

Functional anatomy of the cerebellum

International Parkinson and Movement Disorder Society – European Section
Diagnosis and Treatment of Cerebellar Ataxias
July 13th 2026

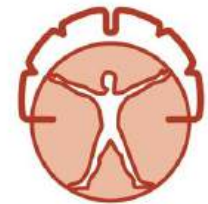
Jeremy D. Schmahmann, MD, FAAN, FANA, FANPA
Martha and Robert Fogelman Endowed Chair in Ataxia and Cerebellar Neurology
Founding Director, Ataxia Center; Division of Behavioral Neurology; Massachusetts General Hospital
Professor of Neurology, Harvard Medical School



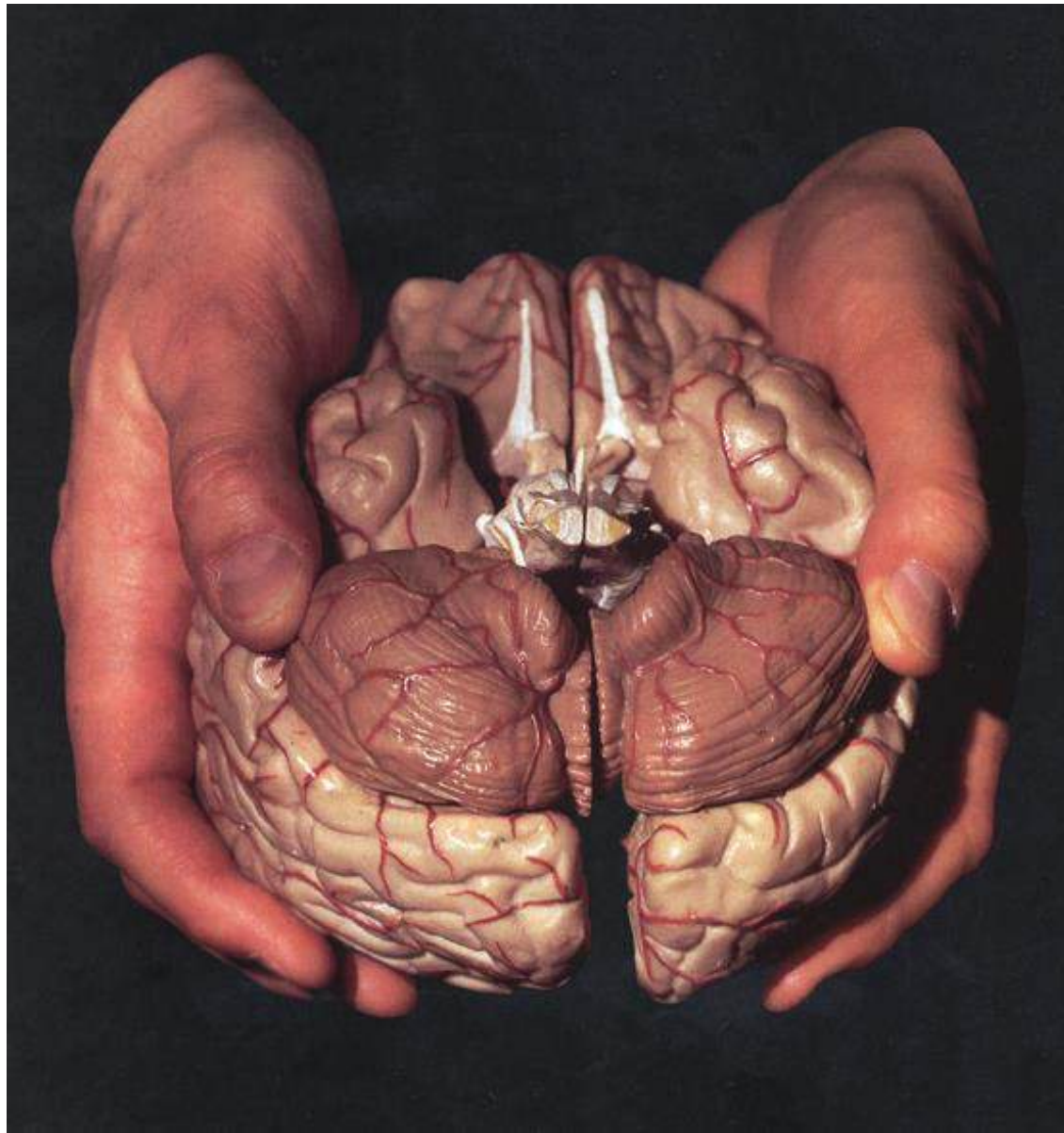
jschmahmann@mgh.harvard.edu



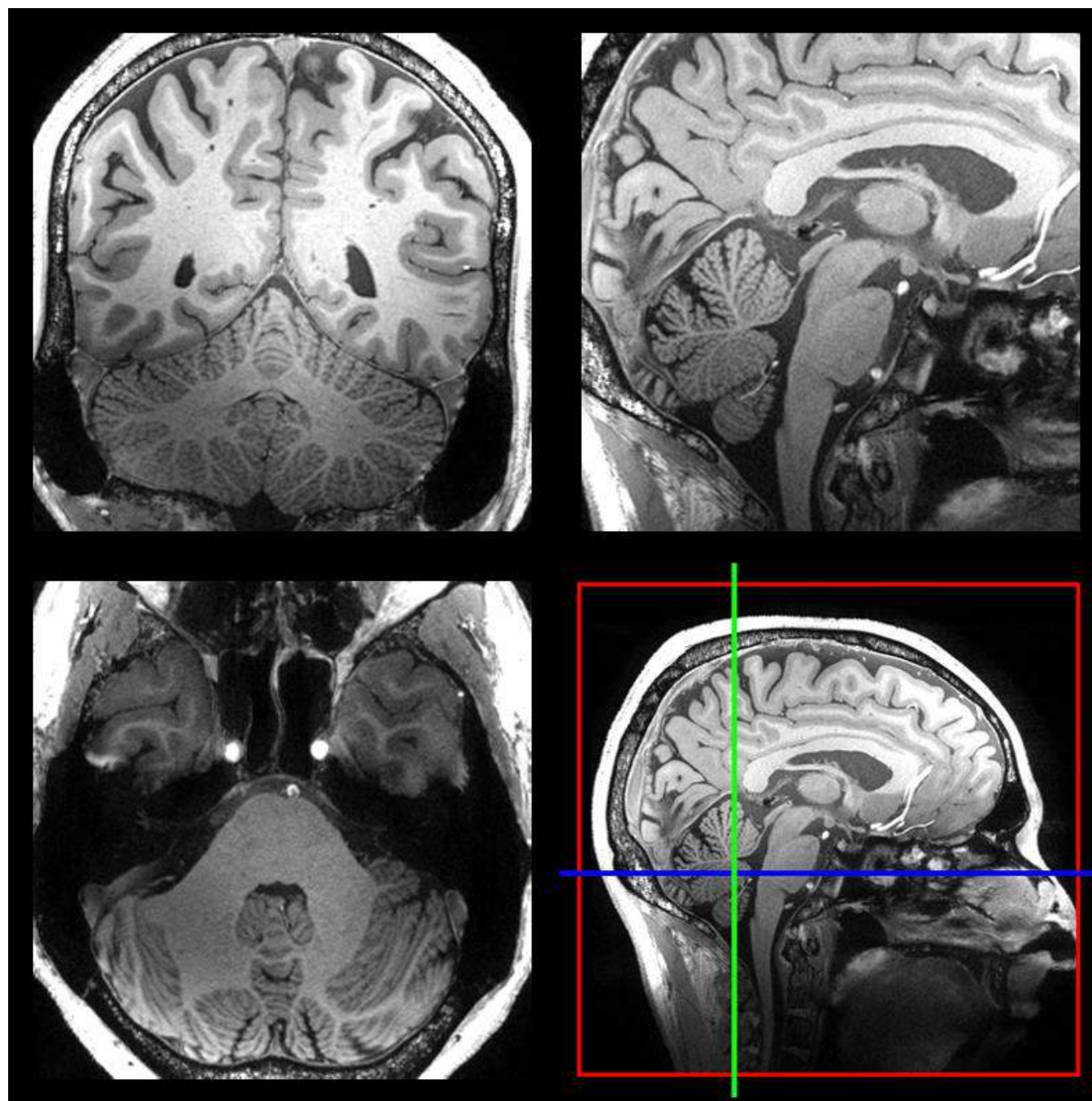
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International Parkinson and
Movement Disorder Society
European Section

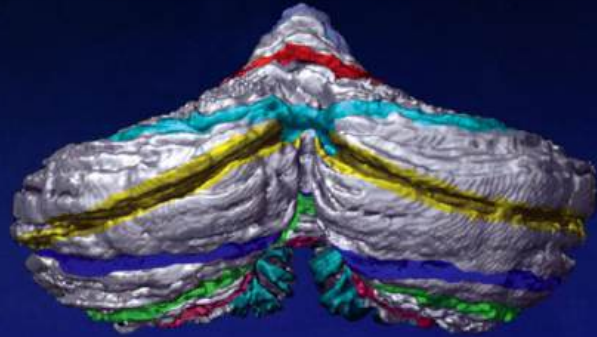


from *The Sorcerer's Apprentice*.
Jonathan Leonard, *Harvard Magazine*, 1999



Gray's Anatomy 42e. Courtesy Bruce Fischl, Andre van Kouwe, Otto Rapalino, Jonathan Polimeni.
Laboratory for Computational Neuroimaging, Martinos Center for Biomedical Imaging, Massachusetts General Hospital

MRI ATLAS of the HUMAN CEREBELLUM



Jeremy D. Schmahmann

Julien Doyon

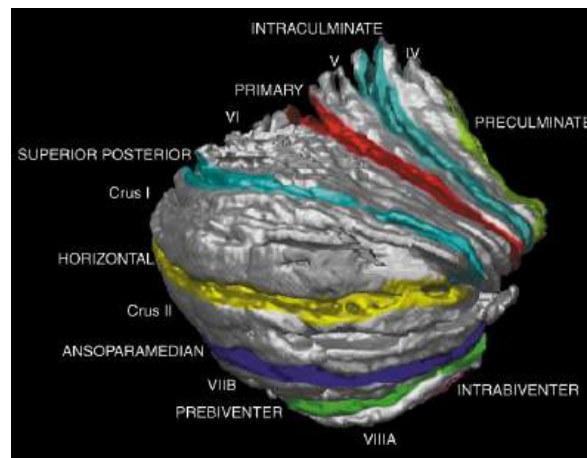
Arthur W. Toga

Michael Petrides

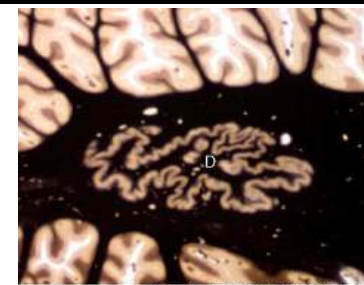
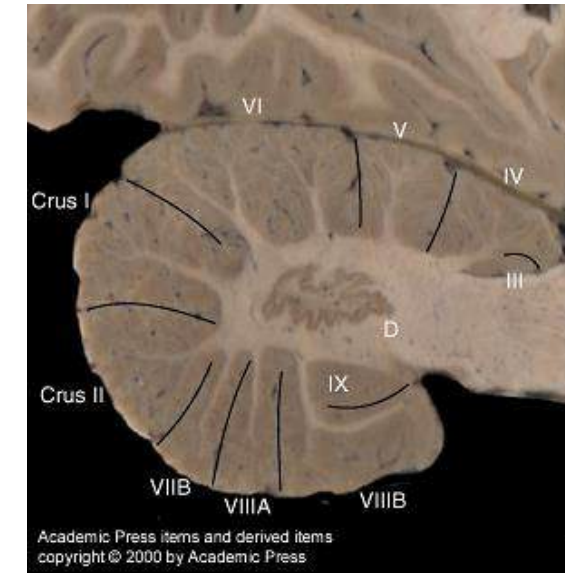
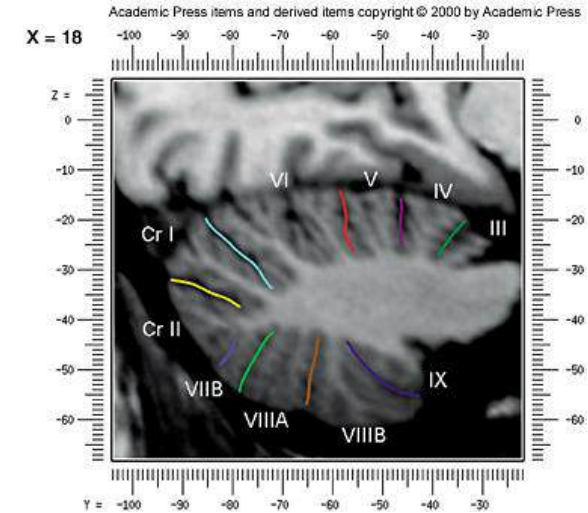
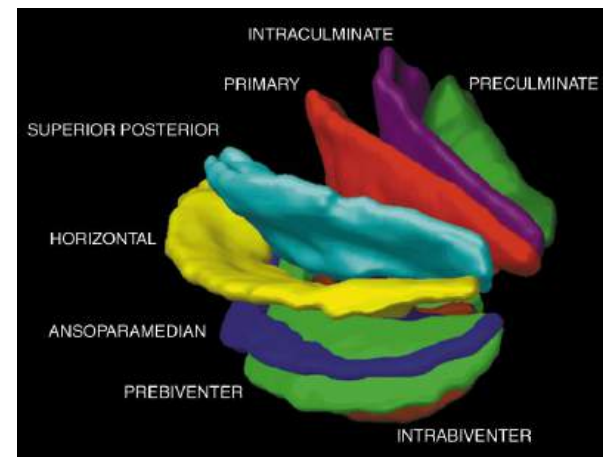
Alan C. Evans

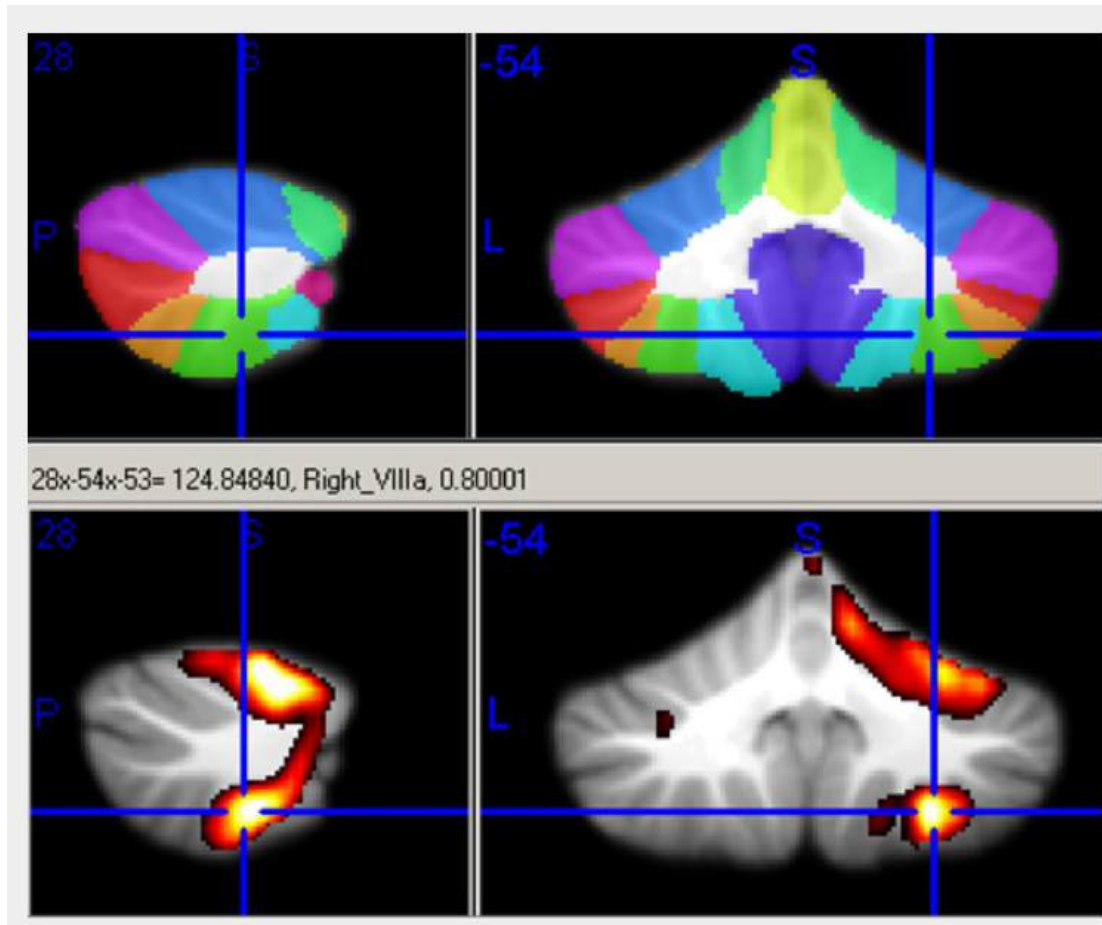


Free Software Included

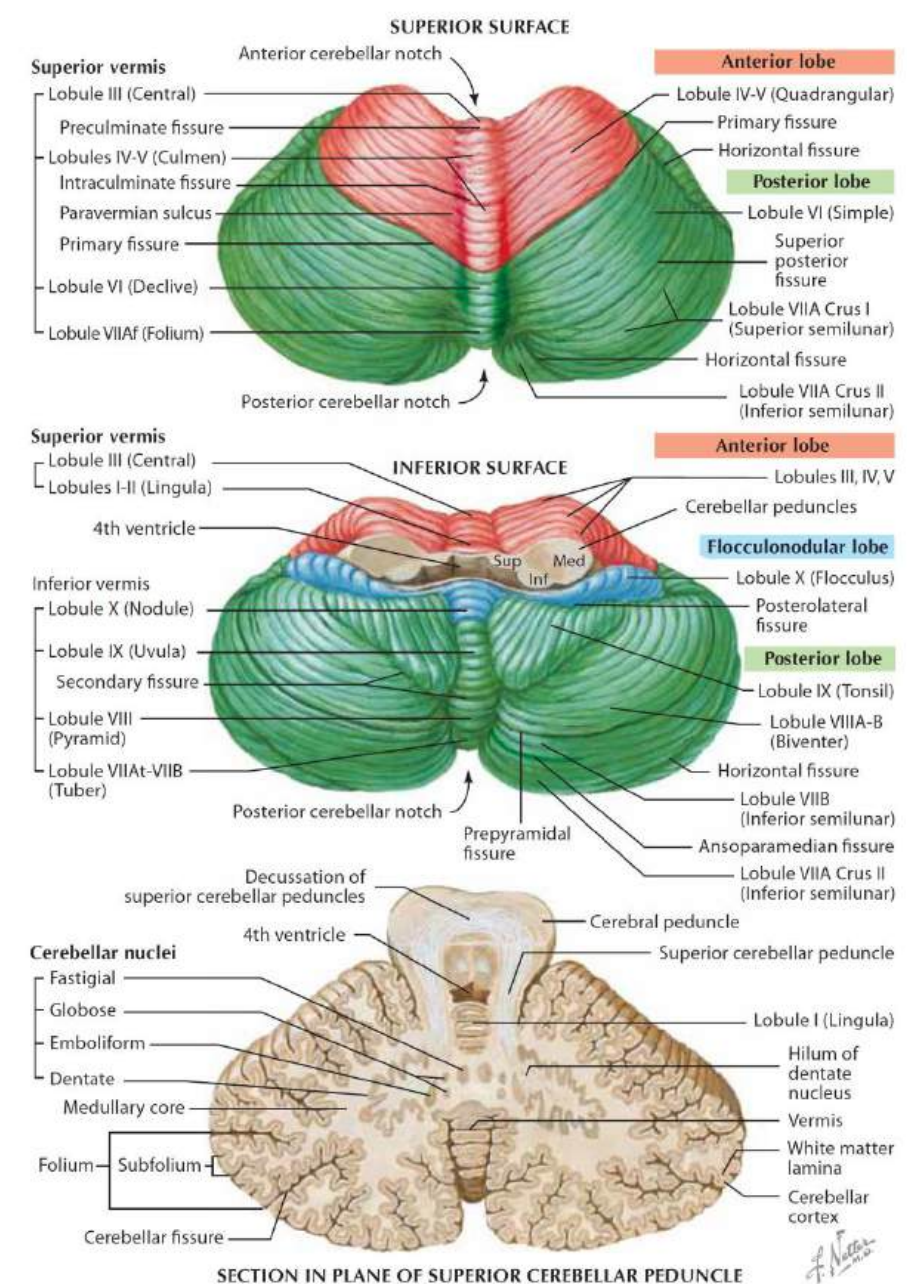


VERMIS	FISSURE	HEMISPHERE
Lobule I,II	Precentral	Lobule I,II
III	Preculminate	III
IV	Intraculminate	IV
V	Primary	V
VI	Superior Posterior	VI
VII Af	Horizontal	Crus I
VII At	Ansoparamedian	Crus II
VIIB	Prepyramidal/Prebiventer	VIIB
VIII A	Intrabiventer	VIII A
VIII B	Secondary	VIII B
IX	Posterolateral	IX
X		X



