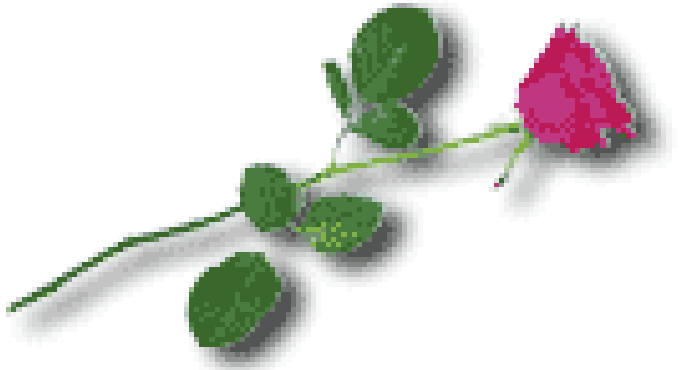# Sensory informed design: An effective clustering of incomplete block consumer data

Chris Findlay, Compusense Inc.
Ryan Brown, Department of Mathematics and Statistics, University of Guelph
Paul McNicholas, Department of Mathematics and Statistics, University of Guelph
John Castura, Compusense Inc.

COMPUSENSE®

UNIVERSITY of GUELPH

# Consumer Category Tests

- Consumer segmentation is important to understand liking

- Consumer-driven product development works

- Large consumer tests are expensive

- Large consumer tests take time and resources

# Considerations for Large Studies

- The Risks
  - Fatigue
  - Carry-over effect
  - Boredom.
  - Consumers behaving like experts
  - Resources
- The Remedies
  - Testing at a single event
  - Incomplete Block Designs
- The Challenges
  - Missing data
  - Validation

The Effect of Order and Day on Consumer Liking
12 White Wines, 115 Consumers, CBD 12:12 over 3 Days
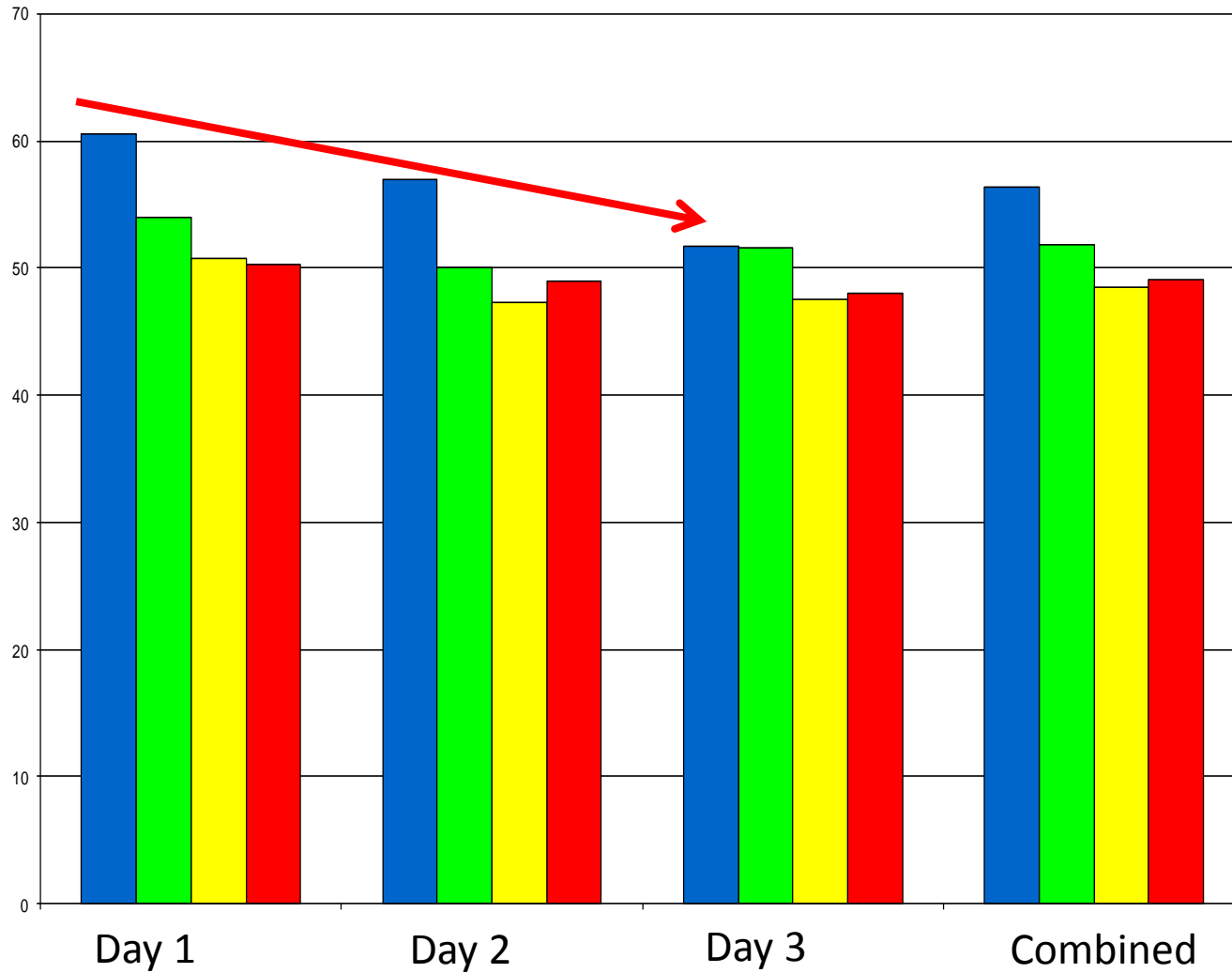
Positions
**1st**
**2nd**
**3rd**
**4th**

# Sensory Informed Design Method Development

Statistical Challenge

- A valid approach to segmentation of consumer BIB data

- Using a combination of sensory best practice, experimental design and advanced statistical analysis

We will explore this approach using three different studies:

➢ Cabernet Sauvignon Study

➢ White Bread Study

➢ Whole Grain Bread study

# Cabernet Sauvignon Study

- A study of 12 Cabernet Sauvignon wines was conducted using over 600 recruited consumers and tested for liking

