

Comparative Neurology of the Telencephalon

Edited by

Sven O. E. Ebbesson

*Catholic University of Puerto Rico
Ponce, Puerto Rico*

FACHBEREICH BIOLOGIE (10)
der Technischen Hochschule-Darmstadt

— Bibliothek —

D – 6100 Darmstadt / B. R. D.
Schnittspahnstraße

Inv.-Nr. 10 020

Plenum Press · New York and London

Contents

1 On the Organization of the Telencephalon in Elasmobranchs

SVEN O. E. EBBESSON

I. Introduction	1
II. Organization of Elasmobranchs	2
III. Brain Weight-Body Weight Ratio	2
IV. Telencephalic Organization in General	4
V. Olfactory Input	8
VI. Visual Input	9
VII. Representation of Other Sensory Systems in the Telencephalon	11
VIII. Telencephalic Efferent Pathways	12
IX. Conclusion	13
X. References	14

2 Telencephalic Function in Elasmobranchs: A Behavioral Perspective

RAYMOND CURTIS GRAEBER

I. Use of Sharks in Comparative Neuropsychology	17
A. Phylogenetic Advantages	17
B. Neuroanatomical Features	19
C. Behavioral Repertoire	21
II. The Reign of Olfaction	24
A. Origins of the "Smell Brain"	24
B. Multimodal Representation	26

III.	Telencephalic Involvement in Visual Discrimination	27
A.	Experimental Evidence	28
B.	Nature of the Deficit	31
C.	Performance Characteristics of Normal Sharks	34
IV.	References	35

3 New Observations on the Organization and Evolution of the Telencephalon of Actinopterygian Fishes

R. GLENN NORTHCUTT and MARK R. BRAFORD, Jr.

I.	Introduction	41
A.	The Fishes	41
B.	The Telencephalon	42
II.	Species Studied	45
III.	Quantitative Considerations	47
IV.	Normal Morphology	50
A.	Olfactory Bulb	50
B.	Area Ventralis Telencephali (V) or Subpallium	53
C.	Area Dorsalis Telencephali (D) or Pallium	60
D.	Summary and Discussion	69
V.	Olfactory Bulb Projections	72
A.	Methods	72
B.	Results	72
C.	Discussion	75
VI.	Histochemistry	76
A.	Introduction	76
B.	Methods	77
C.	Results and Discussion	79
VII.	General Discussion	85
A.	Previous Interpretations of the Telencephalon	86
B.	A New Hypothesis	91
C.	Evolutionary Considerations	94
VIII.	References	95

4 The Telencephalon of Teleosts

DOLORES M. SCHROEDER

I.	Introduction	99
II.	Terminology	100
III.	Gross Anatomy and Cytoarchitecture	100
IV.	Olfactory Tract Projections	110
V.	Nonolfactory Efferent and Afferent Projections	110

VI. Behavior following Ablations	111
VII. Regeneration	112
VIII. Conclusion	113
IX. References	113

5 Projections of the Teleostean Telencephalon

HORACIO VANEGAS and SVEN O. E. EBBESSON

I. Introduction	117
II. Commissural Fibers	119
III. Projection to Pretectum and Optic Tectum	120
IV. Medial Forebrain Bundle	122
V. Projection to Nucleus Rotundus or Prethalamicus	122
VI. Strio-lobar Bundle	125
VII. Lateral Forebrain Bundle	125
VIII. Projection to the Central Gray of Brain Stem	125
IX. Contralateral Descending Projection	125
X. Final Considerations	126
XI. References	126

6 The Fish Telencephalon and Its Relation to Learning

GEORGE ERIC SAVAGE

I. Introduction	129
A. Evolutionary Considerations	129
B. Anatomy	130
II. Ablation of the Telencephalon	132
A. General Effects	132
B. Habituation	138
C. Classical Conditioning	138
D. Avoidance Problems	140
E. Approach Problems	147
III. Electrical Recording from the Telencephalon	150
A. Olfaction	150
B. Ascending Influences	152
IV. Electrical Stimulation of the Telencephalon	155
A. Effects on General Behavior and on Feeding	155
B. Reinforcement Effects	157
C. Effects on Other Brain Areas	157
D. Effects on Learning	158
V. Theories of Telencephalic Function	159
A. Introduction	159
B. Arousal	159

C. Attention and Consolidation	163
D. Secondary Reinforcement Processing	165
E. Conclusions and Prospects	166
VII. References	167