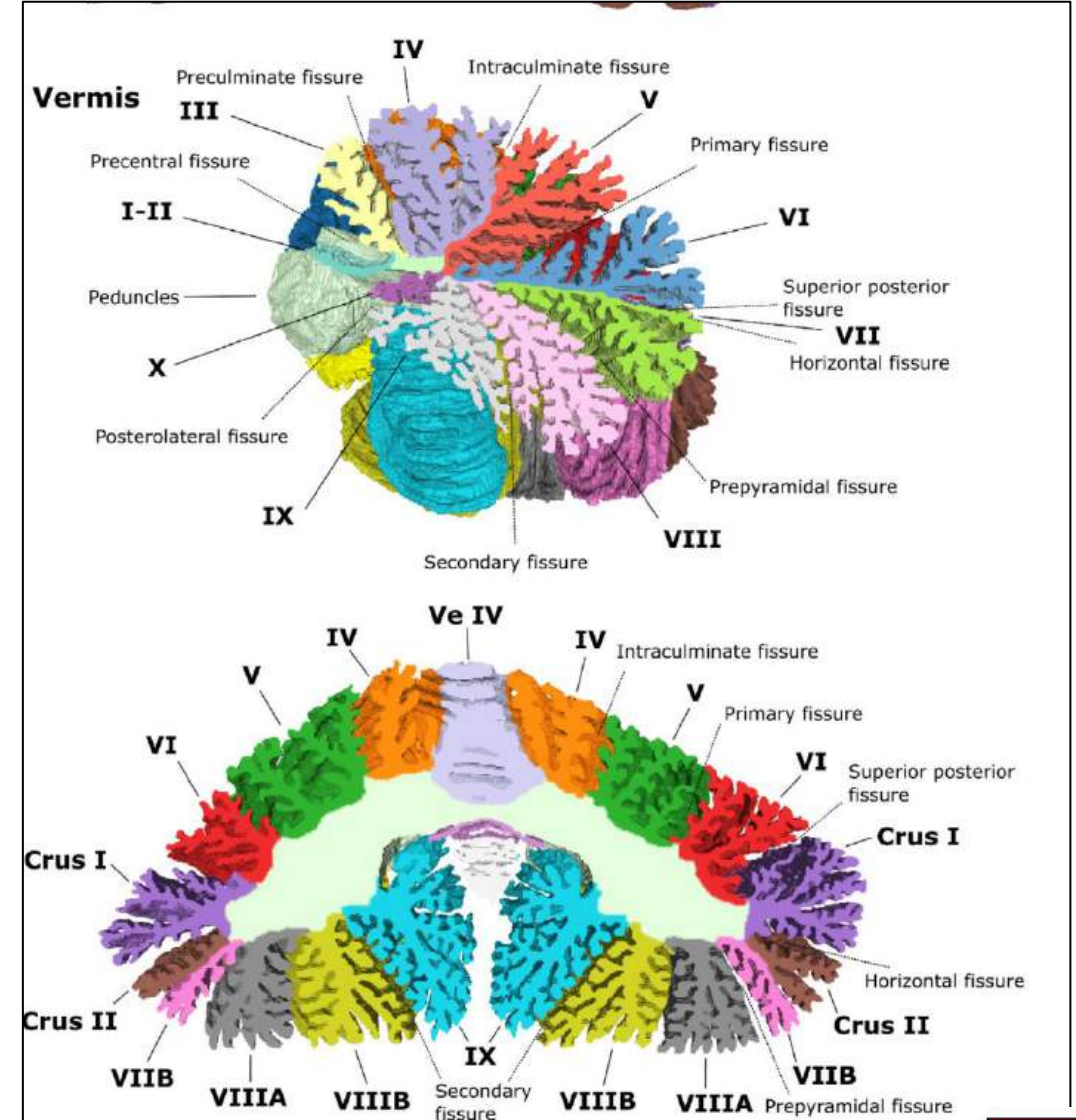
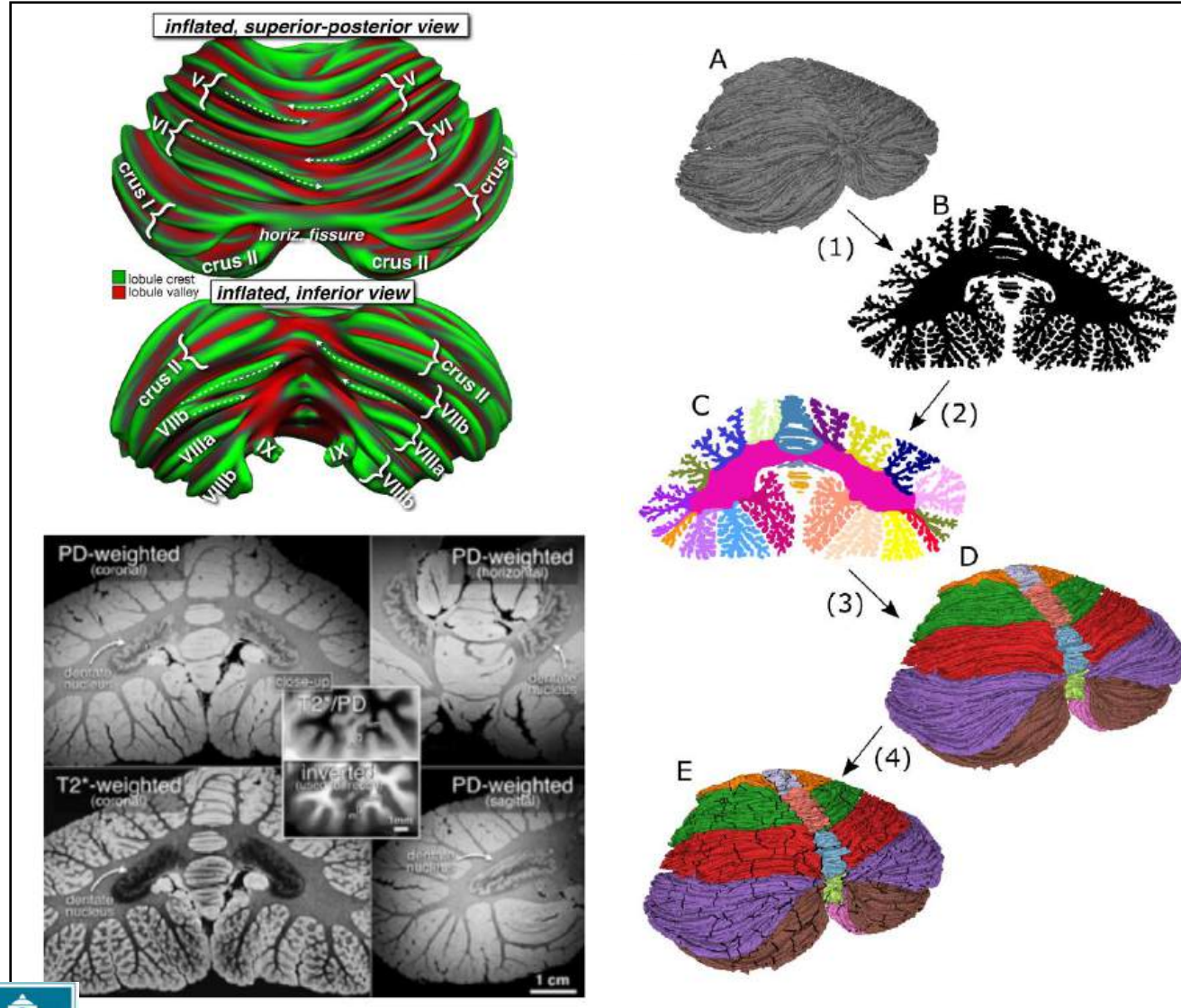


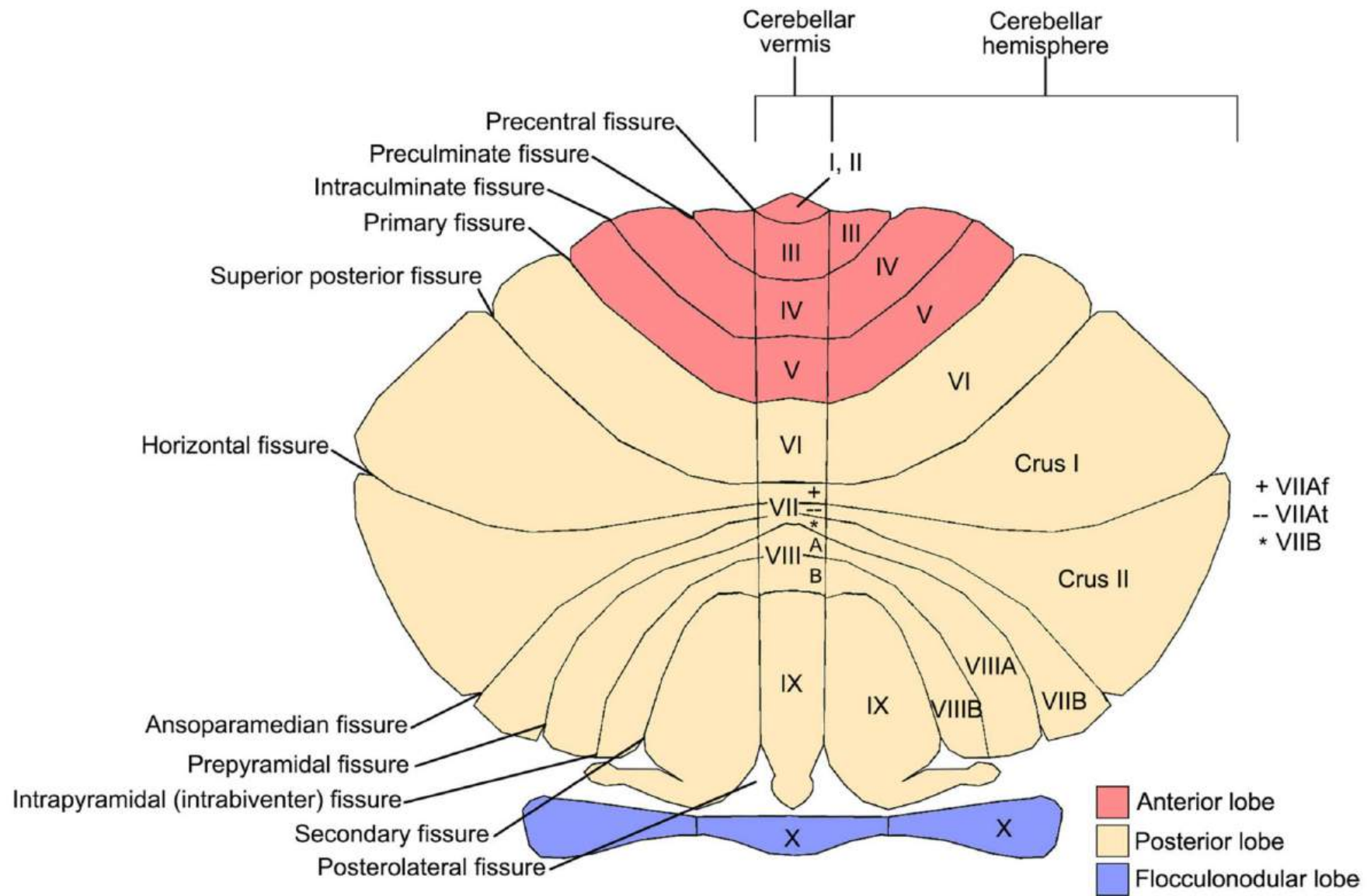
SUIT Atlas: diedrichsenlab.org/imaging/propatlas

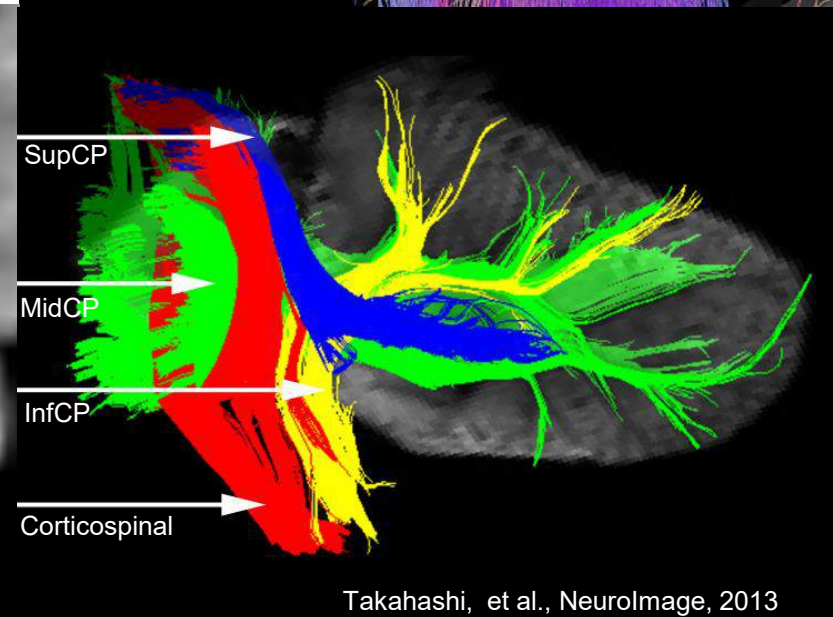
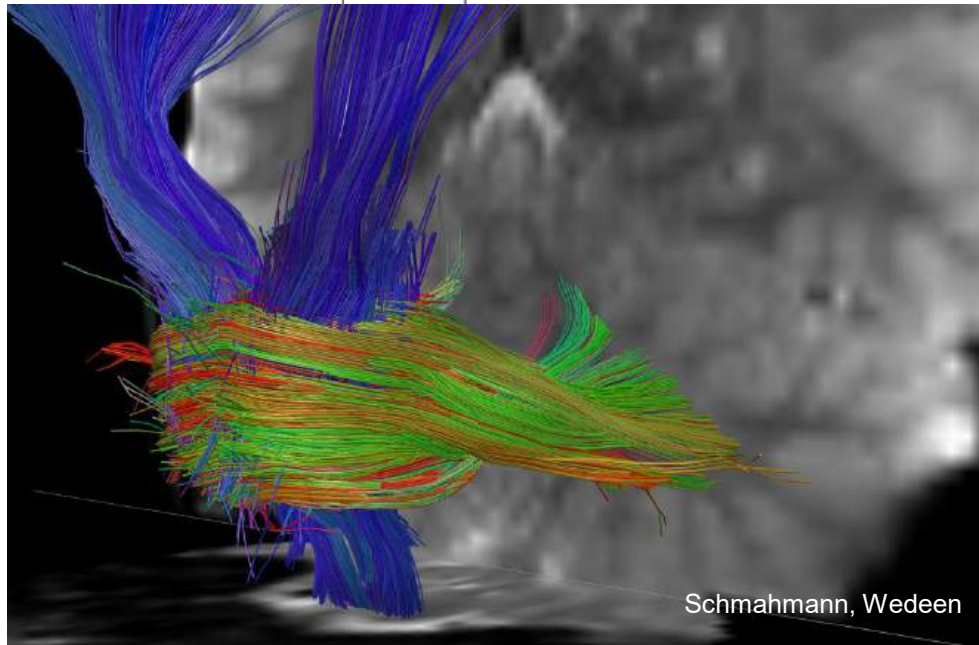
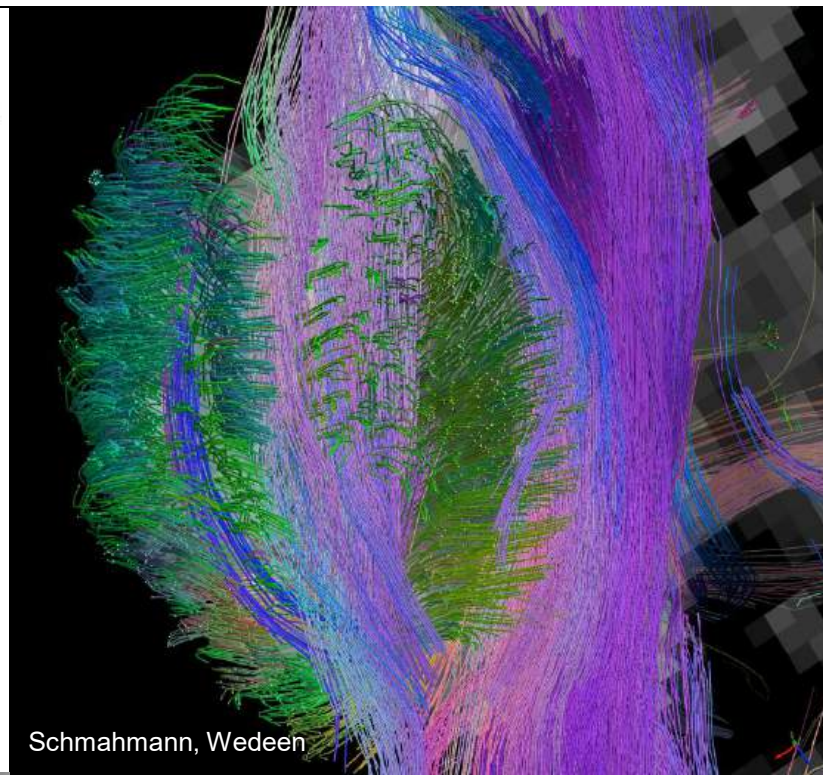
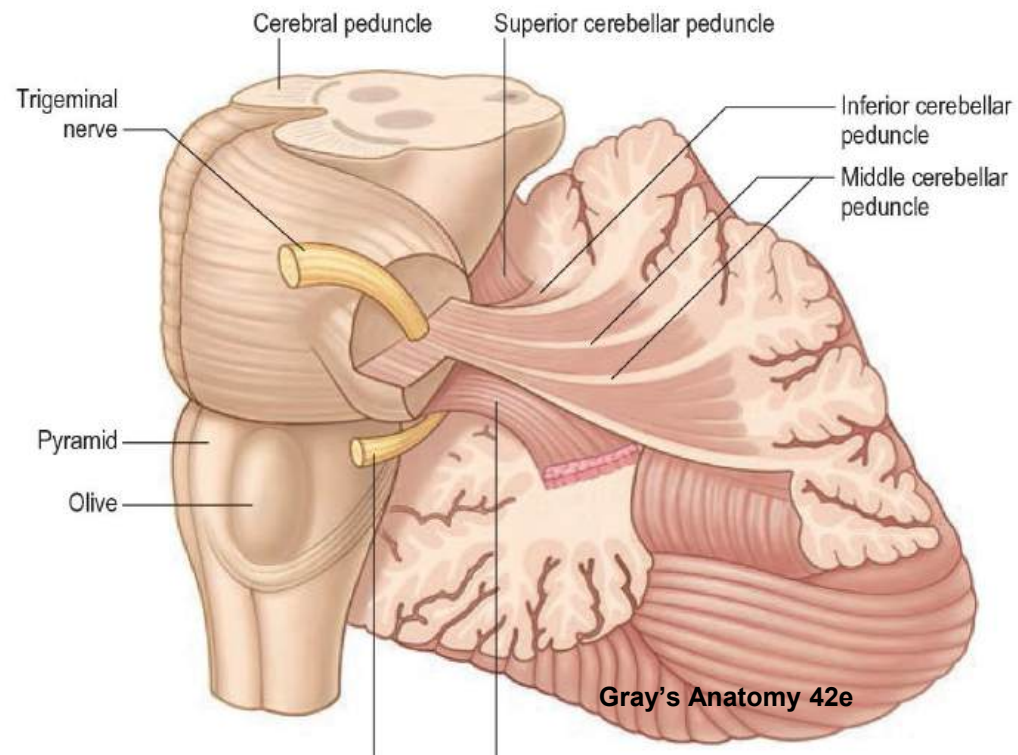


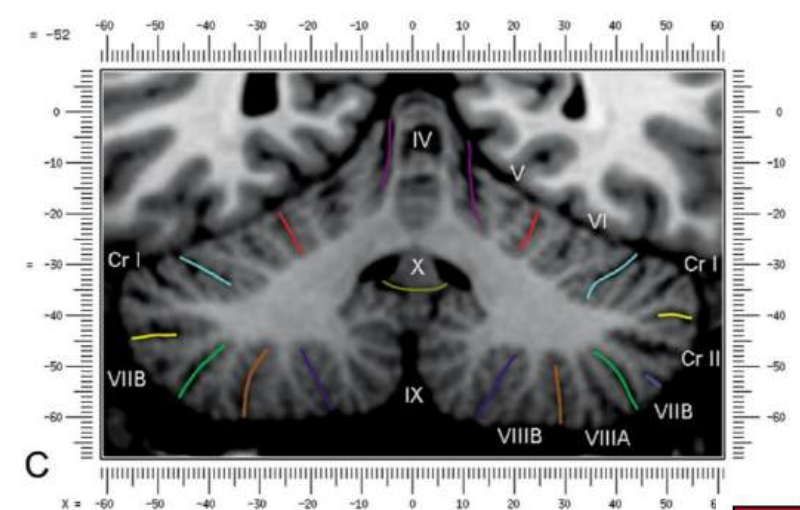
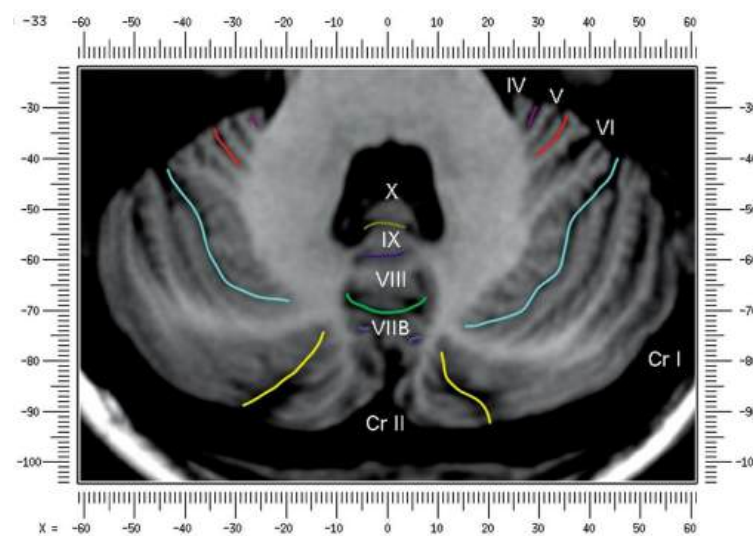
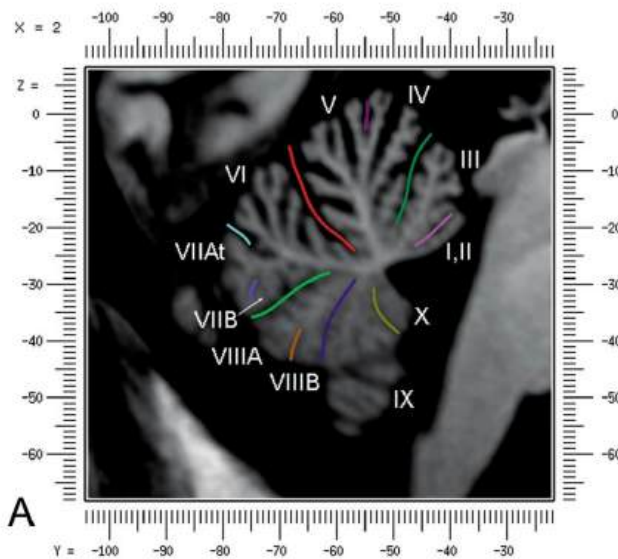
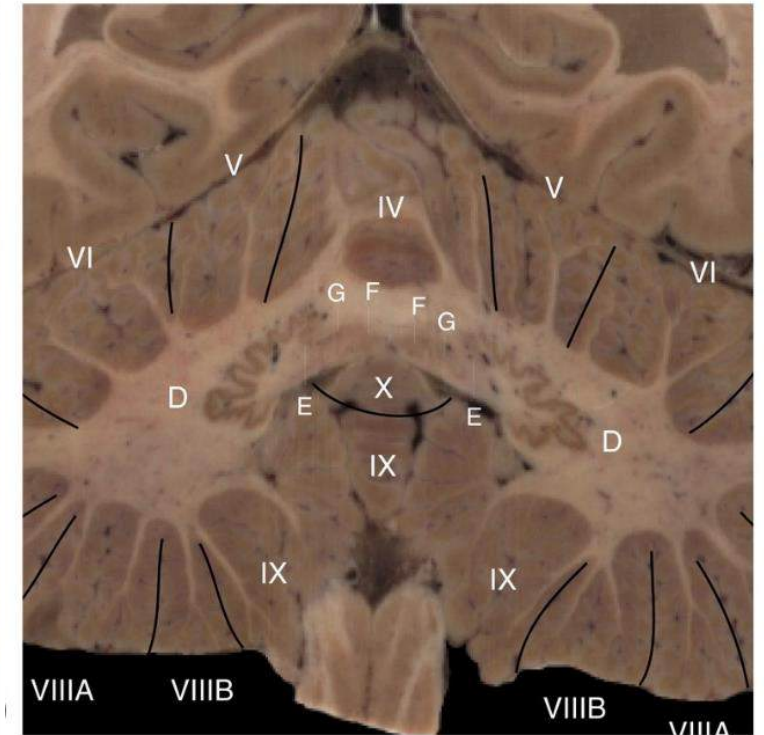
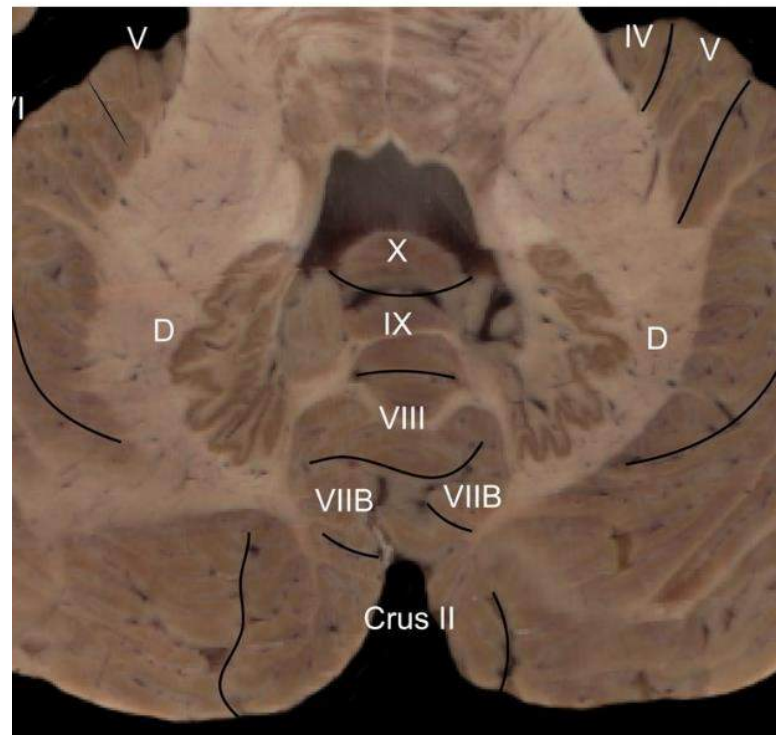
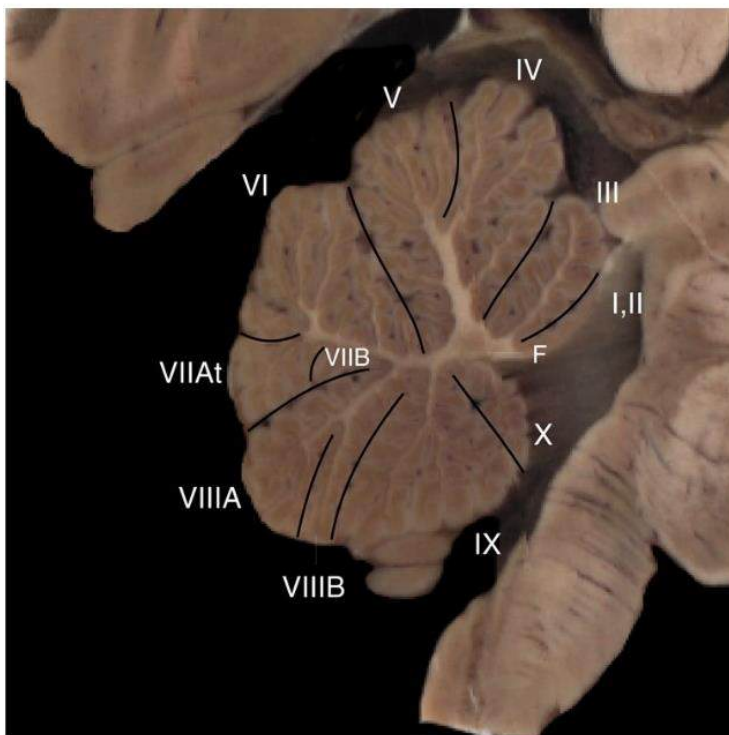
Netter, 2nd edition. Volume 7

