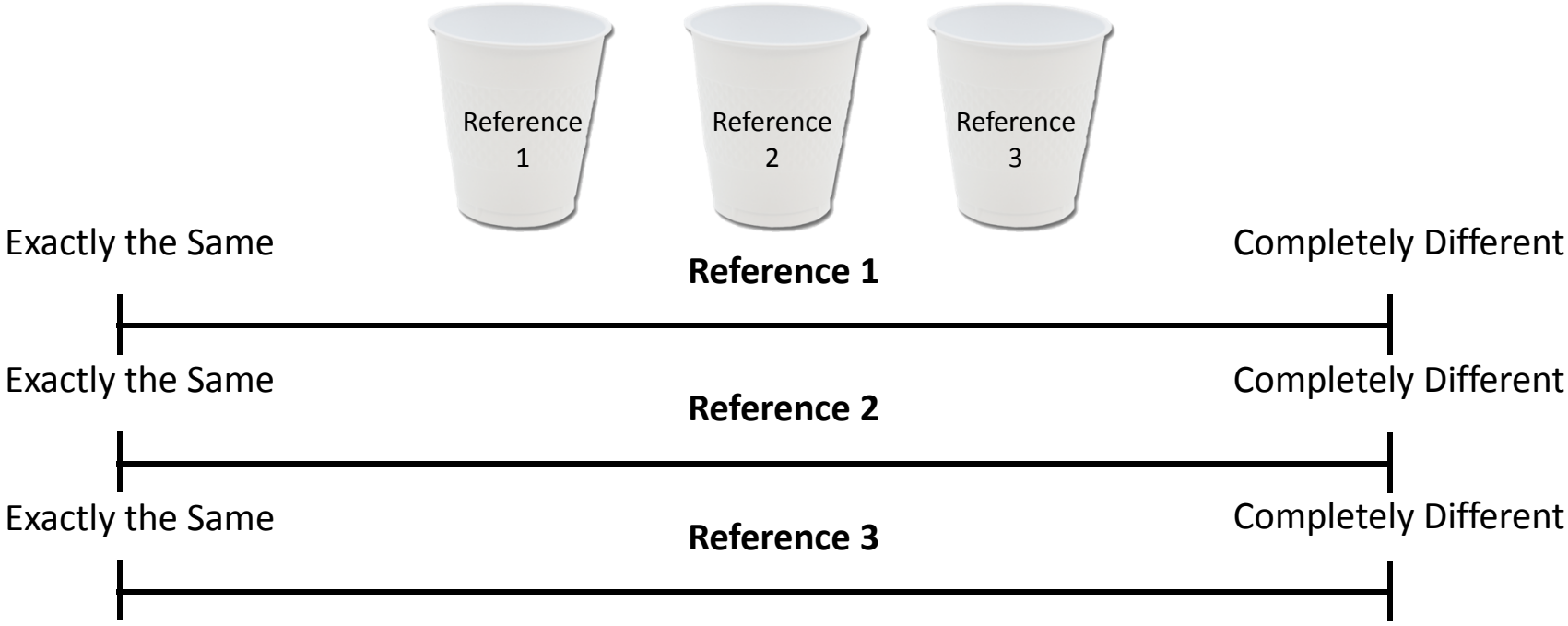
- Multiple choice questions often used to reduce response burden of participants (Rasinksi et al. 1994)
- CATA terms generated from previous studies on astringent sub-qualities (Lawless 1991); basic tastes and other chemesthetic sensations
- Presentation order of words (13) counterbalanced across subjects
- Alum= blind duplicate
- Testing completed in individual sensory booths

Sorting

- Participants form groups (sort) based on the similarity/dissimilarity of the tastes or sensations elicited by each sample
- A min. of 2 and max. of 10 groups (11 total samples) with no other constraints
- Alum= blind duplicate
- Lists of words/terms can be used as an aid
- Testing conducted 1:1 with experimenter

