9th Pangborn Sensory Science Symposium
4-8 September 2011
The Sheraton Centre Toronto Hotel, Toronto, Canada

Using Thurstonian Predictions and Experimental Data to Investigate the Optimal Category Scale Structure for the Degree of Difference Protocol

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Outline

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- Degree of difference methodology
- Issue and investigation

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- Sample selection for main study
- Torgerson's method of triads

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Background

Using Thurstonian Predictions and Experimental Data
to Investigate the Optimal Category Scale Structure
for the Degree of Difference Protocol

Background

- **Degree of Difference Methodology**

Sample 1 *Sample 2*

Instructions

How different are the two samples on a scale from 0 to N?

0	1	2	3				N

Identical ***Extremely different***

- Useful when evaluation of more than 2 samples is difficult
- N=? ***1 (same-different)*** ***5*** ***7*** ***10*** ***...***
- Is there an optimal number of categories?

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Issue

- **Previous internal research**
  - Large scales can result in sparse data
  - Assessors might not use the scale the same way
- **Effect of number of categories on scale performance?**
- **Index of scale performance: *d´***
  - Standardized measure of sensory difference/scale performance
    - ***d´*** = 0: No difference
    - ***d´*** > 0: Difference (usually ***d´*** < 2 for discrimination)
  - Theoretically independent of the method used

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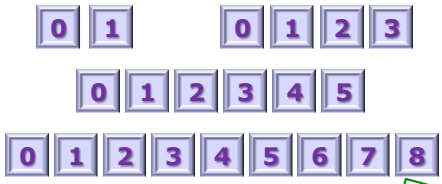
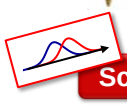
Investigation

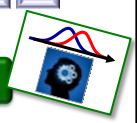
How different are the two samples?





Scale used similarly

- All scales → Same ***d´*** value
- Larger ***d´*** → Smaller ***d´*** variance
- More categories → Lower ***d´*** variance *(better estimate)*



Scale used differently

- More categories → Lower ***d´*** *value (more noise due to scale usage)* → Higher ***d´*** variance

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Preliminary Research

Using Thurstonian Predictions and Experimental Data to Investigate the Optimal Category Scale Structure for the Degree of Difference Protocol

Objectives and Product Preparation

- For main study: 2 pairs of products needed
  - 'Smaller' difference: $d'=0.6$
  - 'Larger' difference: $d'=1.5$
- Cherry flavored Kool-Aid powder mix
  - Base: 150g powder added to 2L of water
  - Differences created: Table sugar added
- Samples prepared in 2oz clear plastic cups
  - 30ml (1oz) per sample
- 5 samples created

0g/L 6g/L 12g/L 18g/L 24g/L

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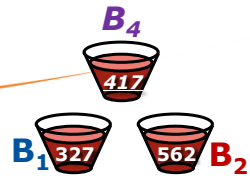
Torgerson's Method & Design



- Efficient way of making multiple comparisons

Which of **327** or **562** is more similar to the reference ***417***?

10 assessors

12 Sessions
6 triads/session

Each of 30 triads evaluated 24 times

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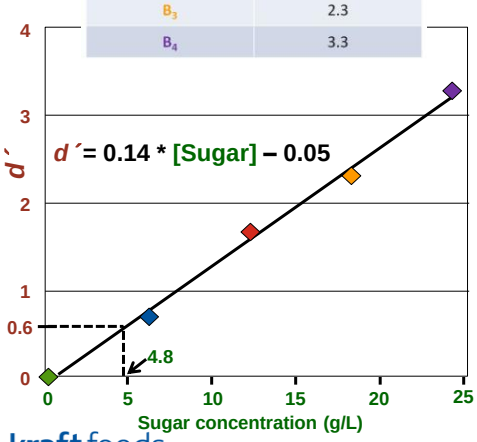
Results

Product	d' value (from B_0)
B_0	0
B_1	0.7
B_2	1.7
B_3	2.3
B_4	3.3



Left	Ref	Right	Choice	N		Left	Ref	Right	Choice	N
B1	B0	B2	15	24		B1	B2	B3	13	24
B1	B0	B3	8	24		B1	B2	B4	14	24
B1	B0	B4	17	24		B3	B2	B4	9	24
B2	B0	B3	13	24		B0	B3	B1	12	24
B2	B0	B4	9	24		B0	B3	B2	11	24
B3	B0	B4	10	24		B0	B3	B4	12	24
B0	B1	B2	12	24		B1	B3	B2	10	24
B0	B1	B3	11	24		B1	B3	B4	10	24
B0	B1	B4	16	24		B2	B3	B4	10	24
B2	B1	B3	15	24		B0	B4	B1	13	24
B2	B1	B4	14	24		B0	B4	B2	10	24
B3	B1	B4	11	24		B0	B4	B3	13	24
B0	B2	B1	18	24		B1	B4	B2	11	24
B0	B2	B3	10	24		B1	B4	B3	15	24
B0	B2	B4	12	24		B2	B4	B3	12	24

