Neuroscience and Informatics

Donald Doherty, Ph.D.
Founder and Chief Executive Officer
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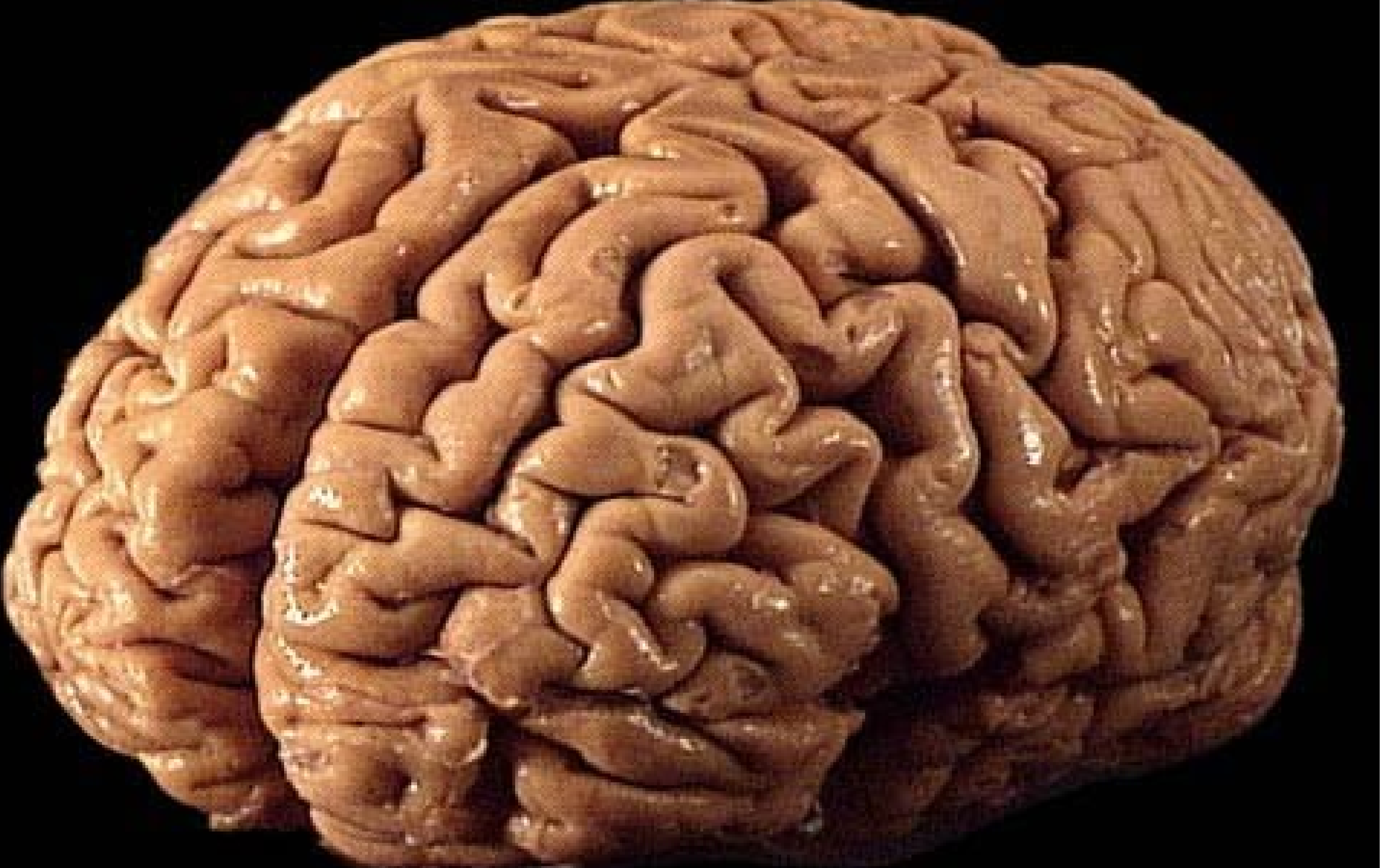
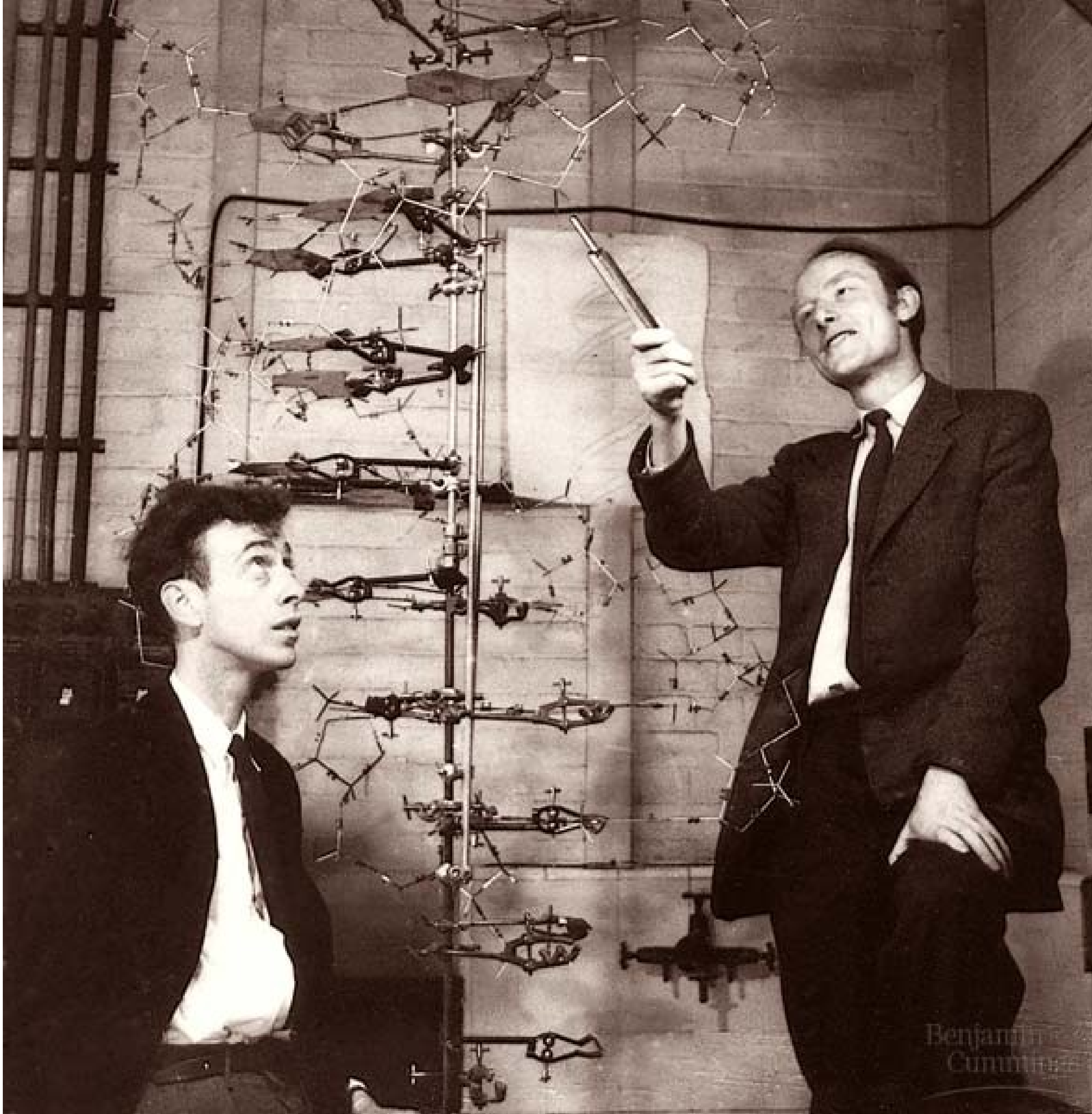


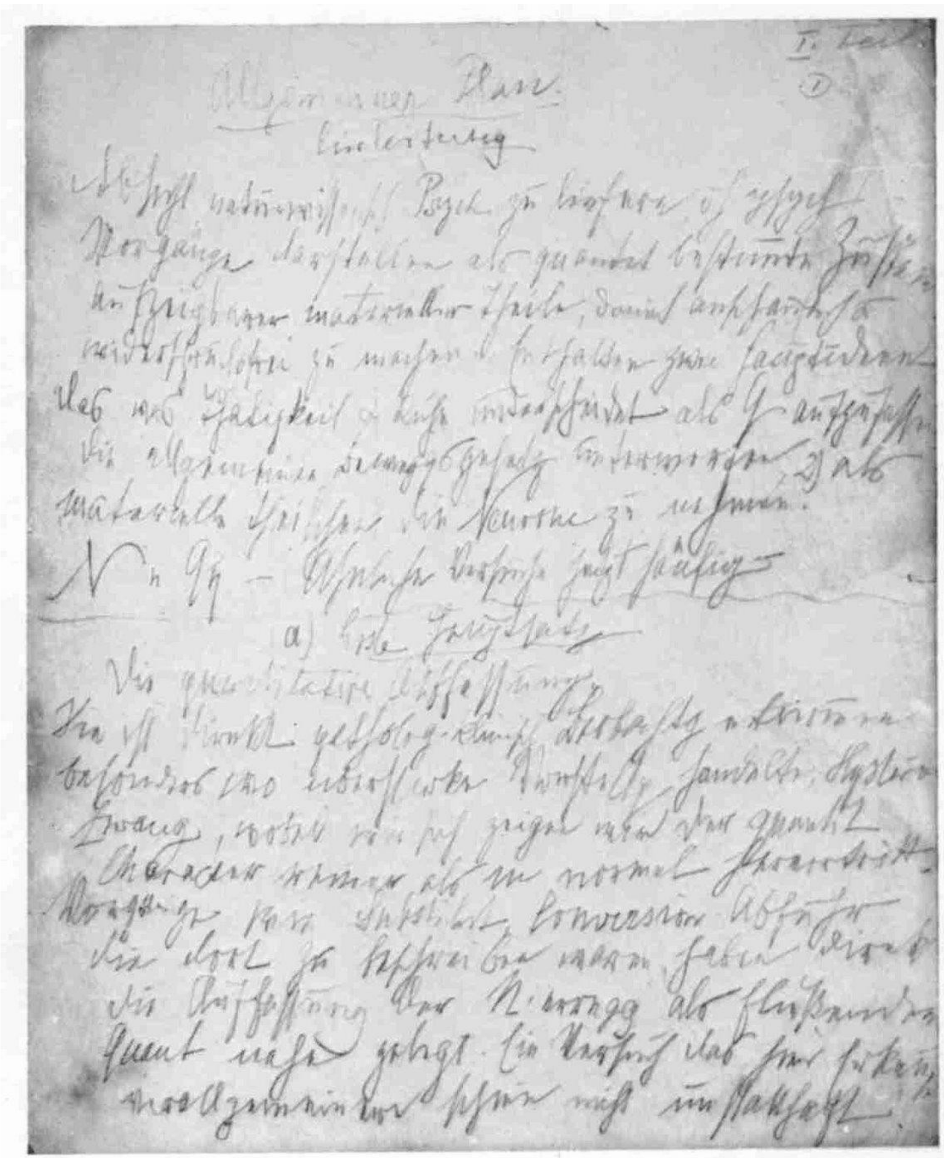
Nicolaus Steno 1638-1686

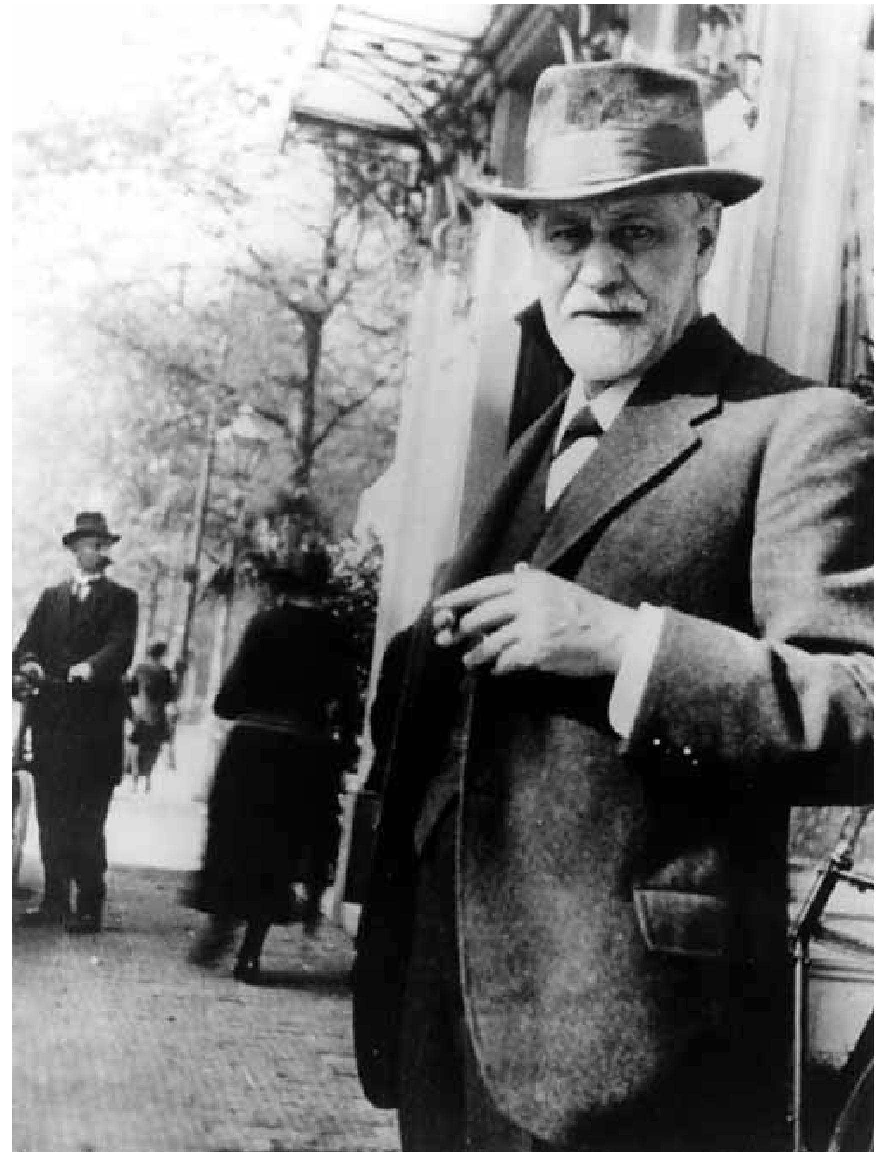
"There are two ways only of coming to knowing a machine: one is that the master who made it should show us its artifice; the other is to dismantle it and examine its most minute parts separately and as a combined unit."