Polarized Sensory Positioning (PSP)

- Participants taste reference samples or “poles”
  - Malic acid, tannic acid, and alum (included in sample set)
- Ratings based on the relative similarity/dissimilarity of all products compared to poles
- Individual sensory booths; alum= blind duplicate



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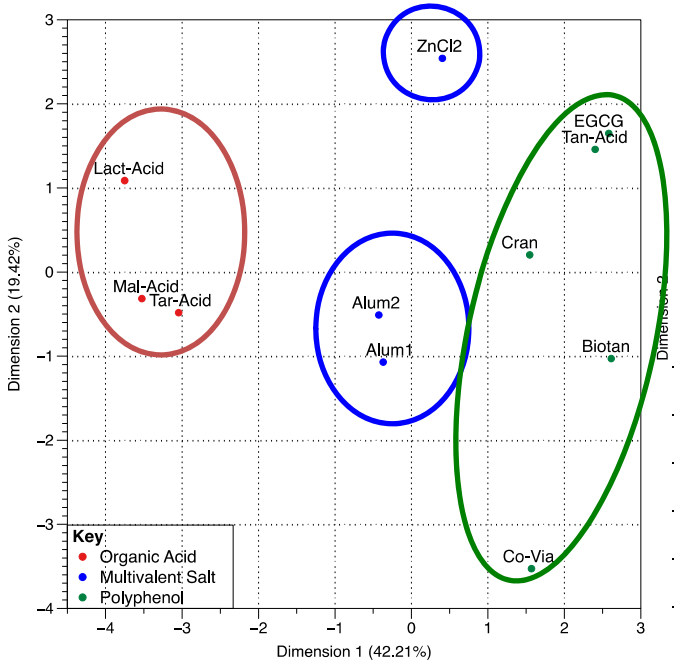
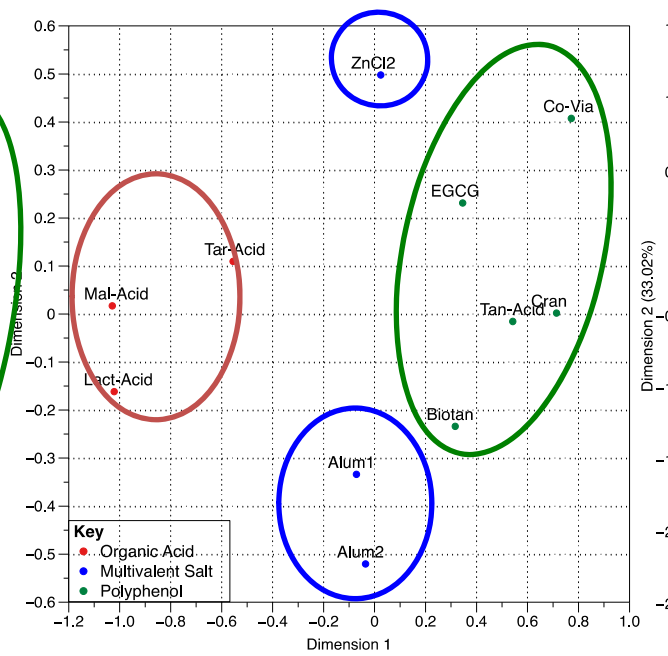
Configurational Congruence