A Digital Anatomical Atlas of the Human Cerebellum at Subfolial Resolution

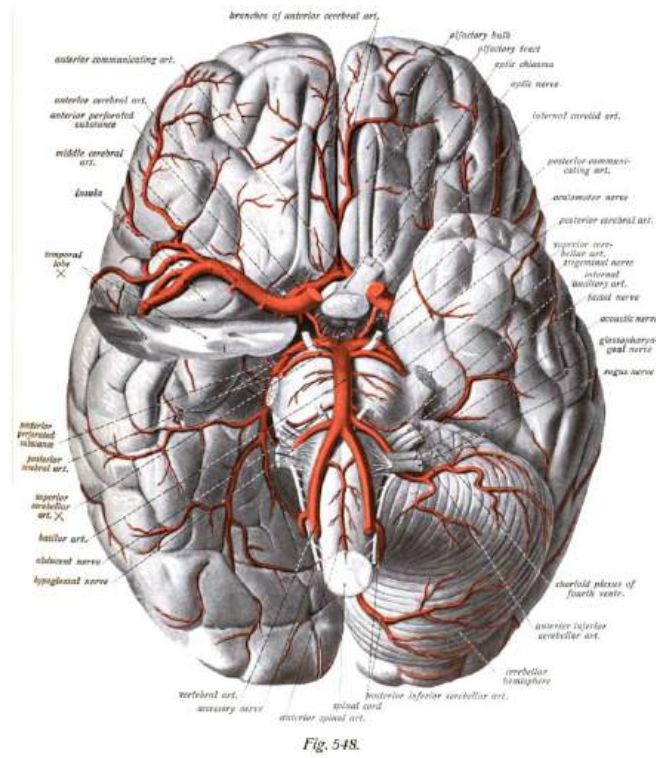




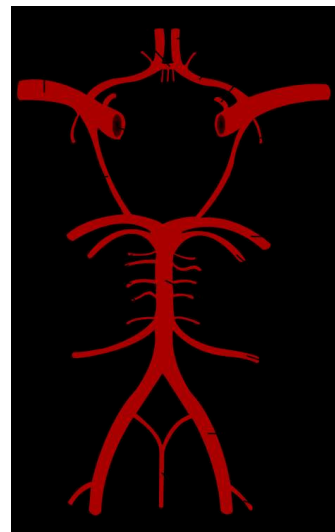
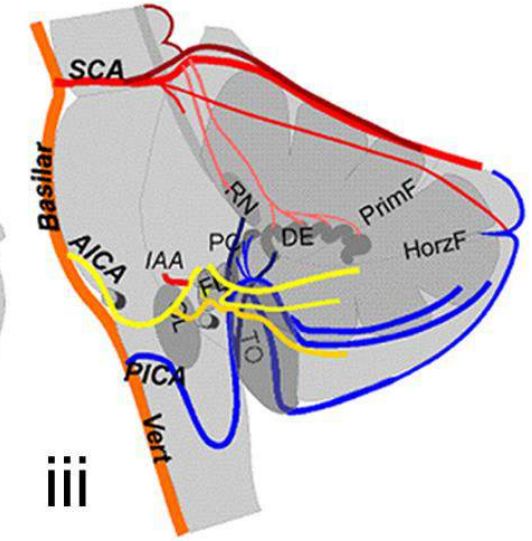
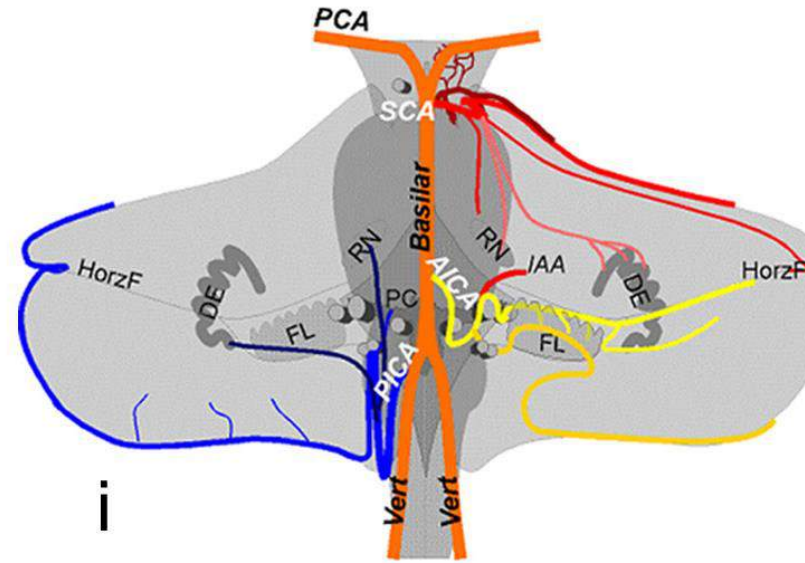




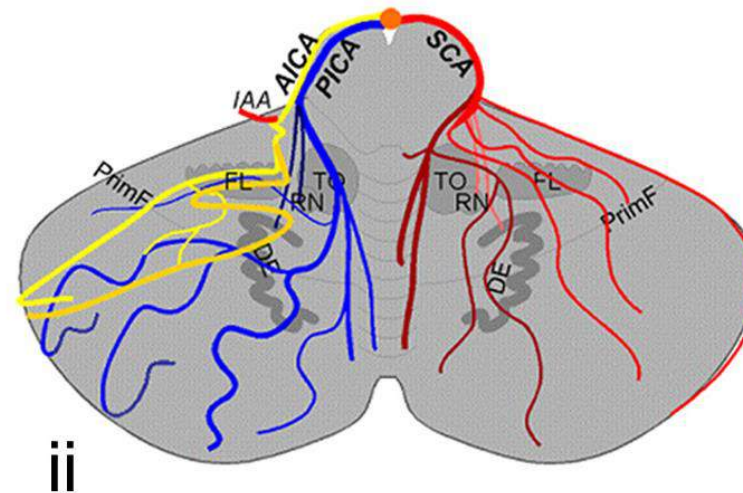
SCA, AICA, PICA



Sobotta



Gray's Anatomy

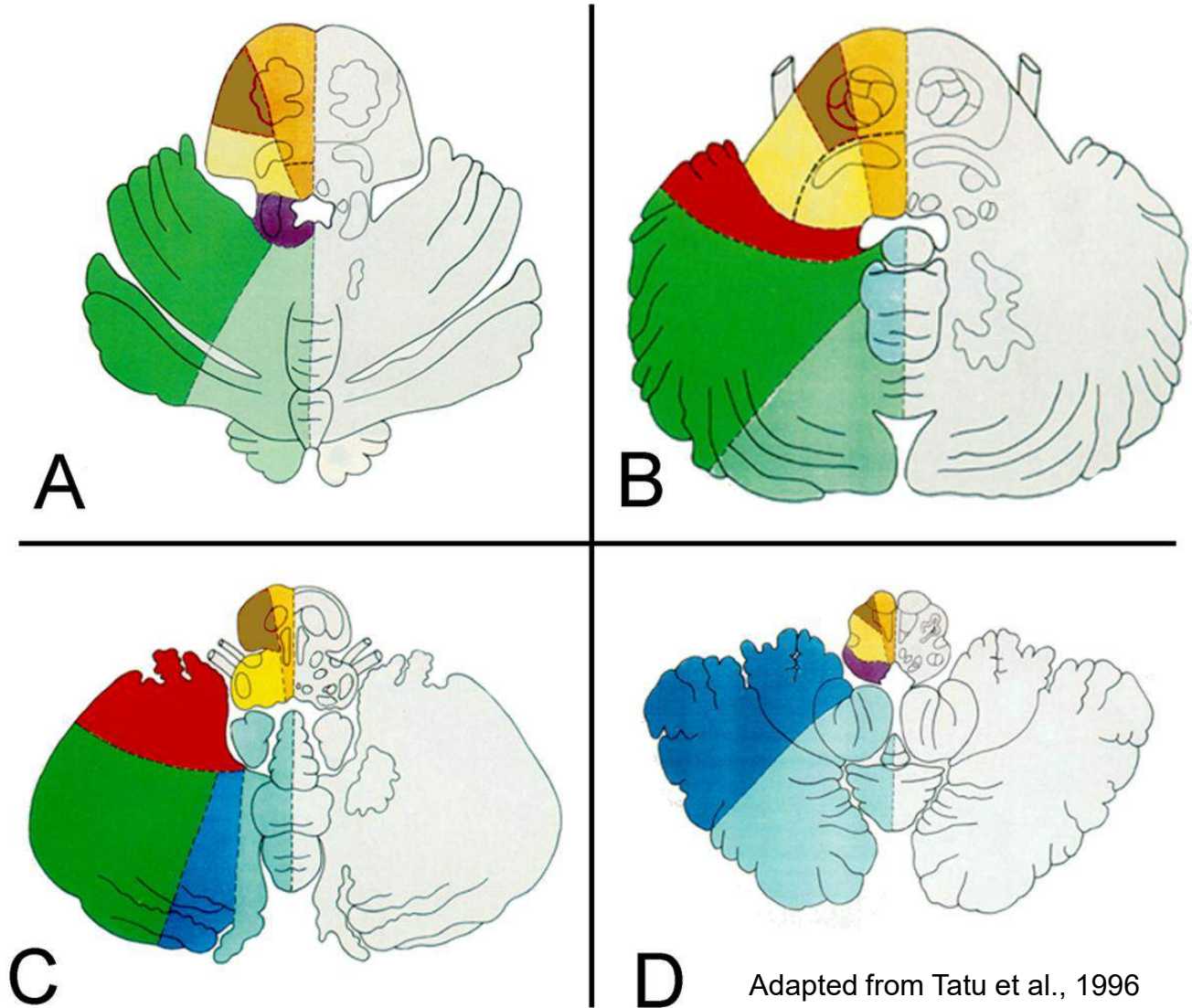
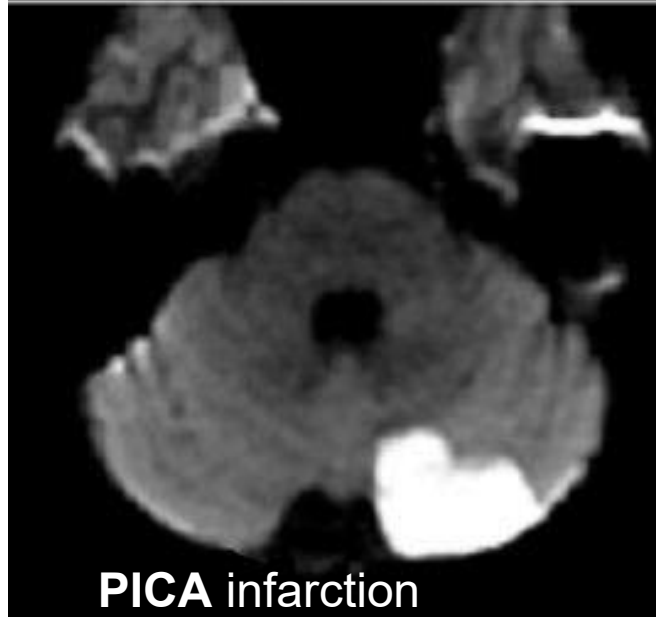


Legend

Vert	Vertebral Artery
Basilar	Basilar Artery
PCA	Posterior Cerebral Artery
SCA	Superior Cerebellar Artery
AICA	Anterior Inferior Cerebellar Artery
PICA	Posterior Inferior Cerebellar Artery
IAA	Internal auditory artery
HorzF	Horizontal fissure
PrimF	Primary fissure
DE	Dentate nucleus
FL	Flocculus
OL	Olive
PC	Plexus choroideus
RN	Roof nuclei
TO	Tonsil

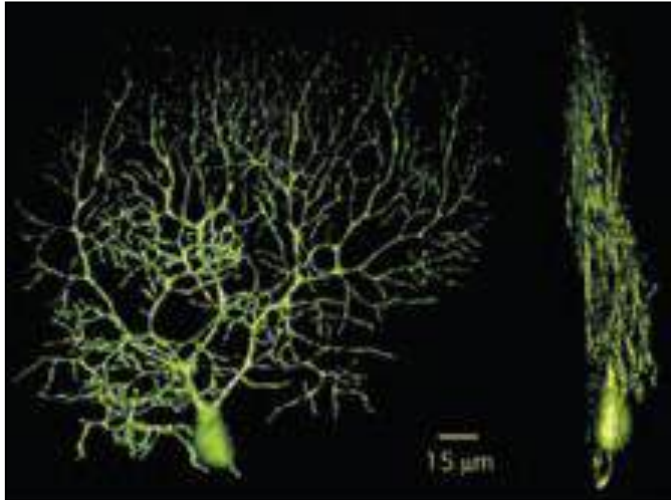
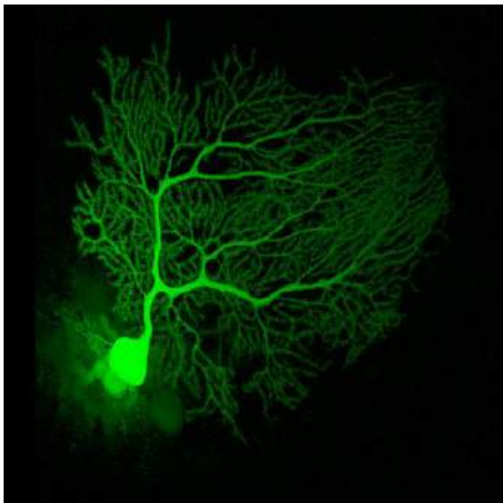
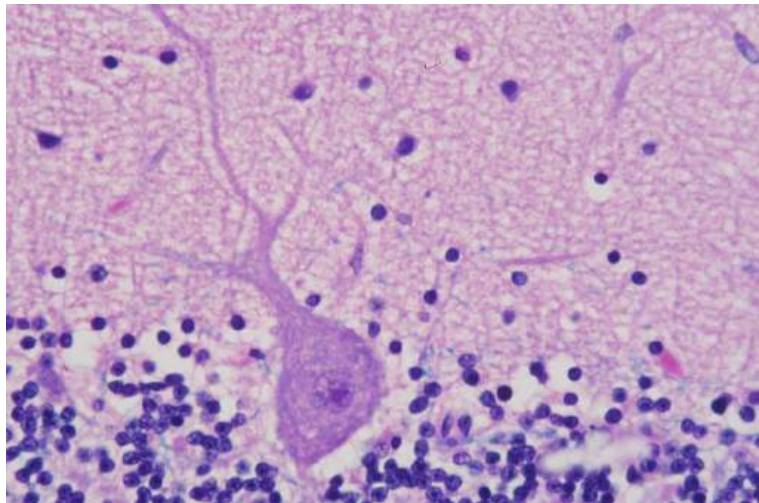
Andreas Luft, in Schmahmann, 2000