Discours de Monsieur Stenon sur L'Anatomie du Cerveau ("M. Steno's lecture on the anatomy of the brain", Paris 1669)



Freud's Project for a Scientific Psychology (1895)





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Brain Research Reviews 46 (2004) 310–314

BRAIN RESEARCH REVIEWS

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Review

The Project for a Scientific Psychology (1895): a Freudian anticipation of LTP-memory connection theory

Diego Centonze[a,b,*], Alberto Siracusano[c], Paolo Calabresi[a,b], Giorgio Bernardi[a,b]

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[b] *IRCCS Fondazione Santa Lucia, Rome, Italy*
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Accepted 6 July 2004
Available online 18 August 2004

Abstract

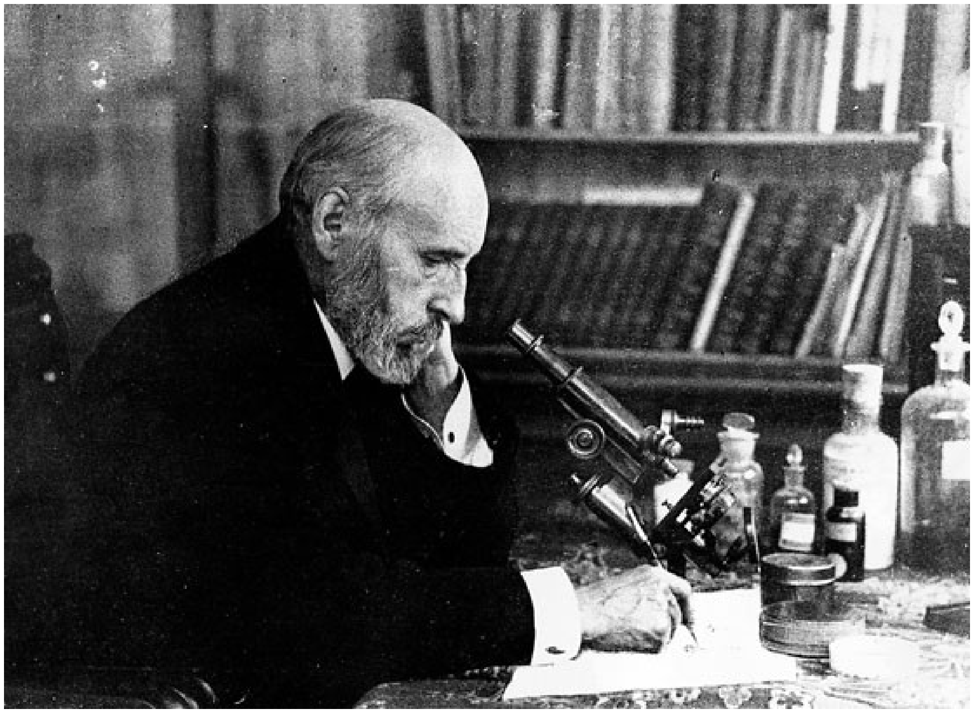
Long-term potentiation (LTP) of synaptic transmission is considered a reliable cellular model of several forms of learning and memory. Described for the first time in 1973, this synaptic phenomenon consists in the enduring facilitation of the communication between two neurons in response to the sustained activation of the synapses by which they are interconnected. In a book of 1895 entitled *Project for a Scientific Psychology*, Sigmund Freud theorized about the possibility of representing memory at the synaptic level as "a permanent alteration following an event", and anticipated several crucial physiological properties of LTP.

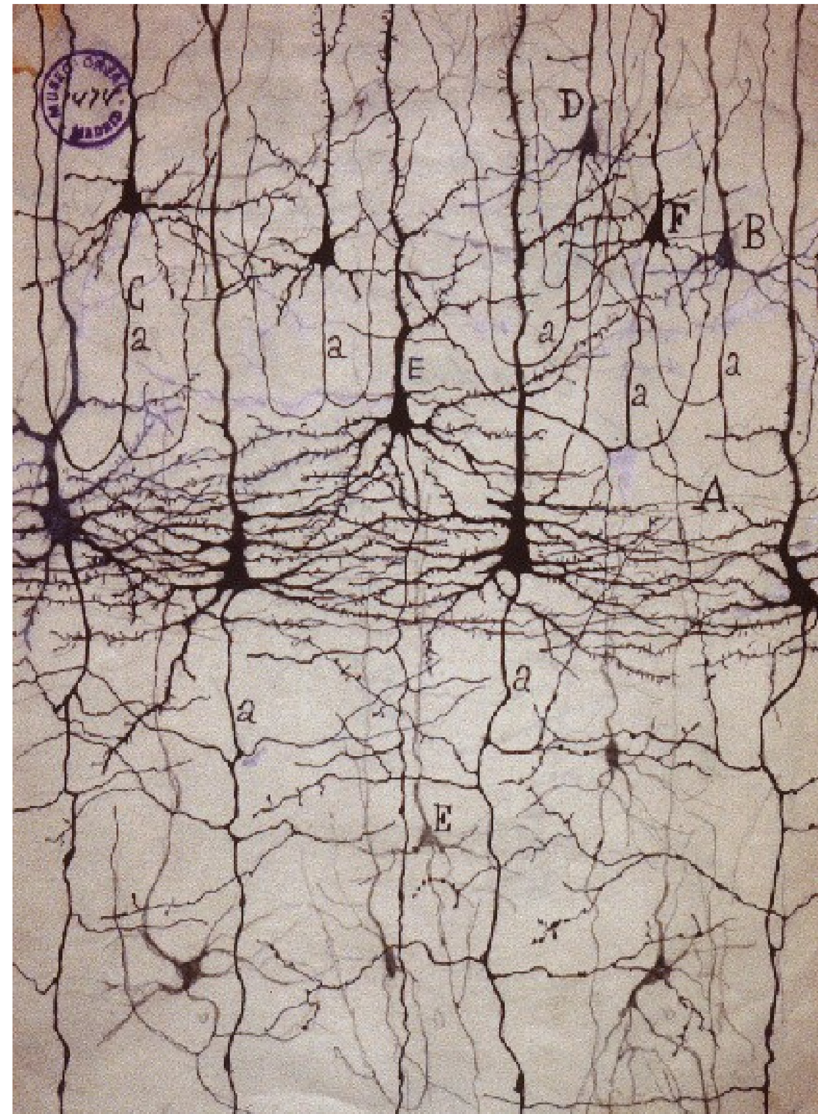
In the present article we aim at presenting Freudian theory on the functional organization of the nervous system developed in the *Project*, with particular respect to his ideas of the cellular bases of memory.

Theme: Neural basis of behavior
Topic: Learning and memory: physiology

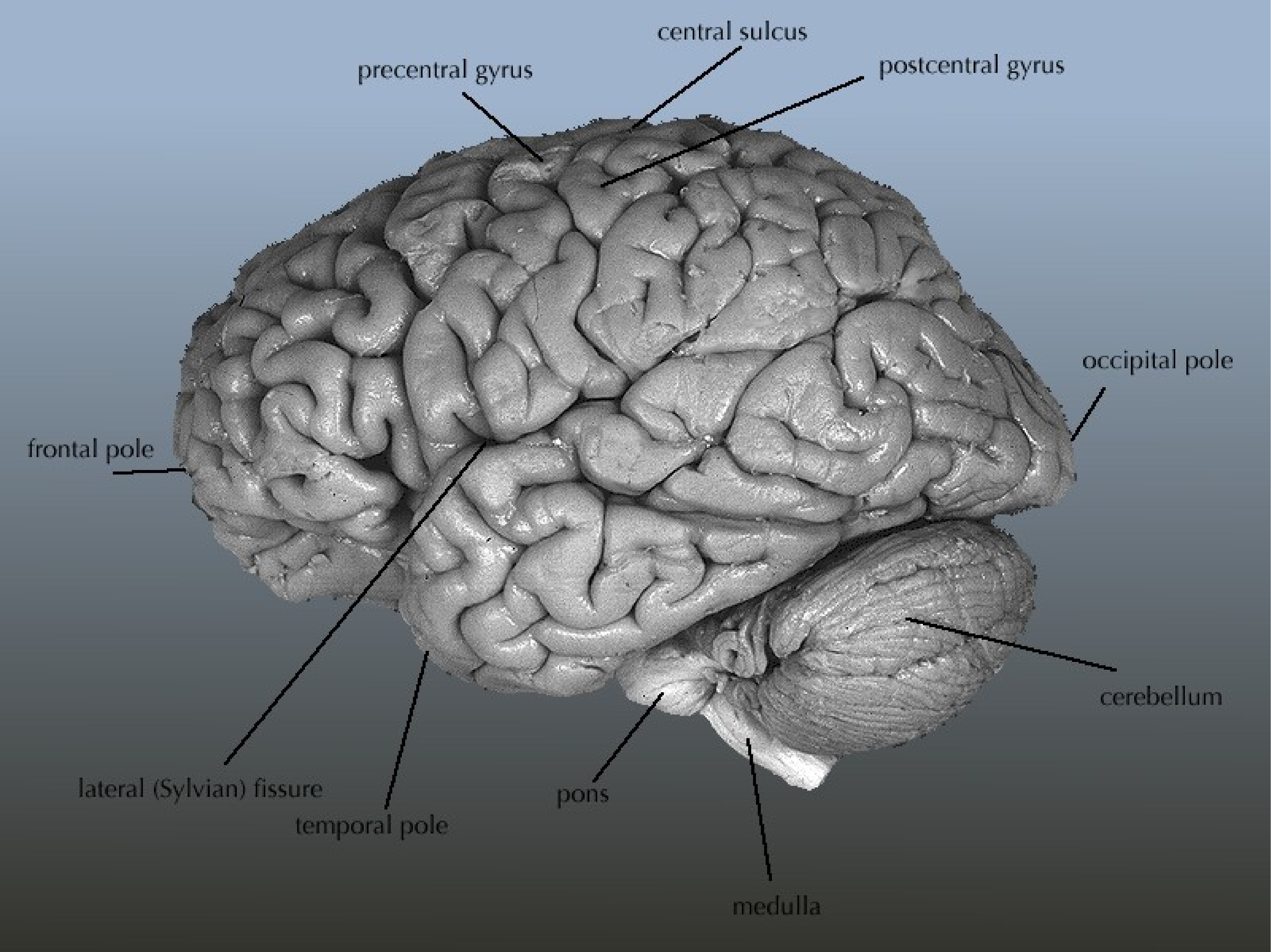
Keywords: Sigmund Freud; Donald Hebb; Synaptic plasticity; Learning; Memory; Psychoanalysis

