

# Contents

	<i>Preface to the second edition</i>	page	xiii
	<i>Acknowledgments</i>		xvi
1	The evolution, development, and modification of behavior		1
	Canalization		3
	Explanation		4
	Function, causation, and teleonomy		6
	Evolution and development		9
	Epigenesis and genetic assimilation		13
	Lamarck, Darwin, and gemmules		17
	Early environment		20
	Summary		22
2	Variation and selection: kineses		24
	Simple orienting mechanisms		24
	Indirect orientation (kineses)		26
	Neurophysiology and behavior		35
3	Reflexes		38
	Volition and the mind-body problem		40
	Sherrington's reflex		41
	Individual reflexes		43
	Threshold		43
	Latency		44
	Refractory period		45
	Temporal summation		45
	Spatial summation		46
	Momentum (after discharge)		47
	Habituation		47
	Rate sensitivity		48
	Reflex interaction		52
	Reciprocal inhibition (competition)		53

	Cooperation	54
	Successive induction	55
	Averaging	61
	Inhibition and reflex strength	62
	Summary	66
4	Direct orientation and feedback	67
	Taxes	67
	Klinotaxis	67
	Tropotaxis	70
	Light-compass reaction	73
	Telotaxis	74
	Feedback analysis	75
	Dynamic analysis	78
	Frequency analysis	80
	Three simple feedback responses	85
	When is feedback useful?	88
	Behavioral integration and the role of variability	90
	The nature of explanation	95
	The meaning of "black-box" analysis	95
	Purpose, teleology, and mechanism	96
	Summary	98
	Appendix A4.1	99
	Linear systems analysis	99
5	Operant behavior	102
	Operant behavior and B. F. Skinner	102
	Causal and functional analysis of operant behavior	104
	Parallel models	108
	Operant behavior and learning	112
	Information theory	115
	Operant and classical conditioning: overview	116
	Habituation	116
	Sensitization	118
	Pseudoconditioning	118
	Classical conditioning	119
	Operant conditioning	120
	Generalization and discrimination	122
	The logic of historical systems	124
	Finite-state systems	125
	Equivalent histories and the experimental method	127
	Between-groups experiments: averaging data	128
	Within-subject method	131

Memory	132
Summary	133
6 Reward and punishment	135
Reinforcement and the law of effect	137
Experimental methods	142
The Skinner box	144
Response- and time-based schedules of reinforcement	146
Equilibrium states	151
Classical conditioning	154
Contingency and feedback functions	156
Contingency space	161
Temporal and trace conditioning	163
Response contingencies and feedback functions	165
Feedback functions for common schedules	168
Ratio schedules	168
Interval schedules	168
Interlocking schedules	169
Escape, avoidance, and omission schedules	171
Shock postponement	171
Detection of response contingency	172
Summary	174
7 Feeding regulation: a model motivational system	175
Reinforcement and homeostasis	175
Obesity and schedule performance: a static analysis	179
The meaning of brain lesion experiments	181
The effects of hypothalamic lesions on eating	182
A regulatory model	185
Finickiness	191
Response to dilution of diet	191
Weak defense of settling weight	192
Improved defense of low settling weights	194
Poor adaptation to work requirements	194
Effects of taste and body weight on work schedules	197
Other motivational effects	198
Limitations of the linear model	199
Human obesity	200
Derivations	202
Summary	203
8 The optimal allocation of behavior	205
Time constraints and behavioral competition	206

132	Rate and time measures	206
133	The allocation of behavior	209
135	Income and substitution effects	211
137	Value, reinforcement, and Darwinian fitness	214
142	Optimal allocation	215
144	The minimum-distance model	218
146	Prediction of response functions	223
151	Bliss point and characteristic space	225
154	Substitutability and indifference curves	226
156	Marginal value and substitutability	229
161	Experimental applications	231
163	Reinforcement constraints	235
165	Summary	240
9	Choice: dynamics and decision rules	242
168	Real time: the cumulative record	244
168	Choice dynamics and the law of effect	244
169	Random-ratio choice	247
171	Identical random ratios	249
171	Concurrent variable-interval schedules	257
172	Optimal choice	259
174	Probability learning	260
175	Delayed outcomes: "self-control"	263
175	Temporal discounting	266
179	Variable outcomes: risk	268
181	Human choice, risk, and behavioral economics	269
182	Matching and maximizing	276
185	Marginal value and momentary maximizing	277
191	Concurrent VI-VI	278
191	Momentary maximizing	280
192	Concurrent VI-VR	285
194	Summary	286
10	Foraging and behavioral ecology	287
197	Diet selection and functional response	287
198	Functional response	288
199	Diet choice	290
200	Switching	292
202	1. Absolute density changes	293
203	2. Nonrandom spatial distribution	294
205	3. Changes in profitability with experience	294
206	4. Changes in effective density with experience	295
	Search image	296