- **Difference 1: d'=0.6**
  - 1st sample: 0g/L
  - 2nd sample: 4.8 g/L
- **Difference 2: d'=1.5**
  - 1st sample: 4.8/2 = 2.4 g/L
  - 2nd sample: 13.4 g/L

Smaller difference: 0g/L & 4.8 g/L

Larger difference: 2.4 g/L & 13.4 g/L

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Main Study

Using Thurstonian Predictions and Experimental Data to Investigate the Optimal Category Scale Structure for the Degree of Difference Protocol

Objectives & Design

- Compared DOD with different number of categories
  - **2 categories** Same | Different
  - **4 categories** 0 | 1 | 2 | 3
  - **6 categories** 0 | 1 | 2 | 3 | 4 | 5
  - **9 categories** 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8

- Also included
  - **'Traditional' DOD** *(Different from Control)*

0 | 1 | 2 | 3 | 4 | 5

  - **Triangle test**

No scale effect

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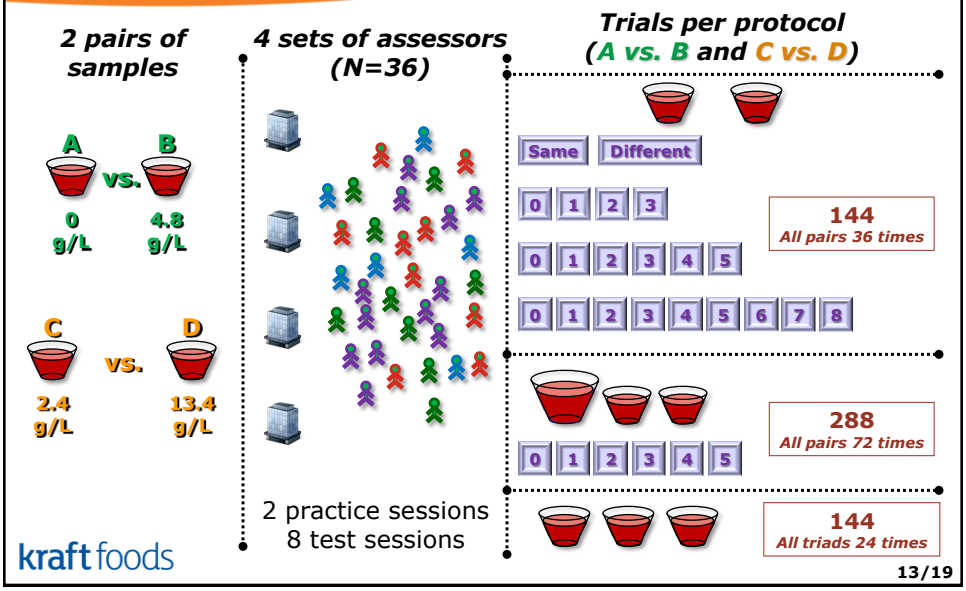
Objectives & Design



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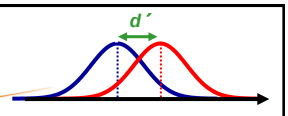
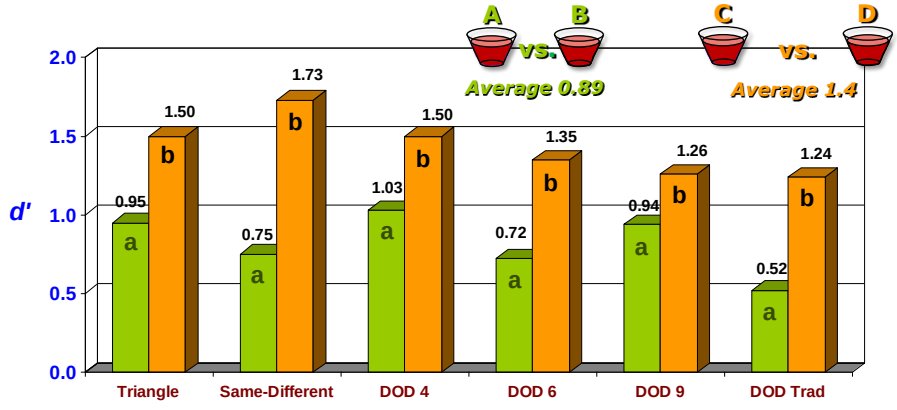
Results