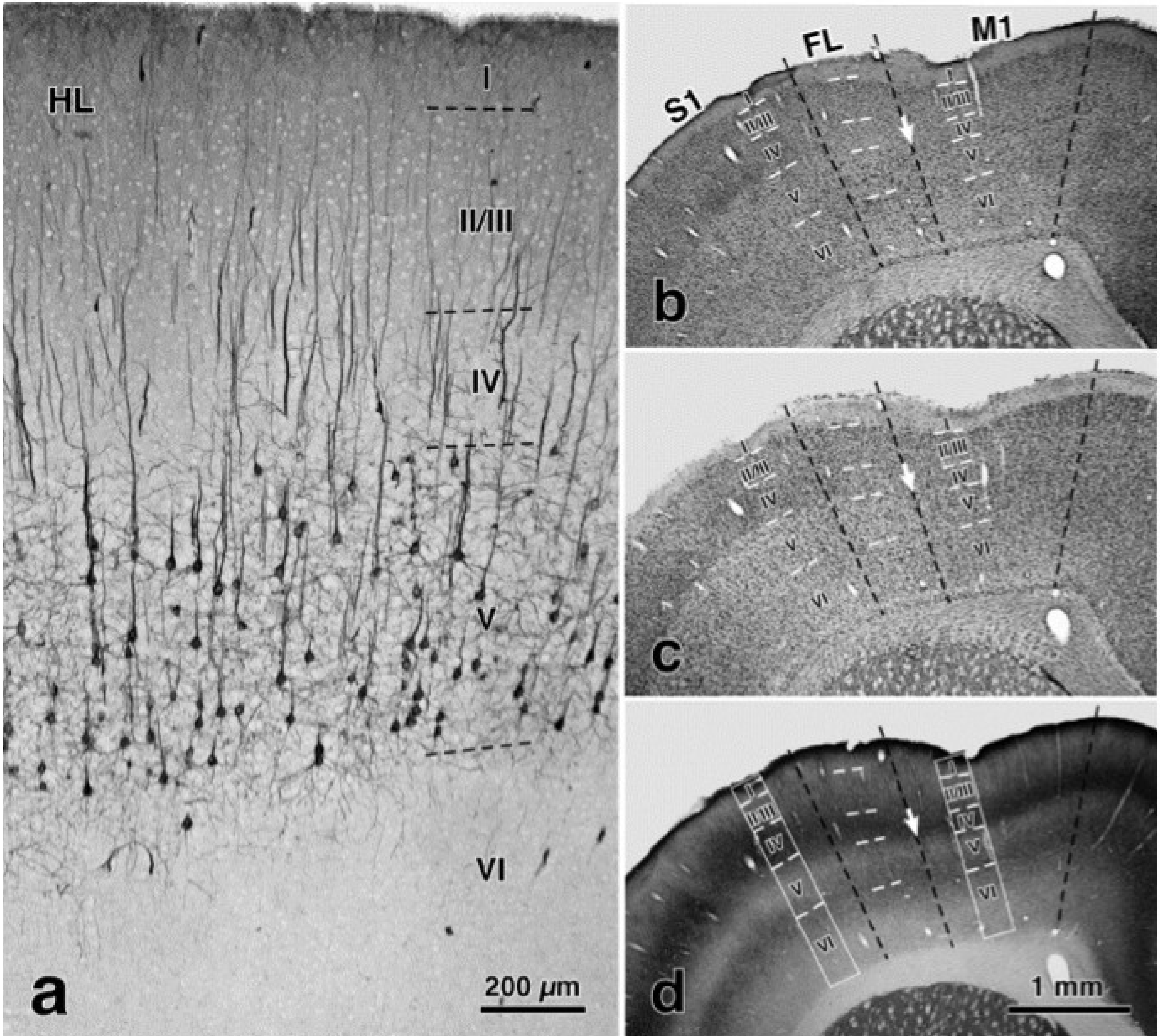
Santiago Ramon y Cajal
(1852-1934)





- the neuron doctrine
- the law of dynamic polarization


central sulcus
precentral gyrus
postcentral gyrus
occipital pole
frontal pole
cerebellum
lateral (Sylvian) fissure
pons
temporal pole
medulla



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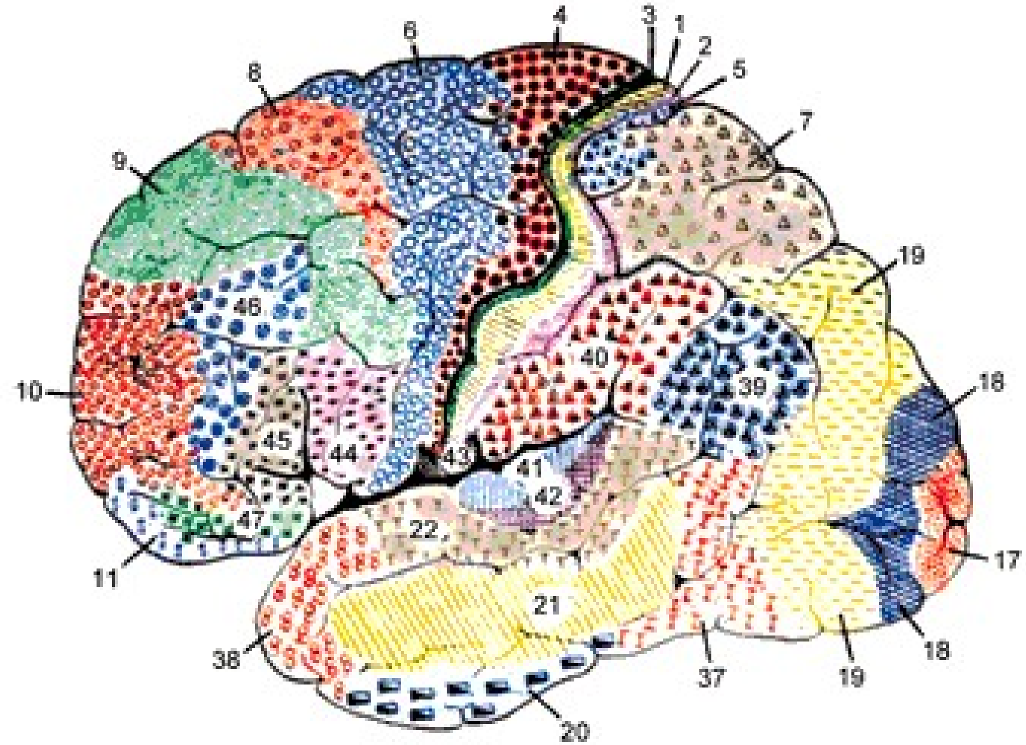
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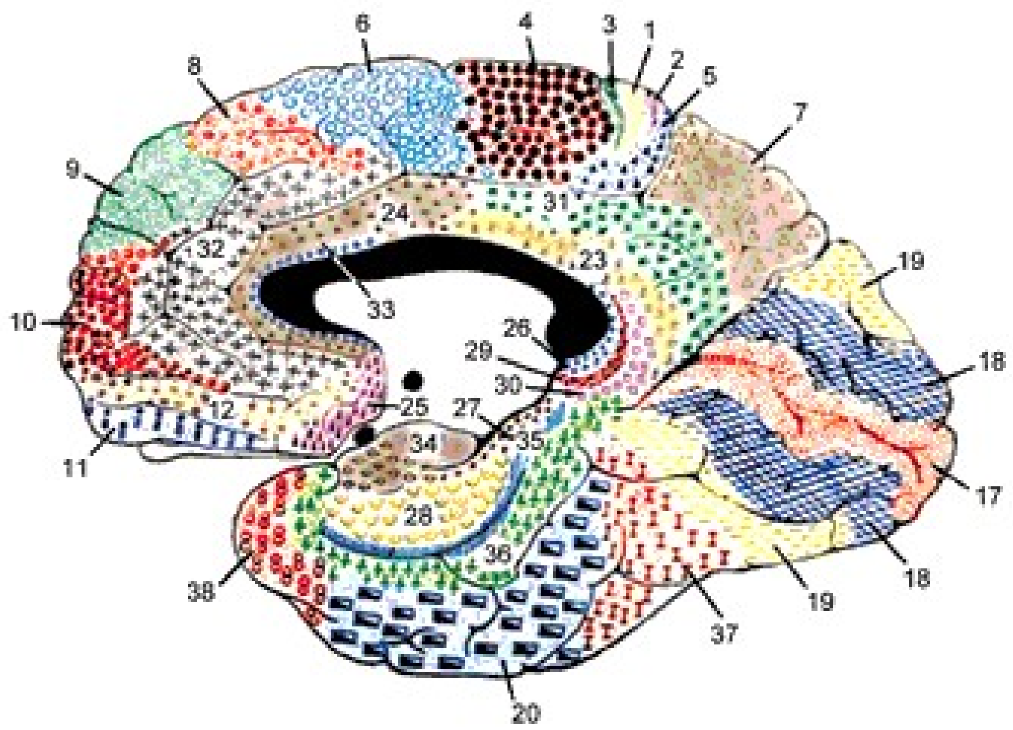
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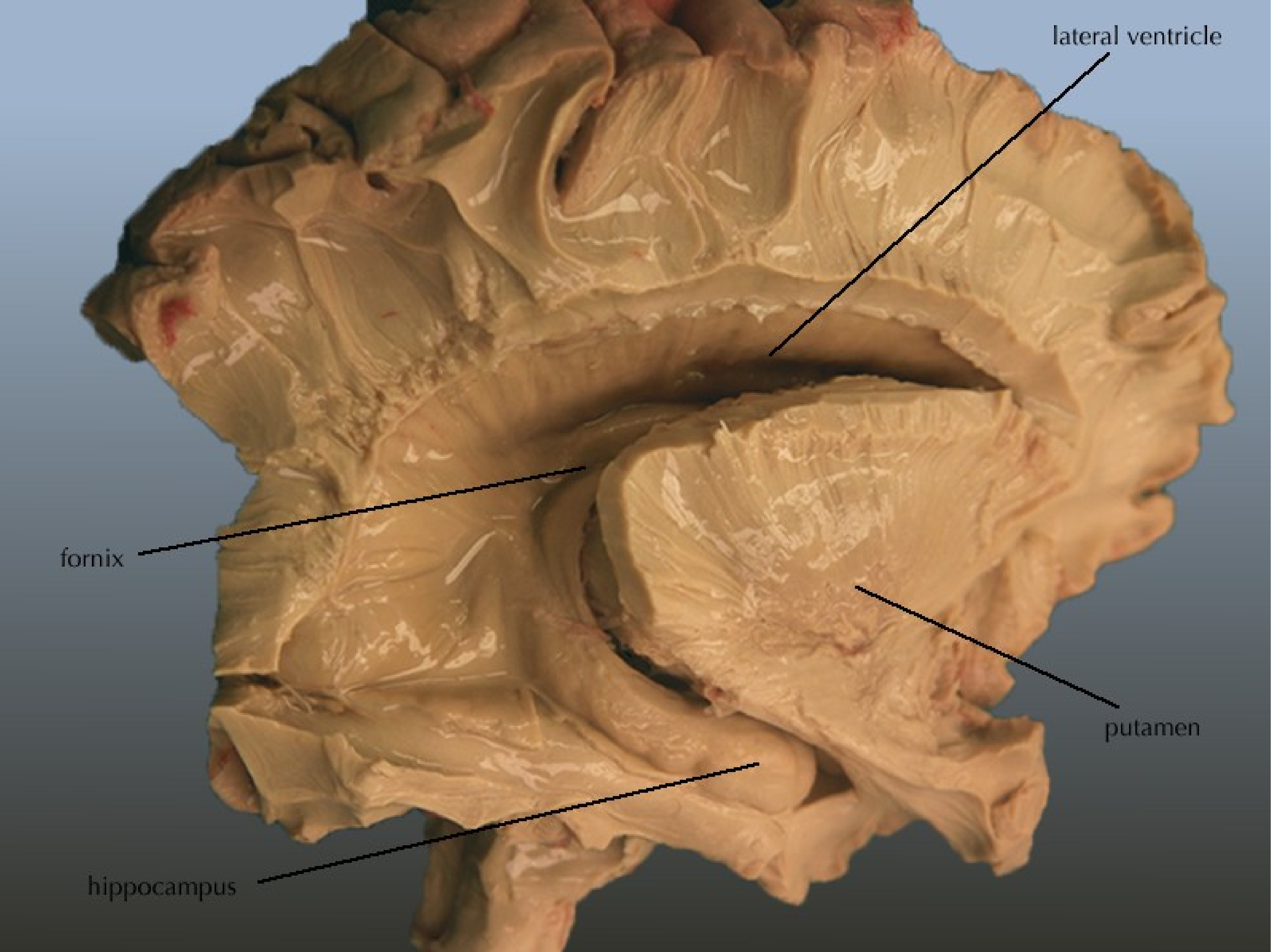

lateral ventricle
fornix
putamen
hippocampus

Table 1 – Nature Neuroscience

http://www.nature.com/neuro/journal/v6/n8/fig_tab/nn1096_T1.html

nature neuroscience

Close window

Table 1

Nature Neuroscience **6**, 795 - 799 (2003)
Published online: 28 July 2003; | doi:10.1038/nn1096

From gene networks to brain networks

Mihail Bota, Hong-Wei Dong & Larry W Swanson

Table 1 Limbic system connections (cell group to cell group)

Era	Major techniques	Total	Valid today	% Valid
Hypothalamus				
1940	Normal silver/myelin degeneration[31,32]	55	10	18%
1969	Axon degeneration (Nauta method)[33,34]	75	38	51%
1987	Axonal transport (autoradiography/HRP)[35]	450	400	90%
2002	PHAL/dyes/histochemistry[a]	3,000	2,850	95%
Hippocampus-amygdala-septum				
1969	Axon degeneration[36–38]	57	40	70%
2002	PHAL/dyes/histochemistry[a]	2,000	1,900	95%
Hypothalamus + Hippocampus-amygdala-septum				
1969	Axon degeneration	116[b]	70	60%
2002	PHAL/dyes/histochemistry	4,000[b]	3,800	95%

[a]Estimate based on informal survey of the literature. [b]Some connections of the hypothalamus are with the hippocampus-amygdala-septum.