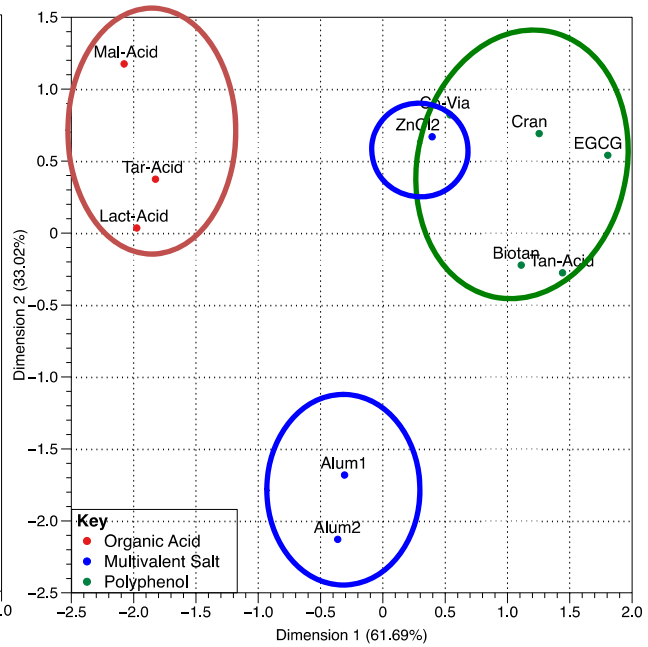
CATA



Sorting



PSP



Multivalent
Organic Acids
Polyphenols
Salts

Zinc Chloride (MS) consistently grouped with polyphenols

Are these plots significantly similar?

PENNSTATE

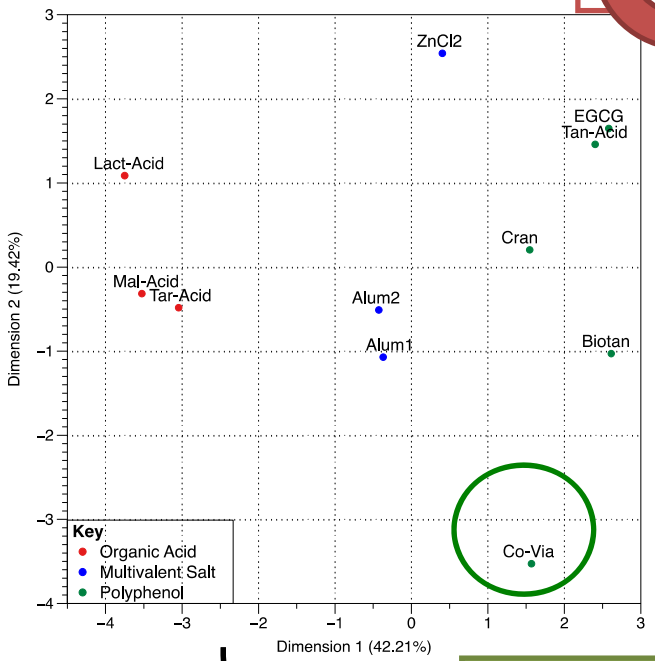
Food Science
College of Agricultural Sciences

CATA v. Sorting
NRV=1.25
p=0.11

Sorting v. PSP
NRV=3.74
p=0.007

Differences due to CocoaVia?

CATA



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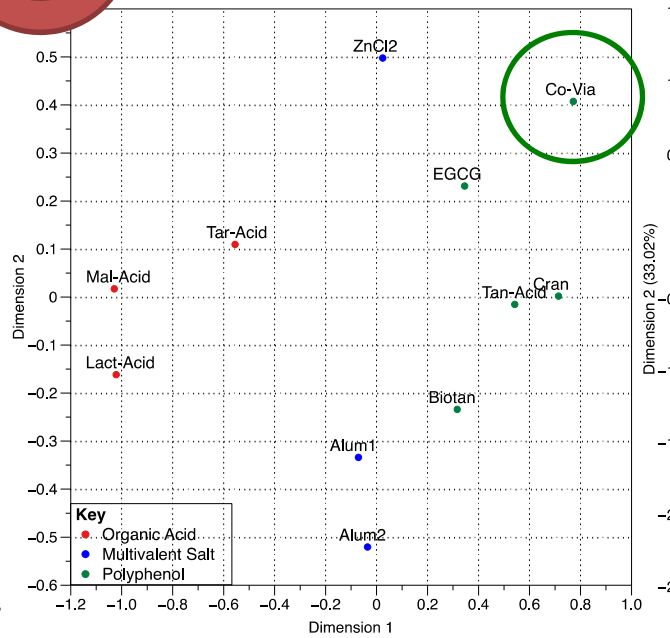

