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THE SENSOMETRIC SOCIETY

Advances in Tetrad Testing

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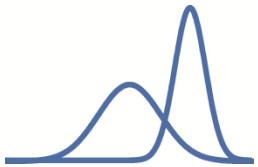
Discrimination Testing

- Discrimination testing as important as ever:
  - Compliance with health initiatives
  - Cost reductions
  - Changes to ingredients, processes, packaging, handling, etc.
  - Quality control
- Three challenges:
  1. Identify sensitive methods for unspecified testing
  2. Measurement:
     a) Quantify sensory differences
     b) Understand precision in measurement
  3. Determine size of meaningful difference



The Tetrad Test - Methodology

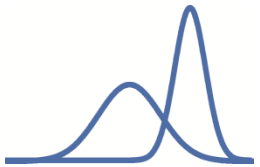
- Four samples presented:

"Group the stimuli into two groups of two samples based on similarity"

- Six possible presentation orders: AABB, ABAB, ABBA BBAA, BABA, BAAB
- Guessing probability = 1/3

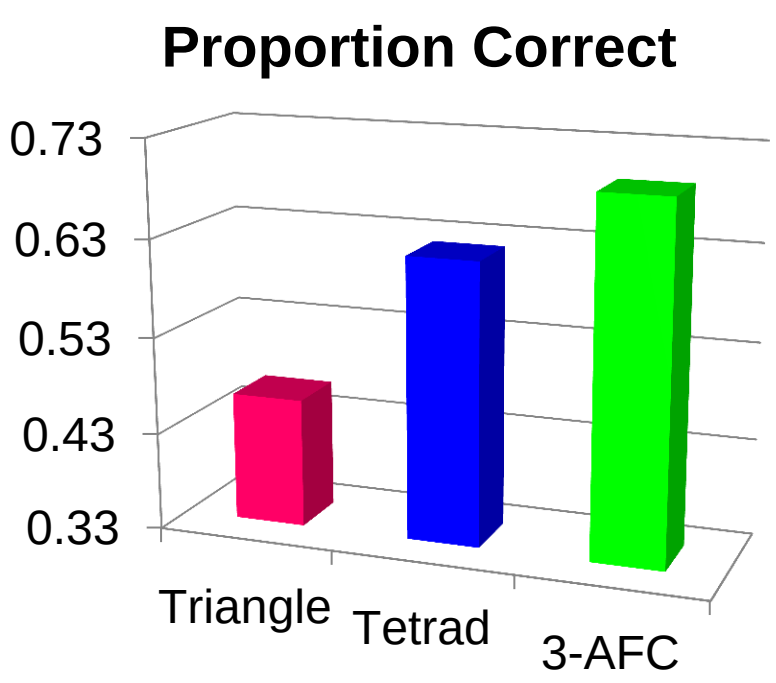
The Tetrad Test - History

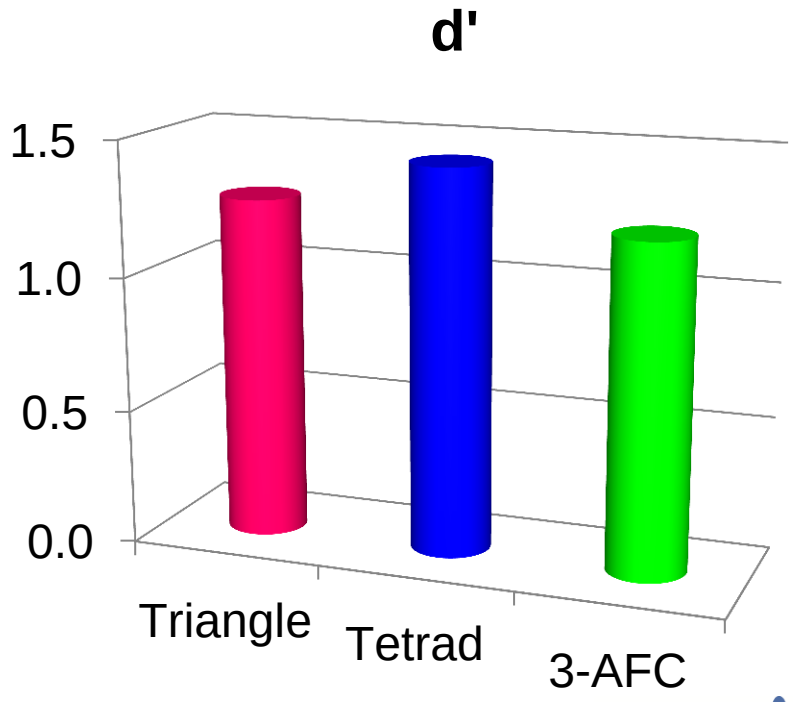
- Mentioned by Lockhart (1951) and Gridgeman (1954)
- Revisited by O'Mahony, Masuoka, & Ishii (1994)
- First experiments:
  - Masuoka, Hatjopolous, & O'Mahony (1995)
  - Delwiche & O'Mahony (1996)
- Psychometric function derived by Ennis et al. (1998)
- Support for Tetrad testing in IFPrograms™ (2009)
- Sample size tables published by Ennis & Jesionka (2011)
- Operational power-based comparison with Triangle test by Ennis (2012)
- Large-scale comparison with Triangle test by Garcia, Ennis, & Prinyawiwatkul (2012)
- Support for Tetrad testing in sensR (2012)



Experimental Results (1/3)

- Masuoka, Hatjopoulos & O'Mahony (1995)
- Beer samples varying in bitterness
- 9 judges with 12 replications: N=108 per condition