Motor deficit following cerebellar stroke

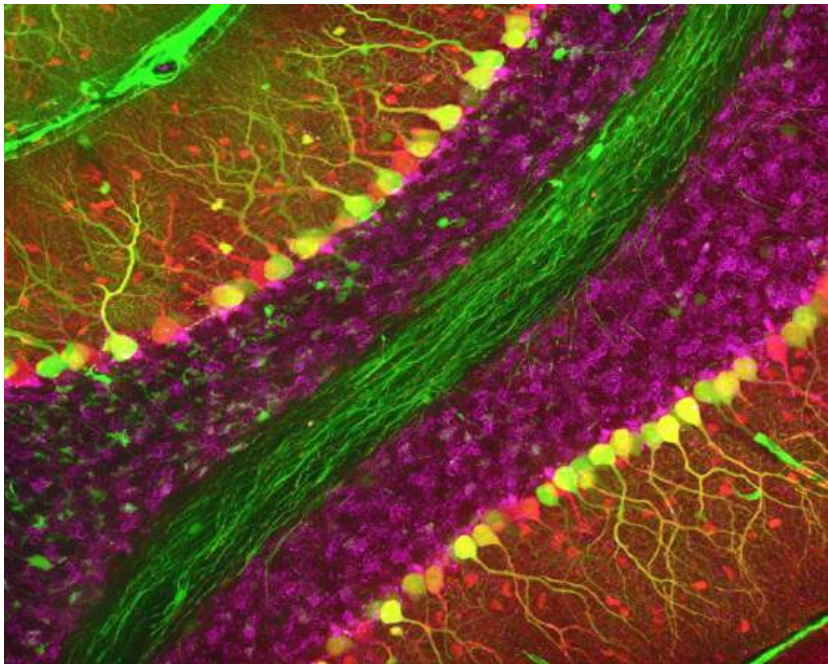


Adapted from Tatu et al., 1996

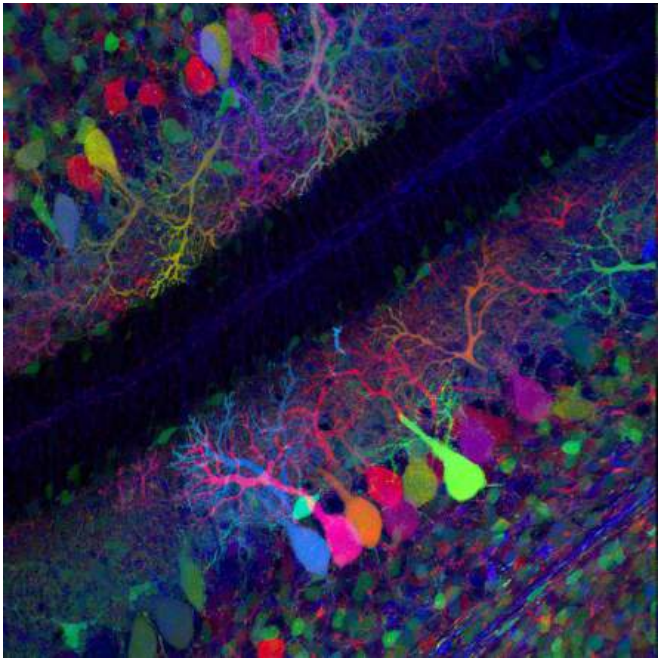
Purkinje Cell



Rossi et al, J Neurophysiol 1995



Jennifer Jahncke, Oregon Health & Science University

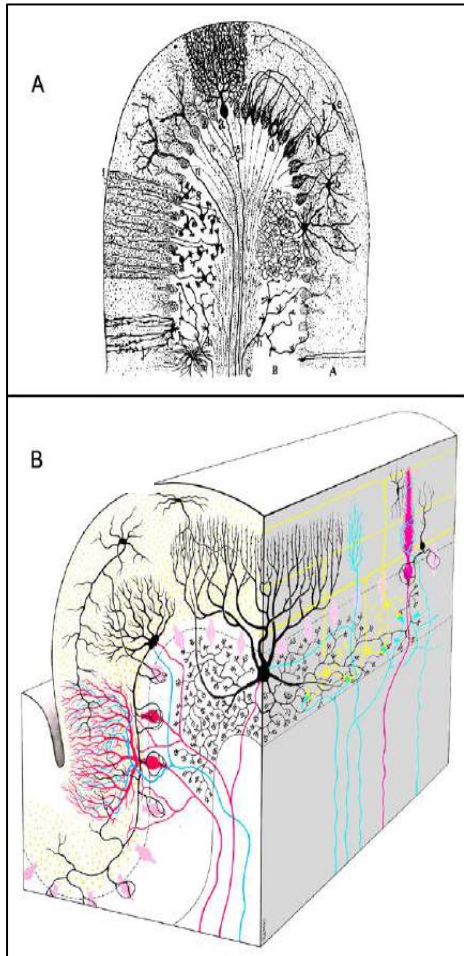


BRAINBOW PCs; Tammy Weisman

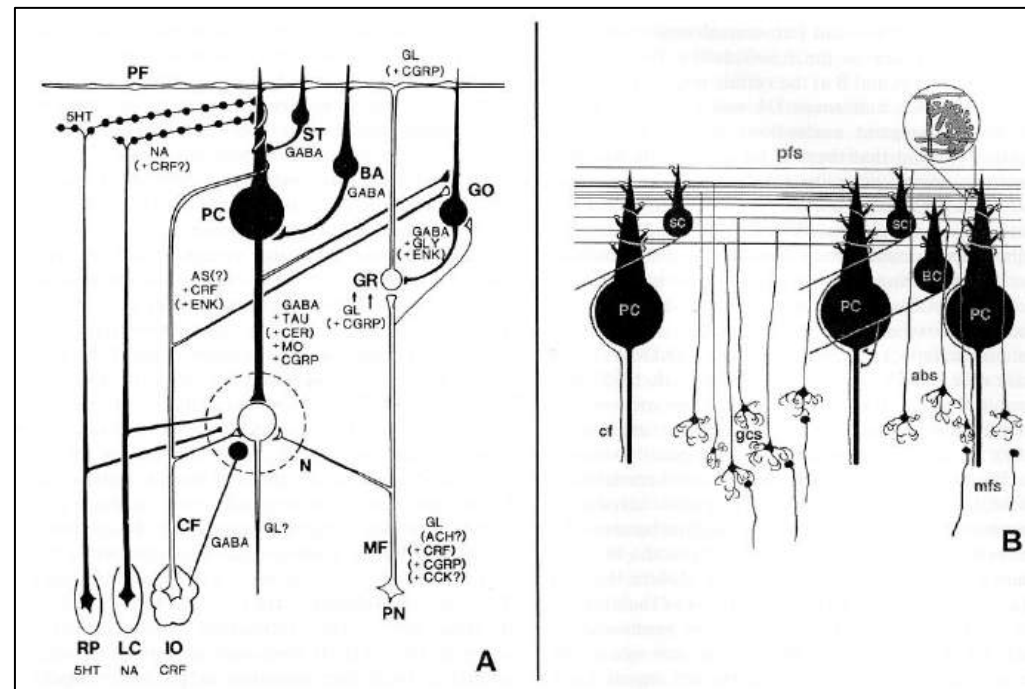


Photos by Jinny Sagorin

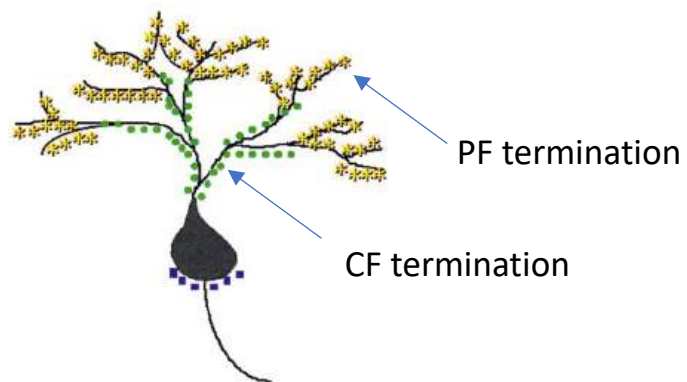
Schematics of cerebellar circuitry



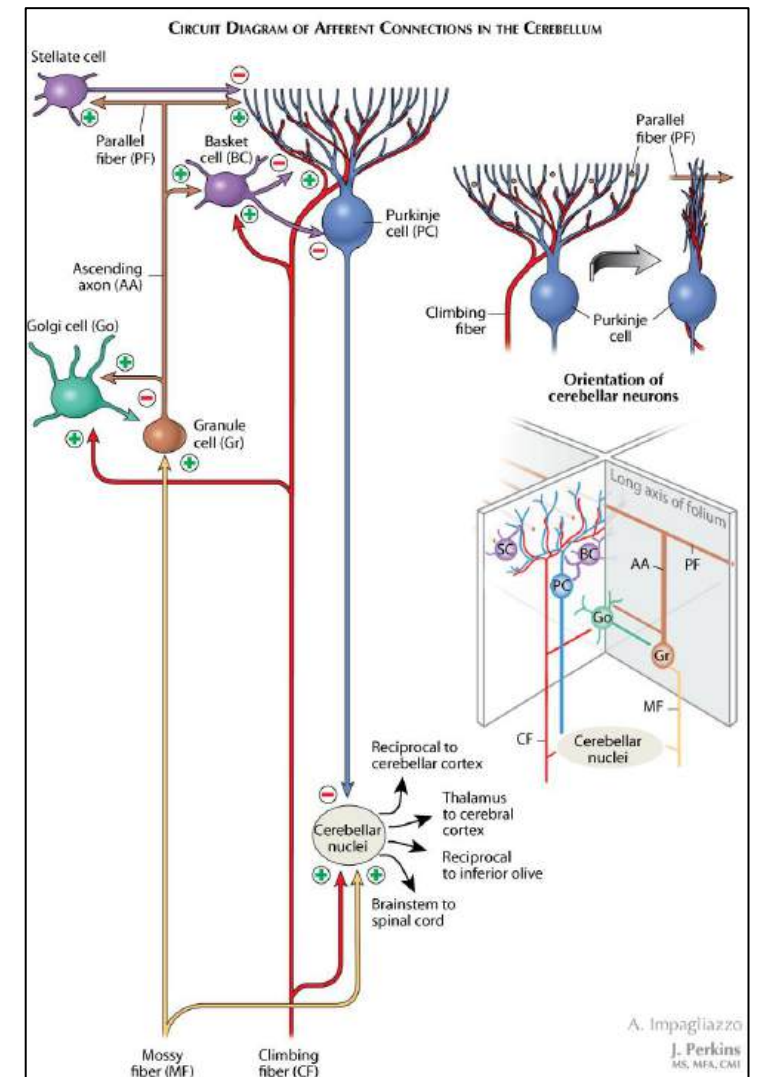
Eccles, Ito, Szentágothai, 1967



Ito, 1984; Bower, 1997

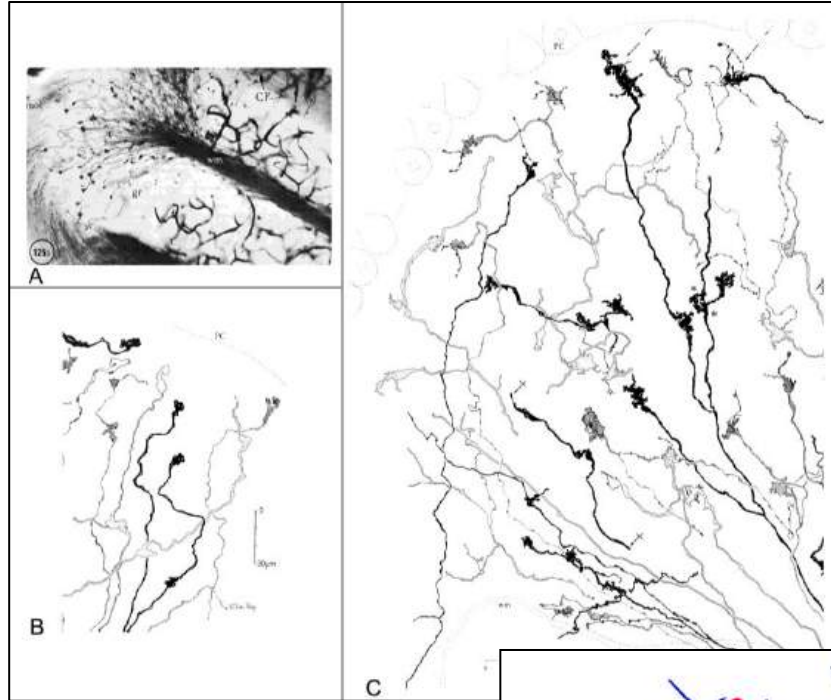


Oberdick et al., 1998



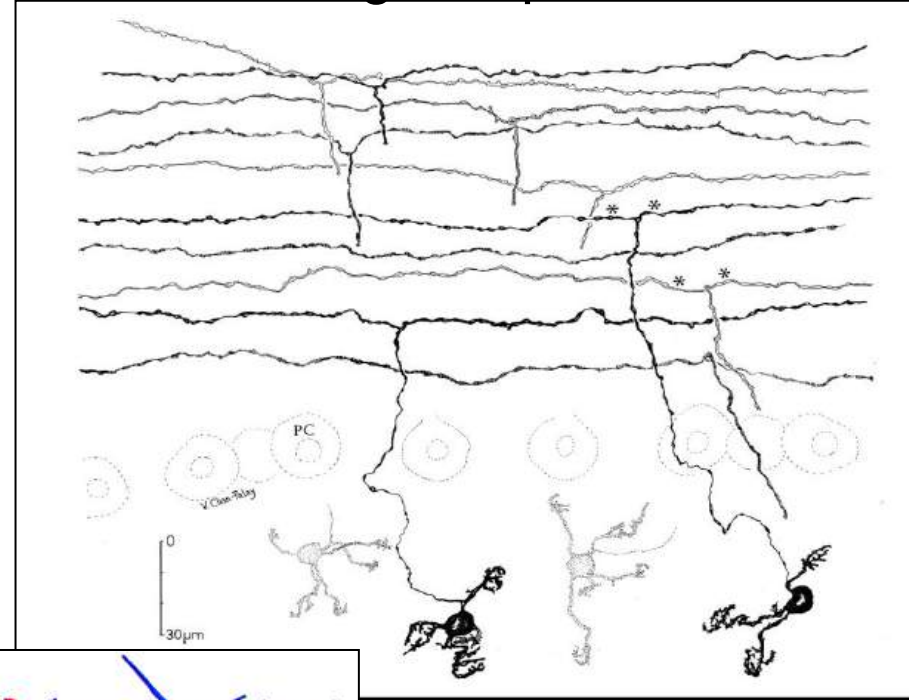
Netter, 2nd edition. Volume 7

Why they are called mossy fibers



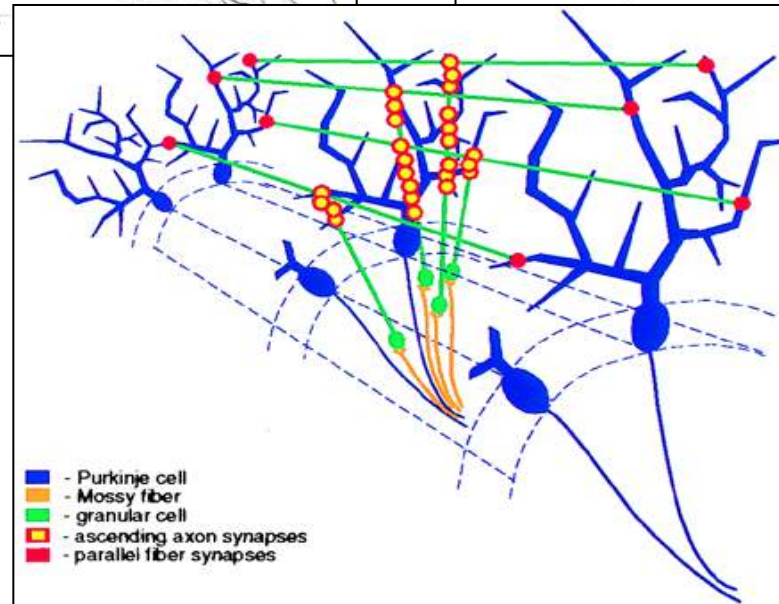
Palay and Chan Palay 1974

Granule cells, ascending axons branching into parallel fibers



Palay and Chan Palay 1974

Ascending granule cell axon

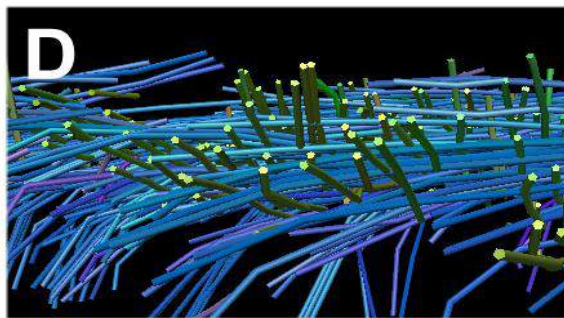
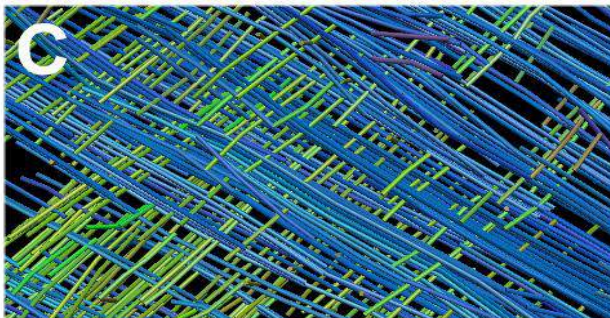
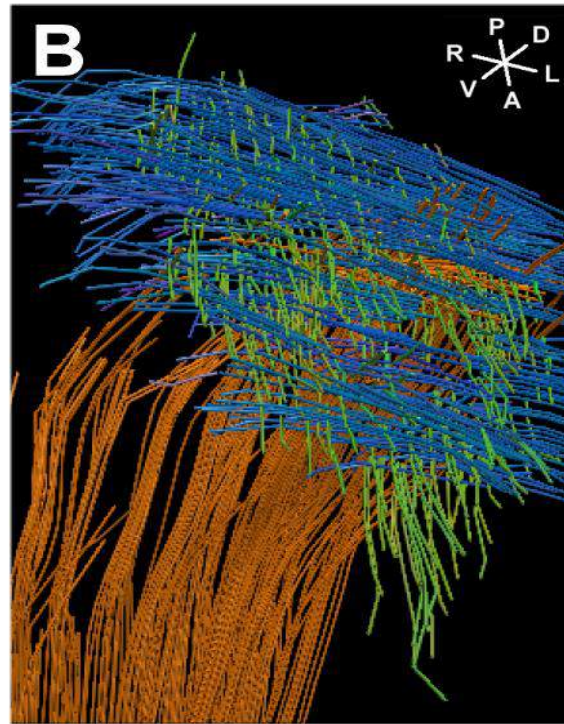
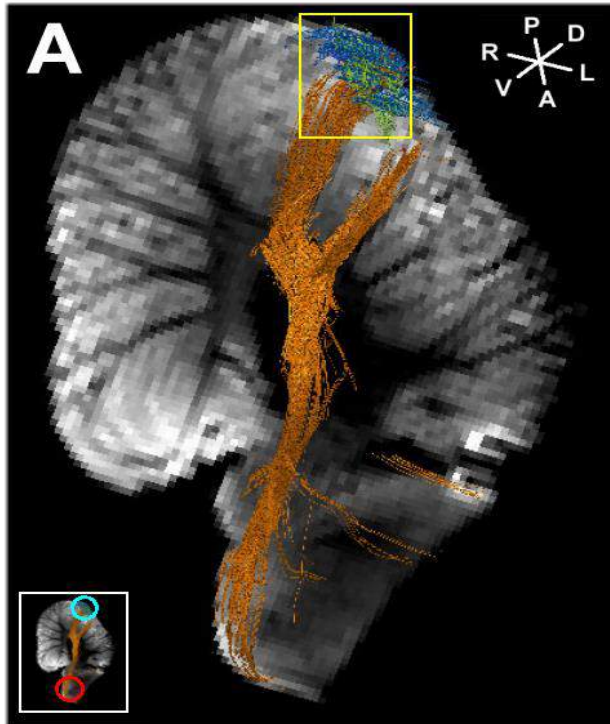


Cohen and Yarom. PNAS 1998

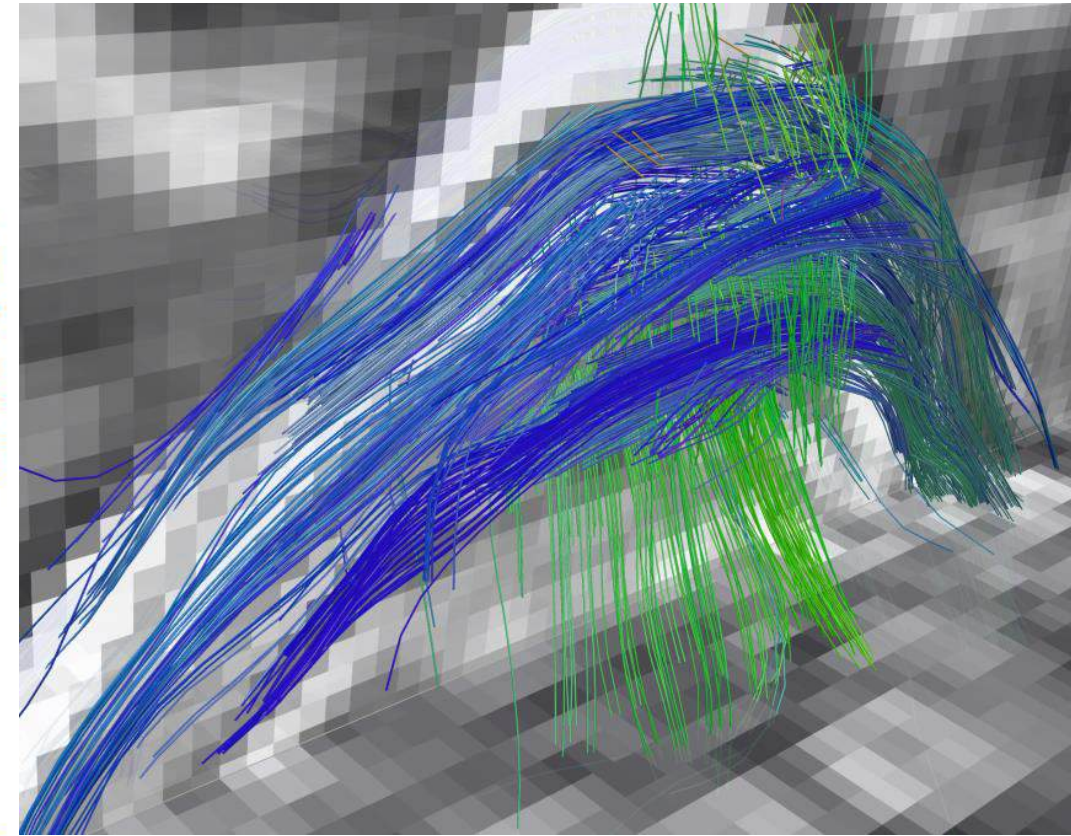
Diffusion spectrum imaging:

Orientation of parallel fibers and basket and stellate cell interneuron fibers

Human

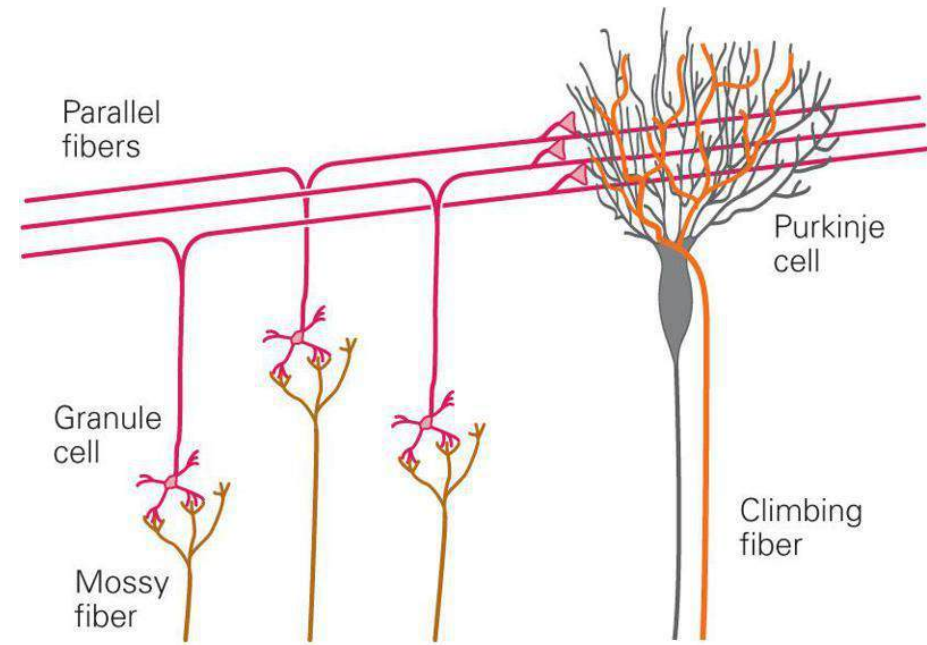


Monkey



Wedeen, Schmahmann, Dai, Wang, Benner, Hagmann

Parallel Fibers (from pons, spinal cord) Climbing Fibers (from inferior olive)



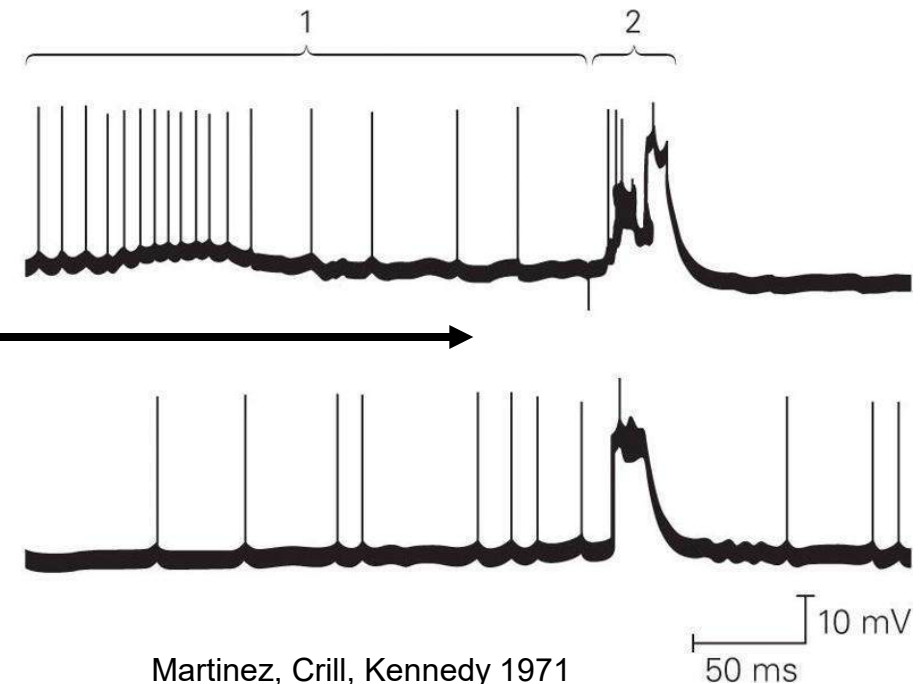
PC Simple spikes, ~ 50Hz

Evoked by parallel fiber input
= Context

PC Complex spikes ~ 1 Hz

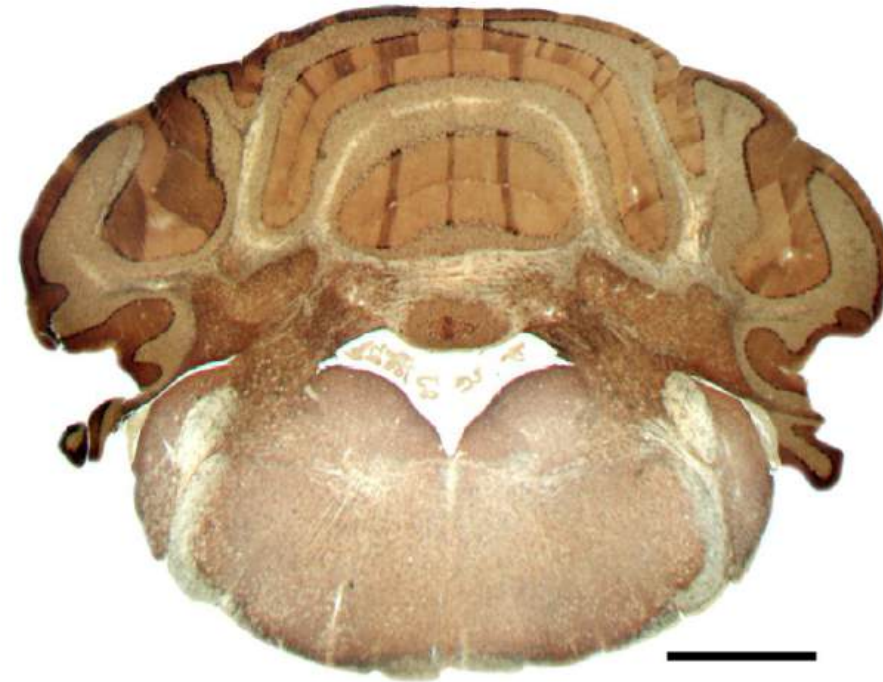
Evoked by climbing fiber input
= Error signal

Interaction between these underlies
cerebellar cortical information processing

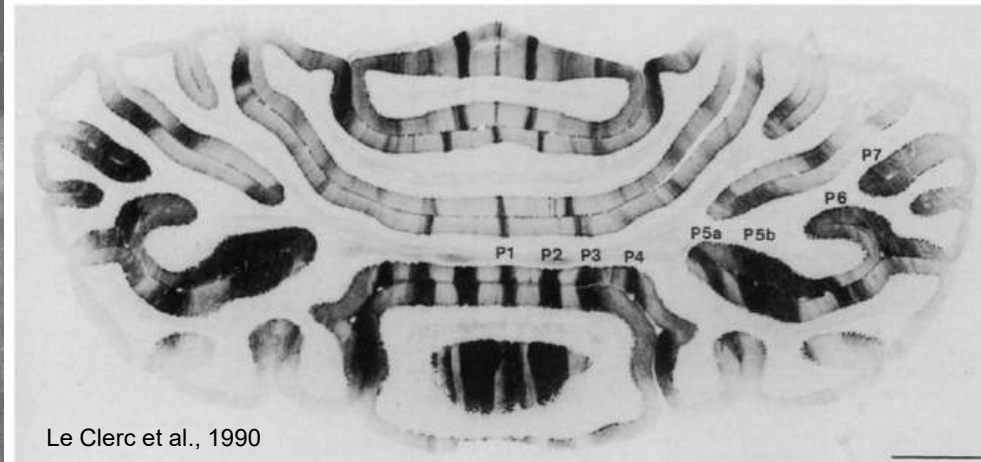


Martinez, Crill, Kennedy 1971

Parasagittal zonation in the cerebellum (zebrin bands)