- Consumers sampled 3 of the 12 wines in a BIB design

- Data was analyzed for liking clusters with missing data replaced with consumer's individual mean

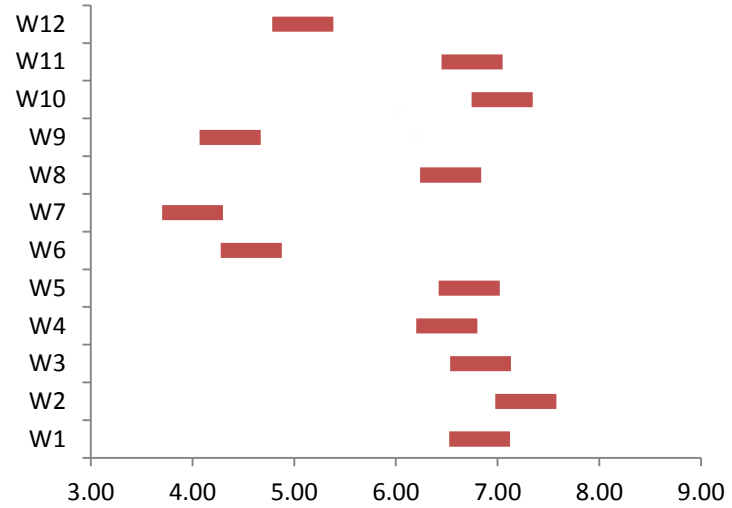- Four liking clusters successfully demonstrated different sensory liking profiles
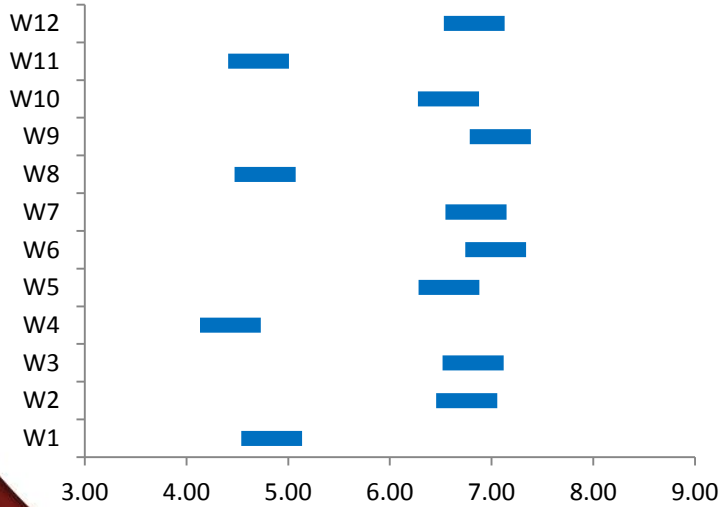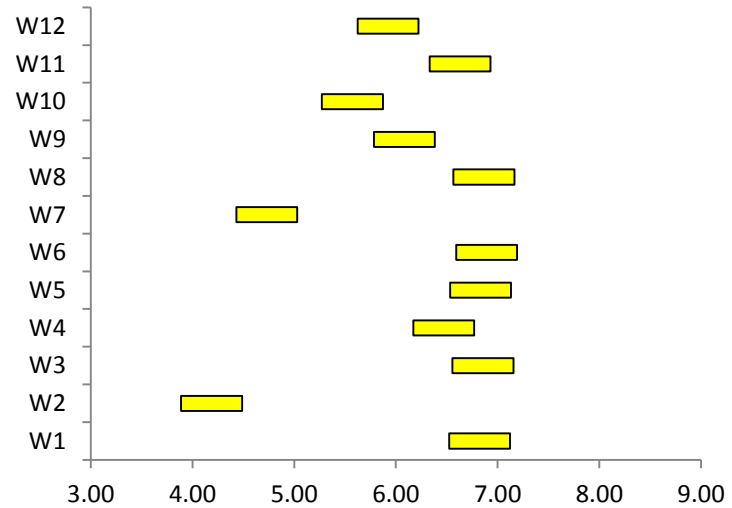
# Cabernet Sauvignon Mean Liking
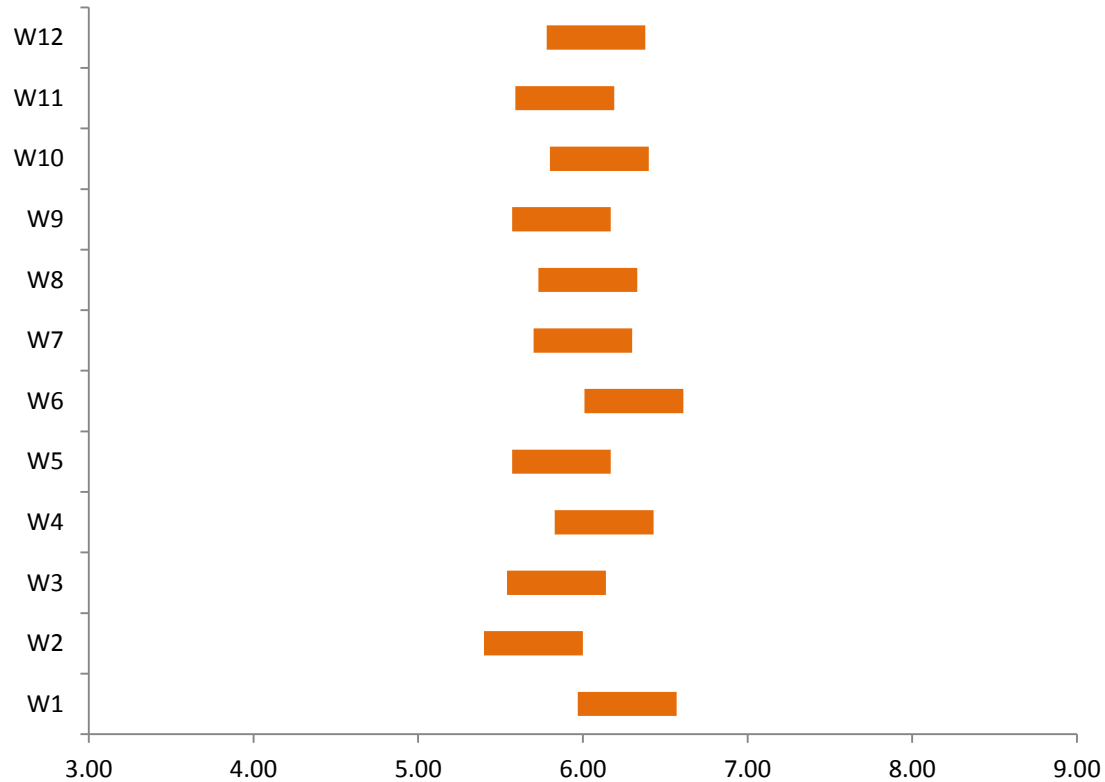
Cluster 1 – 28%
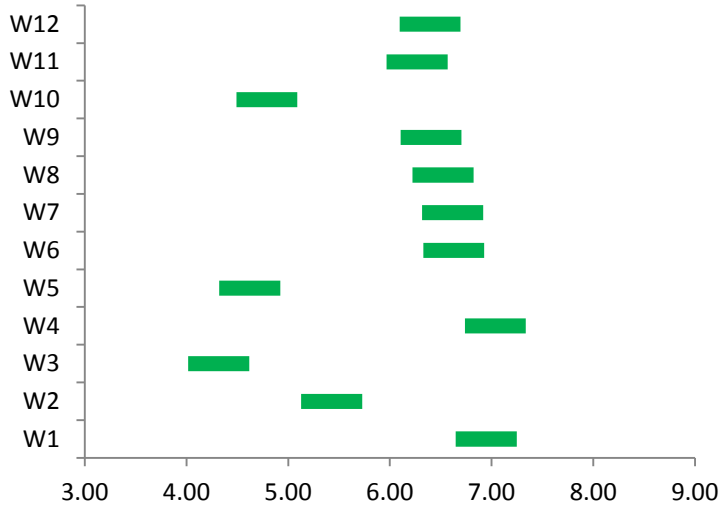
Cluster 2 – 23%