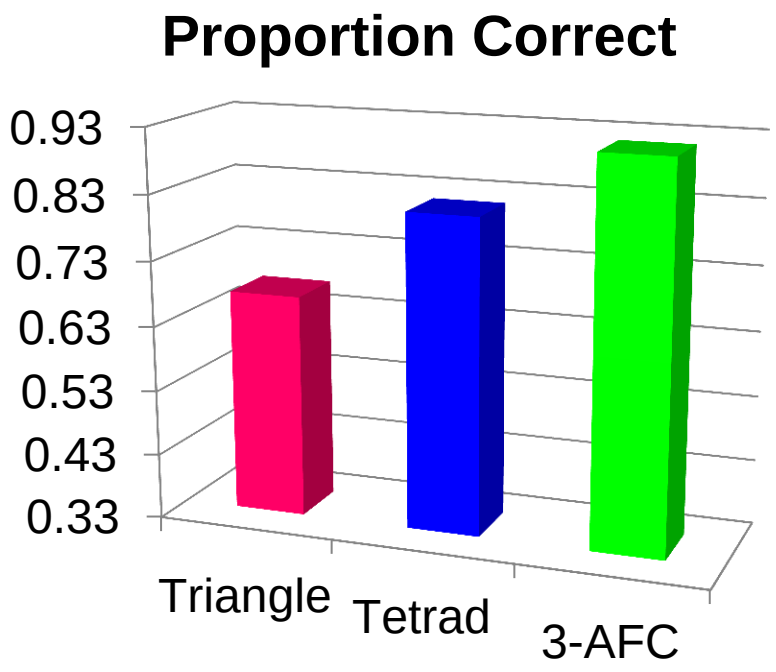


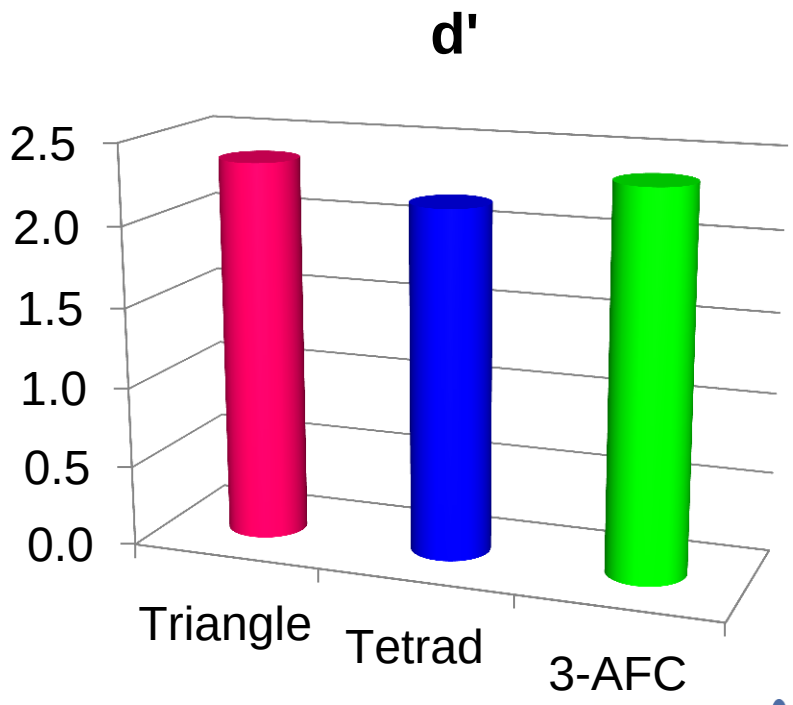


- d' values not significantly different

Experimental Results (2/3)

- Delwiche & O'Mahony (1996)
- Chocolate pudding varying in sweetness
- 13 judges with 12 replications: N = 156 per condition

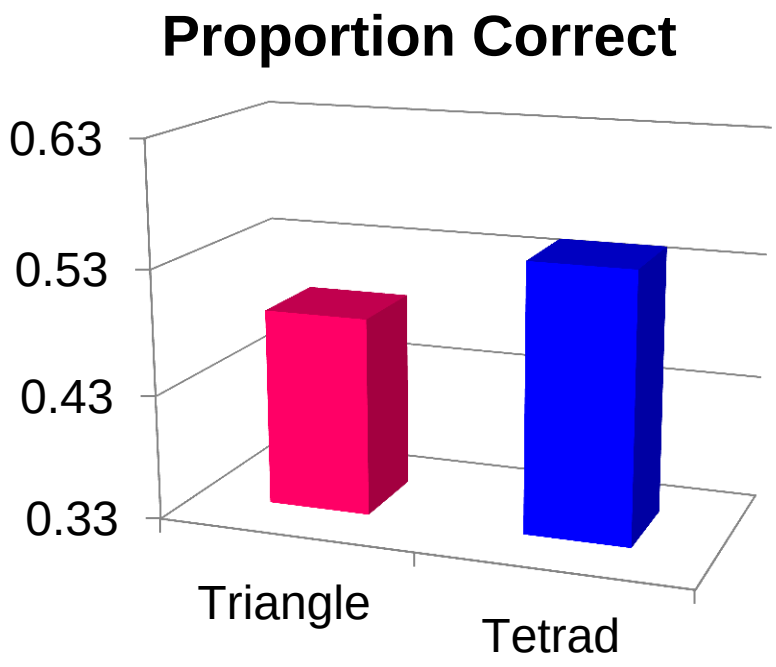


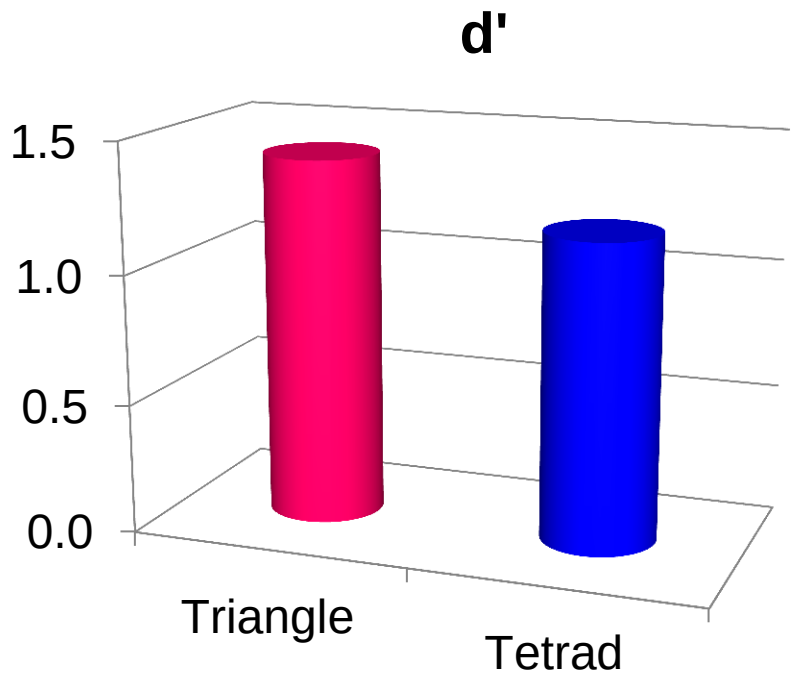


- d' values not significantly different

Experimental Results (3/3)