7 Telencephalon and Behavior in Teleost Fish: A Neuroethological Approach

JAN P. C. de BRUIN

I. Introduction	175
A. Ethological Introduction	175
B. Neuroanatomical Introduction	176
II. Methods of Studying Telencephalic Functions	178
A. Ablation and Specialized Lesions	178
B. Stimulation and Recording	179
C. Histological Control	180
III. Behavioral Changes following Ablation and Specialized Lesions of the Telencephalon	181
A. Introduction	181
B. Nesting Behavior	182
C. Sexual and Parental Behavior	183
D. Aggressive Behavior	187
IV. Behavioral Observations during Stimulation of and Recording from the Telencephalon	191
A. Nesting Behavior	191
B. Sexual and Parental Behavior	191
C. Aggressive Behavior	193
D. Arousal and Reward	195
V. Regenerative Aspects	196
VI. Concluding Remarks	197
VII. References	198

8 Organization of the Amphibian Telencephalon

R. GLENN NORTHCUTT and EARL KICLITER

I. Introduction	203
A. The Amphibia	203
B. The Amphibian Telencephalon—Primitive or Degenerate?	204
II. Species Studied	205
III. Normal Morphology	206
A. Olfactory Bulbs	208
B. Pallium	210
C. Subpallium	220

IV.	Organization of the Olfactory System	224
A.	Olfactory Organs	224
B.	Olfactory Projections	227
C.	Olfactory Mediated Behaviors	230
V.	Ascending Telencephalic Afferents	231
A.	Anterograde Degeneration Studies: Regional Sources of Telencephalic Afferents	231
B.	Cellular Sources of Telencephalic Afferents: The Horseradish Peroxidase Method	233
C.	Ultrastructure of the Ascending Afferents	238
D.	Other Ascending Afferents: A Quintofrontal Tract in Amphibians?	239
E.	Functional Significance of Telencephalic Afferents	240
VI.	Some Intratelencephalic Connections in Amphibians	241
A.	Projections of the Pallium	241
B.	Projections of the Subpallium	242
VII.	Telencephalic Efferents	243
VIII.	Amphibian Telencephalic Organization	245
A.	Telencephalic Organizational Pattern	245
B.	Comparisons with Other Vertebrates	246
IX.	References	251

9 The Telencephalon of Snakes

MIMI HALPERN

I.	Introduction	257
II.	Normal Anatomy	260
A.	Gross Appearance	260
B.	Lateral Ventricle	261
C.	Main Olfactory Bulb	261
D.	Main Olfactory Tract	268
E.	Accessory Olfactory Bulb	270
F.	Accessory Olfactory Tract	271
G.	Retrobulbar Region	272
H.	Septum	275
I.	Cortical Mantle	277
J.	Dorsal Ventricular Ridge	281
K.	Paleostriatum	283
L.	Archistriatum or Amygdala	284
M.	Preoptic Area	285
III.	Fiber Connections	285
A.	Main Olfactory Bulb	285
B.	Accessory Olfactory Bulb	286
C.	Nucleus Sphericus	287
D.	Medial Cortex	289
E.	Dorsal Cortex	290

F. Lateral Cortex	291
G. Septum	292
IV. Concluding Remarks	293
V. References	293

10 Cytoarchitectonic and Connectional Organization of the Lacertilian Telencephalon with Comments on Vertebrate Forebrain Evolution

ANN B. BUTLER

I. Introduction	297
II. Anatomy of the Lacertilian Forebrain	298
III. Connections of the Lacertilian Forebrain	301
A. Ascending Sensory Projections	301
B. Intrahemispheric Corticocortical Projections	305
C. Interhemispheric Corticocortical Connections	306
D. Descending Telencephalic Projections	306
IV. Forebrain Organization in Other Reptiles and Birds	306
A. Cortex	307
B. Dorsal Ventricular Ridge	308
V. Telencephalic Connections in <i>Iguana</i> and <i>Gekko</i>	311
A. Ascending Projections	311
B. Cortical Efferent Projections	315
VI. Discussion	316
A. Dorsal Ventricular Ridge	316
B. Dorsal Cortex	320
C. Trends in Forebrain Evolution	322
VII. References	325

