

# The suitability of the tetrad test as a replacement for the triangle test in the brewing industry

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Hopsteiner



WADWORTH & CO

LION

DIAGEO



AB InBev



ADNAMS SOUTHWOLD



GREENE KING BURY ST EDMUNDS



Carib Brewery



BHL Banks Holdings Limited



BARTH-HAAS GROUP



# Difference Testing



- Difference/discrimination testing is used to determine whether a perceivable difference exists between two product samples
  - Assessing the impact of changes to a recipe, protocol or equipment
  - Assessing for differences between breweries
  - Shelf life determination
  - Competitor matching
- Results can be combined with Descriptive Tests

# Difference Testing

- Null hypothesis:  
*'There is no difference between the samples'*
- Significance level is determined prior to the test, usually set at  $\alpha = 0.05$
- Once the test is complete, binomial distribution tables can be used to calculate the p-value
- If  $p \leq 0.05$  it can be concluded that the two samples are different with 95% confidence

# Triangle Test

- Assessors are presented with 3 samples, two of one sample and one of the other
- **1/3 chance** of correctly guessing the 'odd' sample
- Sample sets are presented in a balanced order to minimise physiological error
- Six different arrangements:

AAB; ABA; BAA; BBA; BAB and ABB



# Tetrad Test

- Assessors are presented with 4 samples, two of each sample
- **1/3 chance** of correctly guessing the grouping of the two pairs of samples based on similarity
- Sample sets are presented in a balanced order to minimise physiological error
- Six different arrangements:

AABB; ABBA; ABAB; BBAA; BAAB and BABA



# Triangle vs. Tetrad

- Studies have demonstrated in theory and in practice that the Tetrad Test has advantages over the Triangle Test
- The Tetrad has been found to be more powerful statistically in comparison to the Triangle Test
- Power is determined by:
  1. The effect size
  2. The value of  $\alpha$  (0.05)
  3. The number of panellists

→ ***More sensitive***

→ ***More precise***

# Advantages and Disadvantages

- According to the Triangle test method referenced in ISO 4120, a minimum of 24 tasters is required
- Studies on other products demonstrated that Tetrad requires only a third of the number of panellists as a Triangle Test
  - *cheaper* ✓
  - *more achievable* ✓
- However, the addition of a fourth stimulus could lead to panellist fatigue, particularly with complex samples

# Aim

- Previous studies investigating Tetrad suitability for beer have generally only focused on one beer and one attribute each
- This study assessed a variety of beers
- The beers were altered with either aroma or basic taste compounds to create varying levels of difference



# Method

- Used tasters from a pool of 37 panellists– fully trained and competent on Triangle Test method (UKAS Accredited to ISO 17025)

- 12 sample pairs were selected and carried out as a Triangle and a Tetrad Test and were performed twice