- Garcia, Prinyawiwatkul, Ennis (2012)
- Apple juices varying in sweetness
- 404 children: 1 Tetrad, 2 Triangle evaluations

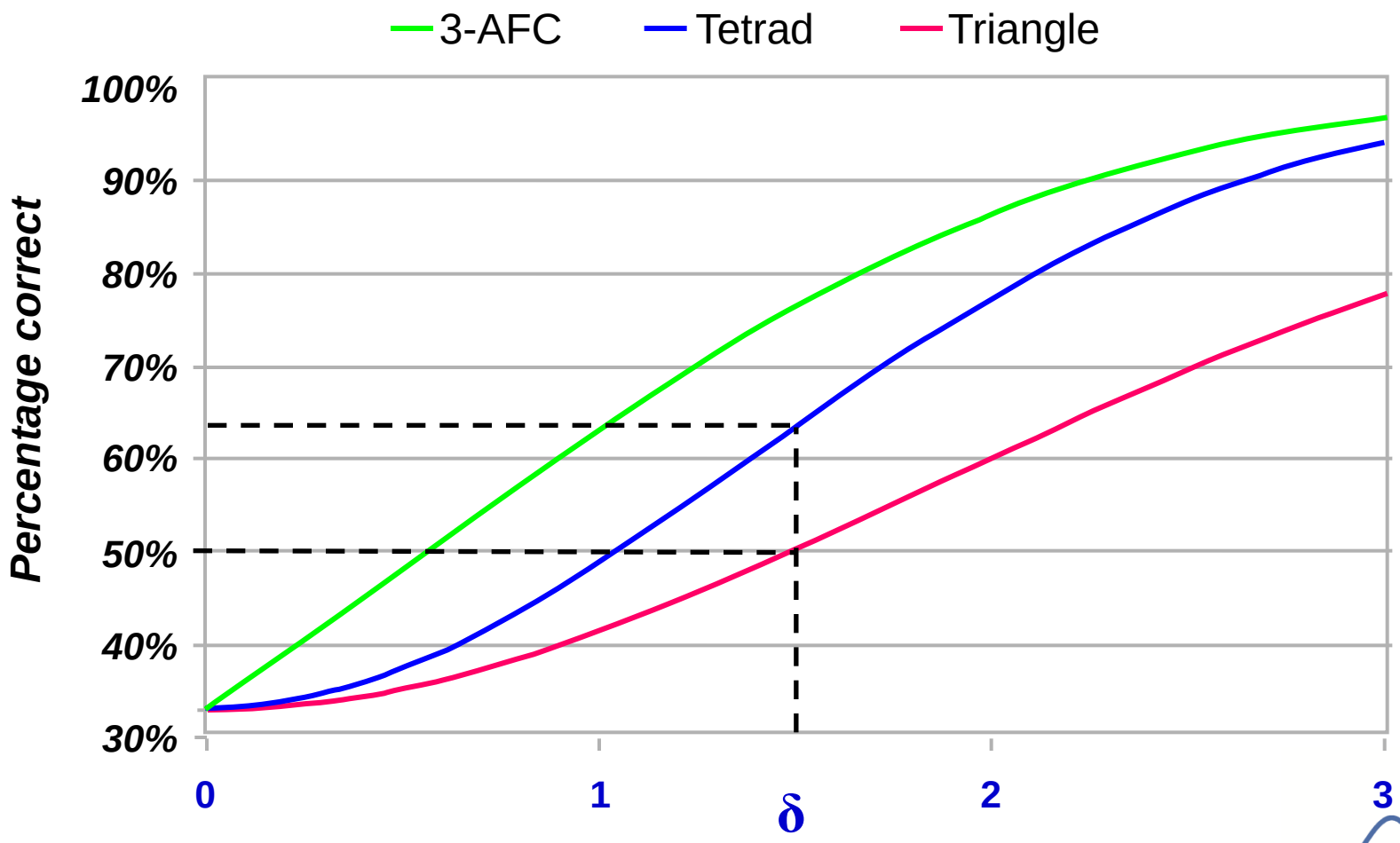




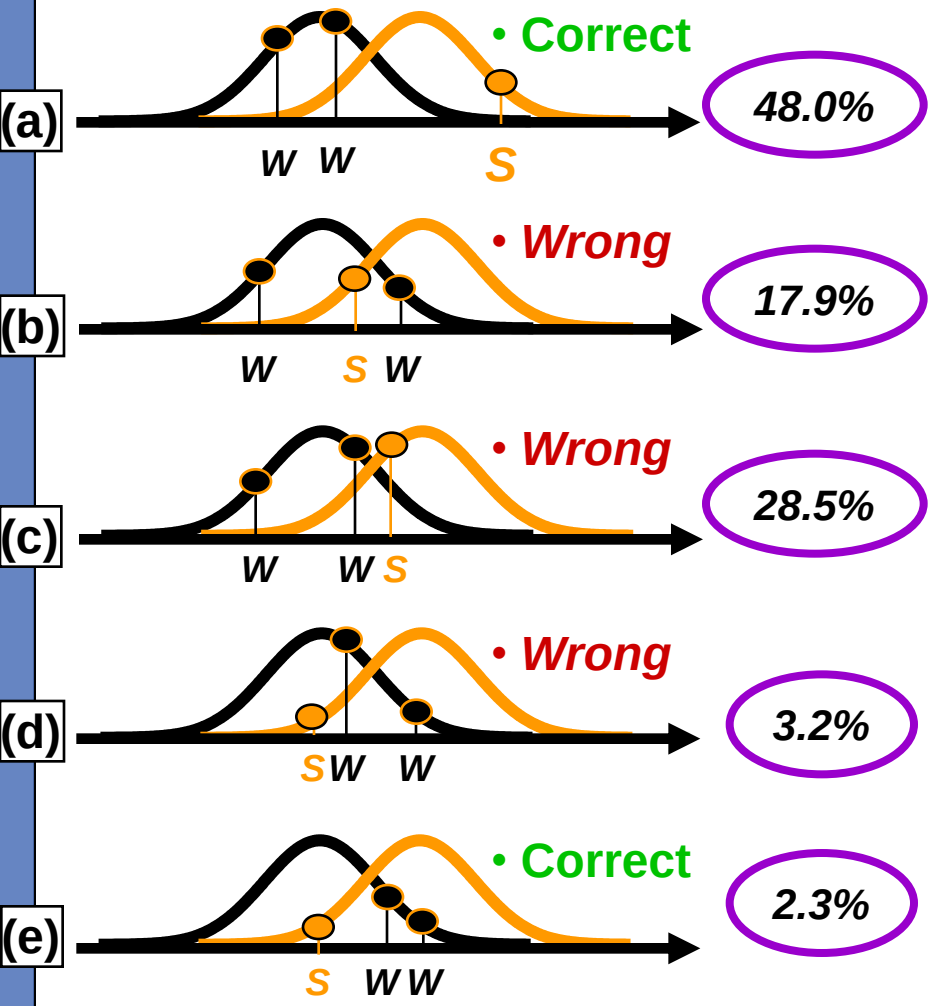