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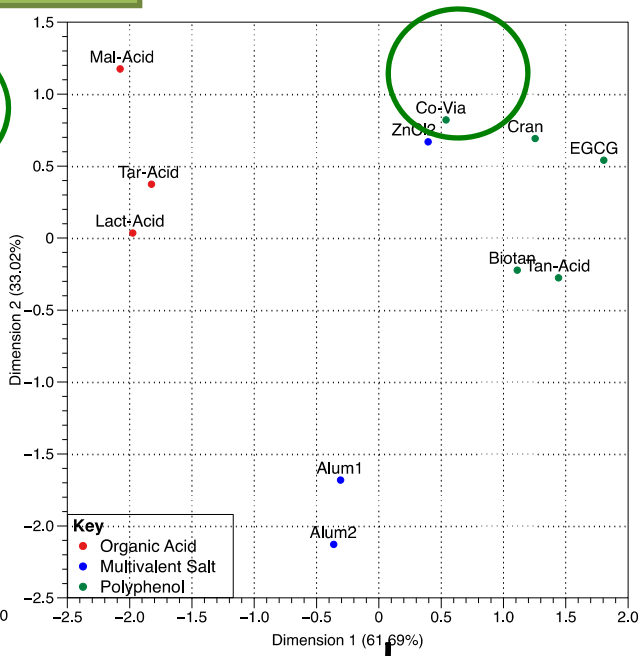

CATA v. PSP
NRV=5.33
p=0.001

"NRV"= normalized RV coefficient; a multivariate generalization of Pearson's R^2. NRV is interpreted similar to a z-score, with a large score (>2) indicating significant similarity between maps

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Descriptive Ability: CATA Frequencies

Multivalent Salts: drying | **Organic Acids: sour** | **Polyphenols: drying and bitter**

CATA Term	Sample										
	Alum 1	Alum 2	Zinc Chloride	Lactic Acid	Malic Acid	Tartaric Acid	Biotan®	CocoVia®	Cranberry Extract	EGCG	Tannic Acid
Drying**	69.0	75.6	73.3	38.1	42.6	38.3	75.6	42.6	51.1	48.9	61.2
Roughing*	28.6	31.1	28.9	14.3	14.9	12.8	37.8	27.7	24.4	29.8	29.1
Puckery*	33.3	26.7	20.0	52.4	51.1	46.8	13.3	6.4	13.3	19.1	11.9
Sour***	42.9	48.9	15.6	88.1	80.9	80.9	20	12.8	17.8	10.6	13.5
Bitter*	47.6	40	46.7	26.2	27.7	23.4	68.9	51.1	82.2	74.5	85.1
Salty**	4.3	6.7	40	26.2	8.5	14.9	6.7	4.3	8.9	0	3.7
Sweet***	28.6	28.6	11.1	21.4	14.9	14.9	2.2	4.3	2.4	0	0
Umami/Savory	2.4	6.7	22.2	9.5	2.1	0.0	6.7	10.6	2.2	2.1	2.2
Stinging/Pricking*	4.4	4.4	17.8	11.9	6.4	8.5	6.7	0	13.3	21.3	13.3
Tickle	2.2	2.2	6.7	7.1	10.6	4.3	0	6.4	0	2.1	0.0
Velvety**	6.4	11.1	13.3	0	2.1	10.6	13.3	31.9	2.2	2.1	5.2
Other	4.3	4.3	13.3	2.4	2.1	2.1	11.1	21.3	8.9	14.9	4.4

*indicates significant differences at α=0.05;** α=0.01;*** α=0.001 using Cochran's Q test