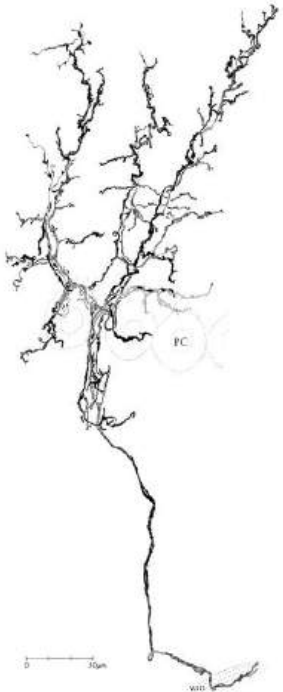


Courtesy of Richard Hawkes, 1999



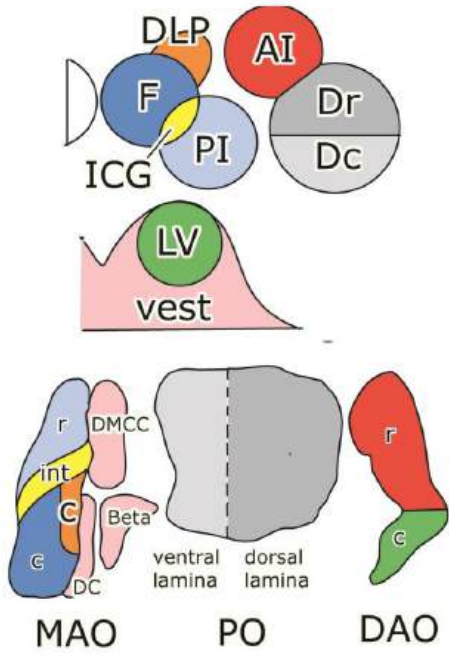
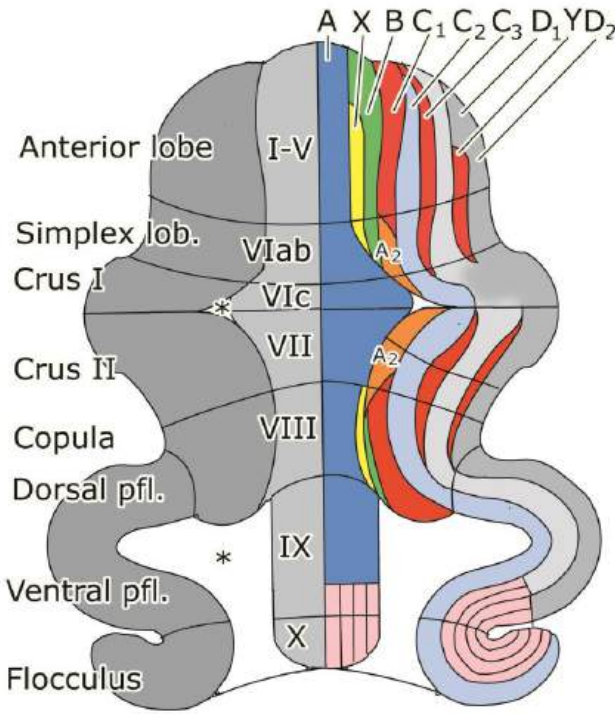
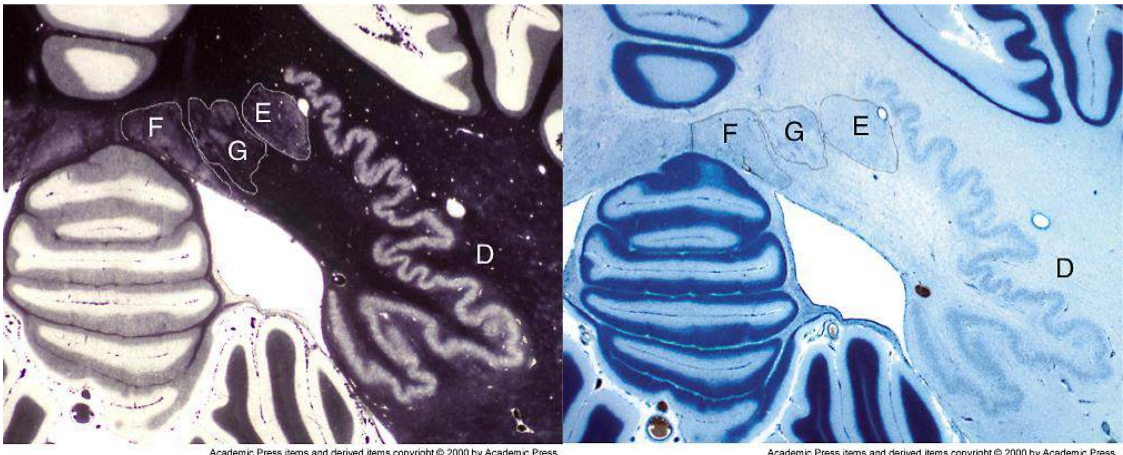
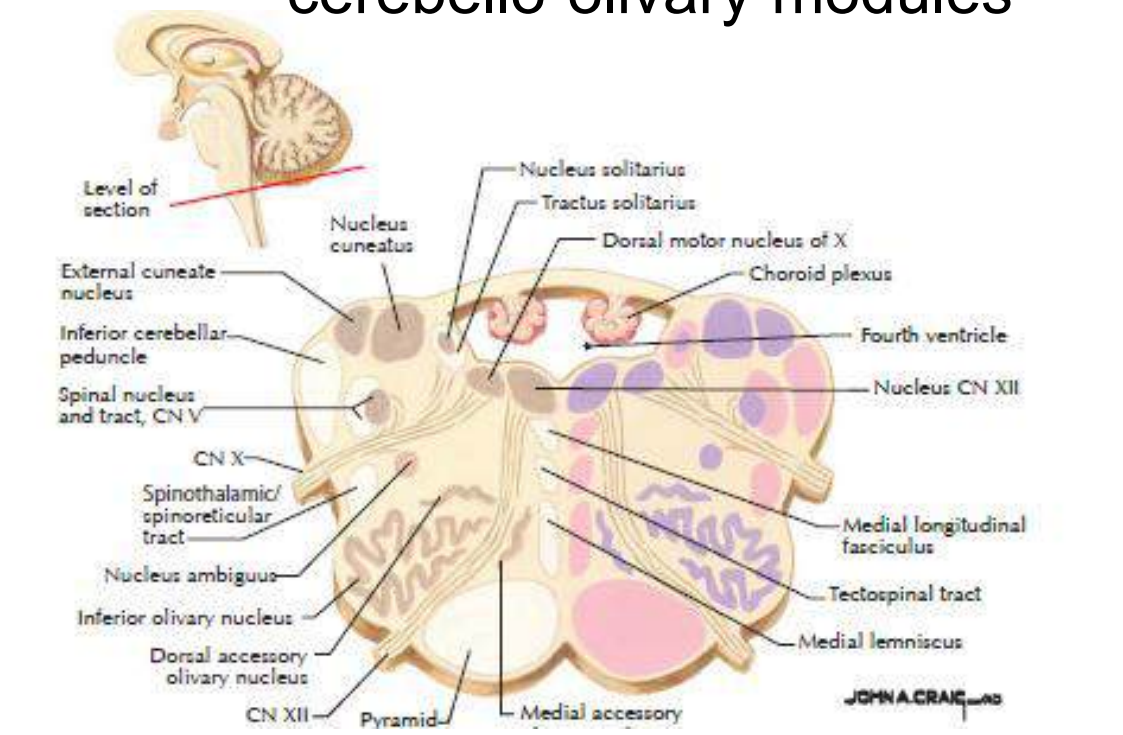
Le Clerc et al., 1990

Climbing fiber



Palay and Chan Palay 1974

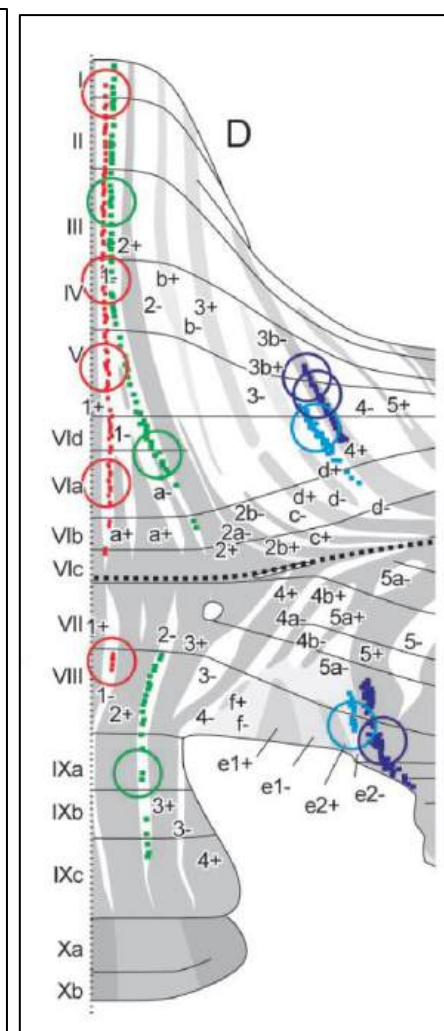
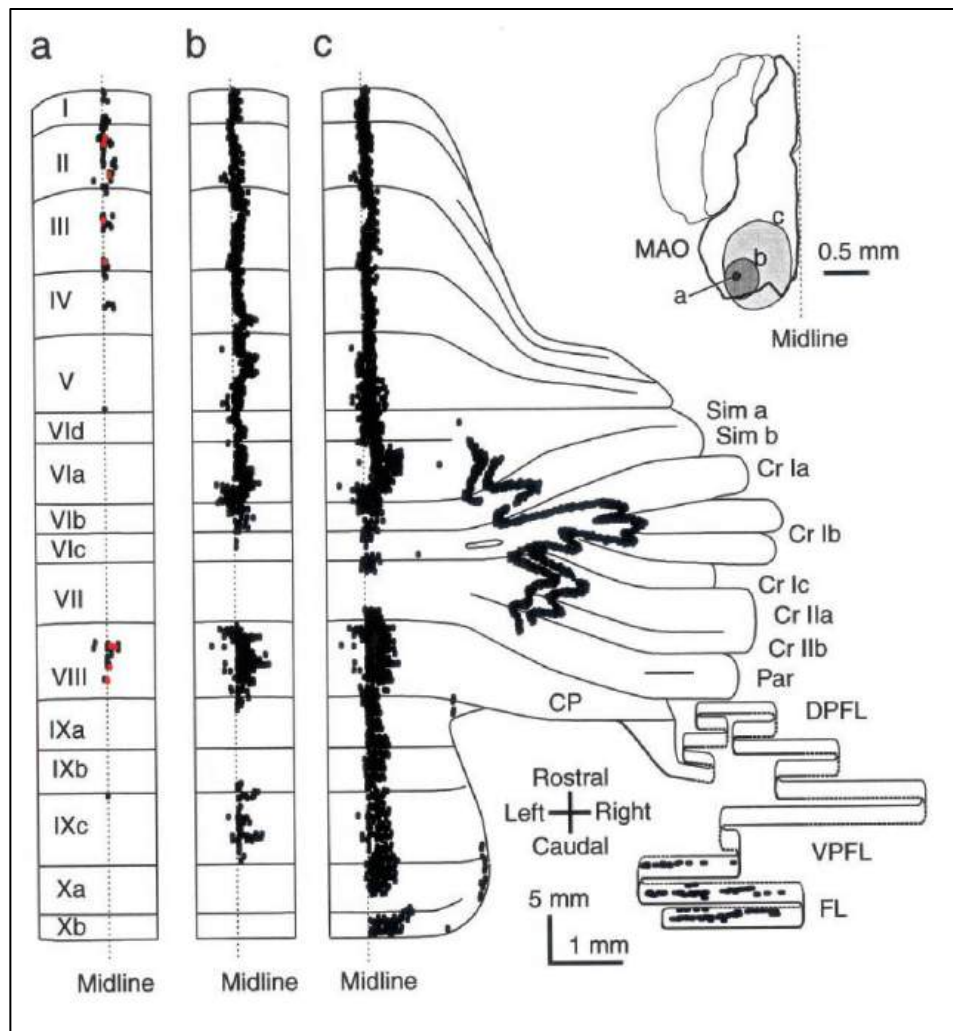
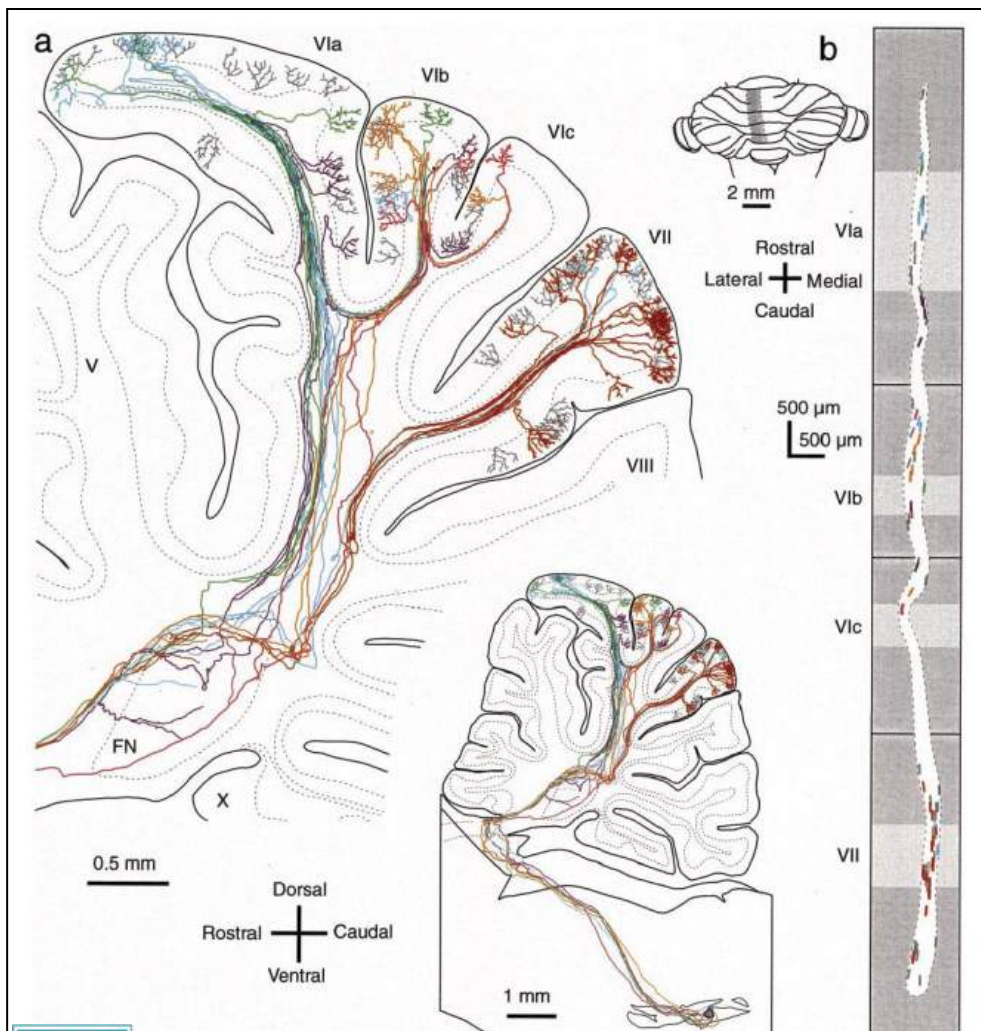
Corticonuclear microcomplexes; cerebello-olivary modules



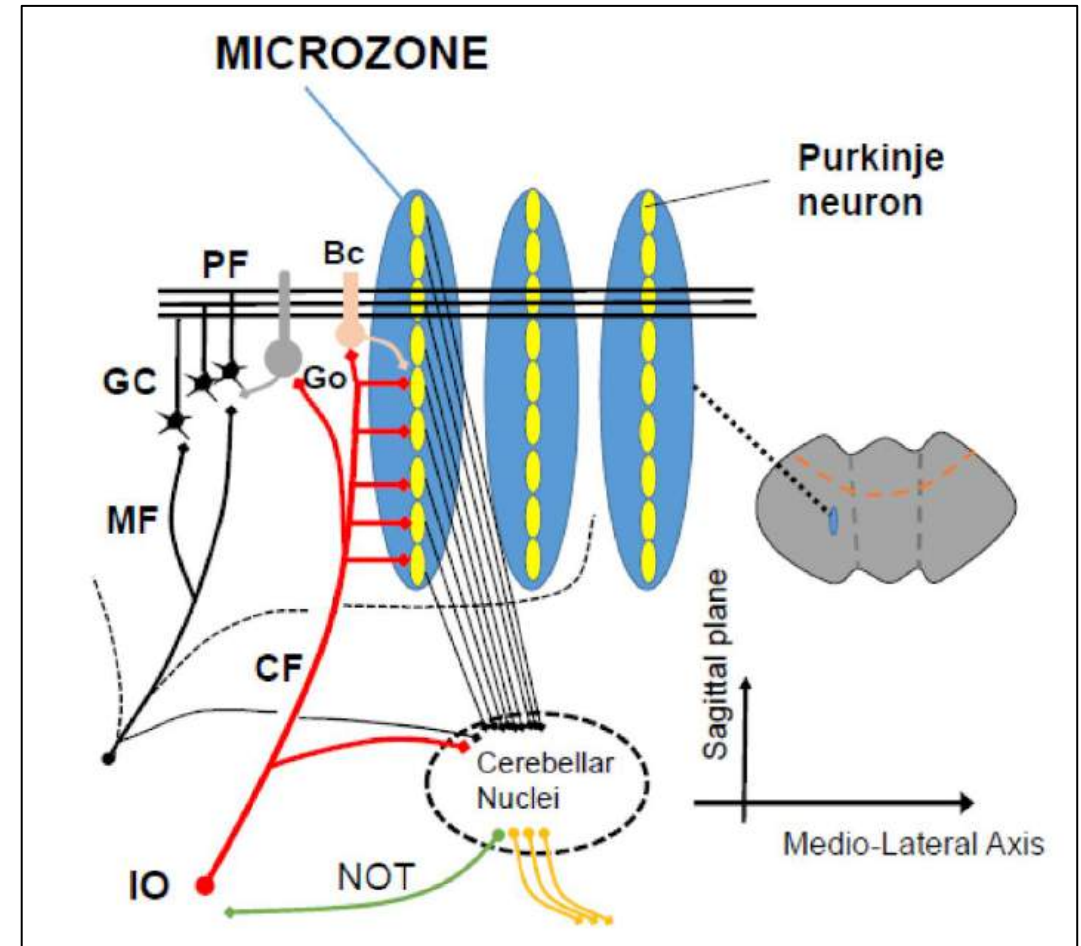
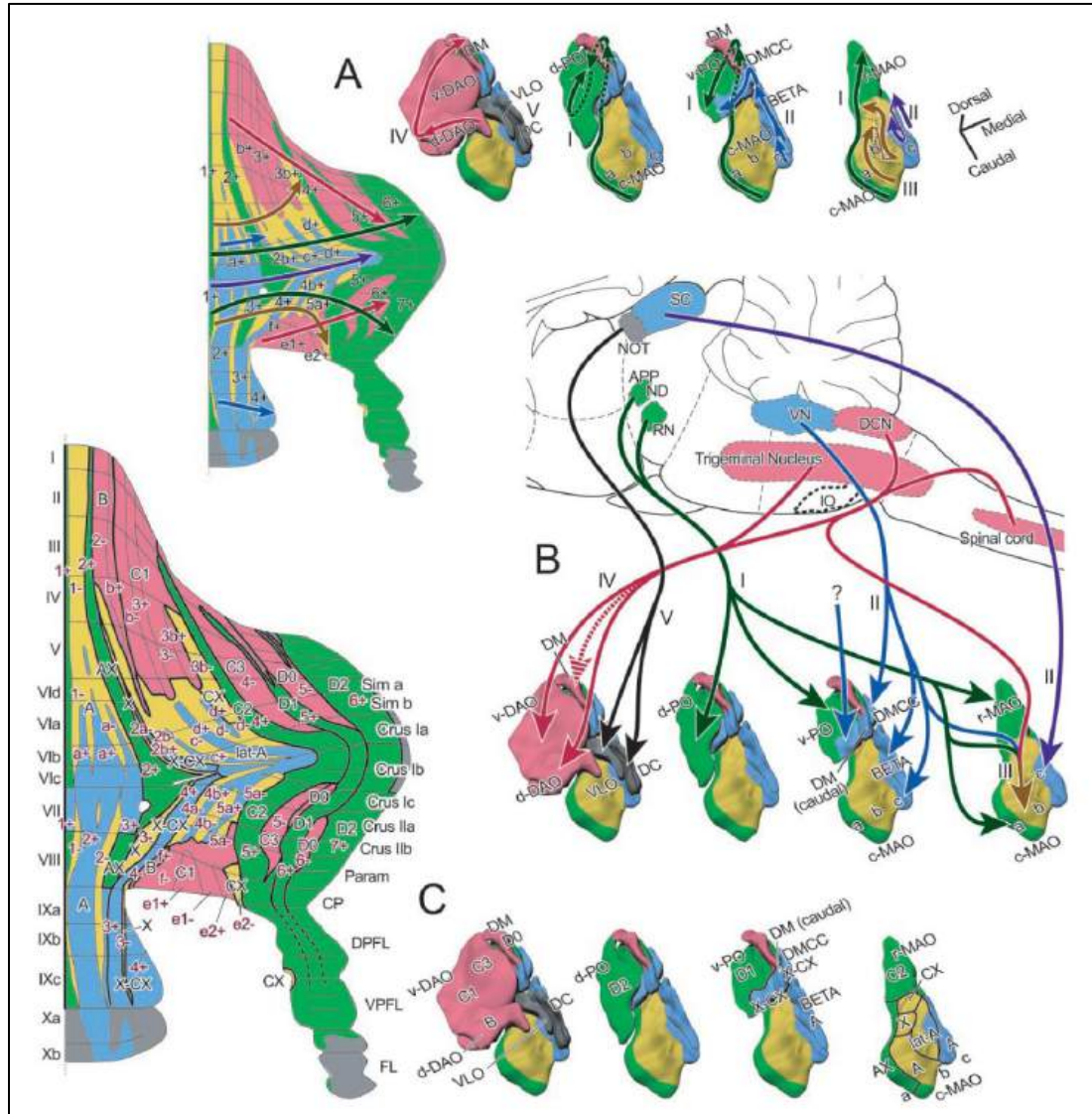
Schmahmann et al., 2000; Voogd, 1965; Voogd and Glickstein, 1998;



Olivocerebellar axons branch to ~7 climbing fibers, terminations clustered in a single narrow longitudinal band / parasagittal zone across one or multiple lobules, respecting zebrin band architecture. Transverse branching between vermis compartments.



Olivocerebellar connections; microzones in cerebellar cortex



Mitoma H, Kakei S, Yamaguchi K, Manto M. Physiology of Cerebellar Reserve: Redundancy and Plasticity of a Modular Machine. *Int J Mol Sci.* 2021 Apr 30;22(9):4777.

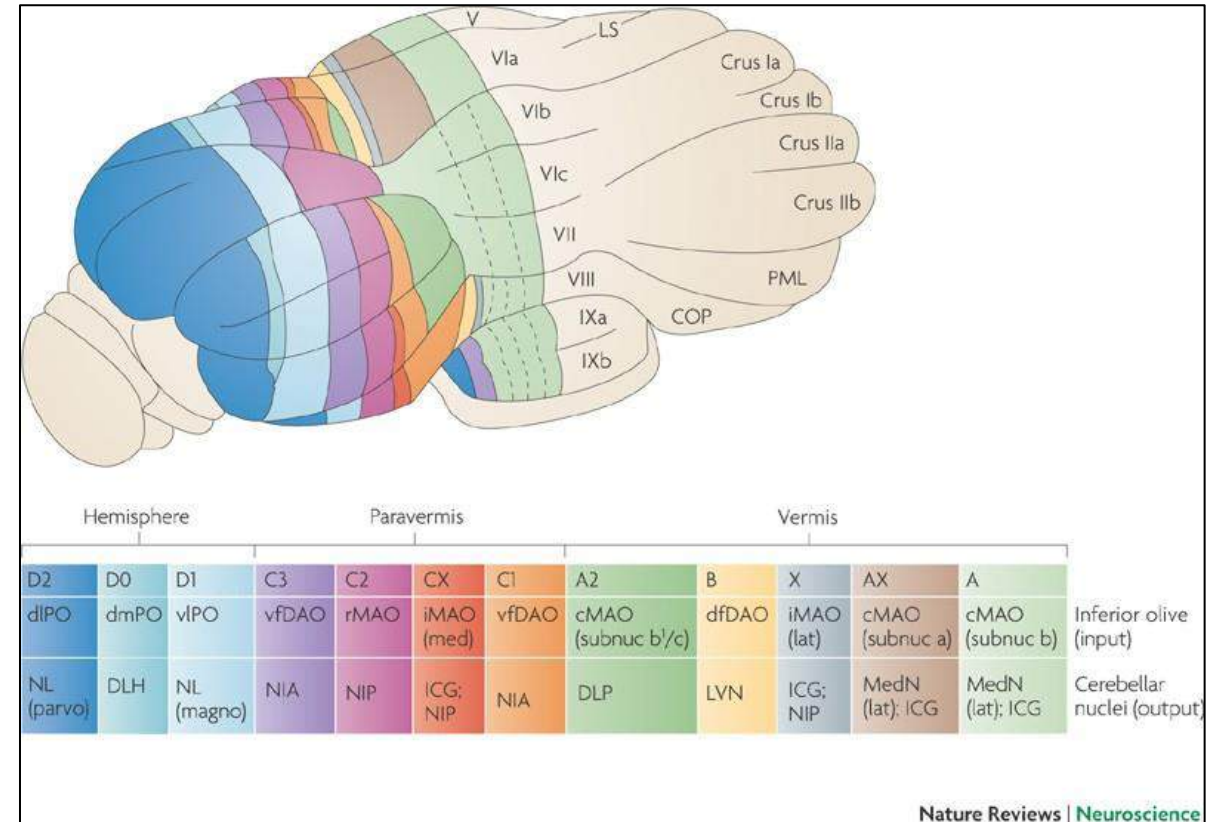
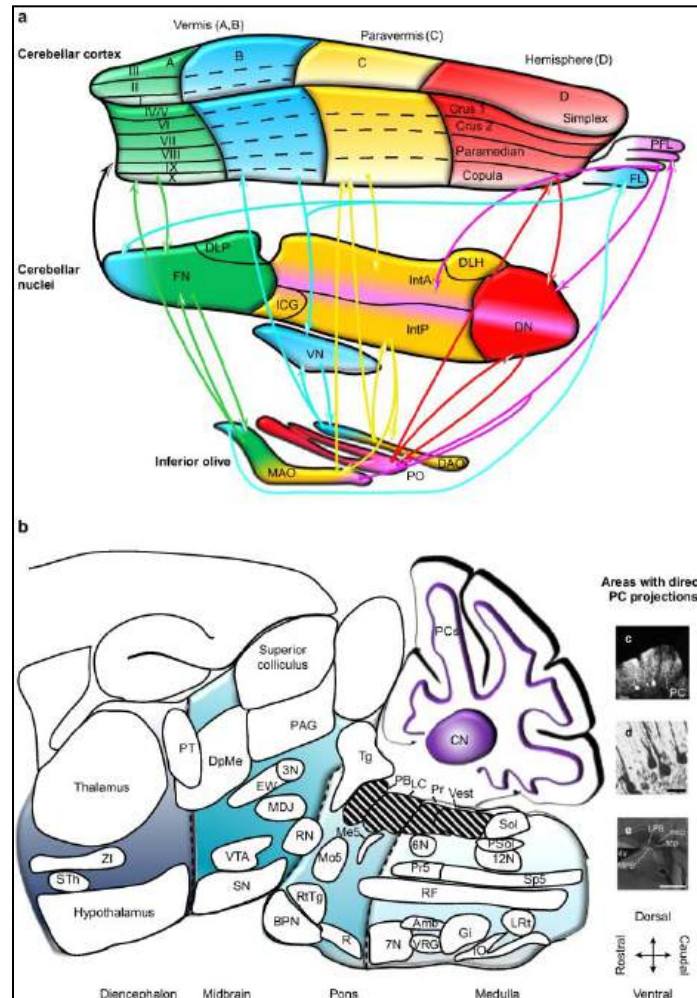
Sugihara I, Wu HS, Shinoda Y. *J Neurosci.* 2001 Oct 1;21(19):7715-23.