- d' values not significantly different

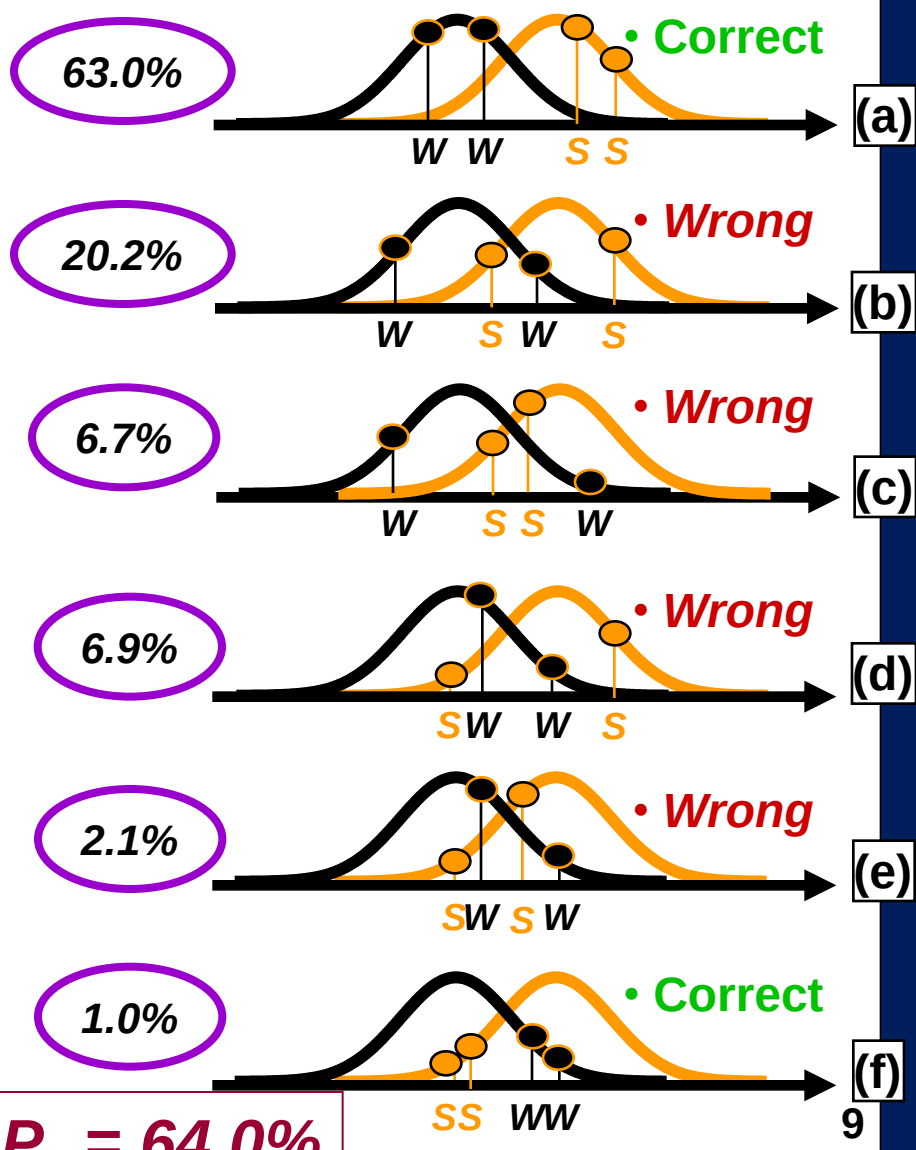
Thurstonian Theory

- Psychometric function (Ennis et al.,1998)



Triangle/Tetrad – Possible Cases (δ = 1.5)