Close window

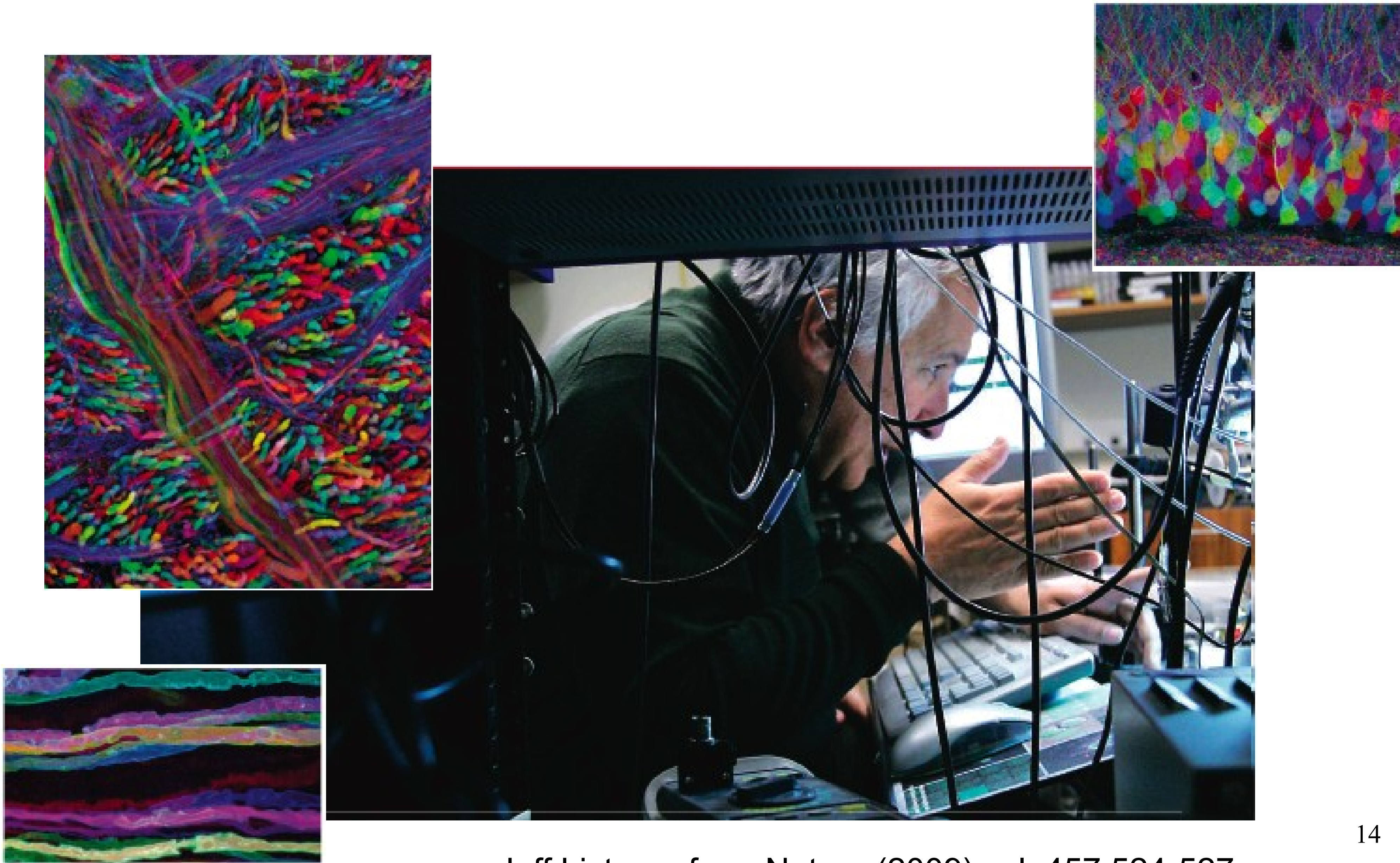
Done

Table 1. Databases and datasets containing information about neuroanatomical connections.

Database	Available Connectivity Information	URL
Brain Architecture Management System (BAMS) [2,26]	Projections in rodent brain, curated manually from existing literature	http://brancusi.usc.edu/bkms/
Collations of Connectivity Data on the Macaque Brain (CoCoMac) [23,24]	Projections in macaque brain, curated manually from existing literature	http://www.cocomac.org
Functional Anatomy of the Cerebro–Cerebellar System (FACCS) [29]	3D atlas of axonal tracing data in rat cerebro–cerebellar system	http://ocelot.uio.no/nesys/
BrainMaps.org [59]	Tables of connections from literature and primary data for some tracer injections	http://brainmaps.org
BrainPathways.org	Multiscale visualization of connectivity data from collated literature reports	http://brainpathways.org
Human Brain Connectivity Database	Curated reports of connectivity studies in postmortem human brain tissue	http://brainarchitecture.org
Internet Brain Connectivity Database	Estimated connectional data between human cortical gyral areas	http://www.cma.mgh.harvard.edu/ibcd/
Surface Management System DataBase (SumsDB) [64]	Connection densities from macaque retrograde tracer injections mapped to surface-based atlas	http://sumsdb.wustl.edu/sums/
SynapseWeb	Reconstructed volumes and structures from serial section electron microscopy	http://synapses.clm.utexas.edu/
Neocortical Microcircuit Database [71]	Connection data between single cells in mammalian cortex	http://microcircuit.epfl.ch/
ICBM DTI-81 Atlas [72]	Probabilistic atlas of human white matter tracts based on diffusion tensor imaging	http://www.loni.ucla.edu/Atlases/Atlas_Detail.jsp?atlas_id=15
Anatomy Toolbox Fiber Tracts [32]	Probabilistic atlas of human white matter tracts based on postmortem studies	http://www.fz-juelich.de/ime/spm_anatomy_toolbox
WormAtlas [30]	Full neuronal wiring data for *C. elegans*	http://www.wormatlas.org

doi:10.1371/journal.pcbi.1000334.t001

New Techniques to See Wiring



Jeff Lictman from Nature (2009) vol. 457:524-527.

Connectome

OPEN ACCESS Freely available online

PLoS COMPUTATIONAL BIOLOGY

Review

A Proposal for a Coordinated Effort for the Determination of Brainwide Neuroanatomical Connectivity in Model Organisms at a Mesoscopic Scale

Jason W. Bohland[1]*, Caizhi Wu[1], Helen Barbas[2], Hemant Bokil[1], Mihail Bota[3], Hans C. Breiter[4], Hollis T. Cline[1], John C. Doyle[5], Peter J. Freed[6], Ralph J. Greenspan[7], Suzanne N. Haber[8], Michael Hawrylycz[9], Daniel G. Herrera[10], Claus C. Hilgetag[11], Z. Josh Huang[1], Allan Jones[9], Edward G. Jones[12], Harvey J. Karten[13], David Kleinfeld[14], Rolf Kötter[15], Henry A. Lester[16], John M. Lin[1], Brett D. Mensh[17], Shawn Mikula[12], Jaak Panksepp[18], Joseph L. Price[19], Joseph Safdieh[20], Clifford B. Saper[21], Nicholas D. Schiff[20], Jeremy D. Schmahmann[22], Bruce W. Stillman[1], Karel Svoboda[23], Larry W. Swanson[3], Arthur W. Toga[24], David C. Van Essen[19], James D. Watson[1], Partha P. Mitra[1]

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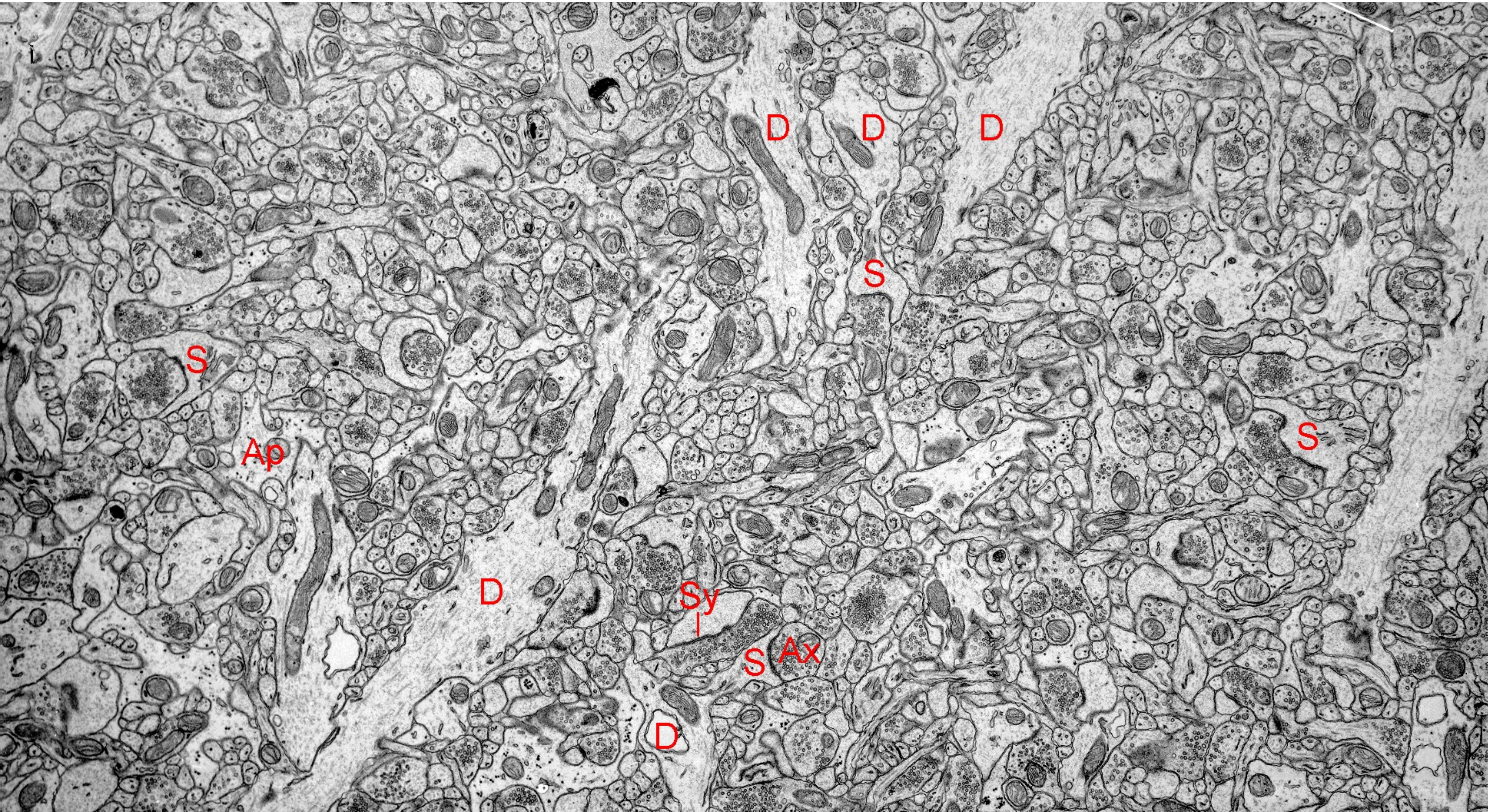
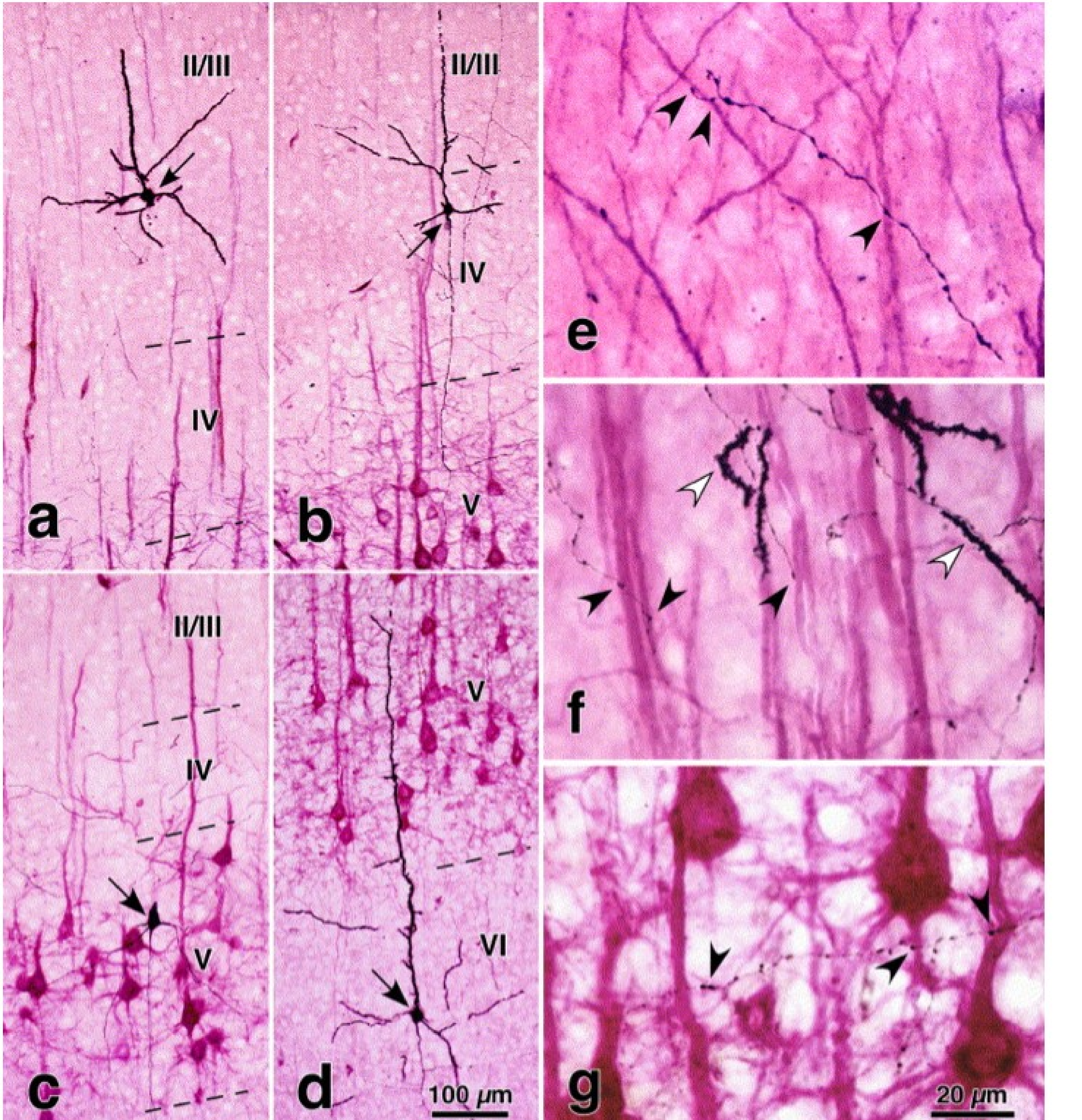
March 2009