Cluster 3 –32%

Cluster 4 – 17%

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# Cabernet Sauvignon Study: Results

- Findings demonstrated that  although the method was not robust, the approach gave useful and actionable results

- A research program was initiated to develop a systematic approach to building designs using sensory information to ensure contrast

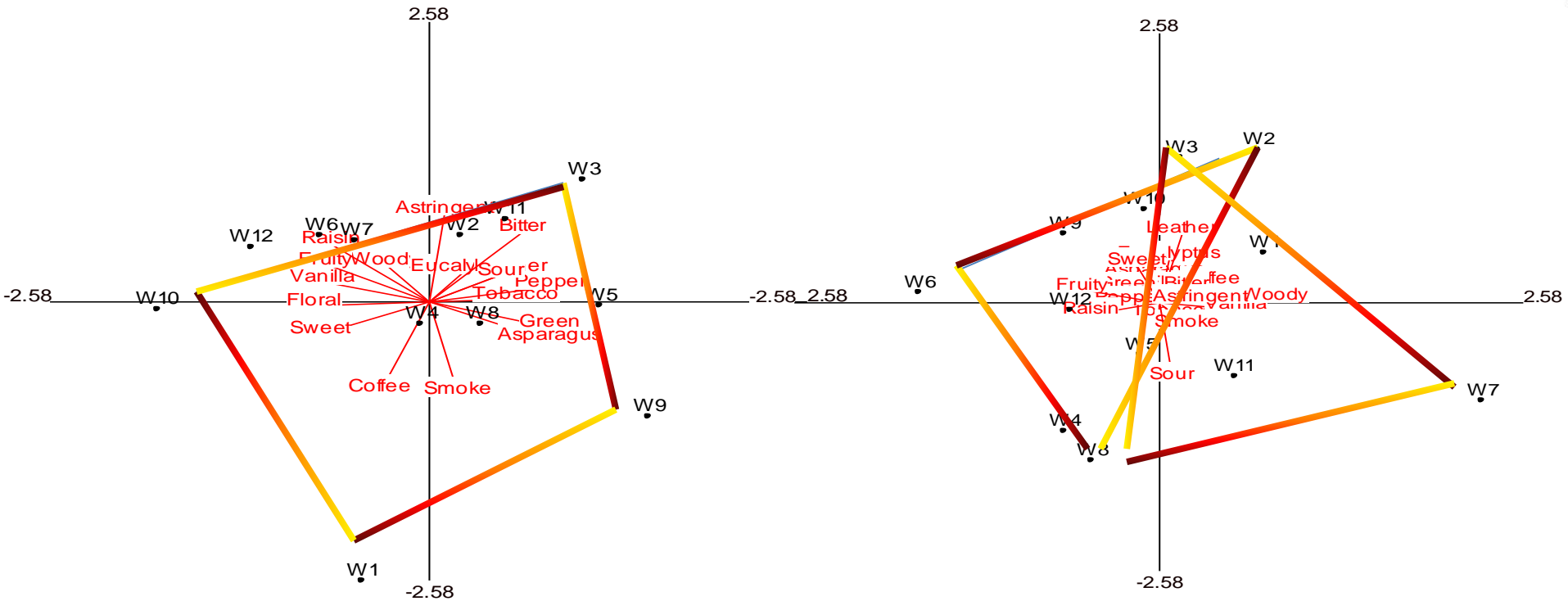# Sensory Design

Is there a Preference?