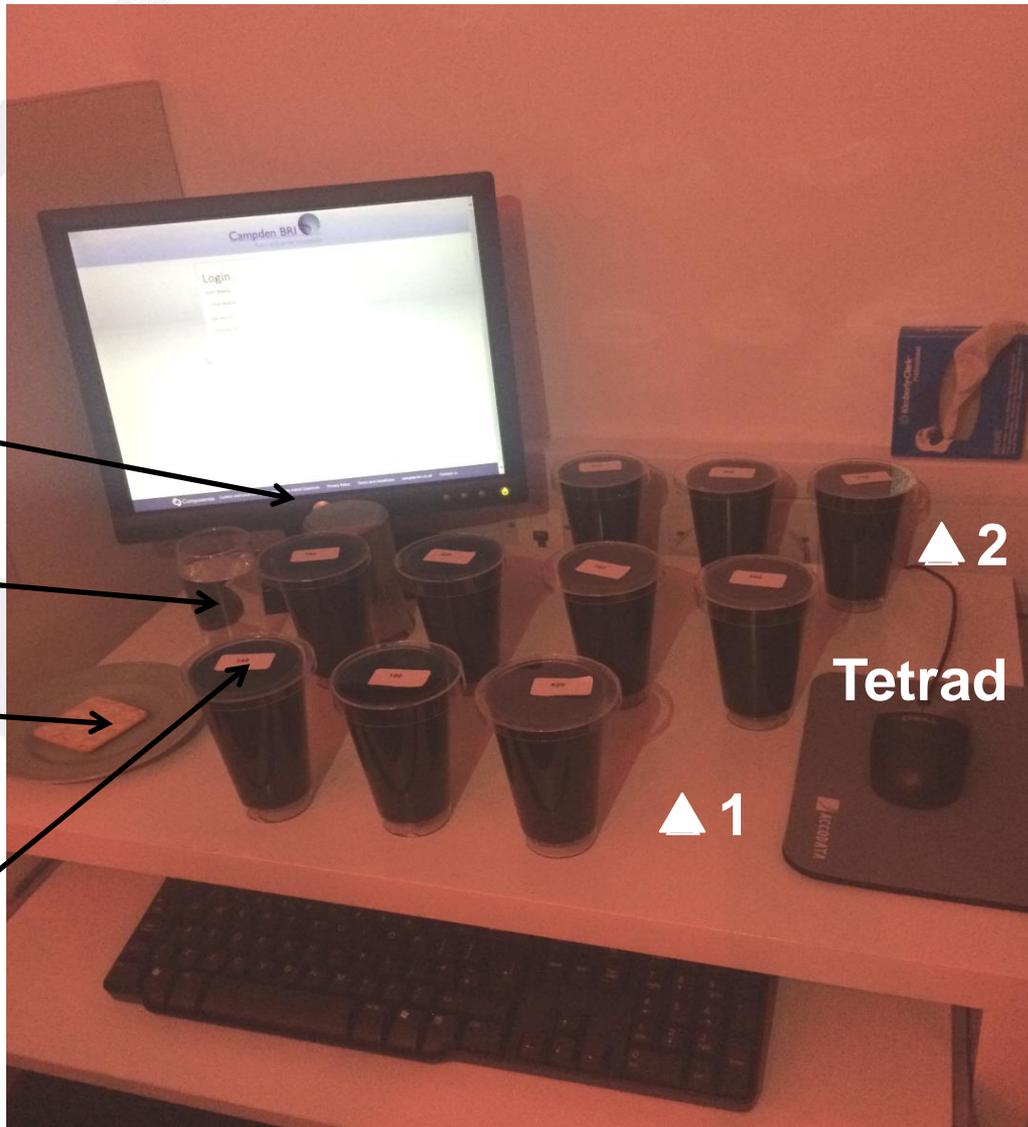
Triangle – 24 tasters

Tetrad – 12 tasters

For every test, each taster completed: **Triangle Rep 1**

**Tetrad**

**Triangle Rep 2**



Spittoon

Water

Palate  
cleanser

Blinding  
codes

Data collected on  
*Compusense®  
Cloud*

Red light and  
dark glasses to  
prevent visual  
cues

Tasting booths -  
prevent interaction  
between panellists

# Method

## Instruction

- Panellists were told to smell and taste each sample, working from left to right
- Re-tasting was allowed in both tests
- Panellists were not given feedback on their choice to minimise learning/bias
- Use of a spittoon was compulsory

# Test Samples

Test no.	Test samples
1	Lager A vs. Lager A + 0.1% aroma hop oil
2	Lager B vs. Lager B + 0.1% aroma hop oil
3	Lager A + 0.05% aroma hop oil vs. Lager A + 0.1% aroma hop oil
4	Lager A + 0.04% aroma hop oil vs. Lager A + 0.08% aroma hop oil
5	Lager A vs. Standard Lager A + 0.04 % aroma hop oil
6	Lager A vs. Lager A + 0.035% aroma hop oil
7	English Ale C vs. English Ale C + 1.3% sugar
8	English Ale C vs. English Ale C + 0.66% sugar
9	English Ale C vs. English Ale C + 1.0% sugar
10	English Ale C vs. English Ale C + 0.03% citric acid
11	English Ale C vs. English Ale C + 1.3% lemon juice
12	Lager B vs. Lager B + 1.5% alcohol