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Practical Considerations

Experiment	CATA	Sorting	PSP
N	41	30	41
Total Hours	4	30	4
Testing Conditions	Individual Sensory Booths	1:1 with the experimenter	Individual Sensory Booths

- Sorting task difficult to conduct in individual sensory booths
  - Cognitive difficulty? Untrained participants?
  - Still more efficient than pairwise comparisons
    - e.g. 55 pairs needed for 11 stimuli
- PSP and CATA intuitive to participants

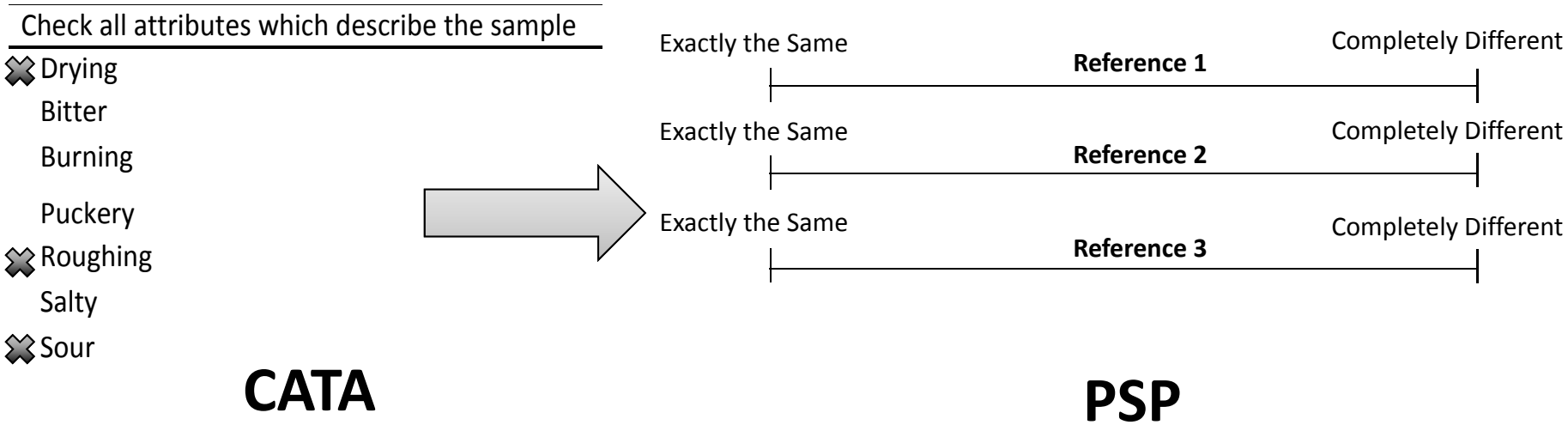
Criteria for Comparison:

	CATA	Sorting	PSP
1. Configurational Congruence	✔	✔	✔
	Plots show consistent visualization of results (CATA v. sorting was not sig. similar)		
2. Descriptive Ability	✔ *	✖	✖
		Lack of descriptive data	
3. Practicality	✔	✖	✔
		Relatively inefficient	

*** language-specific/ not a semantic-free task; difficult to adopt cross-culturally**

Take Home Messages:

- CATA and PSP relatively more efficient than sorting
- CATA has greatest descriptive ability
  - PSP semantic-free therefore easily adopted cross-culturally
- Recommendation: CATA first then PSP



Thank you!

- Dr. John Hayes
- Dr. Greg Ziegler
- Lab mates:
  - Rachel Antenucci, Rachel Primrose, Alissa Allen Nolden, Nadia Byrnes, Emma Feeney, Toral Zaveri, Catherine Shehan, Bangde Li, Alyssa Bakke Chilton, Demi Perry, & Michelle Reyes
- Undergraduates
- Participants

Questions?