Neuropil




II/III
IV
a
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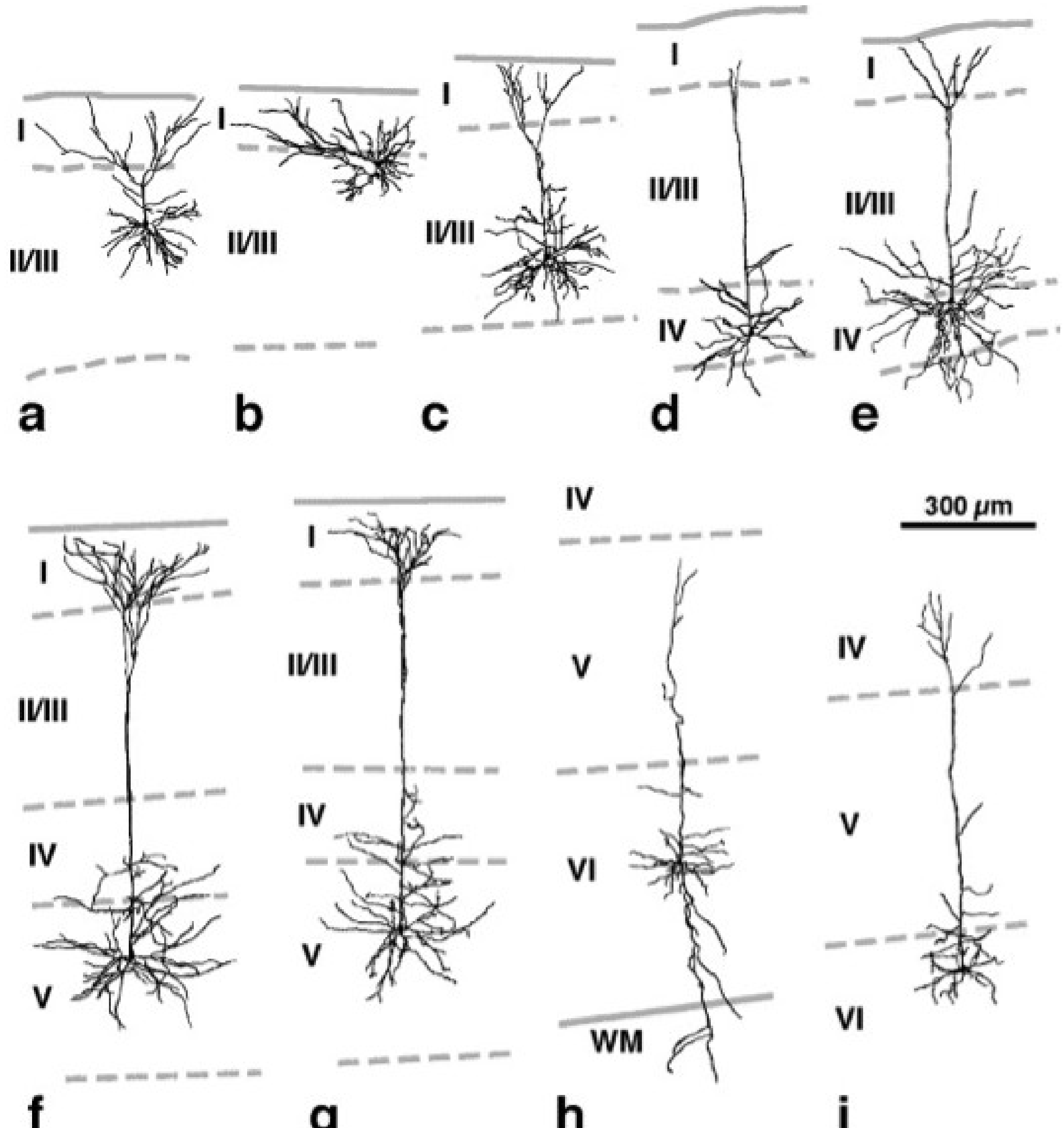
IV
V
b
II/III
IV
V
c
V
VI
d
100 μm
e
f
g
20 μm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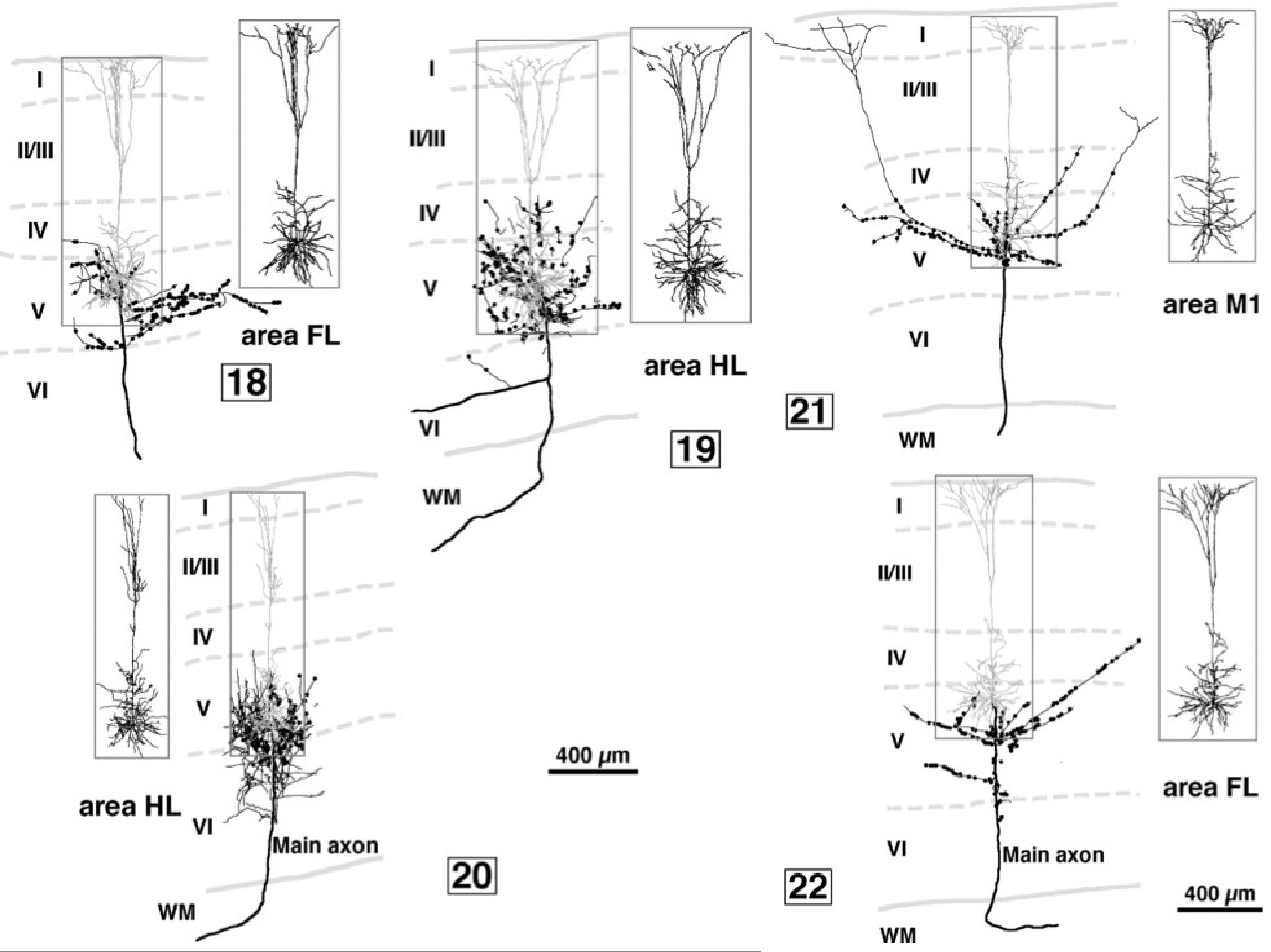
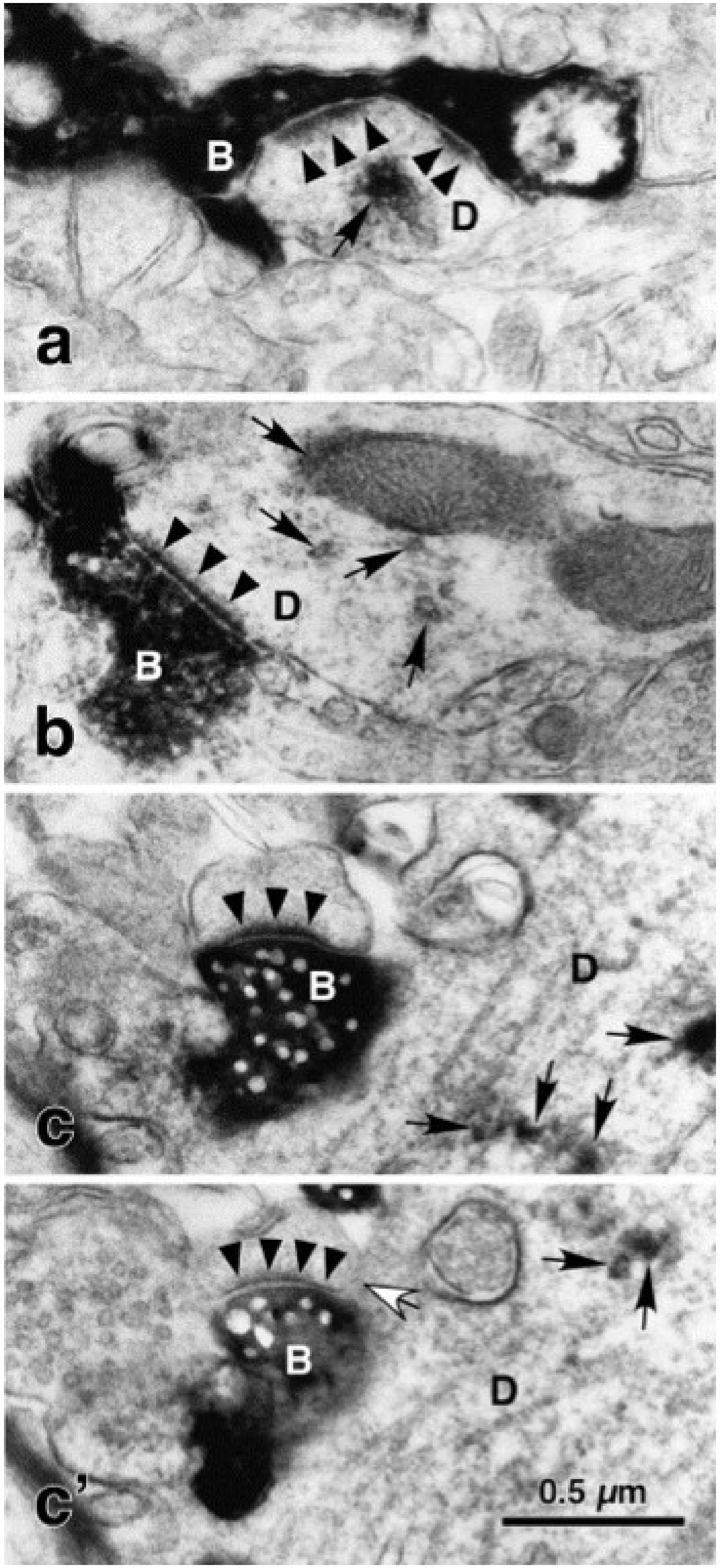
WM
h
300 μm
IV
V
VI
i



I
II/III
IV
V
VI
WM
area FL
18
area HL
19
area M1
21
area HL
Main axon
20
400 μm
area FL
Main axon
22
400 μm


