

# Contents

<i>Preface</i>	ix
<i>Acknowledgements</i>	xi
<b>1 Introduction</b>	<b>1</b>
1.1 The Distinction between Trained Sensory Panels and Consumer Panels	1
1.2 The Need for Statistics in Experimental Planning and Analysis	2
1.3 Scales and Data Types	3
1.4 Organisation of the Book	3
<b>2 Important Data Collection Techniques for Sensory and Consumer Studies</b>	<b>5</b>
2.1 Sensory Panel Methodologies	5
2.2 Consumer Tests	7
<b>PART I PROBLEM DRIVEN</b>	
<b>3 Quality Control of Sensory Profile Data</b>	<b>11</b>
3.1 General Introduction	11
3.2 Visual Inspection of Raw Data	15
3.3 Mixed Model ANOVA for Assessing the Importance of the Sensory Attributes	18
3.4 Overall Assessment of Assessor Differences Using All Variables Simultaneously	19
3.5 Methods for Detecting Differences in Use of the Scale	24
3.6 Comparing the Assessors' Ability to Detect Differences between the Products	27
3.7 Relations between Individual Assessor Ratings and the Panel Average	29
3.8 Individual Line Plots for Detailed Inspection of Assessors	33
3.9 Miscellaneous Methods	34
<b>4 Correction Methods and Other Remedies for Improving Sensory Profile Data</b>	<b>39</b>
4.1 Introduction	39
4.2 Correcting for Different Use of the Scale	40

4.3	Computing Improved Panel Averages	43
4.4	Pre-processing of Data for Three-Way Analysis	45
<b>5</b>	<b>Detecting and Studying Sensory Differences and Similarities between Products</b>	<b>47</b>
5.1	Introduction	47
5.2	Analysing Sensory Profile Data: Univariate Case	48
5.3	Analysing Sensory Profile Data: Multivariate Case	59
<b>6</b>	<b>Relating Sensory Data to Other Measurements</b>	<b>67</b>
6.1	Introduction	67
6.2	Estimating Relations between Consensus Profiles and External Data	68
6.3	Estimating Relations between Individual Sensory Profiles and External Data	74
<b>7</b>	<b>Discrimination and Similarity Testing</b>	<b>79</b>
7.1	Introduction	79
7.2	Analysis of Data from Basic Sensory Discrimination Tests	80
7.3	Examples of Basic Discrimination Testing	81
7.4	Power Calculations in Discrimination Tests	85
7.5	Thurstonian Modelling: What Is It Really?	86
7.6	Similarity versus Difference Testing	87
7.7	Replications: What to Do?	89
7.8	Designed Experiments, Extended Analysis and Other Test Protocols	93
<b>8</b>	<b>Investigating Important Factors Influencing Food Acceptance and Choice</b>	<b>95</b>
8.1	Introduction	95
8.2	Preliminary Analysis of Consumer Data Sets (Raw Data Overview)	99
8.3	Experimental Designs for Rating Based Consumer Studies	102
8.4	Analysis of Categorical Effect Variables	106
8.5	Incorporating Additional Information about Consumers	113
8.6	Modelling of Factors as Continuous Variables	117
8.7	Reliability/Validity Testing for Rating Based Methods	118
8.8	Rank Based Methodology	119
8.9	Choice Based Conjoint Analysis	120
8.10	Market Share Simulation	123
<b>9</b>	<b>Preference Mapping for Understanding Relations between Sensory Product Attributes and Consumer Acceptance</b>	<b>127</b>
9.1	Introduction	128
9.2	External and Internal Preference Mapping	129
9.3	Examples of Linear Preference Mapping	136
9.4	Ideal Point Preference Mapping	141
9.5	Selecting Samples for Preference Mapping	146
9.6	Incorporating Additional Consumer Attributes	147