- To state a true preference a consumer must be able to see a real difference
- Otherwise it's just a guess

- Consequently we must present the consumer with truly different samples

- Let's consider a sensory space
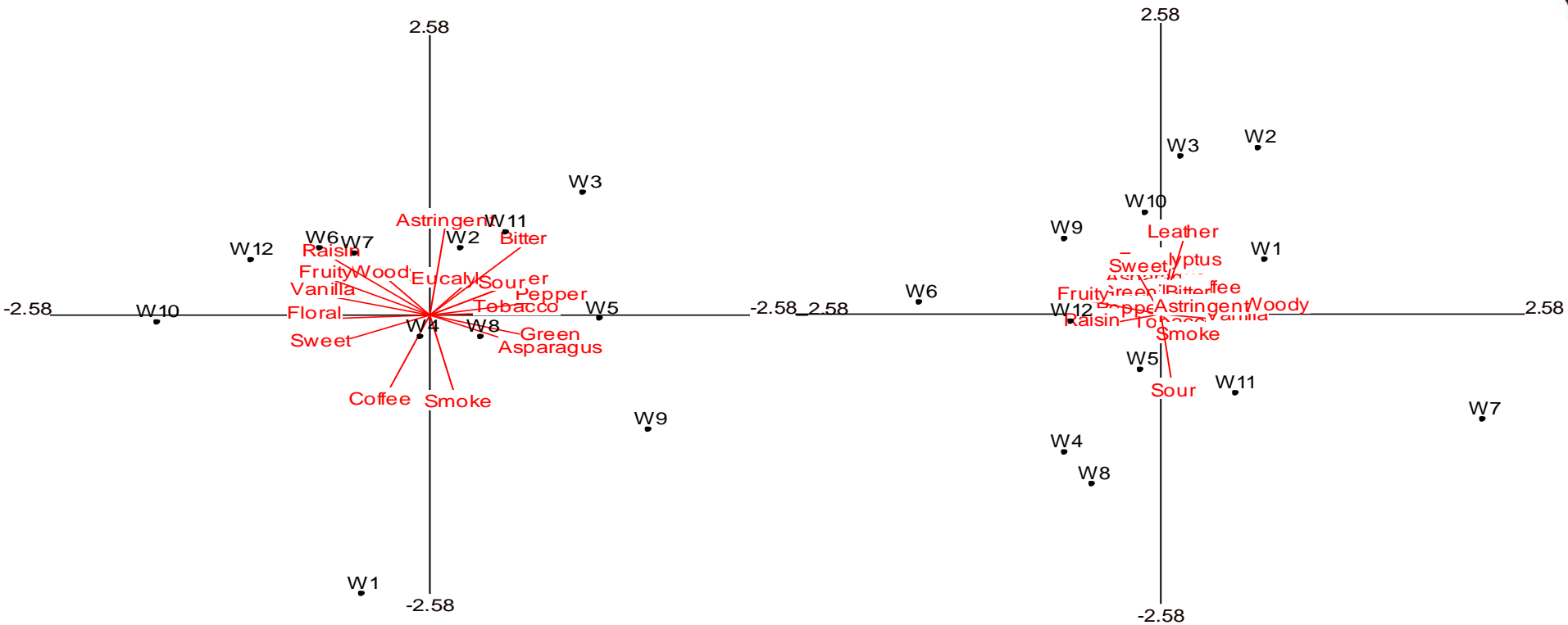


- Can we find logical contrasts to test

# • Quadrangles and Triangles
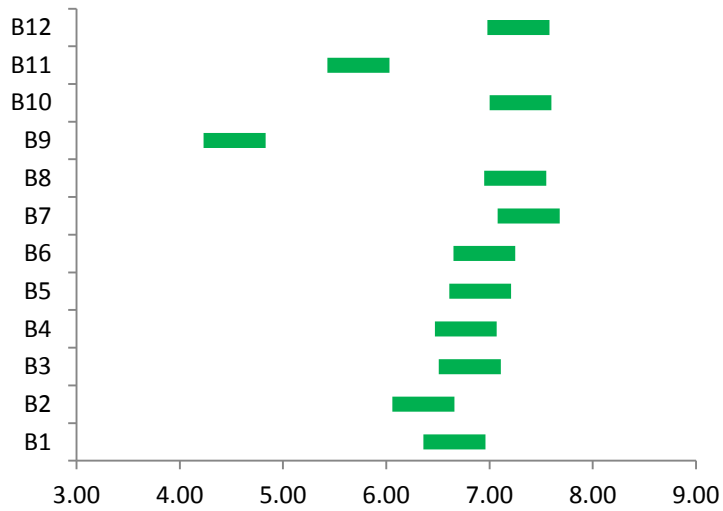
# White Bread Study

- All breads were profiled using calibrated descriptive analysis and using a trained panel

- The Sensory Informed Design (SID) was used to construct a balanced incomplete block design (12:6)

- Two smaller SIDs (12:3 and 12:4) were nested within the experiment to evaluate efficiency and stability.