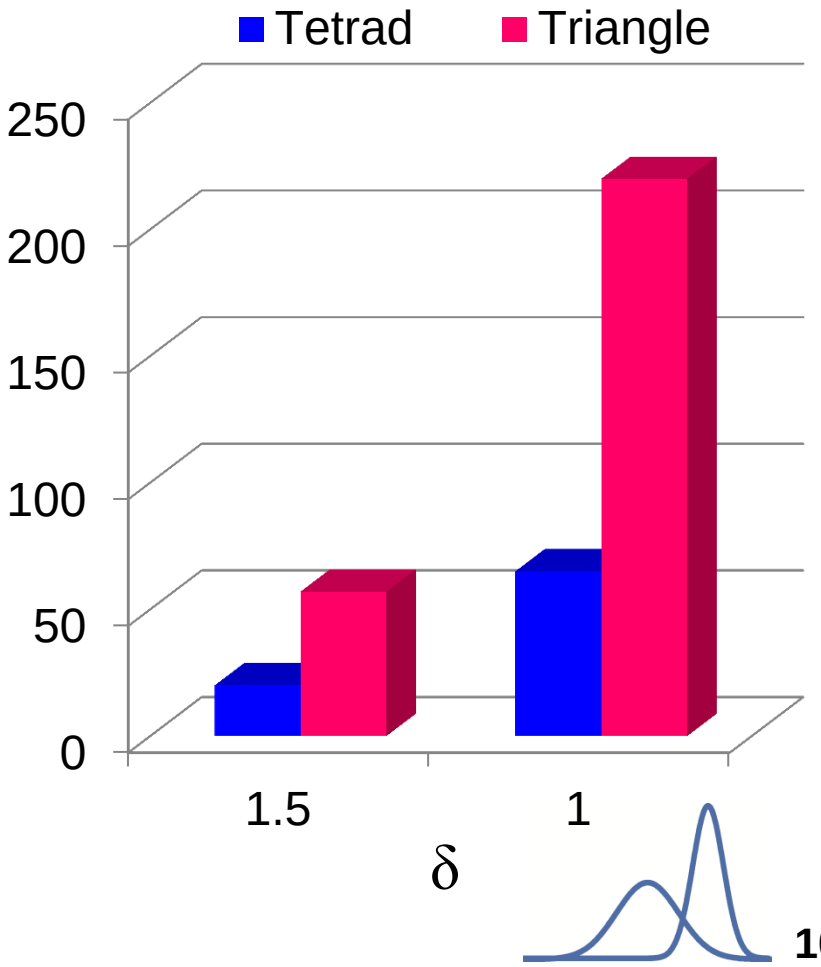


$P_c = 50.3\%$

$P_c = 64.0\%$

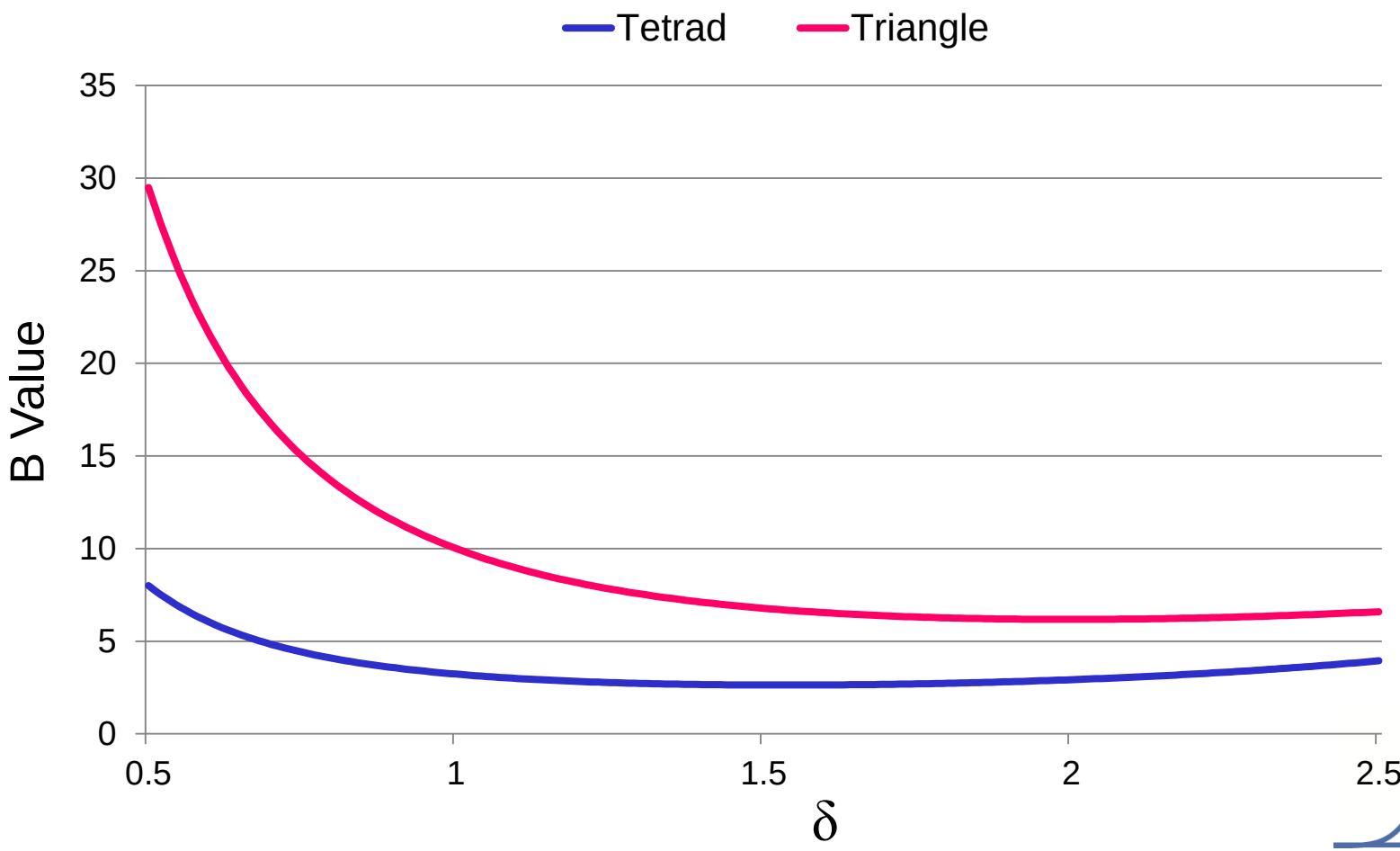
Triangle/Tetrad – Sample Sizes

- Suppose α = 0.05 and want 80% power
- If δ = 1.5
  - Tetrad N = 20
  - Triangle N = 57
- If δ = 1.0
  - Tetrad N = 65
  - Triangle N = 220
- Tetrad sample sizes are roughly 1/3 Triangle sample sizes
- See Ennis & Jesionka (2011) for more information