Receiver operating characteristic (ROC) analysis	297
Ecological implications	302
Nutrient constraints and sampling	305
Natural feedback functions	307
Summary	309
Appendix A10.1	310
The effect of prey density on prey risk	310
Appendix A10.2	311
Switching and functional response	311
Appendix A10.3	312
Foraging in a repleting food source	312
11 Stimulus control and cognition	313
Discriminative and eliciting stimuli	314
Stimulus equivalence and data structure	316
Analog versus digital coding	318
Psychophysics and similarity	319
Measuring stimulus control	320
Stimulus generalization	323
Generalization gradients	323
Compounding of elements	325
Stimulus control and reinforcement: variation and attention	326
Attention	328
Attention to different dimensions	329
Similarity	334
Maps	337
Multidimensional scaling	340
Spatial representation as a data structure	341
Summary	343
12 Stimulus control and performance	345
Inhibitory and excitatory control	345
Feature effects	346
Behavioral contrast and discrimination performance	348
Schedule-induced behavior	351
Intertemporal effects	353
Inhibitory generalization gradients	356
Conjoint stimulus control and peak shift	359
Historical Note: Spence's Theory of Transposition	366
Transitive Inference	367
Dynamic effects in multiple schedules	369
Stimulus effects	374
Summary	375

13	Molar laws	377
	Matching and optimality	377
	Matching and minimum distance	378
	Contrast and matching	379
	1. Simple VI (single-response case)	380
	2. Concurrent VI-VI (two-response case)	380
	3. Multiple VI-VI	381
	Boyle and the molar law	384
	Historical review	384
	Resistance to change	387
	A continuous model	390
	Multiple VI-VI	391
	Multiple VI-VI-VT	391
	CMP Model: Conclusion	393
	Problems	393
	Summary	397
14	Time and memory, I	398
	Temporal control	398
	The reinforcement omission effect	400
	Excitatory and inhibitory temporal control	403
	Conditions for temporal control	405
	Timing and fixed-ratio schedules	408
	Characteristics of the time marker	409
	Overshadowing	415
	Conclusion: the discrimination of recency	415
	Time estimation	416
	Proaction and retroaction	418
	Summary	419
15	Time and memory, II	421
	Discrimination reversal and learning set	423
	Reversal learning in human infants	426
	The serial position effect (SPE)	428
	Learning set	428
	Learning dynamics	429
	Memory and spatial learning	430
	The radial-arm maze	431
	Radial-maze performance	431
	A two-part code	433
	Spatial code	433
	Temporal code	433
	Search image	436

	Response rule	434
	Spatial effects	435
	Temporal effects	437
	Other spatial situations	438
	The route finder	441
	Summary	443
16	Template learning	445
	Imprinting	446
	Song learning	451
	Summary	455
17	Learning, I	457
	Bees	458
	Learning as program assembly	459
	Reinforcement and learning	460
	Latent learning	461
	Inference	463
	Partial reinforcement	465
	Bayes' rule	466
	Taste-aversion learning	467
	Delay-of-reward gradient	471
	The order of learning	472
	What is learned?	473
	Surprise	473
	Methodology	477
	Expectation and classification	478
	Learning and classification	479
	Recognition and expectation	483
	Summary	484
18	Models of classical conditioning	486
	Inference and classical conditioning	486
	Contingency space	487
	Blocking	488
	Conditioning to novel tastes	488
	Latent inhibition	488
	Preexposure to the US	488
	Models for conditioning	490
	New learning model	496
	Conclusion: trial-level models	499
	Temporal variables	500

19	Learning, II	501
	Classical conditioning and the origins of operant behavior	503
	The “superstition” experiment	506
	Behavioral variation: the origins of operant behavior	511
	Inference, action, and operant conditioning	512
	Misbehavior	514
	Behavioral variation and sampling	515
	The guidance of action	516
	Initial state	516
	Selection rules	519
	Response–reinforcer contiguity	519
	Shaping	523
	Feedback function	525
	Schedule-induced behavior	526
	Conclusion: operant learning	529
	Summary	529
20	Learning, III: procedures	532
	Conditioned reinforcement	532
	Concurrent chained schedules	536
	On the virtues of optimality analysis	539
	Quasi-reinforcement	539
	Second-order schedules	541
	Conditioned emotional response	542
	Anxiety?	543
	Avoidance and escape	544
	Limits to variation: response-produced shock and “learned helplessness”	548
	Learned helplessness (LH)	550
	Sampling versus exploitation	551
	Extinction	554
	Summary	561
21	Comparative cognition	563
	Insight	564
	Fast mapping	567
	Metacognition	569
	The logic of metacognition	572
	Summary	577
	<i>Index</i>	579