Sugihara I, Shinoda Y. *J Neurosci.* 2004 Oct 6;24(40):8771-85. Fujita and Sugihara, 2013

Climbing fibers organized in parasagittal microzones tracking zebrin stripes, enables cerebellar modular organization for error signaling, motor learning, domain-specific processing - motor, cognitive, emotional.

Z- higher simple spike rates, greater plasticity (e.g., LTD), phasic

Z+ lower baseline firing, tonic/modulatory



Apps R, Hawkes R. Cerebellar cortical organization: a one-map hypothesis. Nat Rev Neurosci. 2009 Sep;10(9):670-81.

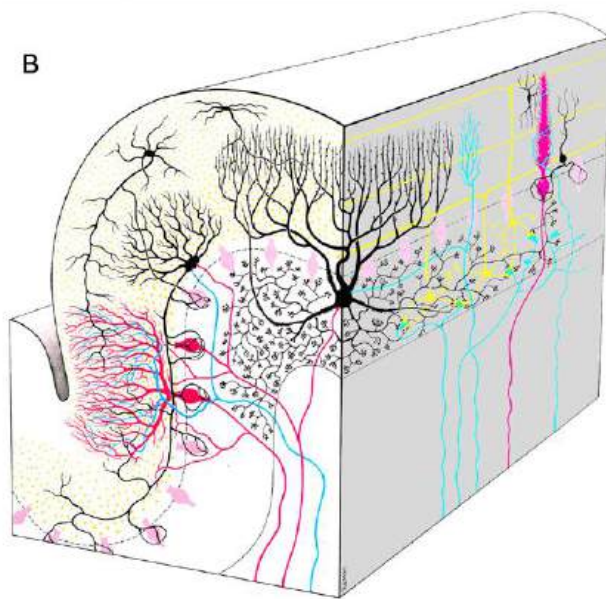
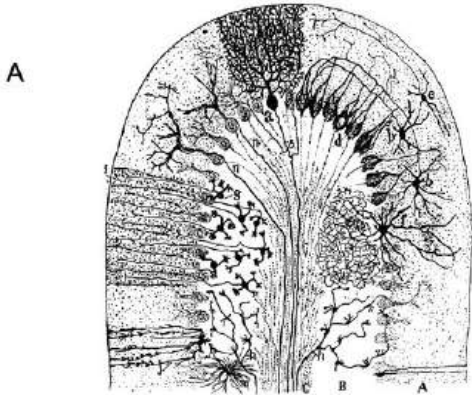
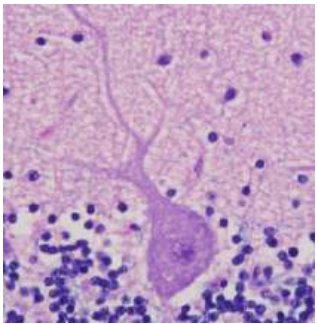
Novello M, Bosman LWJ, De Zeeuw CI. CA Cerebellum. 2024 Feb;23(1):210-239.

Cerebellar histology is essentially consistent throughout

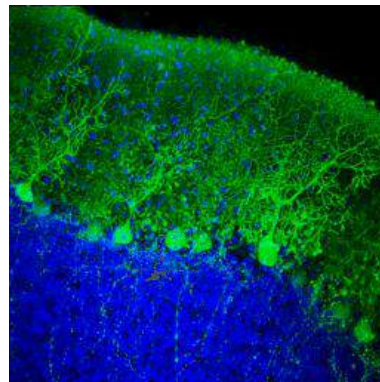
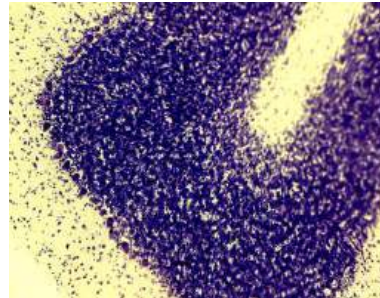
The computing power of the cerebellum which contains 70 - 80% of the brain's neurons is applied to almost every domain of neurological function.



Santiago Ramon y Cajal, 1911
vocesdelaciencia.com.ar



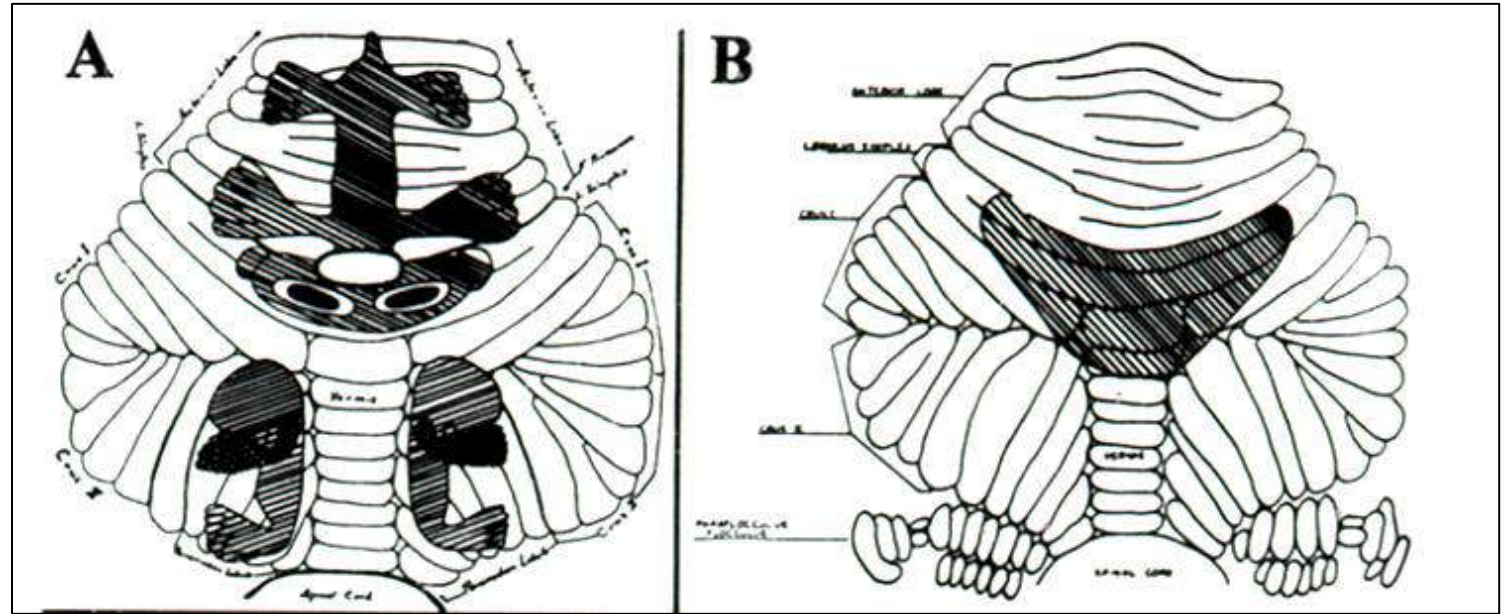
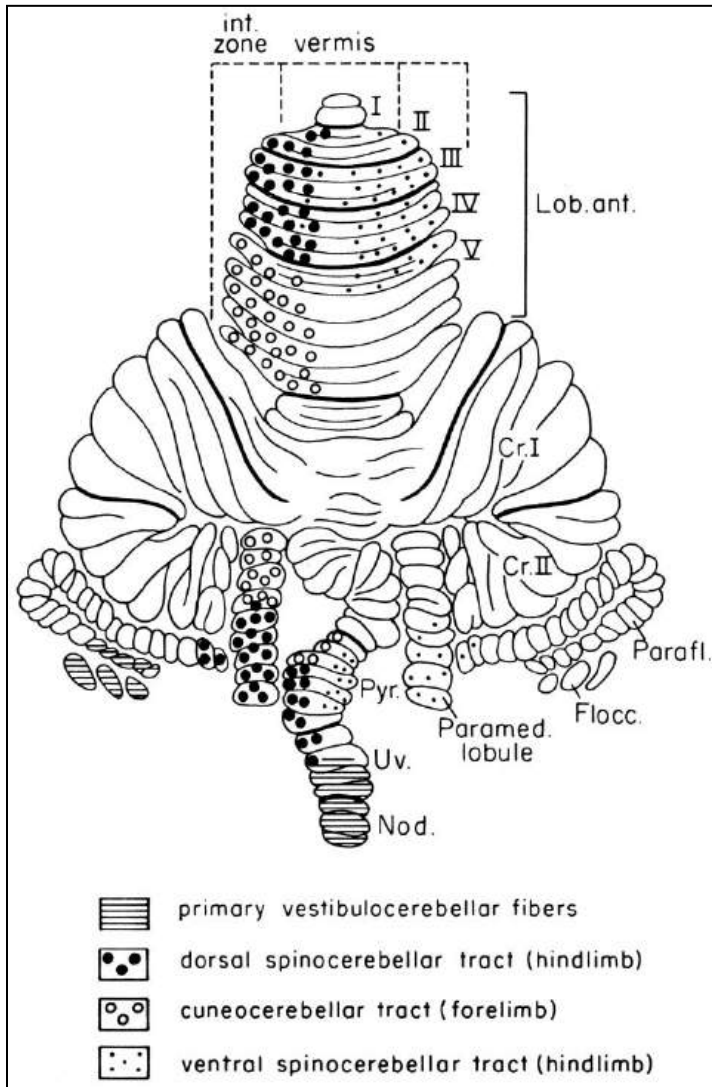
Eccles, Ito, Szentágothai, 1967



The mostly invariant architecture of the cerebellar cortex contrasts with the heterogeneity of cerebellar connections with extracerebellar structures

Schmahmann et al., 2019

Functional topography shapes the understanding of cerebellar neurobiology and disease

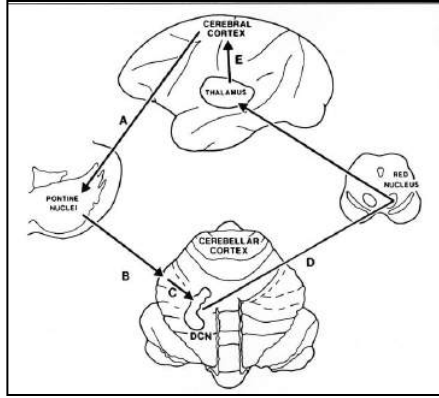


Snider and Stowell, 1946

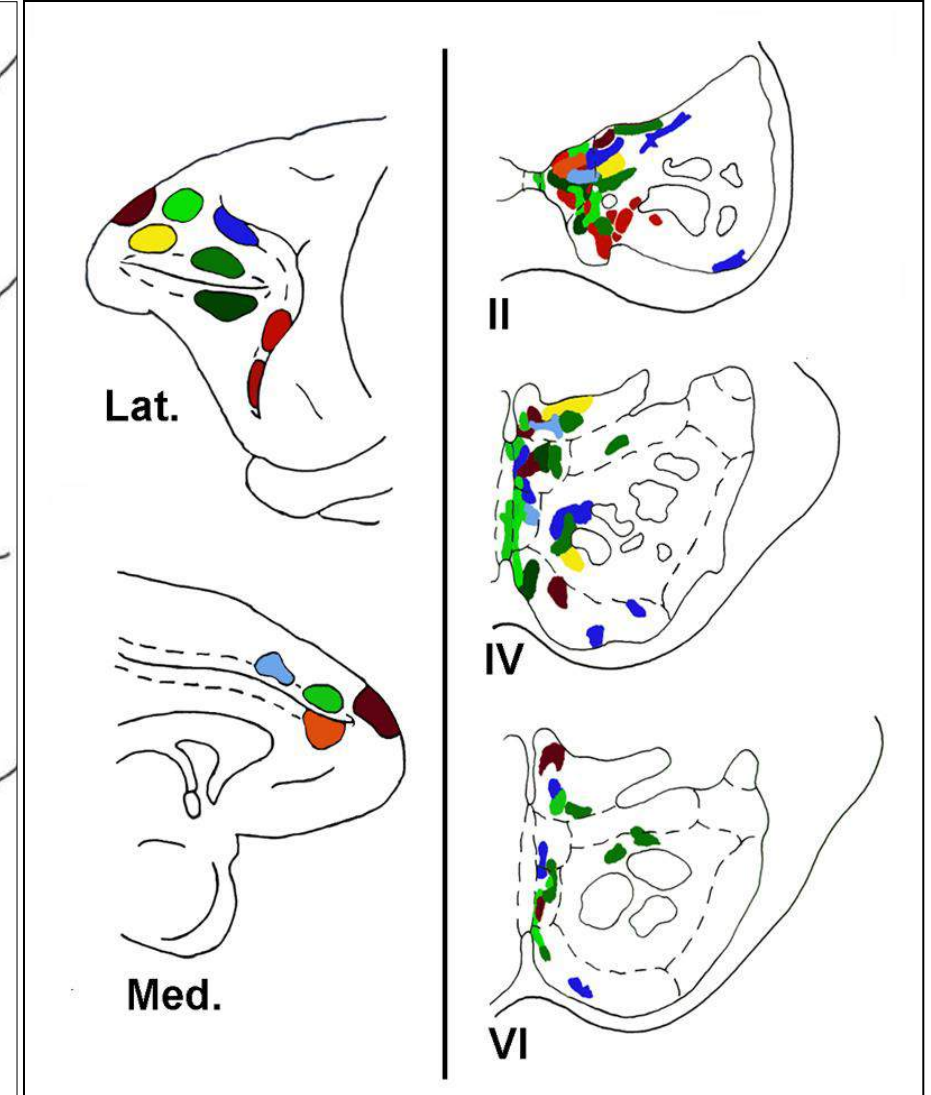
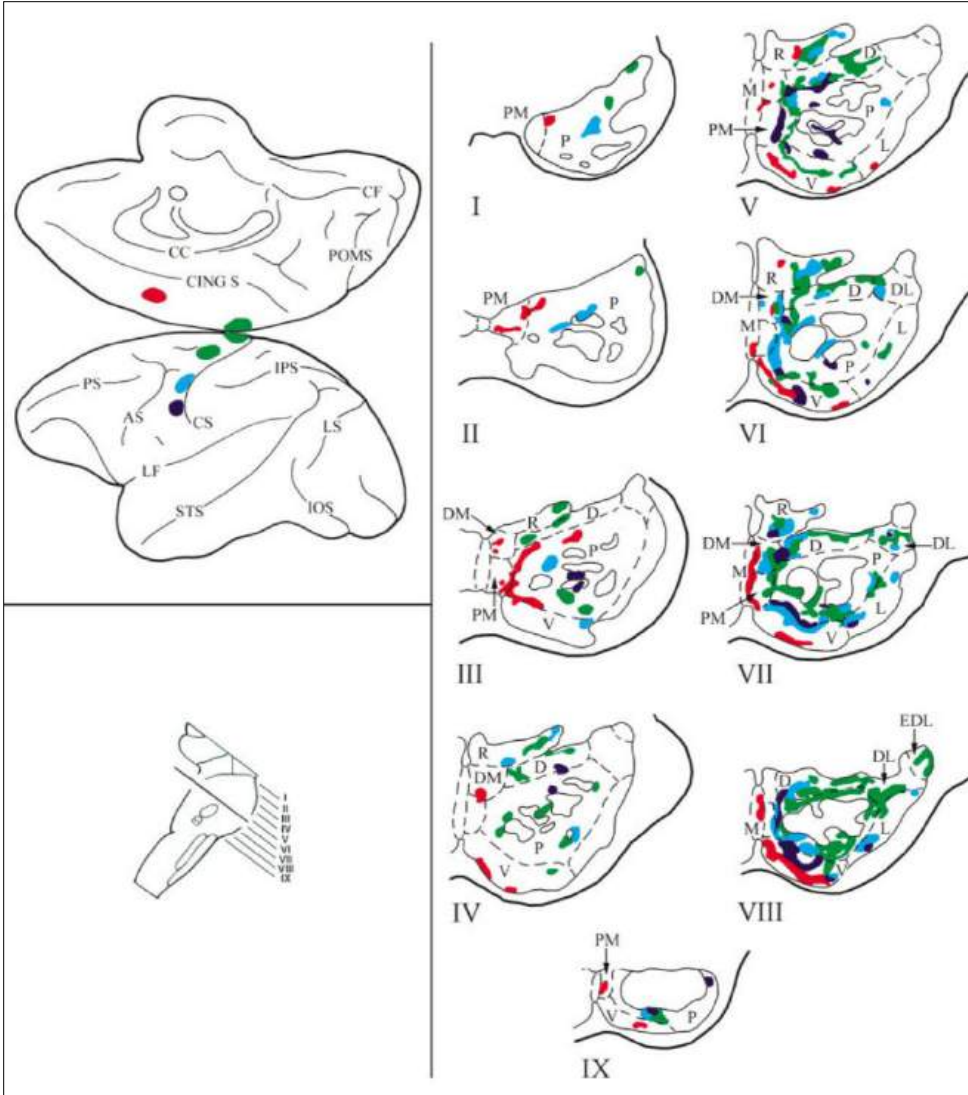
Snider, 1950

Snider and Eldred, 1951

Corticopontine projections in rhesus monkey



Deepak Pandya



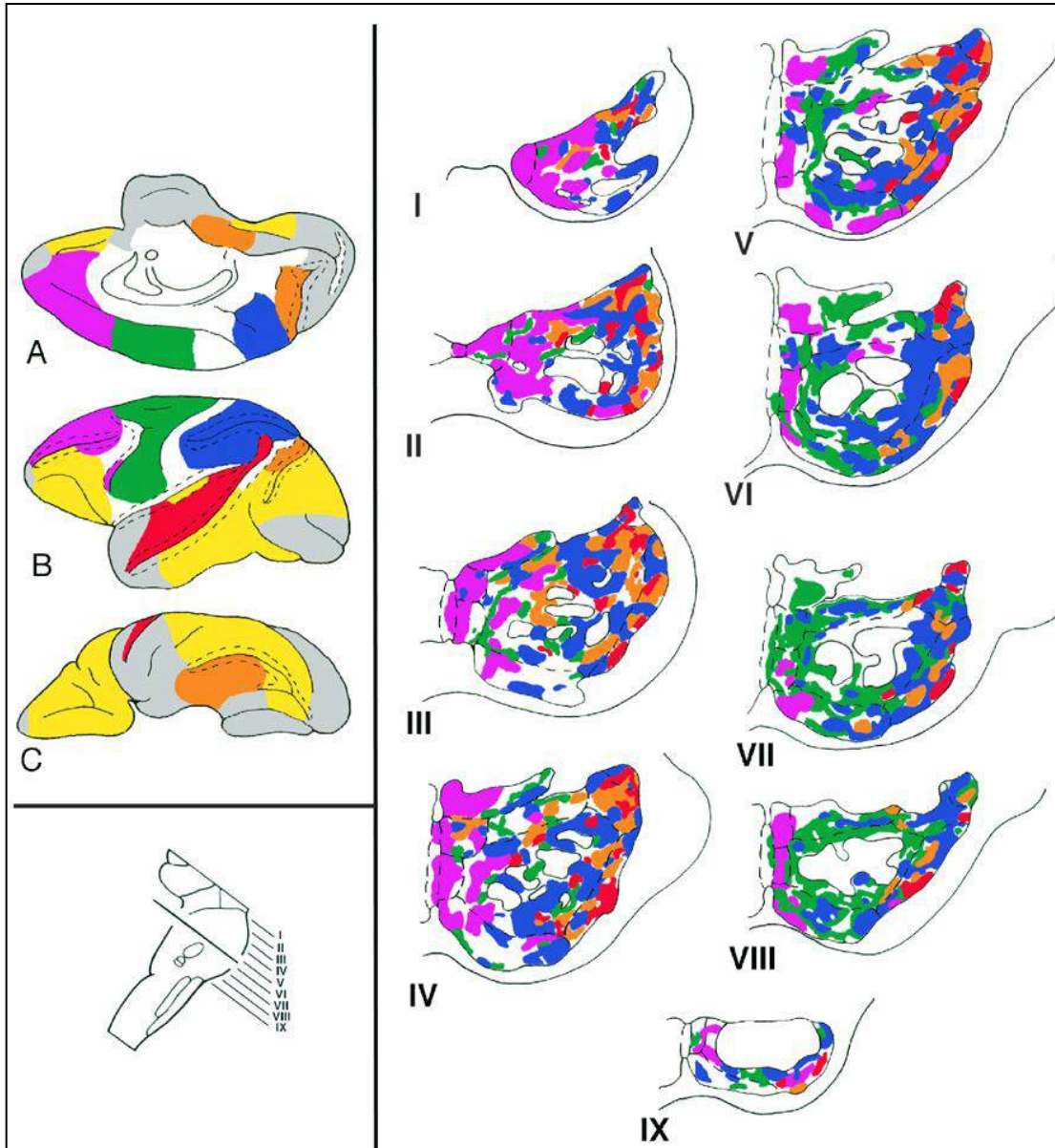
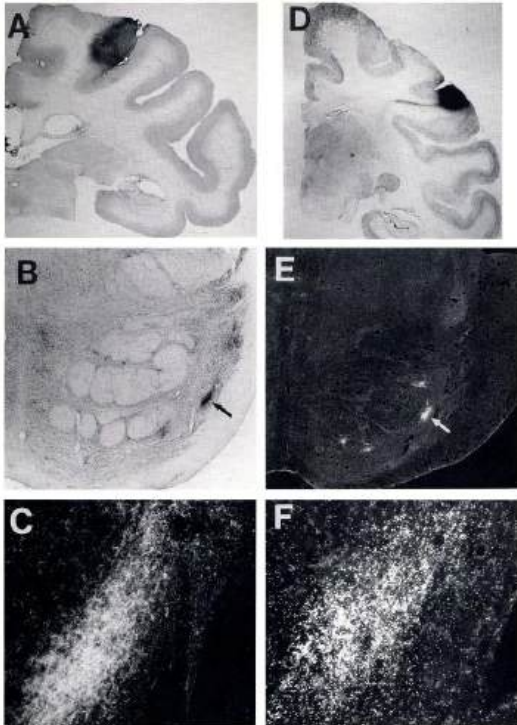
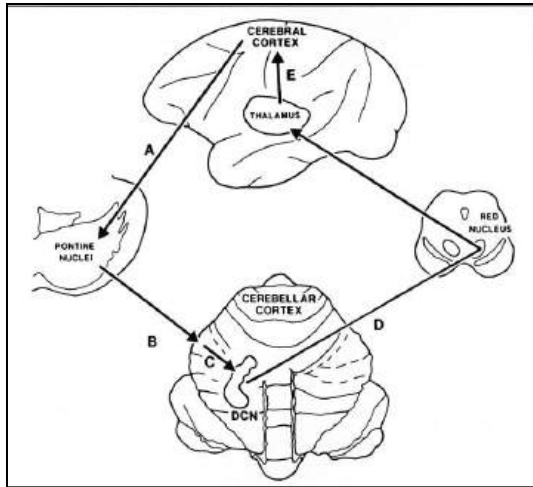
Motor projections

Schmahmann, Rosene, Pandya. J Comp Neurol, 2004

Prefrontal projections

Schmahmann and Pandya, Neurosci Lett, 1995; J Neurosci 1997

Cerebro-cerebellar circuits: Feedforward limb



Schmahmann and Pandya. Neurology, 1987. Int Rev Neurobiol, 1997, based on J Comp Neurol 1989, 1991, 1992, 1993, 1997, 2004; Schmahmann, Hum Brain Mapp, 1996