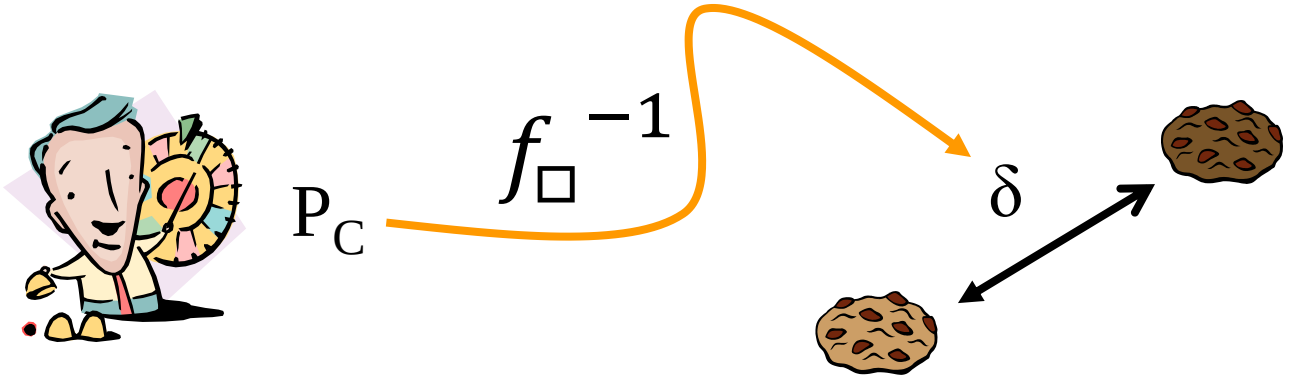
Precision of Measurement (1/4)

- Variance in estimate of δ (Bi, Ennis, & O'Mahony, 1997)
  - Variance is B value divided by sample size



Precision of Measurement (2/4)

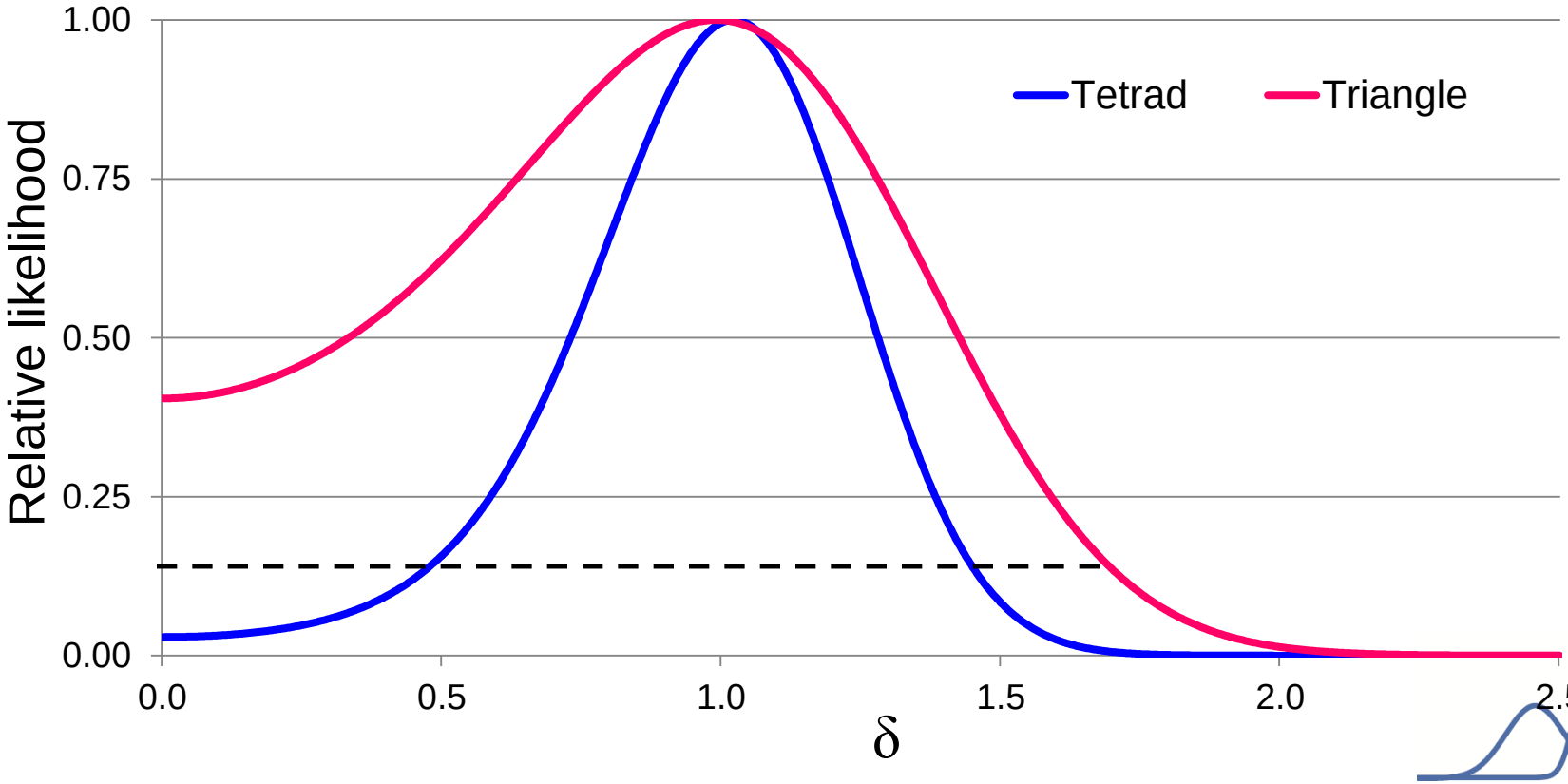
- Tetrad test can be analyzed using GLM framework (Brockhoff and Christensen, 2010):