Test no.	BEER	
	Triangle Significant at $\alpha=0.05$ ?	Tetrad Significant at $\alpha=0.05$ ?
1	YES YES	YES YES
2	YES YES	YES YES
3	YES YES	YES YES
4	YES NO	NO NO
5	YES NO	YES YES
6	NO NO	YES NO
7	YES YES	YES YES
8	YES NO	NO NO
9	YES YES	YES YES
10	YES NO	NO NO
11	NO YES	YES YES
12	YES NO	NO YES

# Triangle vs. Tetrad Results Comparison

Out of a total of 24 tests

→ 16 significant Triangle Tests

→ 16 significant Tetrad Tests

# Aroma Differences



Test no.	Repeat	Triangle Test				Tetrad Test				
		Number of correct responses out of 24	Significant at $\alpha=0.05$ ?	p. Value	d'	Number of correct responses out of 12	Significant at $\alpha=0.05$ ?	p. Value	d'	
1	Rep 1	14	Yes	0.010	1.89	10	Yes	0.001	2.25	
	Rep 2	14	Yes	0.010	1.89	9	Yes	0.004	1.89	
2	Rep 1	17	Yes	0.000	2.55	9	Yes	0.004	1.89	
	Rep 2	17	Yes	0.000	2.55	9	Yes	0.004	1.89	
3	Rep 1	14	Yes	0.010	1.89	9	Yes	0.004	1.89	
	Rep 2	16	Yes	0.001	2.32	10	Yes	0.001	2.25	
4	Rep 1	13	Yes	0.028	1.68	5	No	0.368	0.37	
	Rep 2	11	No	0.140	1.24	7	No	0.066	1.31	
5	Rep 1	13	Yes	0.028	1.68	8	Yes	0.019	1.59	
	Rep 2	8	No	0.576	N/A	9	Yes	0.004	1.89	
6	Rep 1	12	No	0.068	1.47	11	Yes	0.000	2.76	
	Rep 2	8	No	0.576	N/A	5	No	0.368	0.37	
			8/12				9/12			

# Basic Taste Differences



Test no.	Repeat	Triangle Test				Tetrad Test				
		Number of correct responses out of 24	Significant at $\alpha=0.05$ ?	p. Value	d'	Number of correct responses out of 12	Significant at $\alpha=0.05$ ?	p. Value	d'	
7	Rep 1	21	Yes	0.00	3.76	10	Yes	0.001	2.25	
	Rep 2	17	Yes	0.00	2.55	10	Yes	0.001	2.25	
8	Rep 1	17	Yes	0.00	2.55	7	No	0.066	1.31	
	Rep 2	12	No	0.07	1.47	5	No	0.368	0.37	
9	Rep 1	17	Yes	0.00	2.55	10	Yes	0.001	2.25	
	Rep 2	13	Yes	0.03	1.68	9	Yes	0.004	1.89	
10	Rep 1	14	Yes	0.01	1.89	6	No	0.178	1.02	
	Rep 2	11	No	0.14	1.24	7	No	0.066	1.31	
			<b>6/8</b>				<b>4/8</b>			