- 400 category consumers
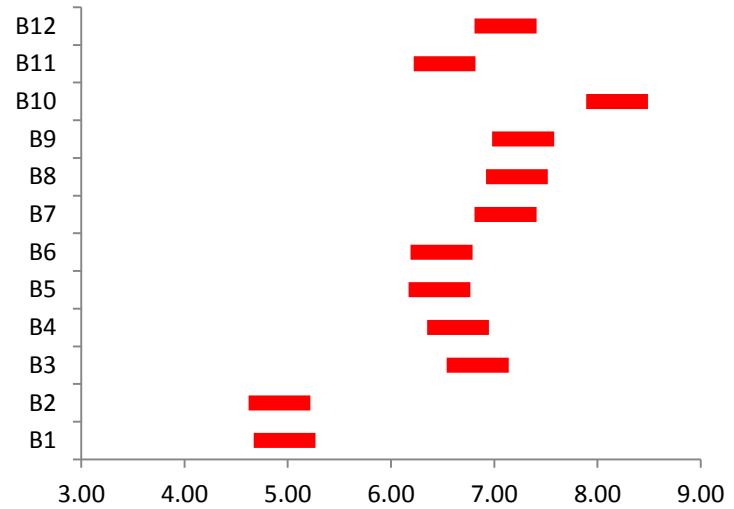
- 200 observations per product
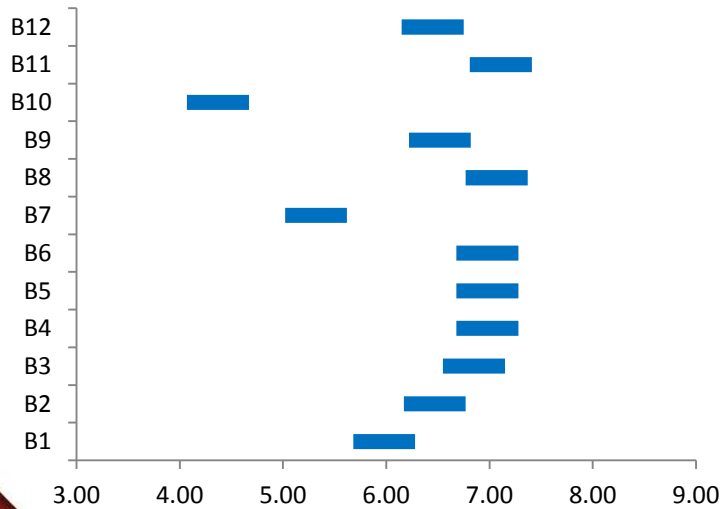
# White Bread Mean Liking
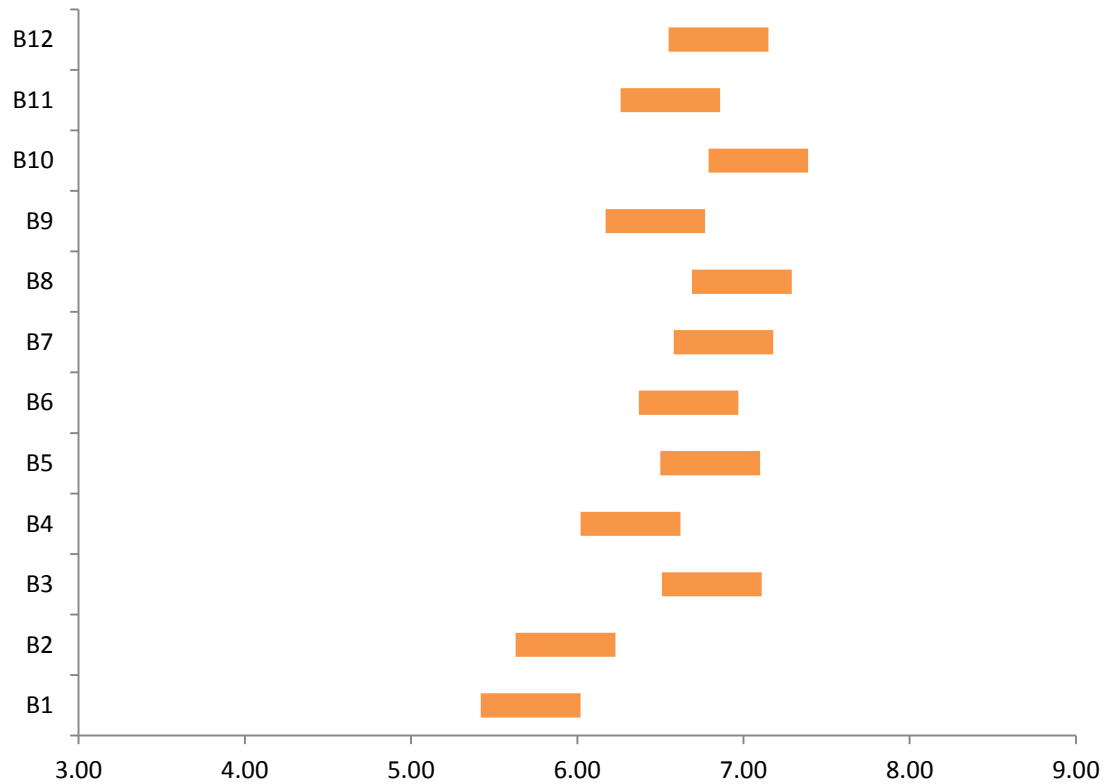
Cluster 1 – 22%

Cluster 2 – 36%

Cluster 3 –20%

Cluster 4 – 22%
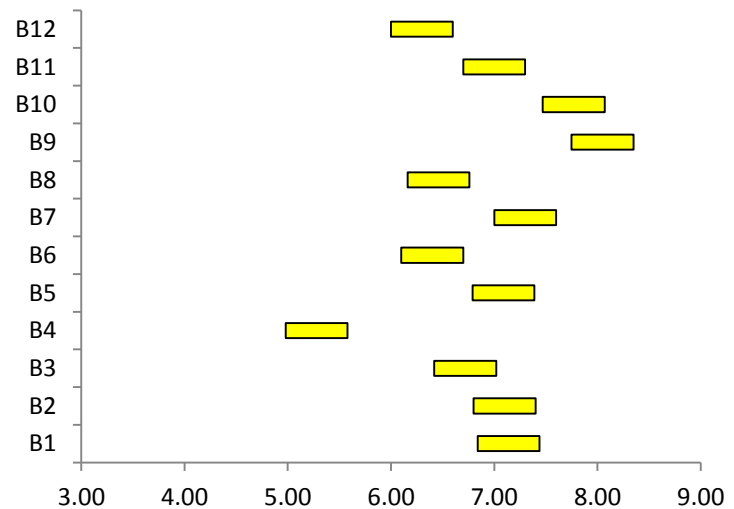
# White Bread Study: Results

- Consumer data (n=400) was collected and missing data was imputed as part of a novel EM approach for mixture model-based clustering

- The scatter plots below demonstrate the stability of the clusters across all three partial present blocks

White Bread Consumer Cluster Analysis (n=400)
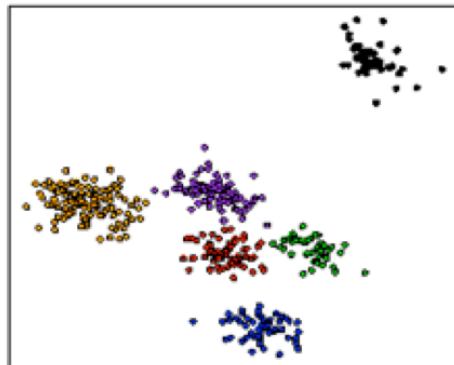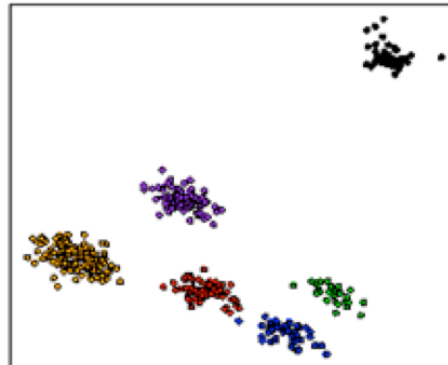