- Convenient access to statistical analysis

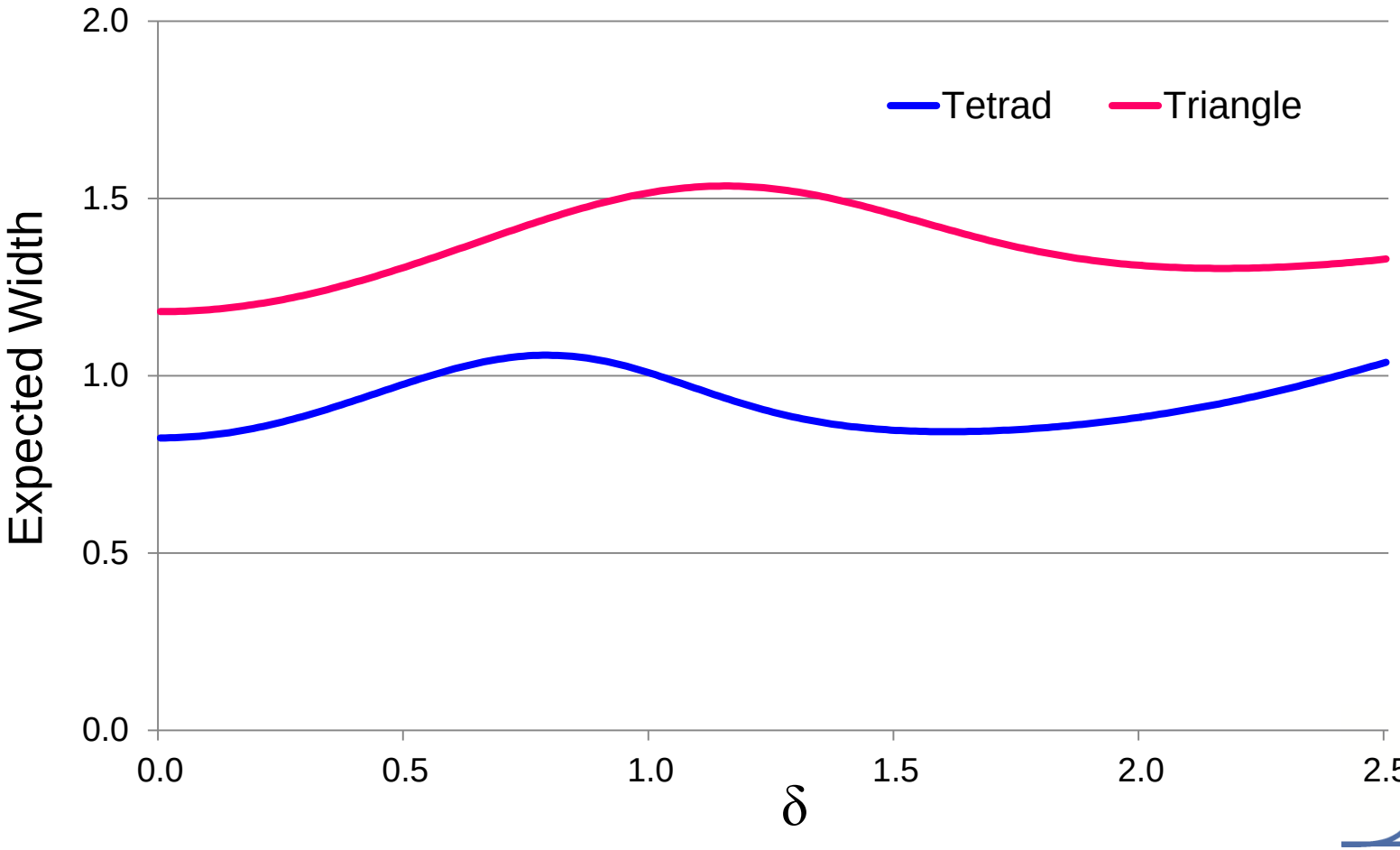
Precision of Measurement (3/4)

- Relative likelihood (Christensen & Brockhoff, 2009)
  - Function shape gives improved estimate of precision
  - Example: N = 60, $\delta \sim 1$



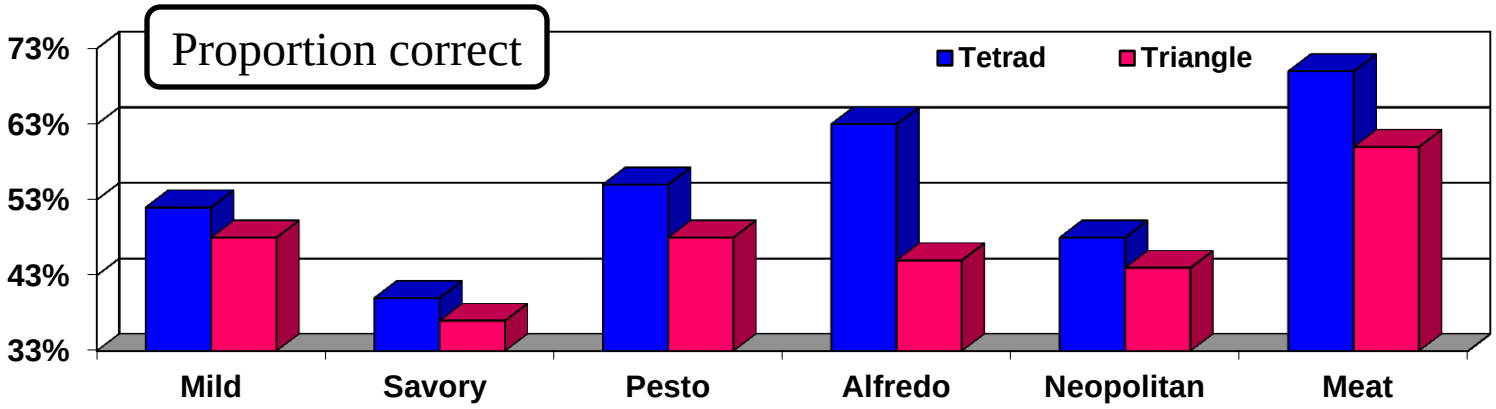
Precision of Measurement (4/4)

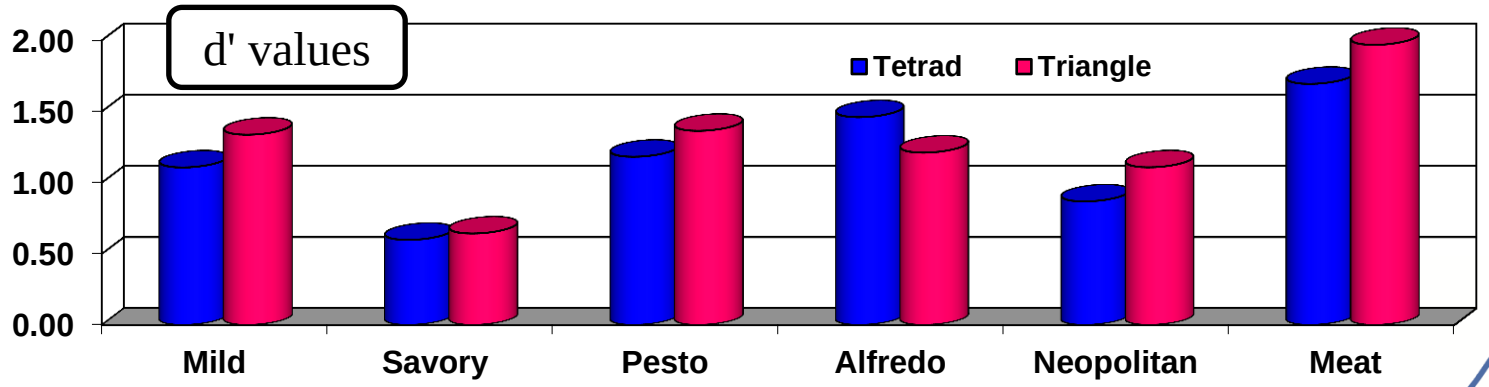
- Expected widths of likelihood confidence intervals
  - N = 60, 95% confidence