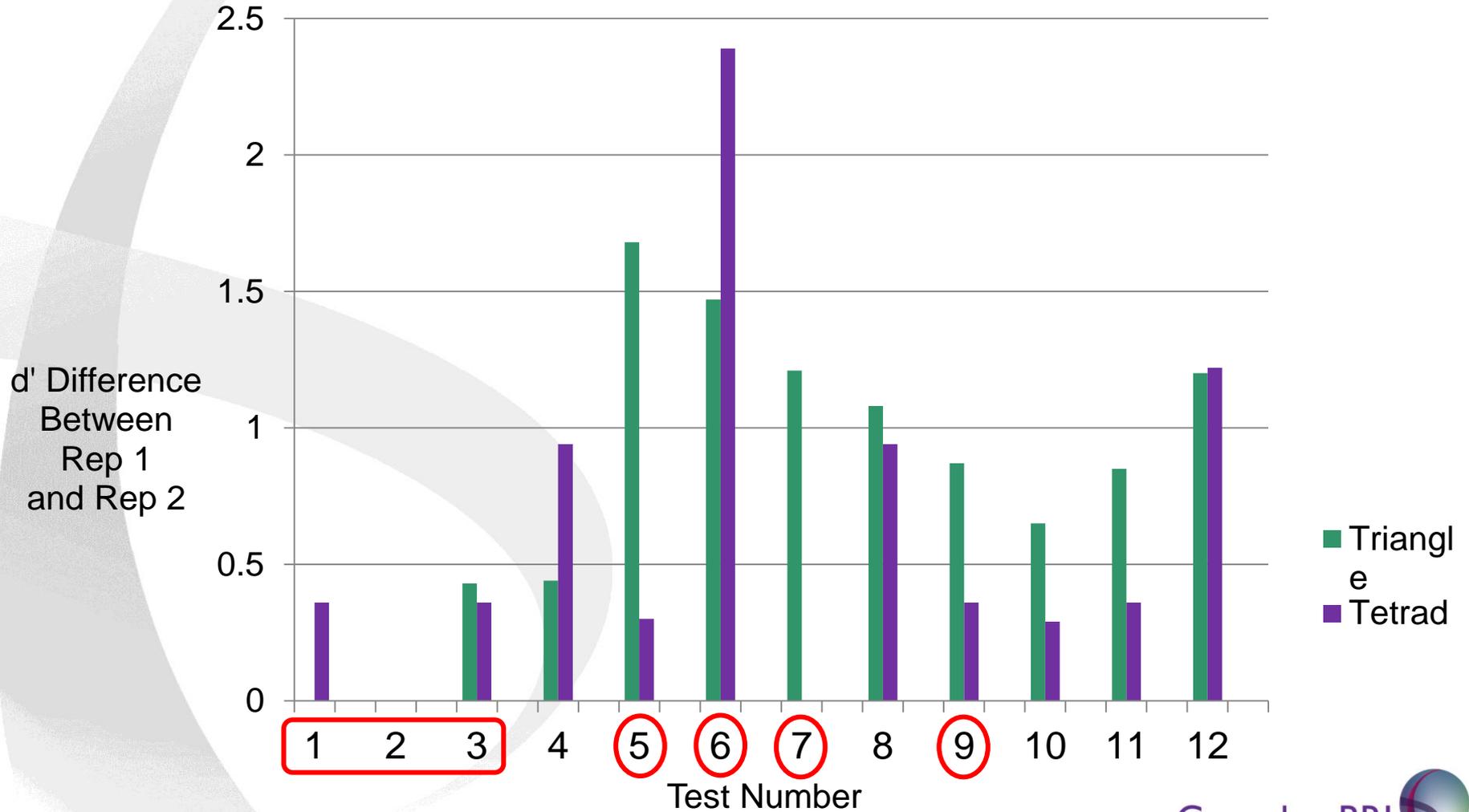
# Aroma + Taste Differences



Test no.	Repeat	Triangle Test				Tetrad Test				
		Number of correct responses out of 24	Significant at $\alpha=0.05$ ?	p. Value	d'	Number of correct responses out of 12	Significant at $\alpha=0.05$ ?	p. Value	d'	
11	Rep 1	12	No	0.07	1.47	10	Yes	0.001	2.25	
	Rep 2	16	Yes	0.00	2.32	9	Yes	0.004	1.89	
12	Rep 1	14	Yes	0.01	1.89	5	No	0.367	0.37	
	Rep 2	9	No	0.41	0.69	8	Yes	0.019	1.59	
			<b>2/4</b>					<b>3/4</b>		

