
Contents

<i>Preface</i>	x
1 Psychophysics I: Introduction and Thresholds	1
1.1 Introduction and Terminology	1
1.2 Absolute Sensitivity	4
1.3 Methods for Measuring Absolute Thresholds	8
1.4 Differential Sensitivity	13
1.5 A Look Ahead: Fechner's Contribution	17
Appendix 1.A: Relationship of Proportions, Areas Under the Normal Distribution, and Z-Scores	18
Appendix 1.B: Worked Example: Fitting a Logistic Function to Threshold Data	20
References	22
2 Psychophysics II: Scaling and Psychophysical Functions	24
2.1 Introduction	24
2.2 History: Cramer, Bernoulli, Weber, and Fechner	26
2.3 Partition Scales and Categories	27
2.4 Magnitude Estimation and the Power Law	28
2.5 Cross-Modality Matching; Attempts at Validation	32
2.6 Two-Stage Models and Judgment Processes	35
2.7 Empirical Versus Theory-Based Functions	39
2.8 Hybrid Scales and Indirect Scales: A Look Ahead	40
2.9 Summary and Conclusions	41
Appendix 2.A: Decibels and Sones	42
Appendix 2.B: Worked Example: Transformations Applied to Non-Modulus Magnitude Estimation Data	44
References	45
3 Basics of Signal Detection Theory	47
3.1 Introduction	48
3.2 The Yes/No Experiment	49
3.3 Connecting the Design to Theory	52
3.4 The ROC Curve	57
3.5 ROC Curves from Rating Scales; the R -Index	62
3.6 Conclusions and Implications for Sensory Testing	67
Appendix 3.A: Table of p and Z	68
Appendix 3.B: Test for the Significance of Differences Between d' Values	69
References	69

4	Thurstonian Models for Discrimination and Preference	71
4.1	The Simple Paired-Choice Model	71
4.2	Extension into n -AFC: The Byer and Abrams “Paradox”	78
4.3	A Breakthrough: Power Analysis and Sample Size Determination	80
4.4	Tau Versus Beta Criteria: The Same–Different Test	84
4.5	Extension to Preference and Nonforced Preference	89
4.6	Limitations and Issues in Thurstonian Modeling	90
4.7	Summary and Conclusions	94
	Appendix 4.A: The Bradley–Terry–Luce Model: An Alternative to Thurstone	95
	Appendix 4.B: Tables for delta Values from Proportion Correct	96
	References	97
5	Progress in Discrimination Testing	99
5.1	Introduction	99
5.2	Metrics for Degree of Difference	104
5.3	Replication in Choice Tests	108
5.4	Current Variations	110
5.5	Summary and Conclusions	118
	Appendix 5.A: Psychometric Function for the Dual Pair Test, Power Equations, and Sample Size	119
	Appendix 5.B: Fun with γ	120
	References	121
6	Similarity and Equivalence Testing	124
6.1	Introduction: Issues in Type II Error	124
6.2	Commonsense Approaches to Equivalence	126
6.3	Allowable Differences and Effect Size	133
6.4	Further Significance Testing	138
6.5	Summary and Conclusions	140
	References	141
7	Progress in Scaling	143
7.1	Introduction	143
7.2	Labeled Magnitude Scales for Intensity	147
7.3	Adjustable and Relative Scales	153
7.4	Explicit Anchoring	155
7.5	Post Hoc Adjustments	158
7.6	Summary and Conclusions	161
	Appendix 7.A: Examples of Individual Rescaling for Magnitude Estimation	162
	References	164
8	Progress in Affective Testing: Preference/Choice and Hedonic Scaling	167
8.1	Introduction	167
8.2	Preference Testing Options	168
8.3	Replication	173