Check-All-That-Apply (CATA) Data Analysis

- Is there a significant difference between samples for each term?
  - Cochran's Q Test
- Bi-dimensional representation of data
  - Multiple Factor Analysis (MFA)
  - Multiple Correspondence Analysis (MCA)

Consumer	Sample 1	Sample 2	Sample 3	....	Sample N
1	1	0	1	...	0
2	1	0	0	...	0
3	1	1	0	...	1
...	...	...	...	...	...
X	0	1	0	...	1

Example of data matrix from CATA questions using Cochran's Q Test

Sample	Acid	Sweet	Rough	....	Creamy
1	84	29	0	...	3
2	22	7	0	...	42
2	56	0	0	...	36
...	...	...	...	...	...
x	6	63	78	...	3

Example of frequency table used for analyzing CATA data for MCA or MFA

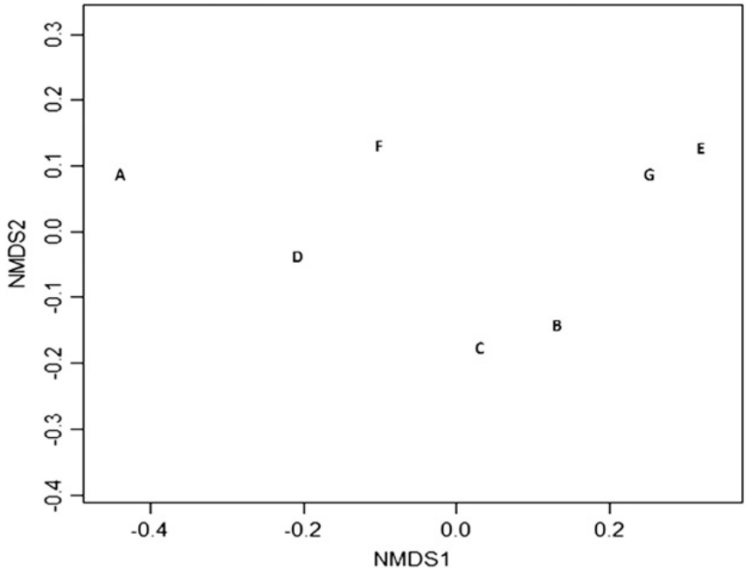
Adapted from Varela and Ares 2012

Sorting
Data Analysis

- Bi-dimensional representation of data
  - Multidimensional Scaling (MDS) most common

	Sample 1	Sample 2	Sample 3	....	Sample n
Sample 1	75	42	14	...	1
Sample 2	42	75	28	...	15
Sample 3	14	28	75	...	56
...	...	...	...	...	...
Sample n	1	13	56	...	75

Example of a similarity matrix for analyzing data from a free sorting task. Each cell indicates the number of times that each pair of samples were placed together in the same group.



Typical sample representation of data from free sorting task using Multidimensional Scaling (MDS)

Adapted from Varela and Ares 2012

PSP Data Analysis

- Bi-dimensional representation of data
  - Multiple Factor Analysis (MFA) most common

Sample	Assessor 1			Assessor 2				Assessor n		
	R1	R2	R3	R1	R2	R3	...	R1	R2	R3
1	1.4	8.3	0.9	1.0	7.6	8.5	...	1.3	7.8	4.4
2	0.2	9.8	7.8	8.9	5.6	2.4	...	3.4	6.5	6.7
...	...	...	...	...	...	...	...	...	...	...
X	3.2	4.8	6.4	5.8	9.9	1.4	...	8.9	7.5	1.4

Example of the data matrix generated from PSP.

Adapted from Varela and Ares 2012

What is Astringency?

- The word astringency originates from the Latin word "*ad stringere,"* meaning " to bind."
- ASTM: "the complex of sensations due to shrinking, drawing, or puckering of the epithelium as a result of exposure to substances such as alums or tannins."
- NOT a taste, but a *tactile* (touch) sensation
- Can be a positive or negative attribute depending on the individual and/or context