B
D
a
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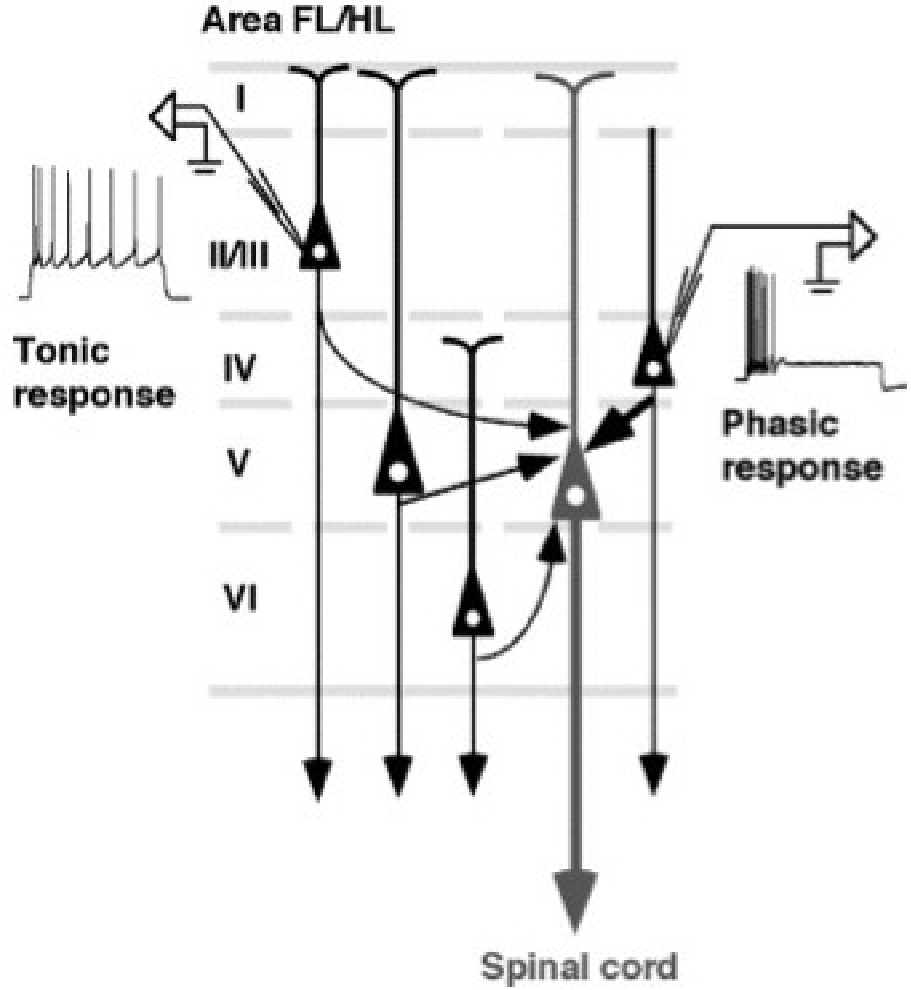
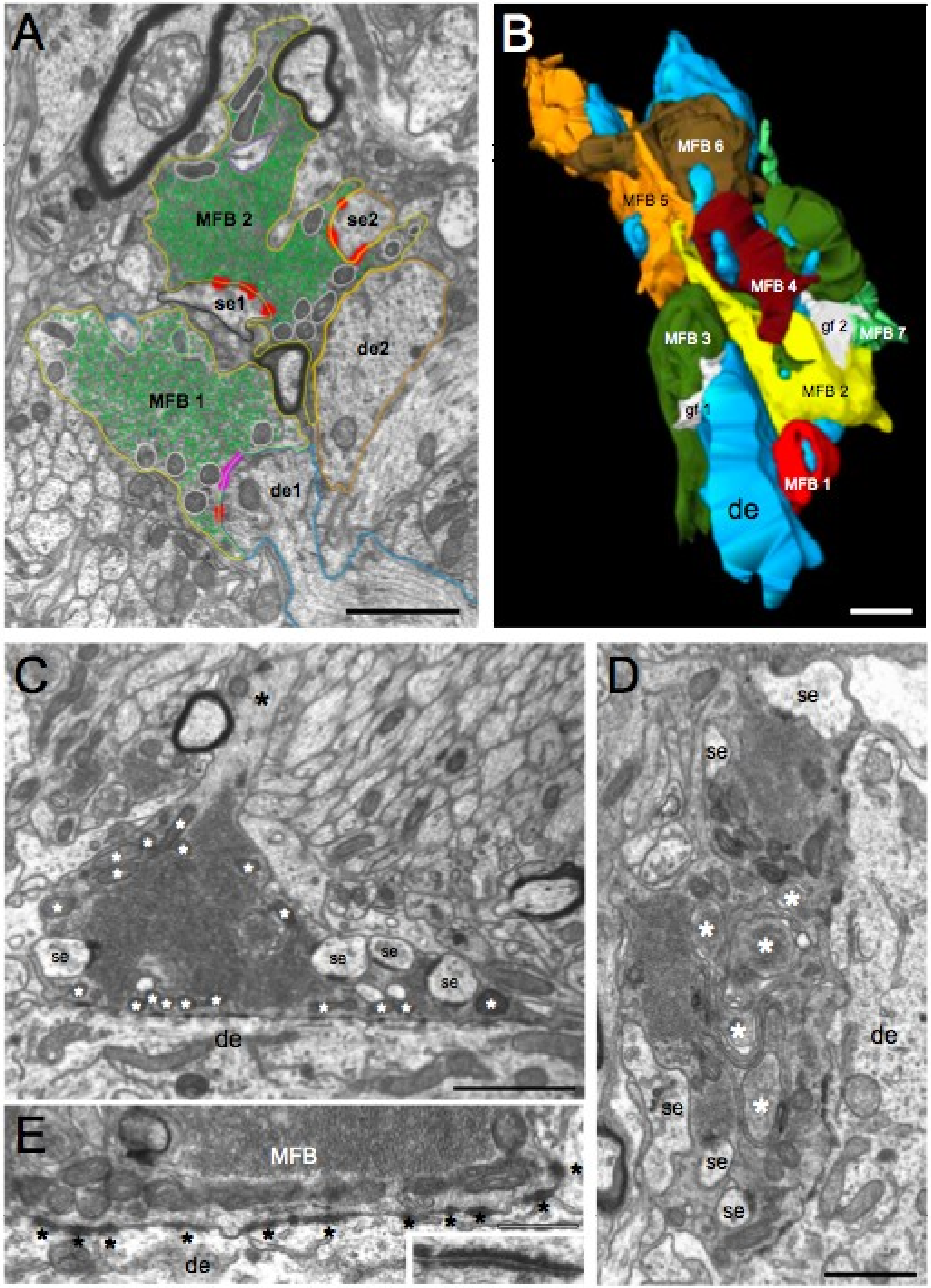
B
D
c
c'
0.5 μm


Area FL/HL
I
II/III
IV
V
VI
Tonic response
Phasic response
Spinal cord



10434 • The Journal of Neuroscience, September 26, 2007 • 27(39):10434–10444

Development/Plasticity/Repair

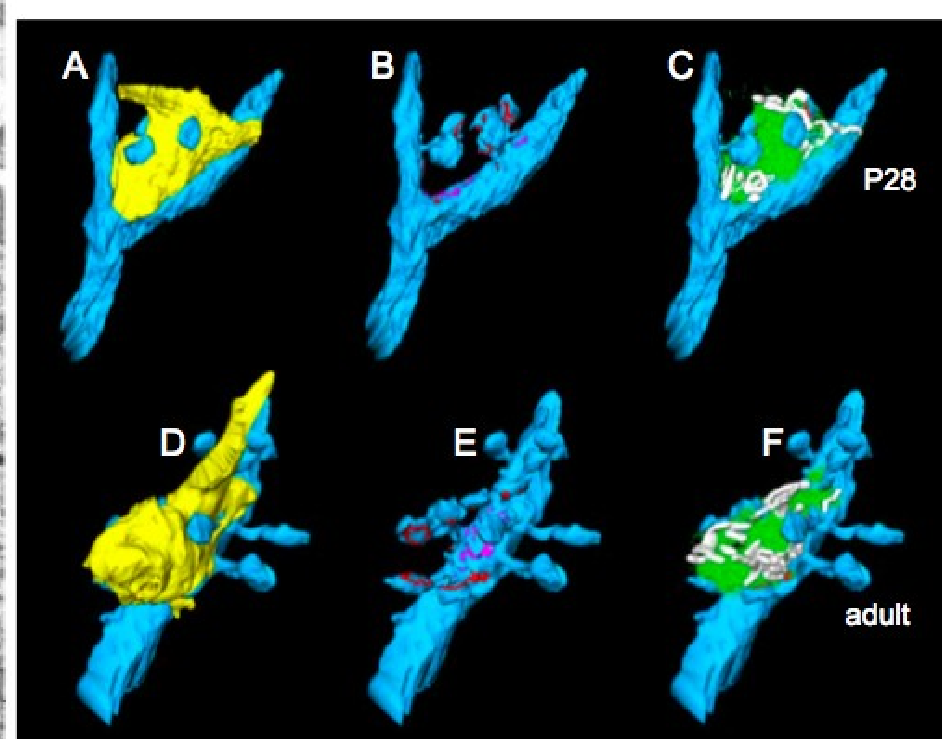
Structural Determinants of Transmission at Large Hippocampal Mossy Fiber Synapses

Astrid Rollenhagen,[1,4]* Kurt Sätzler,[2]* E. Patricia Rodríguez,[2] Peter Jonas,[3] Michael Frotscher,[4] and Joachim H. R. Lübke[1,4]

[1]Institute of Neuroscience and Biophysics INB-3, Research Centre Jülich, D-52425 Jülich, Germany, [2]School of Biomedical Sciences, University of Ulster, Coleraine, County Londonderry BT52 1SA, United Kingdom, and Institutes of [3]Physiology and [4]Anatomy and Cell Biology, Albert Ludwigs University of Freiburg, D-79104 Freiburg, Germany

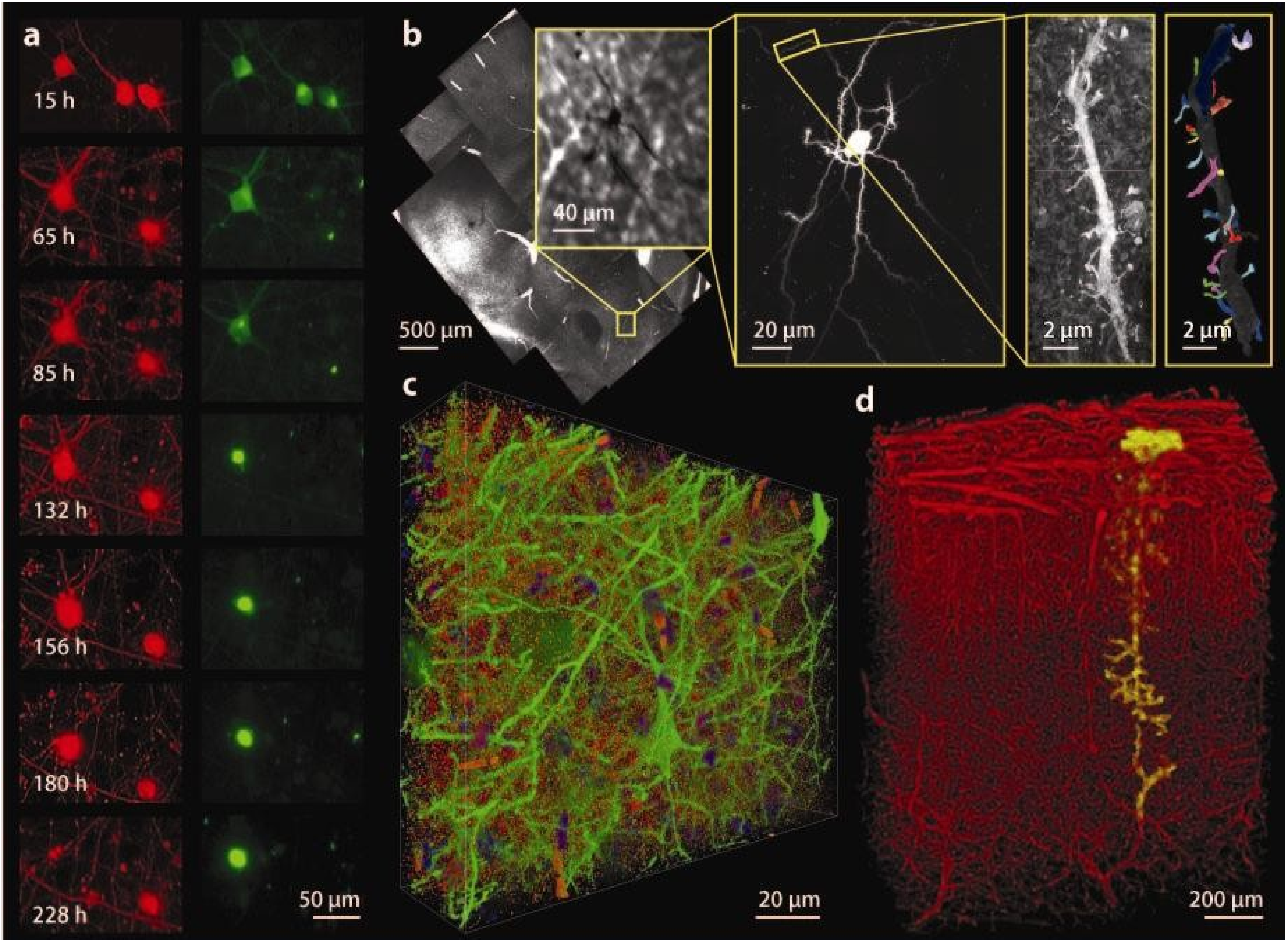
Synapses are the key elements for signal processing and plasticity in the brain. To determine the structural factors underlying the unique functional properties of the hippocampal mossy fiber synapse, the complete quantitative geometry was investigated, using electron microscopy of serial ultrathin sections followed by computer-assisted three-dimensional reconstruction. In particular, parameters relevant for transmitter release and synaptic plasticity were examined. Two membrane specializations were found: active zones (AZs), transmitter release sites, and puncta adherentia, putative adhesion complexes. Individual boutons had, on average, 25 AZs (range, 7–45) that varied in shape and size (mean, 0.1 μm^2; range, 0.07–0.17 μm^2). The mean distance between individual AZs was 0.45 μm. Mossy fiber boutons and their target structures were mostly ensheathed by astrocytes, but fine glial processes never reached the active zones. Two structural factors are likely to promote synaptic cross talk: the short distance between AZs and the absence of fine glial processes at AZs. Thus, synaptic cross talk may contribute to the efficacy of hippocampal mossy fiber synapses. On average, a bouton contained 20,400 synaptic vesicles; ~900 vesicles were located within 60 nm from the active zone, ~4400 between 60 and 200 nm, and the remaining beyond 200 nm, suggesting large readily releasable, recycling, and reserve pools. The organization of the different pools may be a key structural correlate of presynaptic plasticity at this synapse. Thus, the mossy fiber bouton differs fundamentally in structure and function from the calyx of Held and other central synapses.