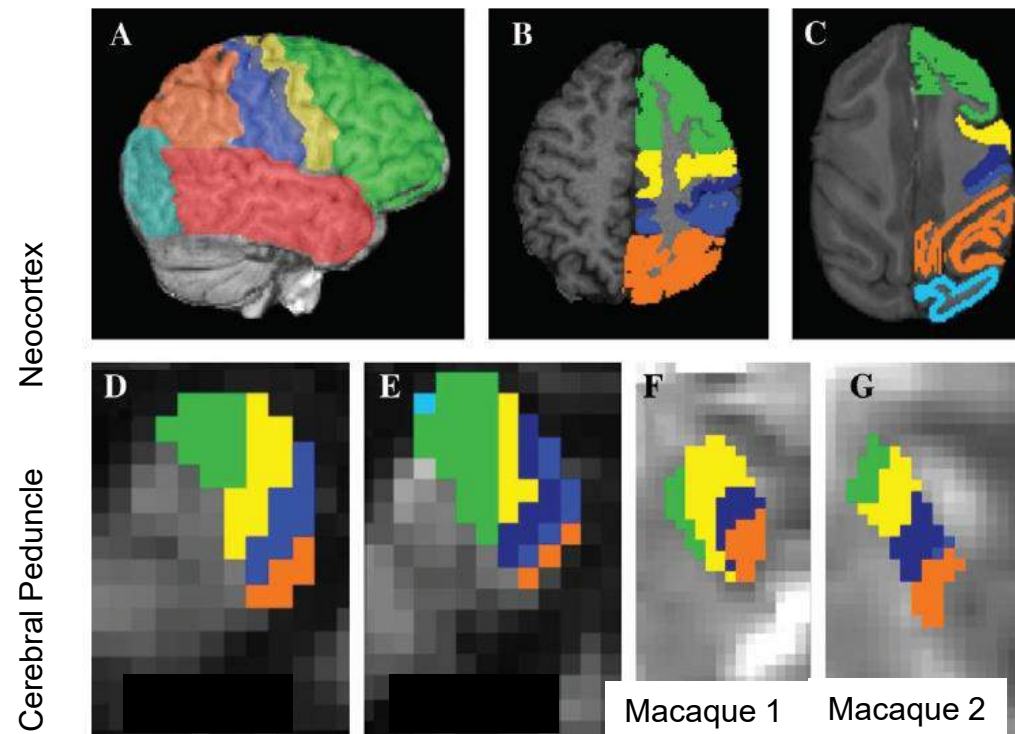
Evolution of corticopontine inputs

Fiber tracking (Diffusion MRI): Segmenting the **cerebral peduncle**
on the basis of fibers of origin

Prefrontal cortex
Premotor cortex
Primary motor cortex

Largest segment in human

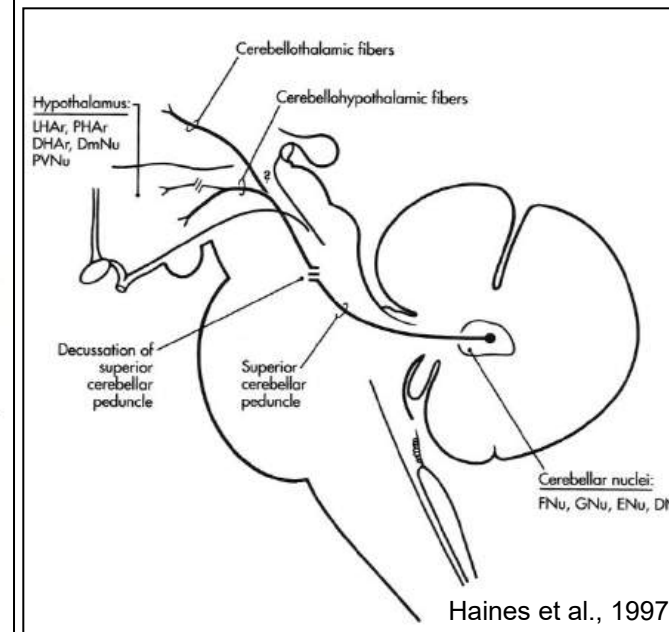
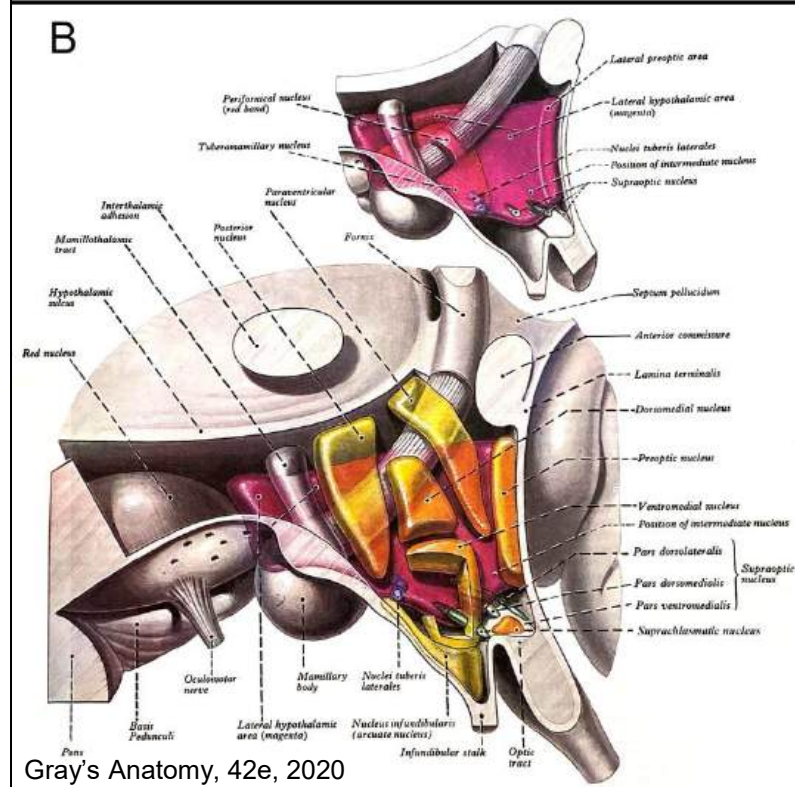
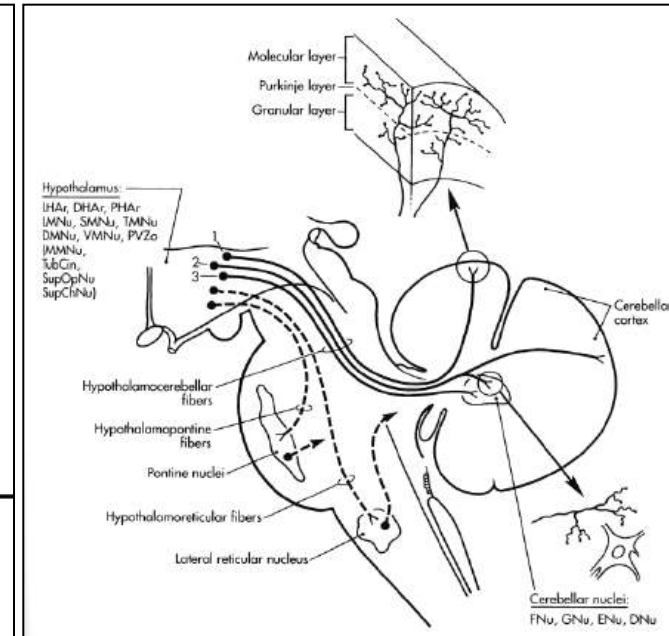
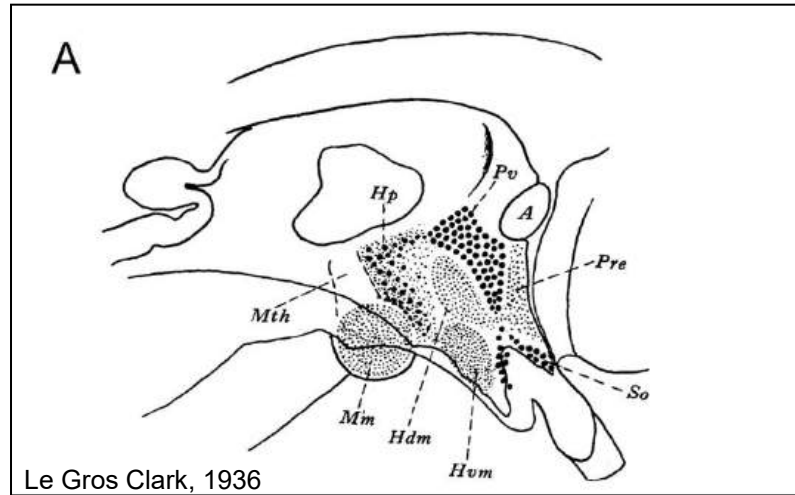
Largest segment in macaque



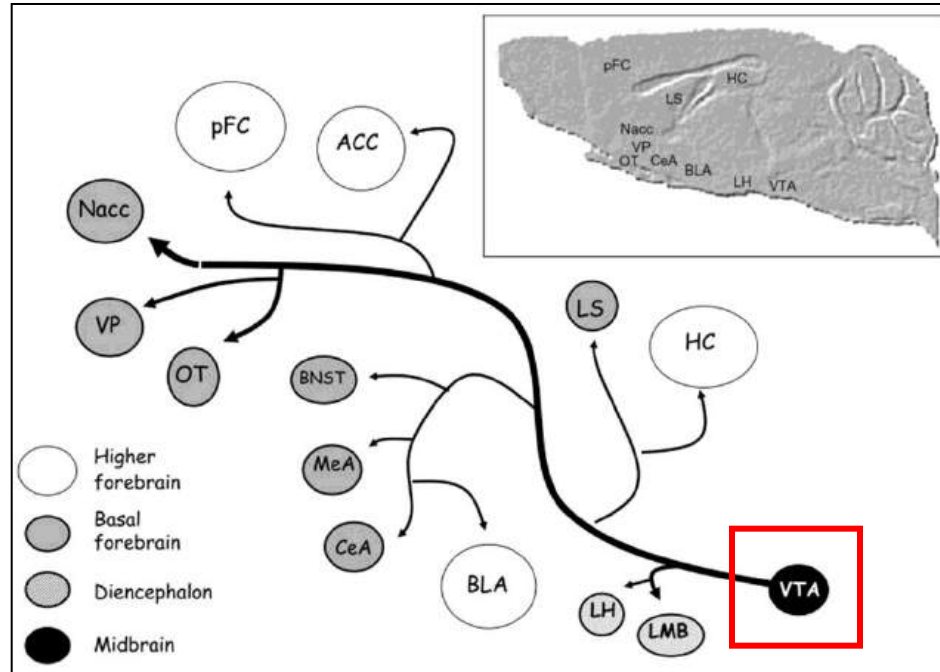
Ramnani et al. Cerebral Cortex 2004;16:811-818



Hypothalamocerebellar connections



Ventral tegmental area: mesolimbic dopaminergic system



From Alcaro et al., 2007

Cerebellar modulation of the reward circuitry and social behavior

Ilaria Carta^{1*}, Christopher H. Chen^{1*}, Amanda L. Schott¹,
Schnaude Dorizan¹, Kamran Khodakhah^{1,2,3†}

The cerebellum has been implicated in a number of nonmotor mental disorders such as autism spectrum disorder, schizophrenia, and addiction. However, its contribution to these disorders is not well understood. In mice, we found that the cerebellum sends direct excitatory projections to the ventral tegmental area (VTA), one of the brain regions that processes and encodes reward. Optogenetic activation of the cerebello-VTA projections was rewarding and, in a three-chamber social task, these projections were more active when the animal explored the social chamber. Intriguingly, activity in the cerebello-VTA pathway was required for the mice to show social preference in this task. Our data delineate a major, previously unappreciated role for the cerebellum in controlling the reward circuitry and social behavior.

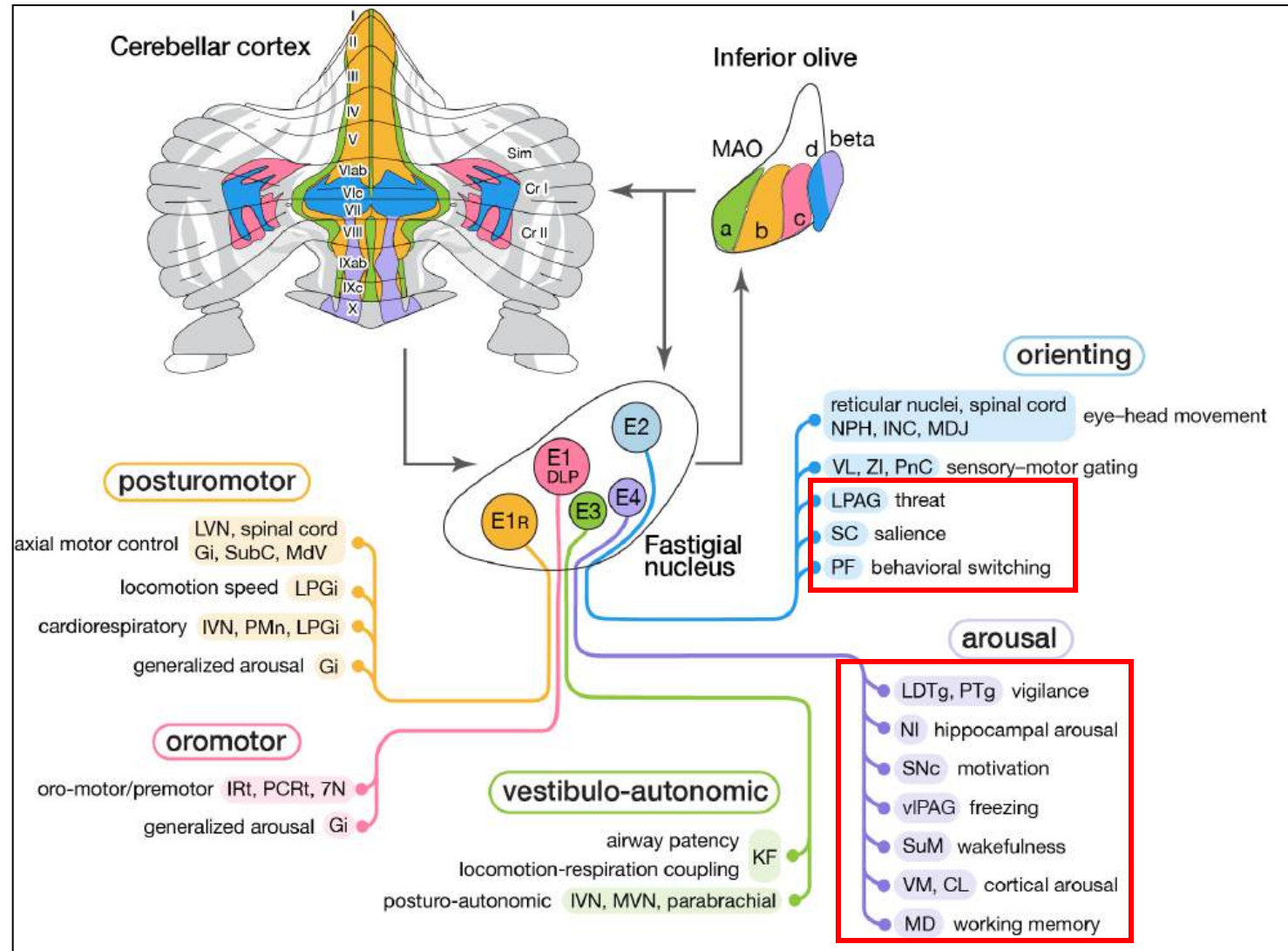
Science. 2019;363(6424):eaav0581

Cerebellar granule cells encode the expectation of reward

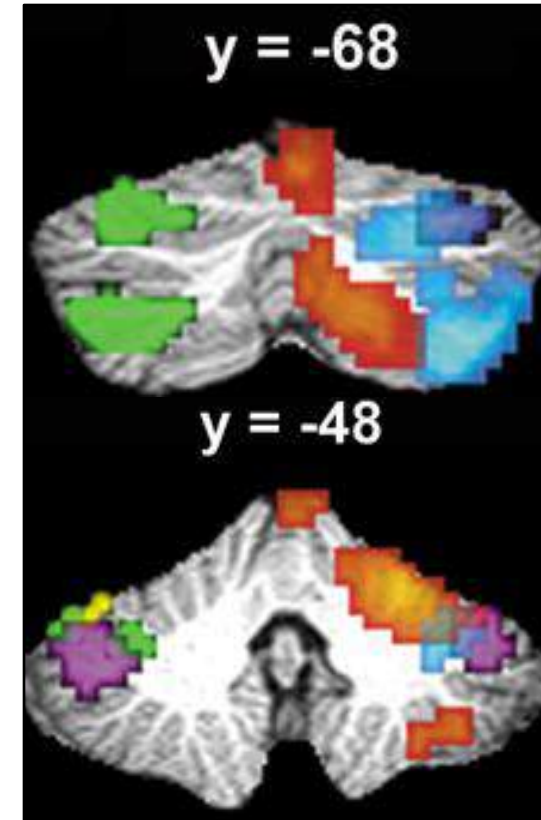
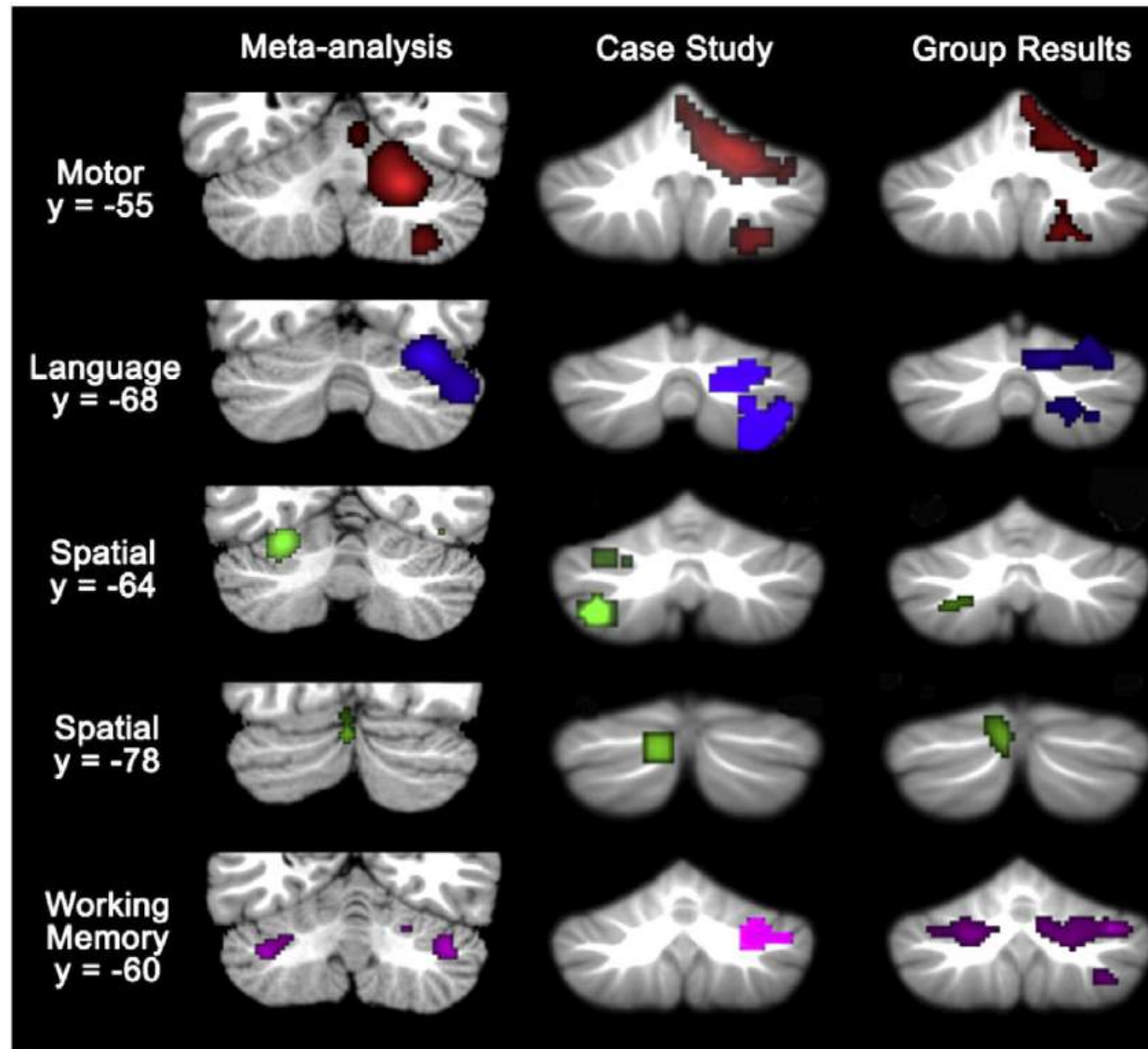
Wagner MJ, Kim TH, Savall J, Schnitzer MJ, Luo L.
Cerebellar granule cells encode the expectation of reward. Nature. 2017 Apr 6;544(7648):96-100.

Fastigial nucleus – VTA
Snider et al., 1976;
Snider and Maiti, 1976

Modular output circuits of the fastigial nucleus for diverse motor and nonmotor functions of the cerebellar vermis



Human cerebellar functional topography. Task-based fMRI



Catherine Stoodley

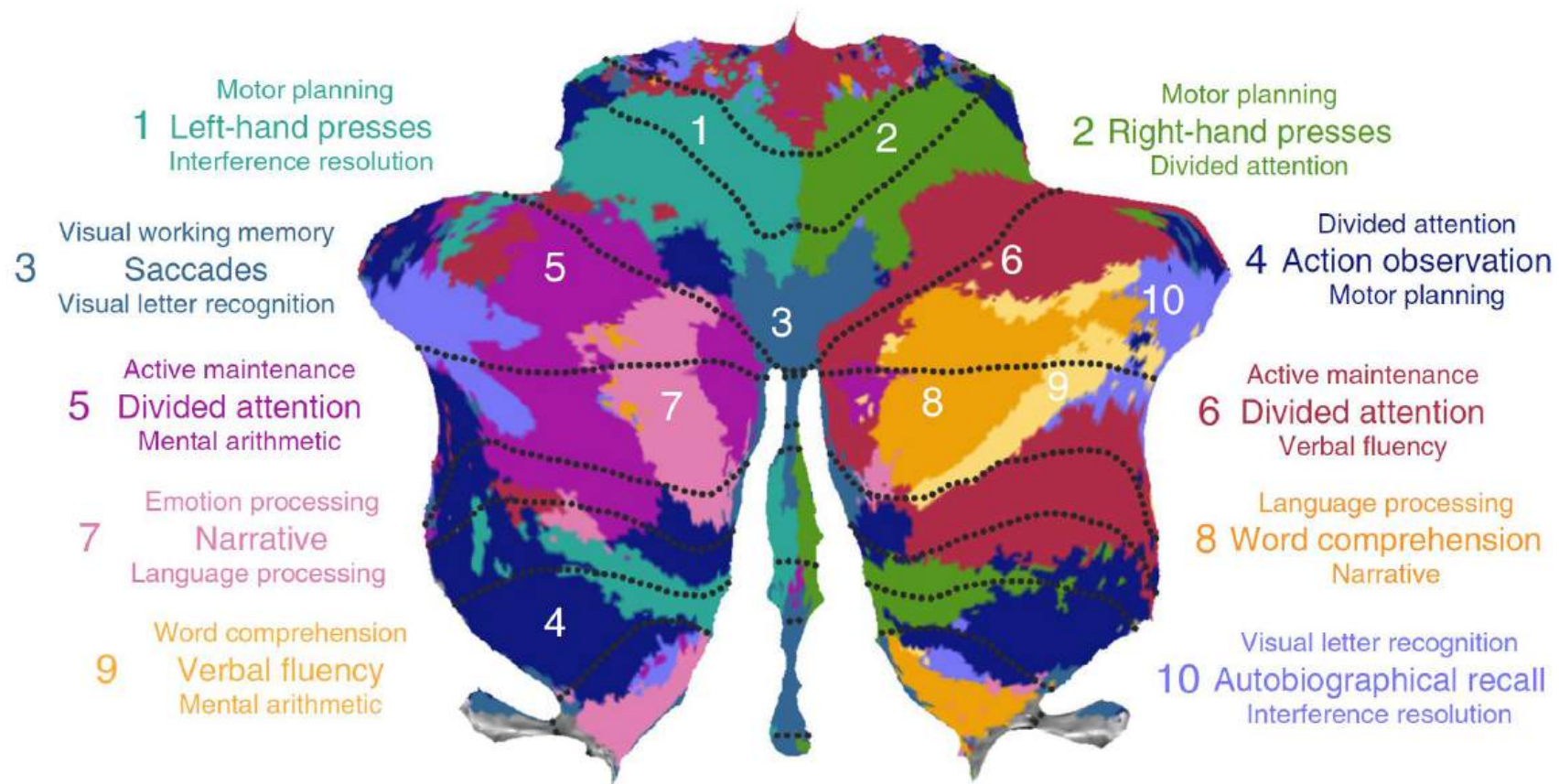


Eve Valera

Stoodley and Schmahmann, NeurolImage 2009

Stoodley, Valera, Schmahmann. Behav Neurol. 2010, NeurolImage 2012

Functional boundaries in the human cerebellum revealed by a multi-domain task battery