11 Parallels in the Organization of Auditory and Visual Systems in Crocodiles

MICHAEL B. PRITZ

I. Introduction	331
II. Parallels in the Organization of Midbrain Auditory and Visual Areas in <i>Caiman</i>	333
III. Parallels in the Organization of Thalamic Auditory and Visual Regions in <i>Caiman</i>	333
IV. Other Parallels in the Organization of Auditory and Visual Systems That Synapse in the Midbrain of <i>Caiman</i>	335
V. Comparison with Other Reptiles and Birds	337
VI. Comparison with Mammals	338

VII. Summary	340
VIII. References	340

12 Behavioral Studies of Telencephalic Function in Reptiles

ELLENGENE PETERSON

I. Introduction	343
II. Subpallium	345
A. Introduction	345
B. Terminology	345
C. Lesion Studies of Subpallial Function: 1823 to 1967	346
D. Lesion Studies of Subpallial Function: 1968 to the Present	348
E. Stimulation Studies of Subpallial Function	352
F. Summary	355
III. Pallium	356
A. Introduction	356
B. Stimulation Studies	358
C. Ablation Studies	361
IV. Discussion	376
A. Telencephalon as an Arousal System	377
B. Visual Telencephalon	378
C. Function of Dorsal Cortex	380
V. References	383

13 Functional Organization of the Avian Telencephalon

LARRY BENOWITZ

I. Introduction	389
II. Development and Organization	390
III. Bilateral Hemispherectomy	396
IV. Lesions of the Tectofugal Visual Pathway	397
V. Thalamofugal Visual Pathway and Wulst	399
VI. Combined Lesions of Tectofugal and Thalamofugal Visual Structures	401
VII. Wulst Lesions and Reversal Learning	404
VIII. Extensive Hyperstriatal Lesions	406
IX. Interhemispheric Relations	407
X. Archistriatum and Agonistic Behavior	408
XI. Nucleus Basalis and Feeding Behavior	410
XII. Central Control of Birdsong	413
XIII. Summary and Conclusions	415
XIV. References	417

14 Morphological Correlates of Specialized Elaborations in Somatic Sensory Cerebral Neocortex

JOHN IRWIN JOHNSON, Jr.

I. Introduction	423
II. Gyral Configuration in Somatic Sensory Cerebral Cortex Related to Behavioral Specialization	425
A. Proposed from Procyonids	425
B. Tested in Marsupial Wombats	425
III. Subcortical Correlates of Gyral Formations: Lobules	429
A. Ventrobasal (Somatic Sensory) Nucleus of Thalamus	431
B. Cuneate-Gracile Nuclear Complex of the Medulla	433
C. What Are Lobules?	433
IV. Role of Receptors in the Development of Lobules	437
A. Relation of Receptor Density to Presence and Volume of Lobules	437
B. Absence of Cuneate-Gracile Lobules following Early Receptor Removal	438
V. Intracortical Correlates of Sensory Specialization: Barrels and Cellular Condensations	438
A. Barrels in Layer IV of Sensory Neocortex	438
B. Role of Receptors in the Development of Barrels	441
C. Regions of Cellular Condensation and Rarefaction Related to Sensory Maps in Layer IV of Sensory Neocortex	441
VI. Possible Relation of Barrels and Other Regions of Cellular Condensation to Gyral Formations	442
VII. Summary	444
VIII. References	445

15 Thalamocortical Relationships in Echidna (*Tachyglossus aculeatus*)

WALLY WELKER and RICHARD A. LENDE

I. Introduction	449
II. Materials and Methods	450
A. Subjects	450
B. Surgical Procedures	451
C. Histological Preparation	451
D. Identification of Cortical Lesions and Thalamic Degeneration	451
III. Results	451
A. Cortical Organization	453
B. Thalamic Nuclear Organization	455
C. Thalamocortical Relationships	456

D. Unaffected Thalamic Nuclei	476
E. Three-Dimensional Organization of Echidna Thalamus	476
IV. Discussion	476
A. Variations in Thalamocortical Circuit Connections among Vertebrates: The Search for Homologies	477
B. Theoretical Concepts	478
V. References	479

16 A Comparative Survey of Visual Cortex Organization in Mammals

JON H. KAAS

I. Introduction	483
II. Survey of Extant Mammals	484
A. Monotremes	484
B. Marsupials	485
C. Edentates	487
D. Lagomorphs and Elephant Shrews	488
E. Insectivores	490
F. Archonta	491
G. Carnivores	494
H. Ungulates	495
I. Rodents	496
III. Conclusions	497
IV. References	500
Index	503