Key words: mossy fiber; neuromodulation; synapse; synaptic transmission; synaptic plasticity; synaptic vesicle release

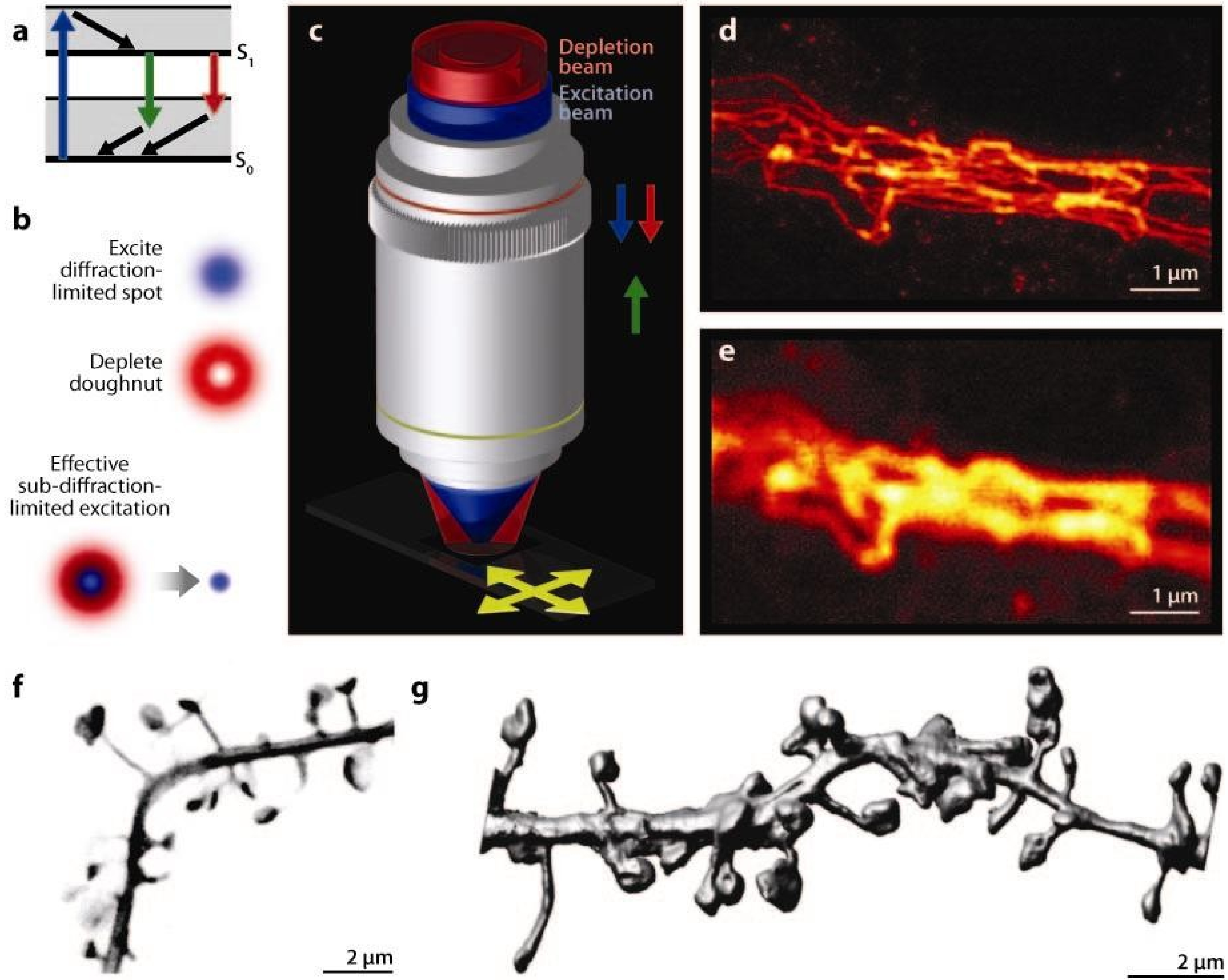


Large-Scale Neural Circuit Reconstruction

- Complete (dense) mapping of neural network structure is needed
- Manual tracing of most networks of interest would require hundreds to tens of thousands of years in human labor

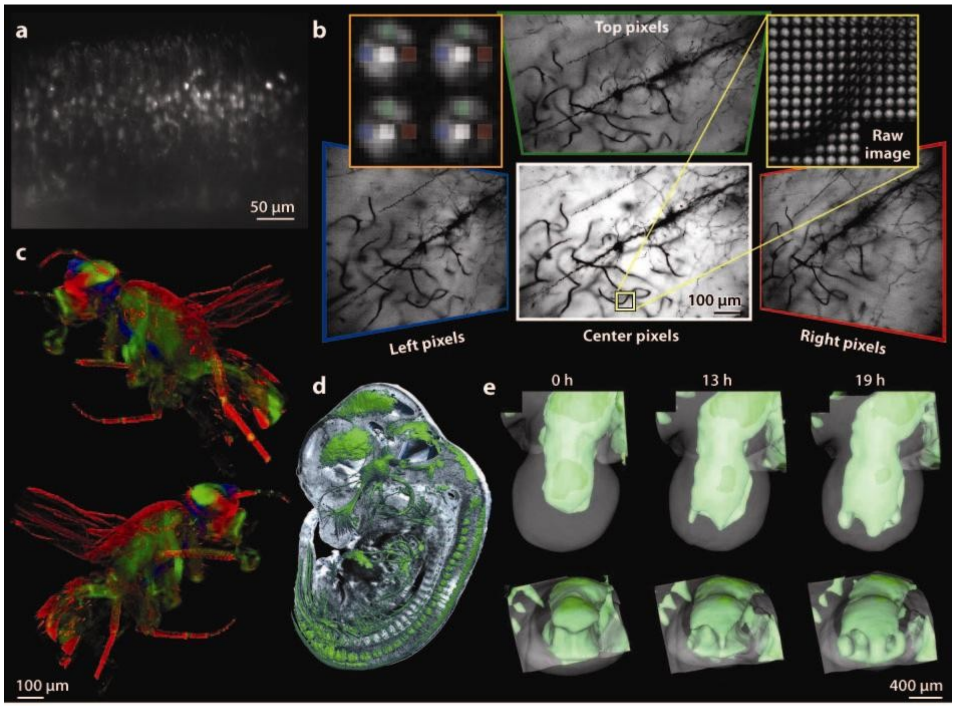


Wilt BA, et al. 2009.
Annu. Rev. Neurosci. 32:435–506



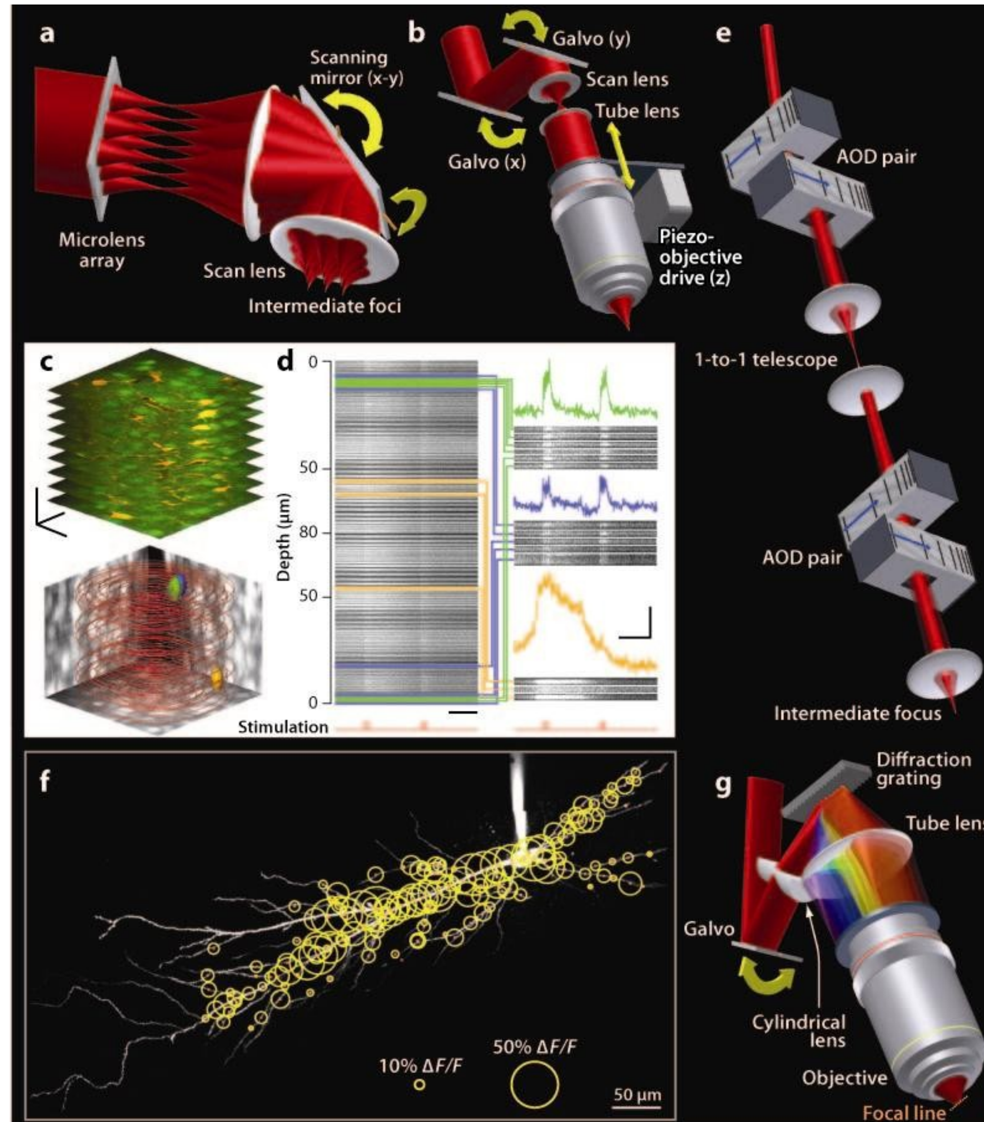
Wilt BA, et al. 2009.
Annu. Rev. Neurosci. 32:435–506

Signals in the Neuropil



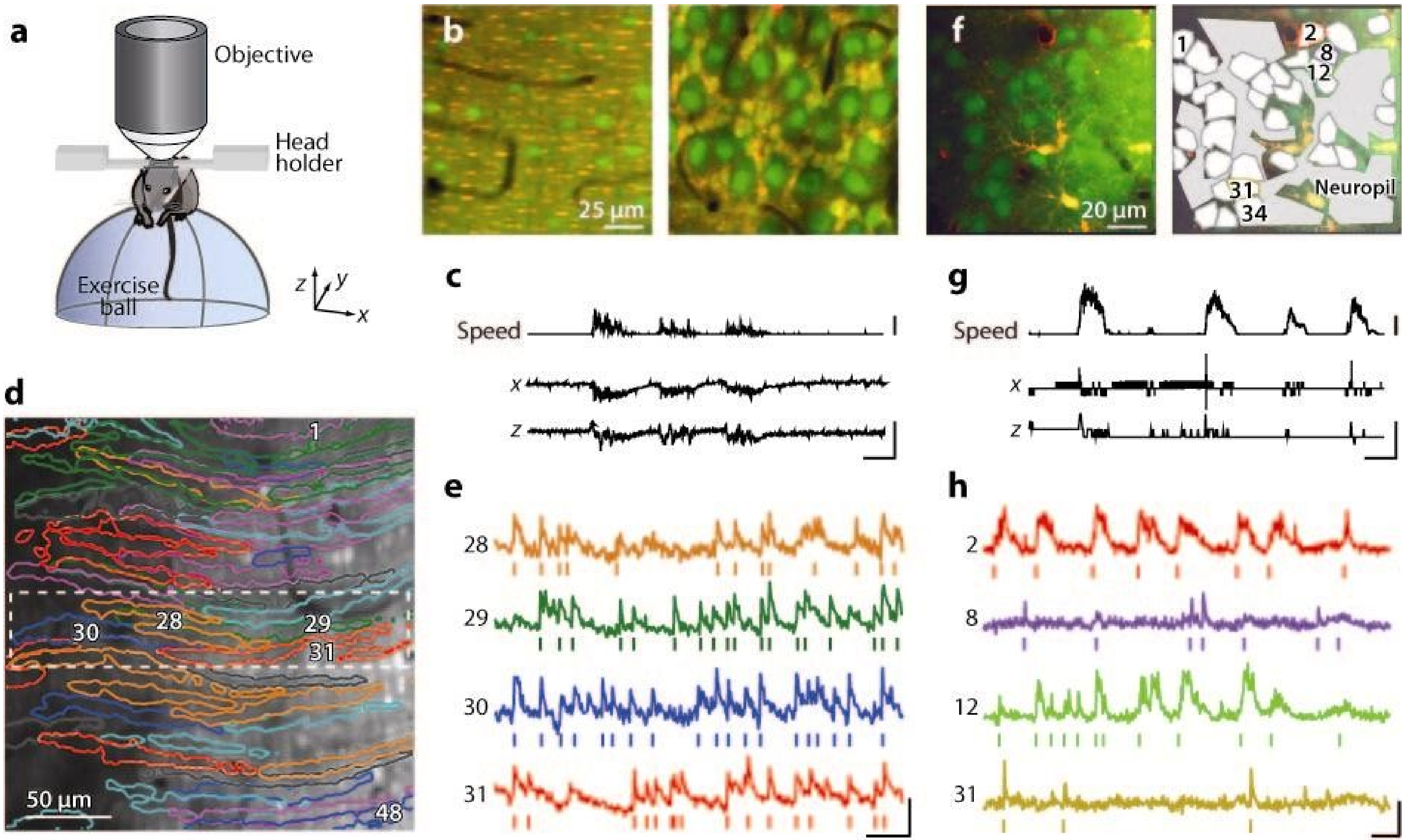
Wilt BA, et al. 2009.
Annu. Rev. Neurosci. 32:435–506