SID of 12 present 6          SID of 12 present 4          SID of 12 present 3
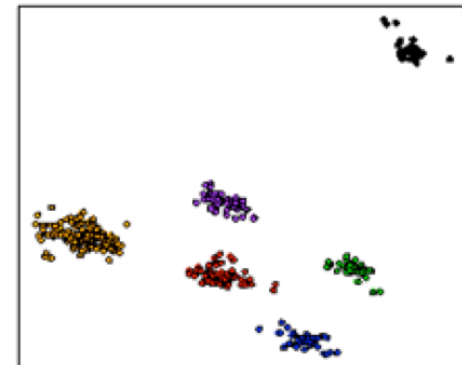
# Whole Grain Bread Study

In a 2012 study of whole grain breads,

570 consumers

16 samples

using an improved SID of 16:6,

with nested designs of

16:3 and 16:4

**GPA of 16 Whole Grain Breads
55 Sensory Attributes**

0.50

-1.10

1.10

-0.50

Variance Accounted for:
DIM1 – 66%
DIM2 –  9%
DIM3 –  7%
DIM4 –  4%

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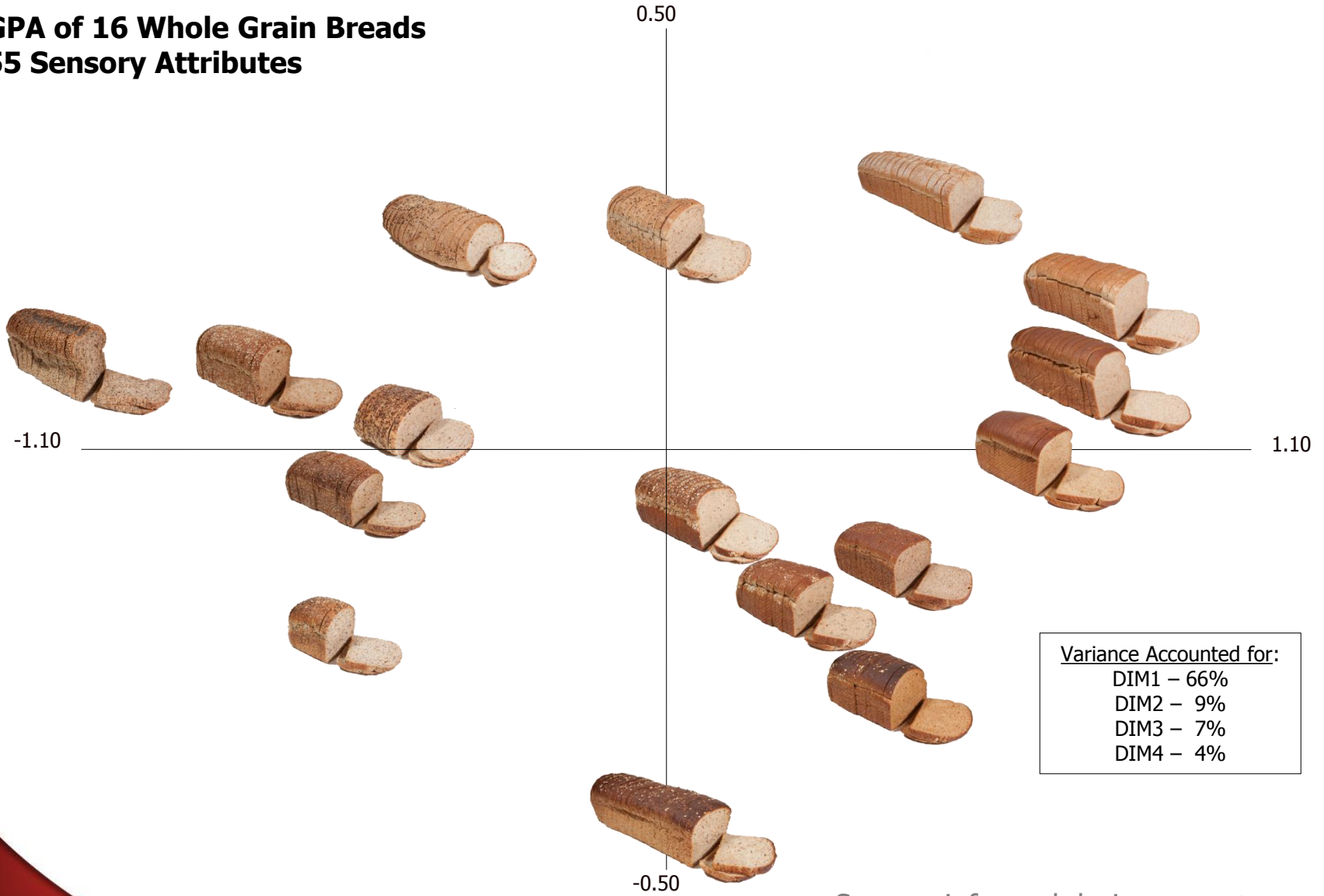
# Overall Liking
# All 570 Category Consumers



☺ LOVE IT!

7.3

7.1

6.8

6.6

6.5

6.4

6.2

5.9

5.9

5.8

5.8

☹ HATE IT!