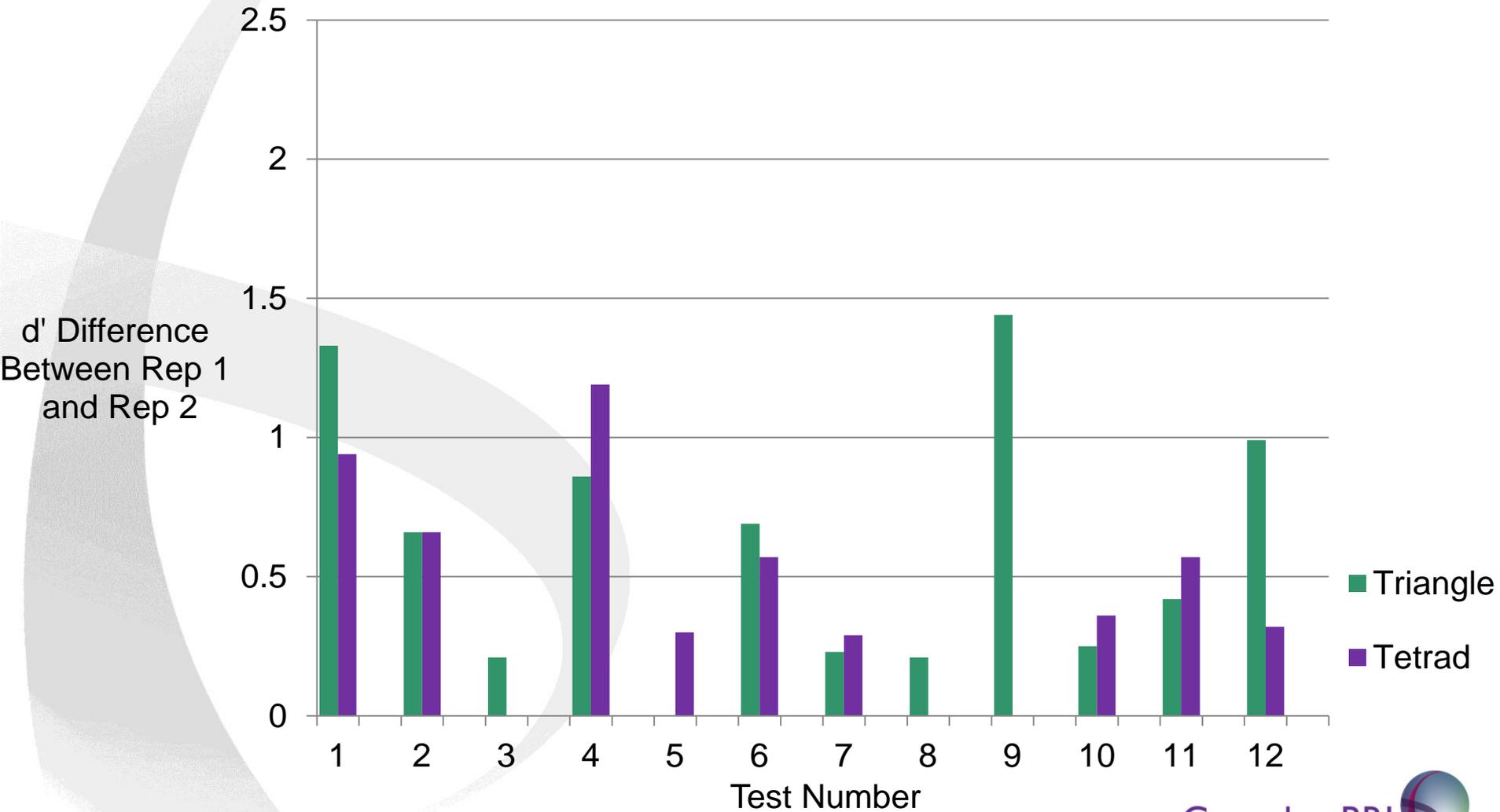
# d' Difference Between Reps: Beer

## Comparison of Triangle Test with Tetrad Test



# d' Difference Between Reps: **Spirits**

## Comparison of Triangle Test with Tetrad Test



# Conclusions

- Some indication that Tetrads are more powerful for samples with minimal differences
- Tetrads appear to be superior for identifying aroma and aroma+taste differences
- Preliminary data suggests that Triangles might be more suitable for discerning basic taste differences
- Tetrads appear to be more consistent
- ***Dependent on products***



# Tetrad Practicalities

- Once trained on Triangle Tests no additional panel training is required
- Same method for interpretation of results
- Overall Tetrad Tests have a quicker set up time and shorter completion time
- If not possible to achieve 24 tasters, Tetrad could be a better alternative

# Acknowledgements

- Thibault Delafontaine, previous Head of Sensory
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- Campden BRI Member Companies
- Panellists

# Any questions?

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