Electrical conduction characteristics of axons and dendrites



Wilt BA, et al. 2009.
Annu. Rev. Neurosci. 32:435–506

Activity in Awake Behaving Animals



Wilt BA, et al. 2009.
Annu. Rev. Neurosci. 32:435–506

Neuroinformatics Challenge

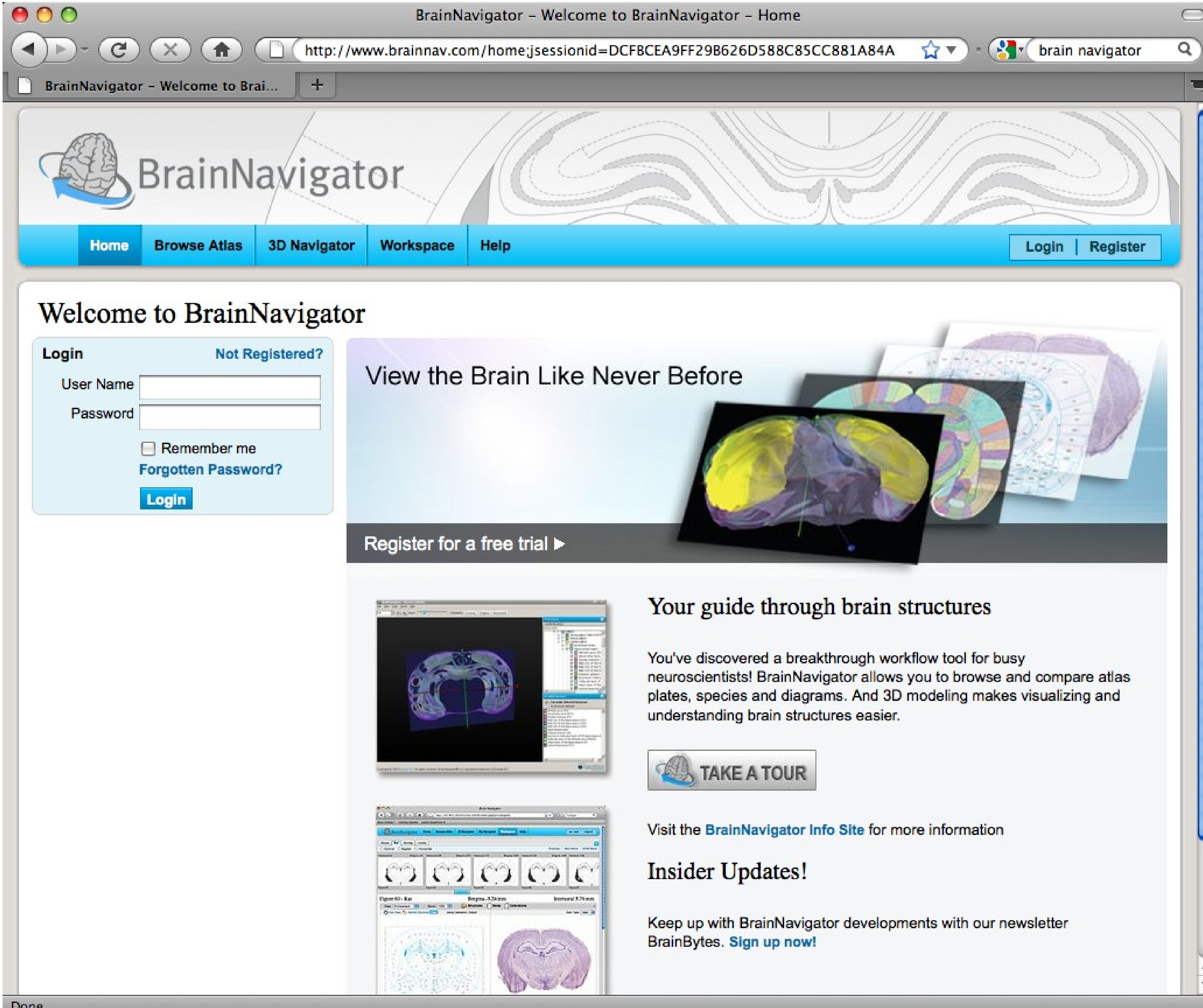
Devise methods for representing, accessing, and integrating vast amounts of diverse and complex data

Some Exciting Technologies/Projects

- NeuroText
- Human Brain Project (HBP)
- Bioinformatics Research Network (BIRN)
- Neuroinformatics Information Network (NIF)
- SenseLab
    - NeuronDB
    - CellPropDB
- Entity-Attribute-Value/Classes and Relationships (EAV/CR)
- BrainML
- NeuroML
    - NeuroML Development Kit
- MorphML
- Catacomb
- GENESIS
    - EXODUS
- Web Interfacing Repository Manager (WIRM)
- Synapse Web
- NeuroSys
- Common Data Model for Neurosciences (CDM)
- Protege
- Cell Centered Database (CCDB)
- VisANT
- Extensible Markup Language (XML)
- Systems Biology Markup Language (SBML)
- MathML
- Virtual RatBrain Project
- MorphML Viewer
- NEURON
    - ModelView
- NeuroConstruct

More Exciting Technologies/Projects

- Brain Information Management System (BIMS)
- Digital Anatomist
- Atlas of the Human Brain
- Medical Neuroscience
- Whole Brain Atlas
- BrainMaps.org
- Mouse Brain Library
- LONI
- Allen Brain Atlas
- CoCoMac
- The Brain Architecture Management System (BAMS)
- Neuroscience Information Framework (NIF)
- Unified Medical Language System (UMLS)
- BrainInfo
- Simulator for Neural Networks and Action Potentials (SNNAP)
- International Neuroinformatics Coordinating Facility (INCF)


BrainNavigator – Welcome to BrainNavigator – Home
http://www.brainnav.com/home;jsessionid=DCFBCEA9FF29B626D588C85CC881A84A
brain navigator
BrainNavigator – Welcome to Brai...
BrainNavigator
Home
Browse Atlas
3D Navigator
Workspace
Help
Login | Register
Welcome to BrainNavigator
Login
Not Registered?
User Name
Password
Remember me
Forgotten Password?
Login
View the Brain Like Never Before
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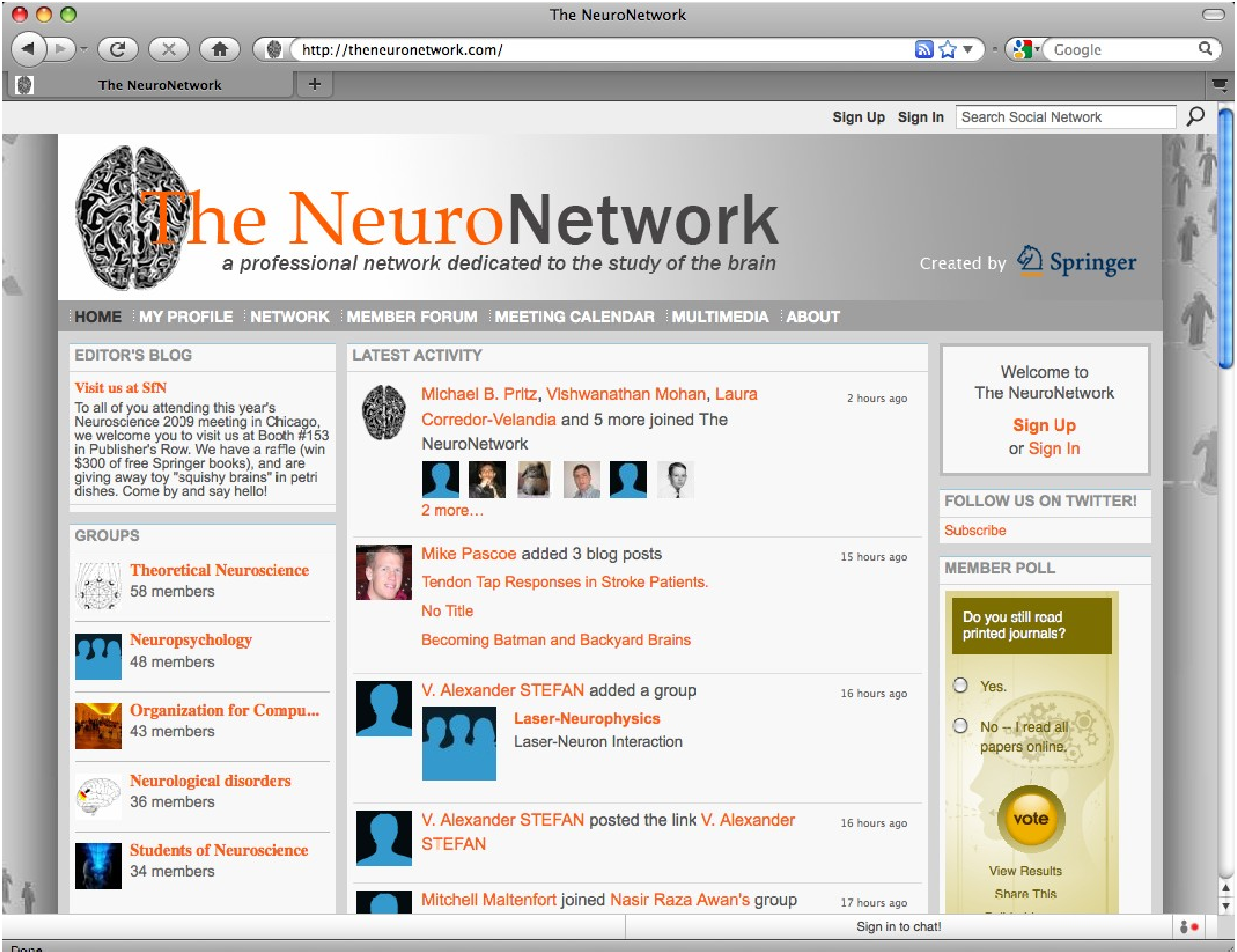
The NeuroNetwork
http://theneuronetwork.com/
Google
The NeuroNetwork
Sign Up Sign In
Search Social Network
The NeuroNetwork
a professional network dedicated to the study of the brain
Created by Springer
HOME
MY PROFILE
NETWORK
MEMBER FORUM
MEETING CALENDAR
MULTIMEDIA
ABOUT
EDITOR'S BLOG
Visit us at SfN
To all of you attending this year's Neuroscience 2009 meeting in Chicago, we welcome you to visit us at Booth #153 in Publisher's Row. We have a raffle (win $300 of free Springer books), and are giving away toy "squishy brains" in petri dishes. Come by and say hello!
GROUPS
Theoretical Neuroscience
58 members
Neuropsychology
48 members
Organization for Compu...
43 members
Neurological disorders
36 members
Students of Neuroscience
34 members
LATEST ACTIVITY
Michael B. Pritz, Vishwanathan Mohan, Laura Corredor-Velandia and 5 more joined The NeuroNetwork
2 hours ago
2 more…
Mike Pascoe added 3 blog posts
15 hours ago
Tendon Tap Responses in Stroke Patients.
No Title
Becoming Batman and Backyard Brains
V. Alexander STEFAN added a group
16 hours ago
Laser-Neurophysics
Laser-Neuron Interaction
V. Alexander STEFAN posted the link V. Alexander STEFAN
16 hours ago
Mitchell Maltenfort joined Nasir Raza Awan's group
17 hours ago
Welcome to
The NeuroNetwork
Sign Up
or Sign In
FOLLOW US ON TWITTER!
Subscribe
MEMBER POLL
Do you still read printed journals?
Yes.
No -- I read all papers online.
vote
View Results
Share This
Sign in to chat!
Done

Summary

- Help neuroscientists do more effectively, affordably, and conveniently a job they have long been trying to do.
- Drive accessibility and broader practical use.
- Informatics innovation related to large-scale automated data collection.