5.7

5.5

5.5

5.2

5.0



3    4    5    6    7    8    9

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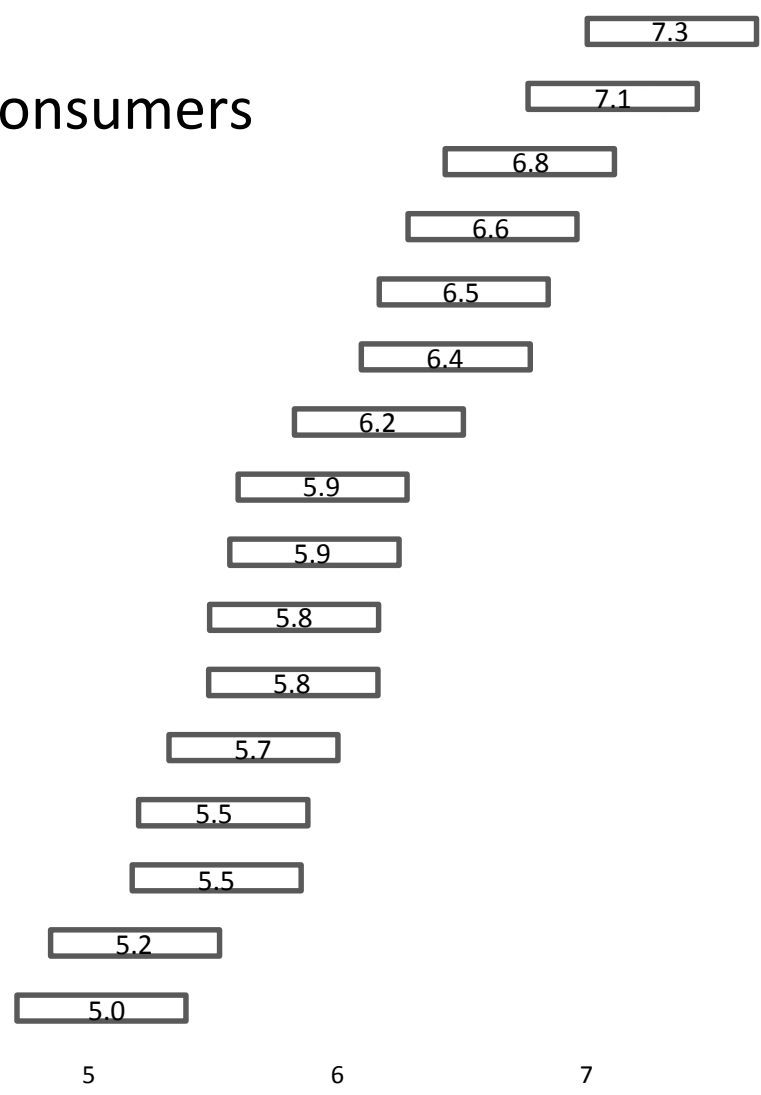
# Cluster 1 Overall Liking
## 25.8 %
## 147 Consumers

☺ LOVE IT!

☹ HATE IT!

7.8

7.4

6.7

6.7

6.6

6.5

6.1

6.0

5.8

5.6

4.9

4.9

4.5

4.4

4.4

3.2
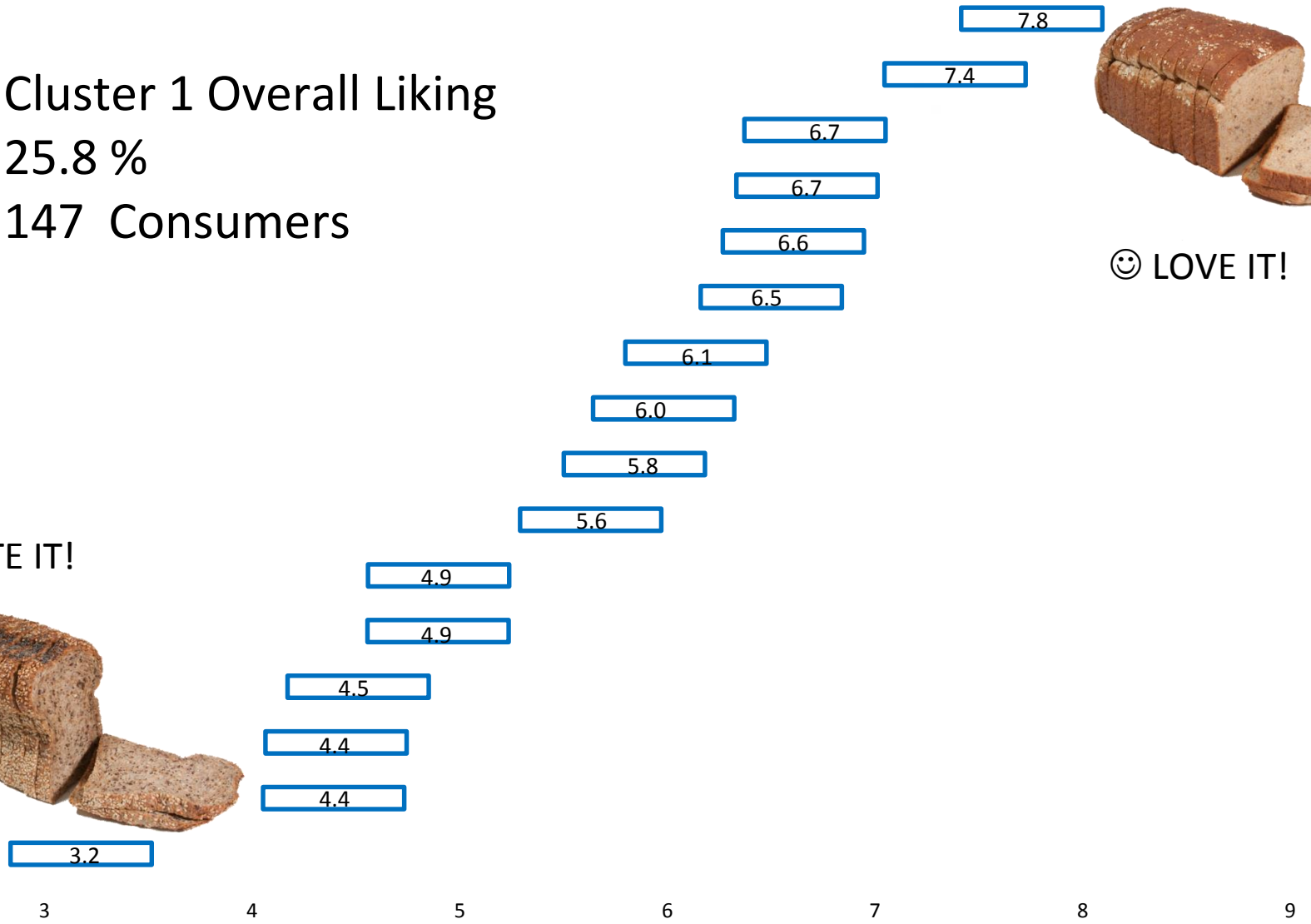
3    4    5    6    7    8    9

# Cluster 2 Overall Liking
# 45.3 %
# 258 Consumers

☺ LOVE IT!