9.7	Combining Preference Mapping with Additional Information about the Samples	149
<b>10</b>	<b>Segmentation of Consumer Data</b>	<b>155</b>
10.1	Introduction	155
10.2	Segmentation of Rating Data	156
10.3	Relating Segments to Consumer Attributes	163
<b>PART II METHOD ORIENTED</b>		
<b>11</b>	<b>Basic Statistics</b>	<b>165</b>
11.1	Basic Concepts and Principles	165
11.2	Histogram, Frequency and Probability	166
11.3	Some Basic Properties of a Distribution (Mean, Variance and Standard Deviation)	168
11.4	Hypothesis Testing and Confidence Intervals for the Mean $\mu$	169
11.5	Statistical Process Control	172
11.6	Relationships between Two or More Variables	173
11.7	Simple Linear Regression	175
11.8	Binomial Distribution and Tests	177
11.9	Contingency Tables and Homogeneity Testing	178
<b>12</b>	<b>Design of Experiments for Sensory and Consumer Data</b>	<b>181</b>
12.1	Introduction	181
12.2	Important Concepts and Distinctions	182
12.3	Full Factorial Designs	185
12.4	Fractional Factorial Designs: Screening Designs	187
12.5	Randomised Blocks and Incomplete Block Designs	188
12.6	Split-Plot and Nested Designs	190
12.7	Power of Experiments	191
<b>13</b>	<b>ANOVA for Sensory and Consumer Data</b>	<b>193</b>
13.1	Introduction	193
13.2	One-Way ANOVA	194
13.3	Single Replicate Two-Way ANOVA	196
13.4	Two-Way ANOVA with Randomised Replications	198
13.5	Multi-Way ANOVA	200
13.6	ANOVA for Fractional Factorial Designs	201
13.7	Fixed and Random Effects in ANOVA: Mixed Models	203
13.8	Nested and Split-Plot Models	205
13.9	Post Hoc Testing	206
<b>14</b>	<b>Principal Component Analysis</b>	<b>209</b>
14.1	Interpretation of Complex Data Sets by PCA	209
14.2	Data Structures for the PCA	210
14.3	PCA: Description of the Method	211

14.4	Projections and Linear Combinations	213
14.5	The Scores and Loadings Plots	214
14.6	Correlation Loadings Plot	217
14.7	Standardisation	219
14.8	Calculations and Missing Values	220
14.9	Validation	220
14.10	Outlier Diagnostics	221
14.11	Tucker-1	223
14.12	The Relation between PCA and Factor Analysis (FA)	224
<b>15</b>	<b>Multiple Regression, Principal Components Regression and Partial Least Squares Regression</b>	<b>227</b>
15.1	Introduction	227
15.2	Multivariate Linear Regression	229
15.3	The Relation between ANOVA and Regression Analysis	232
15.4	Linear Regression Used for Estimating Polynomial Models	233
15.5	Combining Continuous and Categorical Variables	234
15.6	Variable Selection for Multiple Linear Regression	235
15.7	Principal Components Regression (PCR)	236
15.8	Partial Least Squares (PLS) Regression	237
15.9	Model Validation: Prediction Performance	238
15.10	Model Diagnostics and Outlier Detection	241
15.11	Discriminant Analysis	244
15.12	Generalised Linear Models, Logistic Regression and Multinomial Regression	245
<b>16</b>	<b>Cluster Analysis: Unsupervised Classification</b>	<b>249</b>
16.1	Introduction	249
16.2	Hierarchical Clustering	251
16.3	Partitioning Methods	254
16.4	Cluster Analysis for Matrices	259
<b>17</b>	<b>Miscellaneous Methodologies</b>	<b>263</b>
17.1	Three-Way Analysis of Sensory Data	263
17.2	Relating Three-Way Data to Two-Way Data	269
17.3	Path Modelling	269
17.4	MDS-Multidimensional Scaling	271
17.5	Analysing Rank Data	271
17.6	The L-PLS Method	273
17.7	Missing Value Estimation	273
	<b><i>Nomenclature, Symbols and Abbreviations</i></b>	<b>277</b>
	<b><i>Index</i></b>	<b>283</b>