- *d´* values estimated for each pair/protocol
  - Data combined over all 36 assessors



- Within each pair, the *d´* values across protocols are not significantly different

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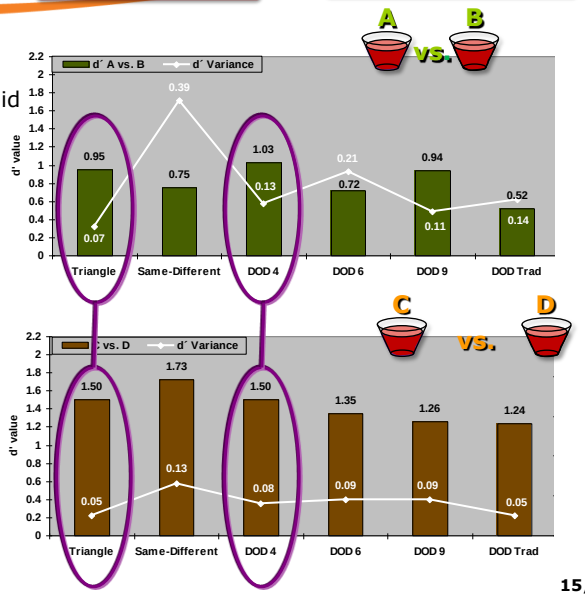
Results *(Cont.)*

Scale used similarly

Scale used differently

- *d´* values across protocols did not differ significantly
- Within protocols

Larger *d´* → Smaller *variance*



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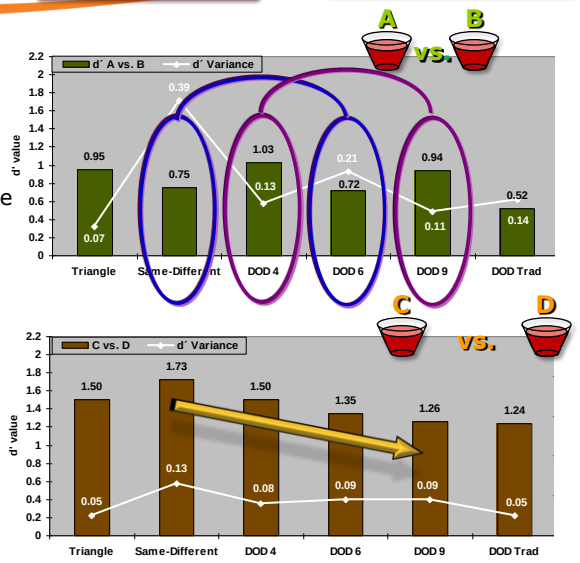
Results *(Cont.)*

Scale used similarly

Scale used differently

- For the same *d'*, more categories, lower *d´* variance
- More categories, lower *d´* value
  - True for **CD** pair only



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Conclusions

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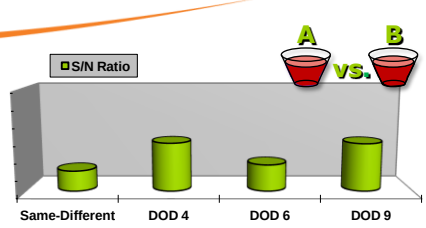
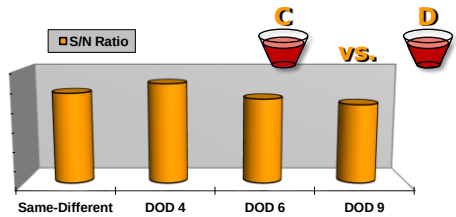
Conclusions

- Signal to noise ratio combines *d'* and its variance
  - $$\frac{S}{N} = \frac{d'}{\sqrt{var(d')}}$$
- Larger S/N indicates better discrimination ability
  - *Largest for 4 and 9 point scales for **AB** pair*
  - *Largest for 4 point scale for **CD** pair*





- **Recommendations**
  - No need for many response categories (too much noise added)
  - Sensitivity lost with greater number of categories (e.g. 9)
  - **4 categories best optimizes the ability to detect differences**

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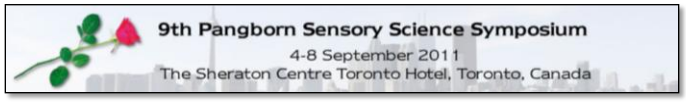

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Any Questions?

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