Comparative Examples (1/2)

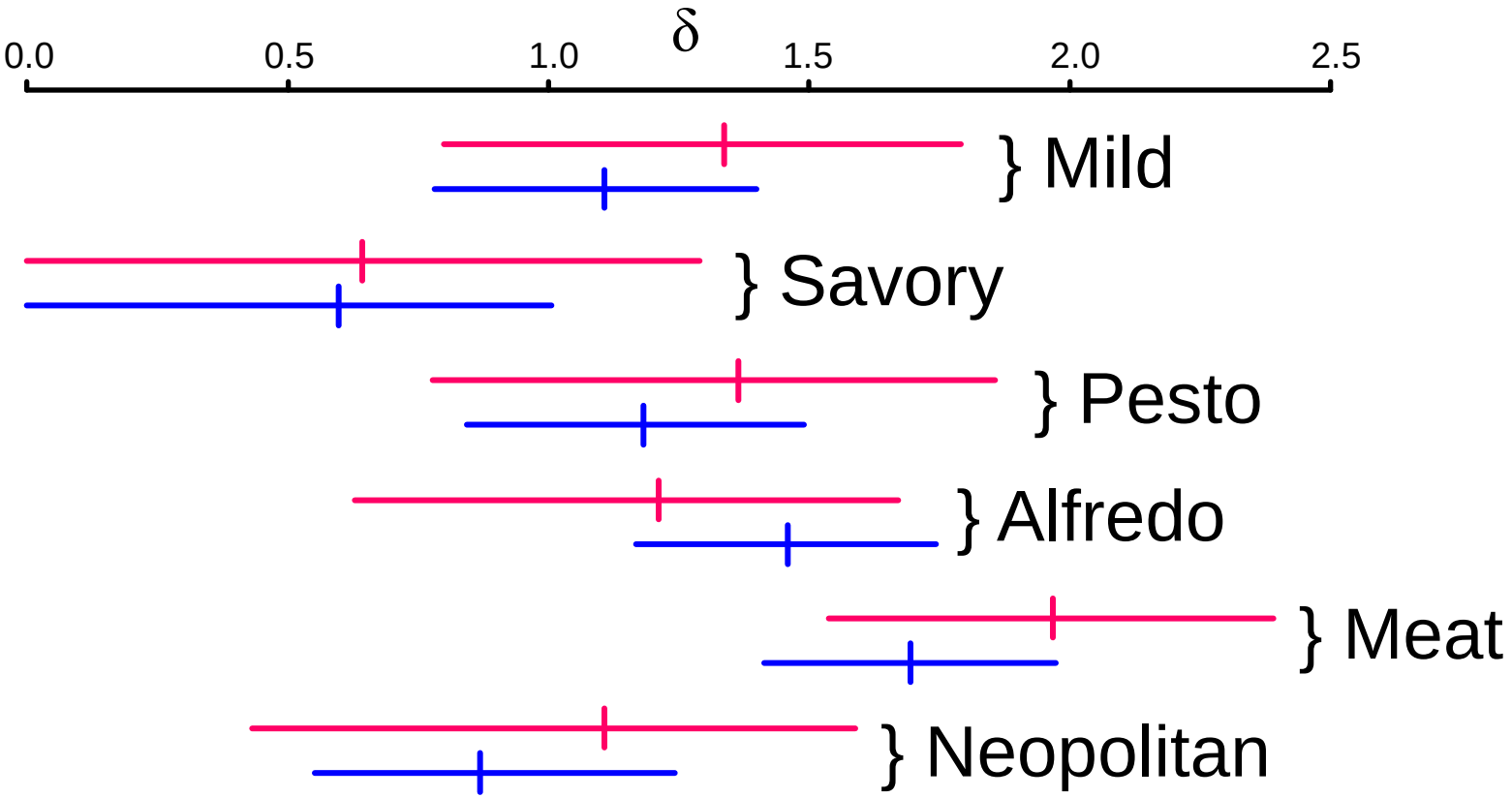
- Six pasta sauces for food service applications
- Research to compare Triangle and Tetrad tests
  - Test sample sizes vary between 96 and 132





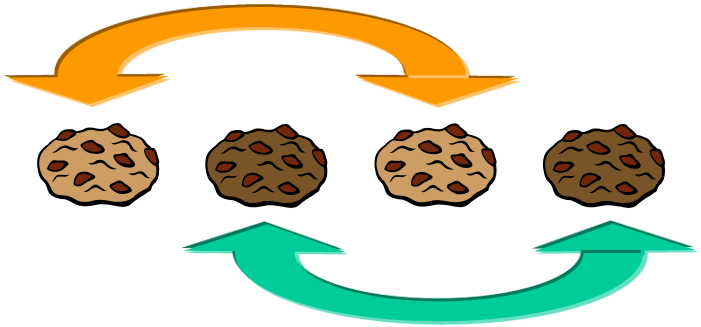
Comparative Examples (2/2)

- Likelihood confidence intervals:



- Tetrad test gives more precise estimate of sensory difference in each case

Final Points



- Future topics:
  - Equivalence
  - Unequal variance
  - Multivariate Tetrad model
  - Comparison to 2-AFCR
  - Decision rule investigation

- Thanks to:
  - Daniel Ennis & Benoit Rousseau, The Institute for Perception
  - Pieter Punter, OP&P Product Research
  - Per Brockhoff, Technical University of Denmark

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