8.4	Alternative Models: Ferris k -visit, Dirichlet Multinomial	176
8.5	Affective Scales	181
8.6	Ranking and Partial Ranking	185
8.7	Conclusions	188
	Appendix 8.A: Proof that the McNemar Test is Equivalent to the Binomial Approximation Z-Test (AKA Sign Test)	188
	References	190
9	Using Subjects as Their Own Controls	194
	Part I: Designs using Parametric Statistics	195
9.1	Introduction to Part I	195
9.2	Dependent Versus Independent t -Tests	198
9.3	Within-Subjects ANOVA (“Repeated Measures”)	203
9.4	Issues	206
	Part II: Nonparametric Statistics	208
9.5	Introduction to Part II	208
9.6	Applications of the McNemar Test: A–not-A and Same–Different Methods	209
9.7	Examples of the Stuart–Maxwell	212
9.8	Further Extensions of the Stuart Test Comparisons	218
9.9	Summary and Conclusions	220
	Appendix 9.A: R Code for the Stuart Test	221
	References	222
10	Frequency Counts and Check-All-That-Apply (CATA)	224
10.1	Frequency Count Data: Situations — Open Ends, CATA	224
10.2	Simple Data Handling	227
10.3	Repeated or Within-Subjects Designs	228
10.4	Multivariate Analyses	230
10.5	Difference from Ideal and Penalty Analysis	231
10.6	Frequency Counts in Advertising Claims	235
10.7	Conclusions	236
	Appendix 10.A: Proof Showing Equivalence of Binomial Approximation Z-Test and χ^2 Test for Differences of Proportions	237
	References	239
11	Time–Intensity Modeling	240
11.1	Introduction: Goals and Applications	240
11.2	Parameters Versus Average Curves	245
11.3	Other Methods and Analyses	250
11.4	Summary and Conclusions	254
	References	254
12	Product Stability and Shelf-Life Measurement	257
12.1	Introduction	257
12.2	Strategies, Measurements, and Choices	258
12.3	Study Designs	261

12.4	Hazard Functions and Failure Distributions	261
12.5	Reaction Rates and Kinetic Modeling	267
12.6	Summary and Conclusions	271
	References	272
13	Product Optimization, Just-About-Right (JAR) Scales, and Ideal Profiling	273
13.1	Introduction	273
13.2	Basic Equations, Designed Experiments, and Response Surfaces	276
13.3	Just-About-Right Scales	279
13.4	Ideal Profiling	285
13.5	Summary and Conclusions	292
	References	294
14	Perceptual Mapping, Multivariate Tools, and Graph Theory	297
14.1	Introduction	297
14.2	Common Multivariate Methods	299
14.3	Shortcuts for Data Collection: Sorting and Projective Mapping	308
14.4	Preference Mapping Revisited	309
14.5	Cautions and Concerns	311
14.6	Introduction to Graph Theory	314
	References	319
15	Segmentation	323
15.1	Introduction	323
15.2	Case Studies	326
15.3	Cluster Analysis	330
15.4	Other Analyses and Methods	336
15.5	Women, Fire, and Dangerous Things	337
	References	338
16	An Introduction to Bayesian Analysis	340
16.1	Some Binomial-Based Examples	340
16.2	General Bayesian Models	347
16.3	Bayesian Inference Using Beta Distributions for Preference Tests	349
16.4	Proportions of Discriminators	352
16.5	Modeling Forced-Choice Discrimination Tests	353
16.6	Replicated Discrimination Tests	355
16.7	Bayesian Networks	356
16.8	Conclusions	359
	References	360
	Appendix A: Overview of Sensory Evaluation	361
A.1	Introduction	361
A.2	Discrimination and Simple Difference Tests	363
A.3	Descriptive Analysis	367
A.4	Affective Tests	372

A.5 Summary and Conclusions	375
References	375
Appendix B: Overview of Experimental Design	377
B.1 General Considerations	377
B.2 Factorial Designs	379
B.3 Fractional Factorials and Screening	380
B.4 Central Composite and Box–Behnken Designs	383
B.5 Mixture Designs	385
B.6 Summary and Conclusions	385
References	386
Appendix C: Glossary	387
<i>Index</i>	398