☹ HATE IT!

8.0
7.9
7.8
7.7
7.5
7.3
7.0
6.9
6.6
6.5
6.3
6.0
5.9
5.9
5.7
5.6

3    4    5    6    7    8    9

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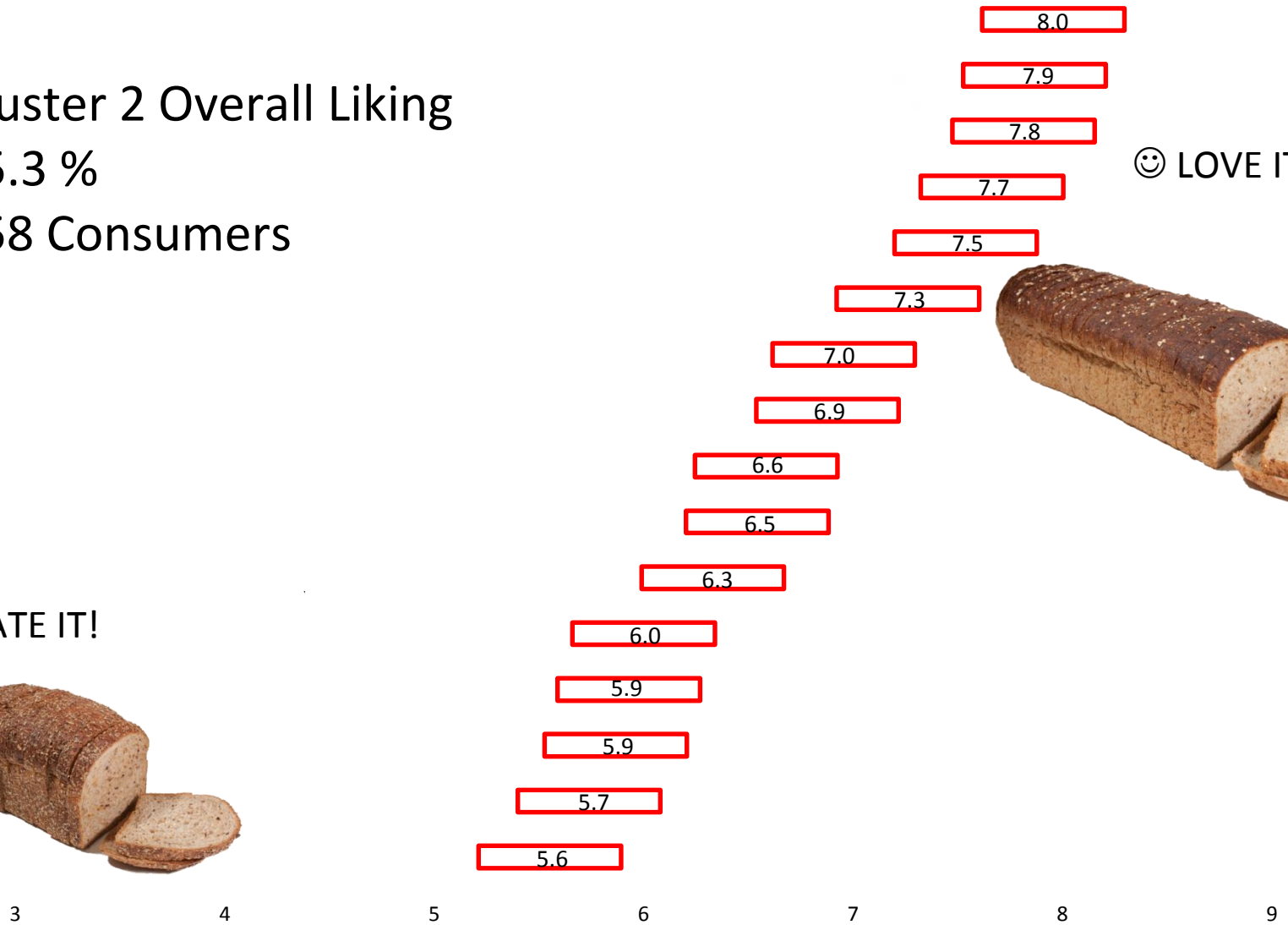
# Cluster 3 Overall Liking
## 28.9 %
## 165 Consumers

☺ LOVE IT!

☹ HATE IT!

| | | | | | |
|---|---|---|---|---|---|
| | | | 7.6 | | |
| | | 6.9 | | | |
| | 6.2 | | | | |
| | 6.1 | | | | |
| | 5.9 | | | | |
| | 5.7 | | | | |
| 5.5 | | | | | |
| 5.5 | | | | | |
| 5.3 | | | | | |
| 4.9 | | | | | |
| 4.6 | | | | | |
| 4.6 | | | | | |
| 4.5 | | | | | |
| 4.5 | | | | | |
| 4.5 | | | | | |
| 3.7 | | | | | |

| 3 | 4 | 5 | 6 | 7 | 8 | 9 |

# Nested Designs and Validation

Demonstrate stable clusters

The cluster membership remains consistent

Provide internal validation

Shows the same outcome independently

# Key elements of Sensory Informed Design

1. Calibrated DA of all products defines the sensory space, followed by the creation of a nested experimental design based upon sensory contrasts using 3 and 4 samples for each consumer data set.
2. Imputation of the missing data using an advanced EM (Expectation Maximization) algorithm. (http://arxiv.org/abs/1302.6625)
3. Model-based cluster analysis to ensure a stable clustering solution.

# Conclusions about Sensory Informed Design

- Improves the efficiency of large studies
- Can be used for any product category
- Improves the quality of data collected
- Delivers actionable consumer clusters
- Saves resources

For more information, please contact

**Chris Findlay, PhD**
Chairman
+1 800 367 6666 (North America)
+1 519 836 9993 (International)
cfindlay@compusense.com

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