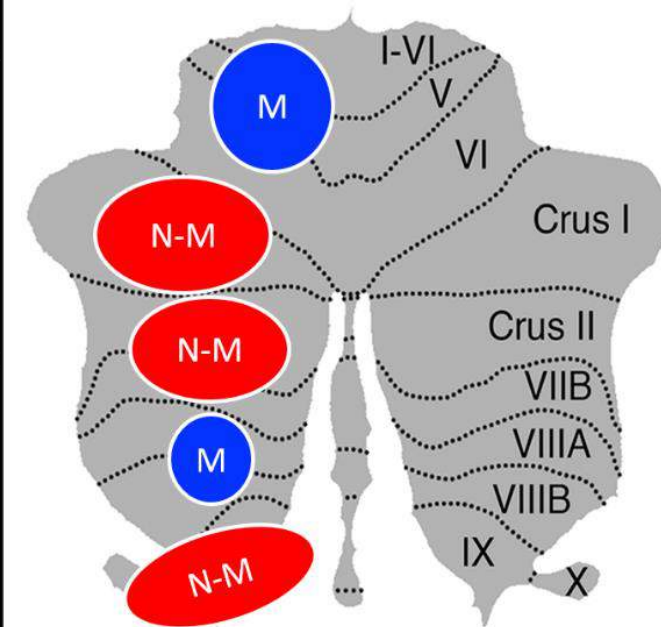
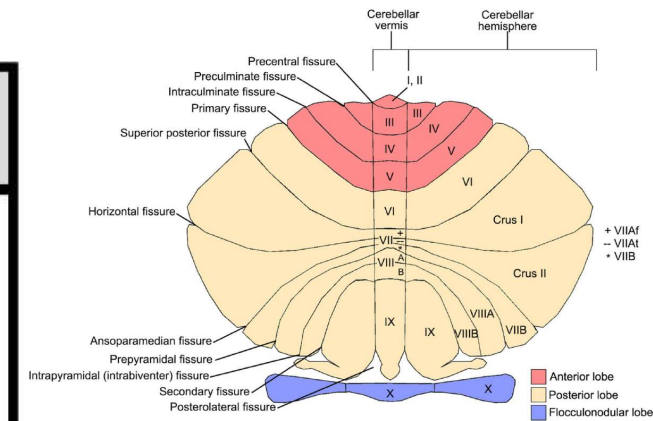
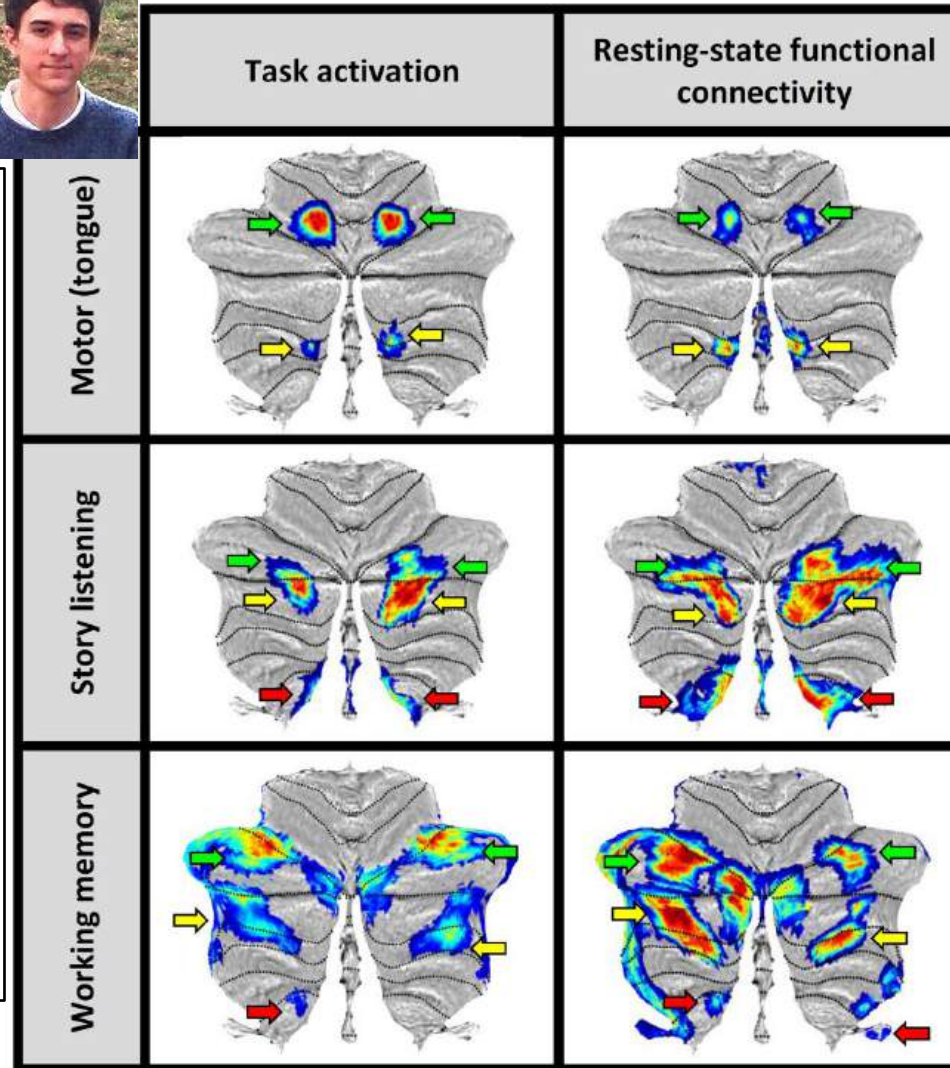
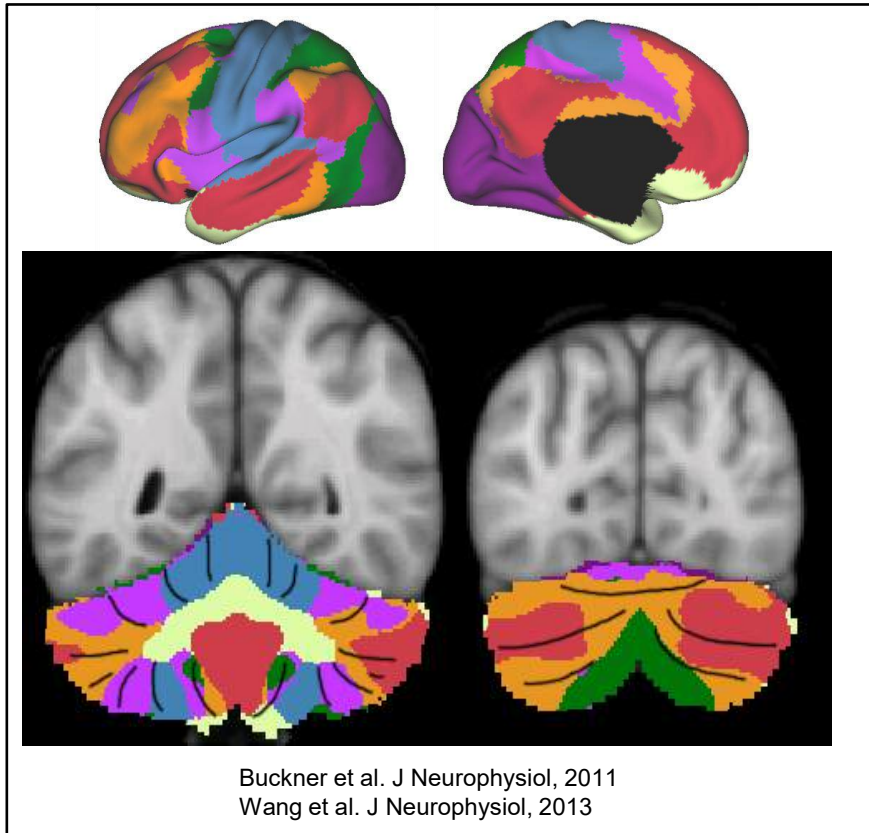


King M, Hernandez-Castillo CR, Poldrack RA, Ivry RB, Diedrichsen J.
Nat Neurosci. 2019; 22: 1371-1378.

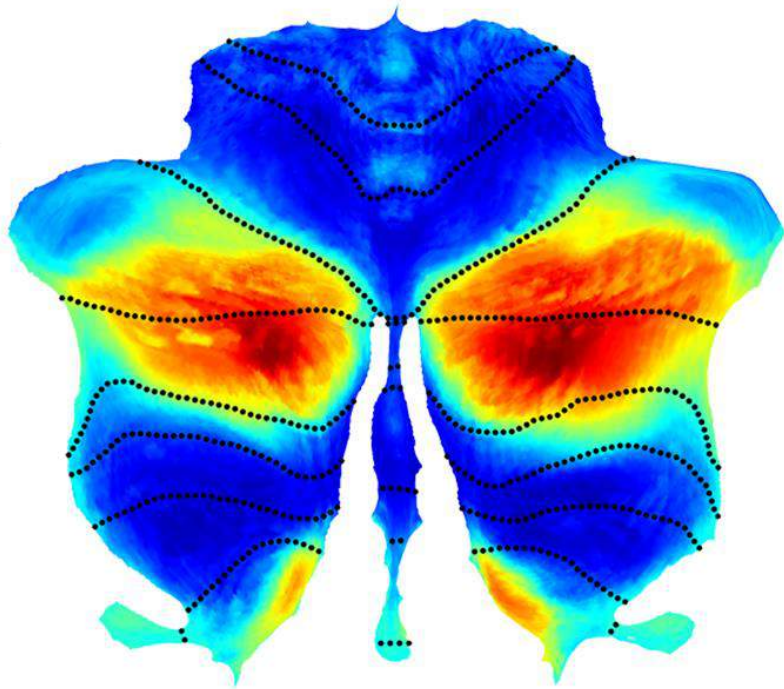
Cerebellum has primary and secondary sensorimotor representations; and primary, secondary, and tertiary cognitive representations



Xavier Guell



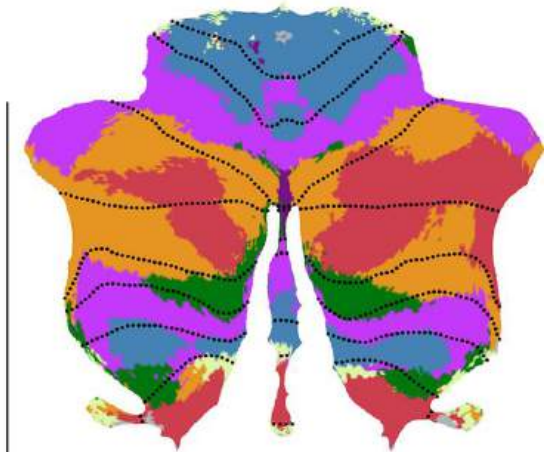
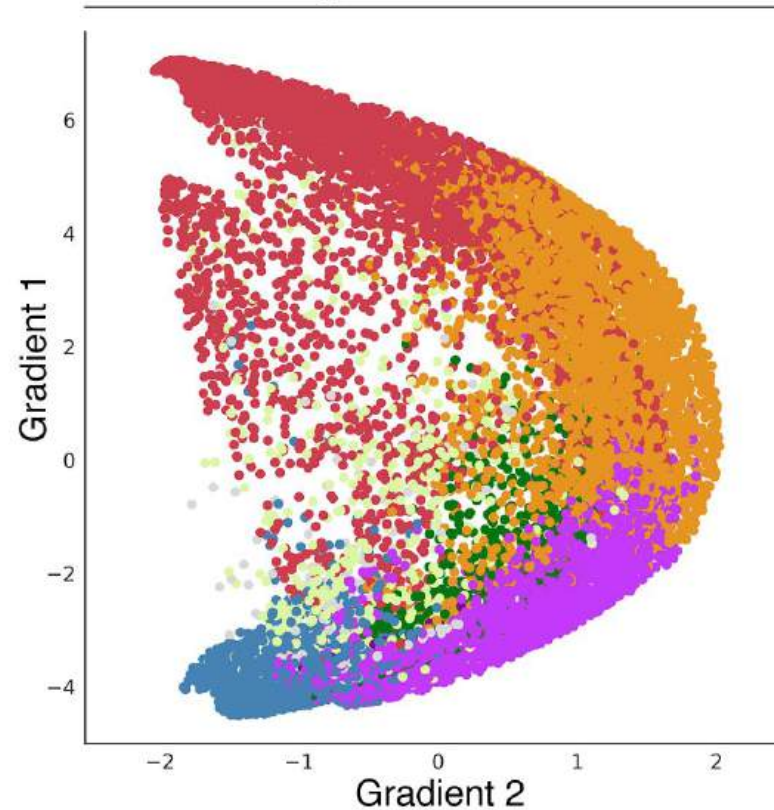
Principal gradient of cerebellar organization: from motor to default-mode network areas



Gradient 1

Gradient 1: From motor (blue)
to default-mode (red)

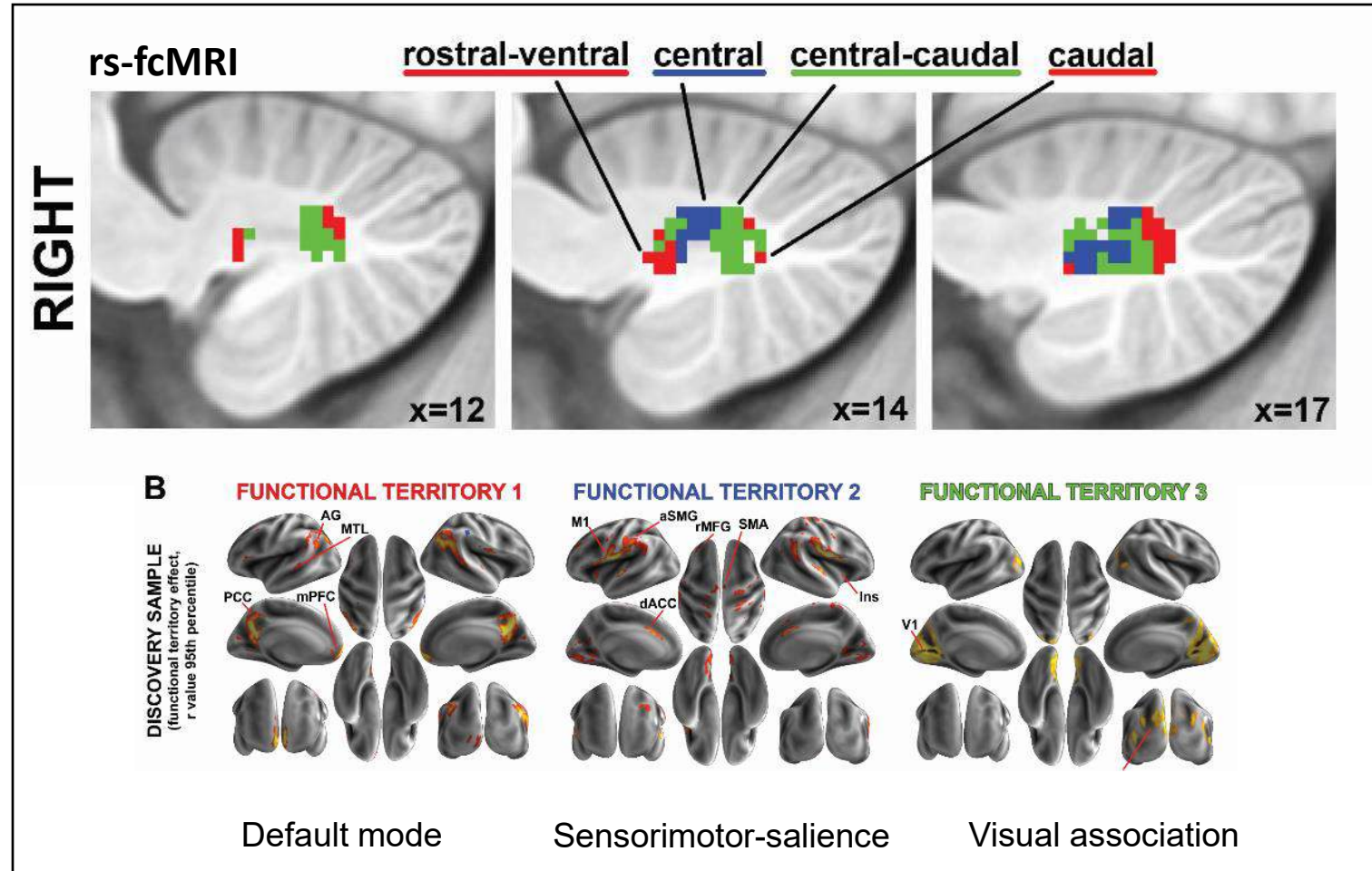
Resting-state networks



- Somatomotor network
- Ventral Attention network
- Dorsal Attention network
- Limbic network
- Frontoparietal network
- Default Mode network
- Visual network

Guell X, Schmahmann JD, Gabrieli J, Ghosh SS. Functional gradients of the cerebellum. Elife. 2018 Aug 14;7. pii: e36652.

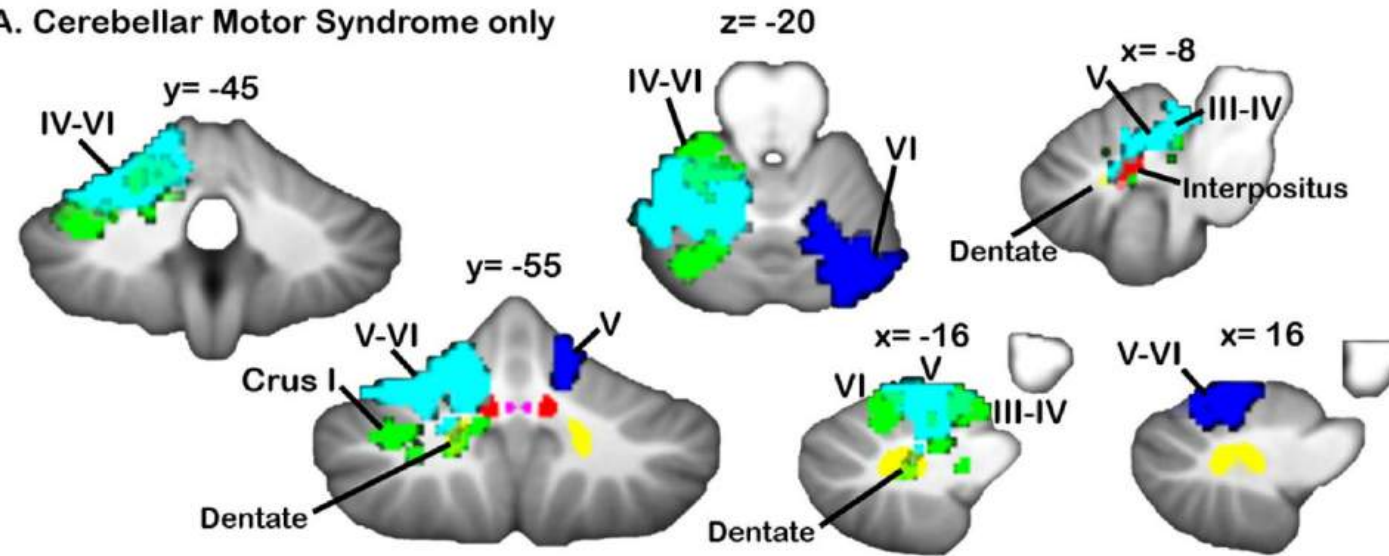
Human Dentate Nucleus functional territories



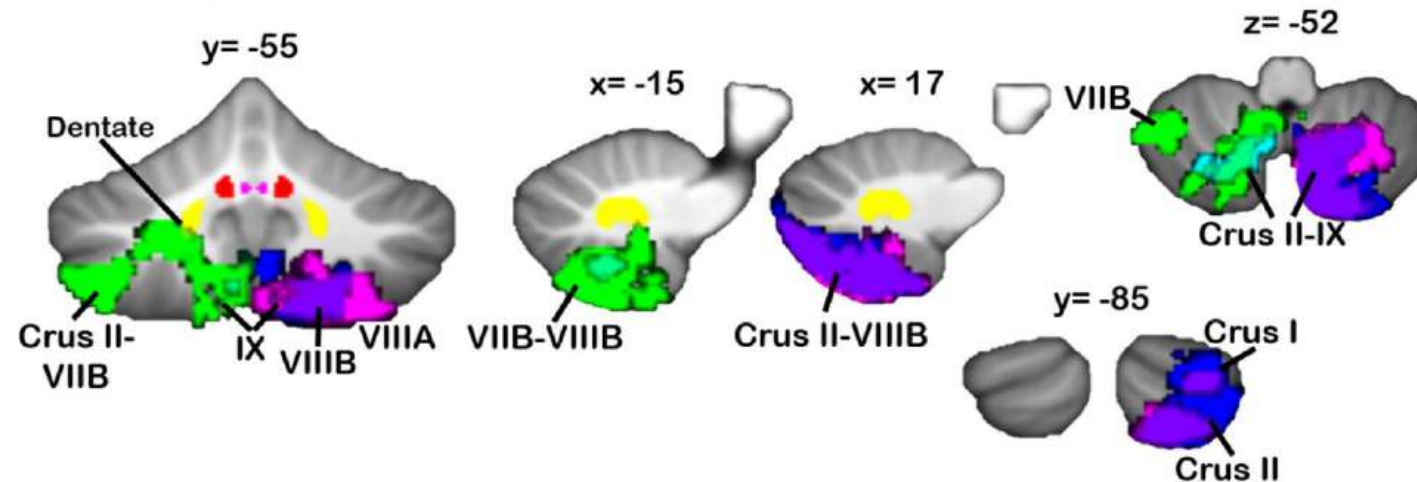
Guell X, D'Mello AM, Hubbard NA, Romeo RR, Gabrieli JDE, Whitfield-Gabrieli S, Schmahmann JD, Anteraper SA. Cerebral Cortex, 2020; 30:2401-2417.

Location of lesion determines motor vs. cognitive consequences in patients with cerebellar stroke

A. Cerebellar Motor Syndrome only



B. CCAS only



Stoodley, MacMore, Makris, Sherman, Schmahmann. Neurolmage Clinical, 2016
Also – Schmahmann, MacMore, Vangel. Neuroscience 2009; Schmahmann and Sherman, 1998

Cerebellar Cognitive Affective Syndrome (CCAS)

- Executive Function

Planning, set-shifting, verbal fluency,
abstract reasoning, working memory

- Spatial Cognition

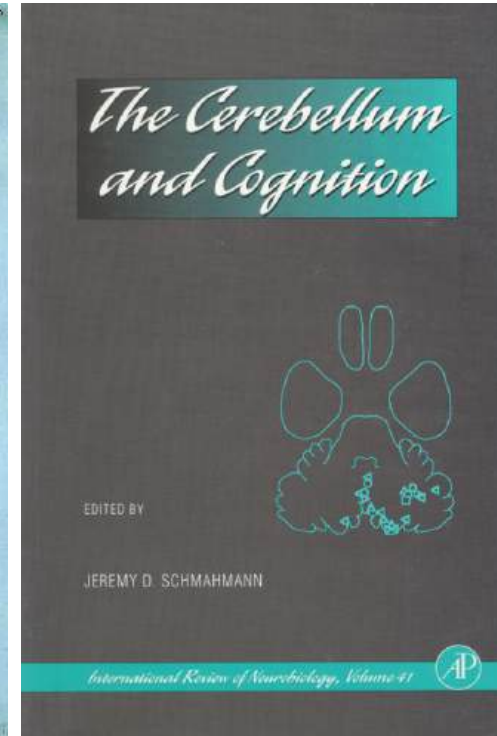
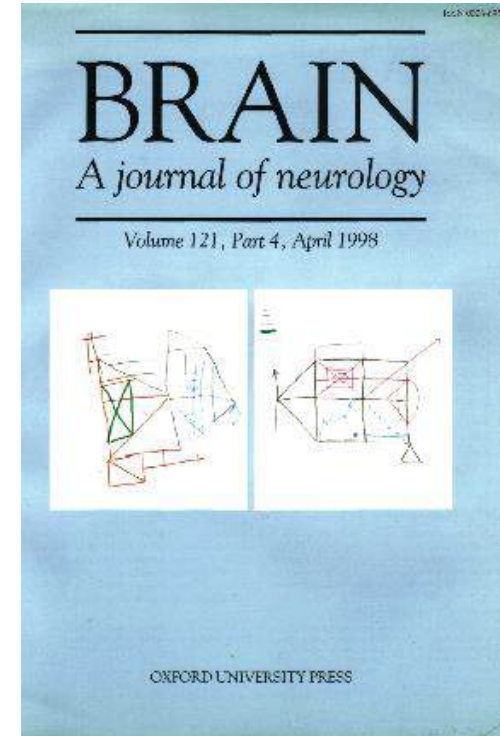
Visual spatial organization and memory

- Language Deficits

Agrammatism, aprosodia, anomia

- Personality Change

Blunting of affect, disinhibited and inappropriate behavior



Schmahmann and Sherman. Brain, 1998



Schmahmann's syndrome - identification of the
third cornerstone of clinical ataxiology

Mario Manto and Peter Mariën. Cerebellum and Ataxias 2015;2:2

Cerebellar Motor Syndrome

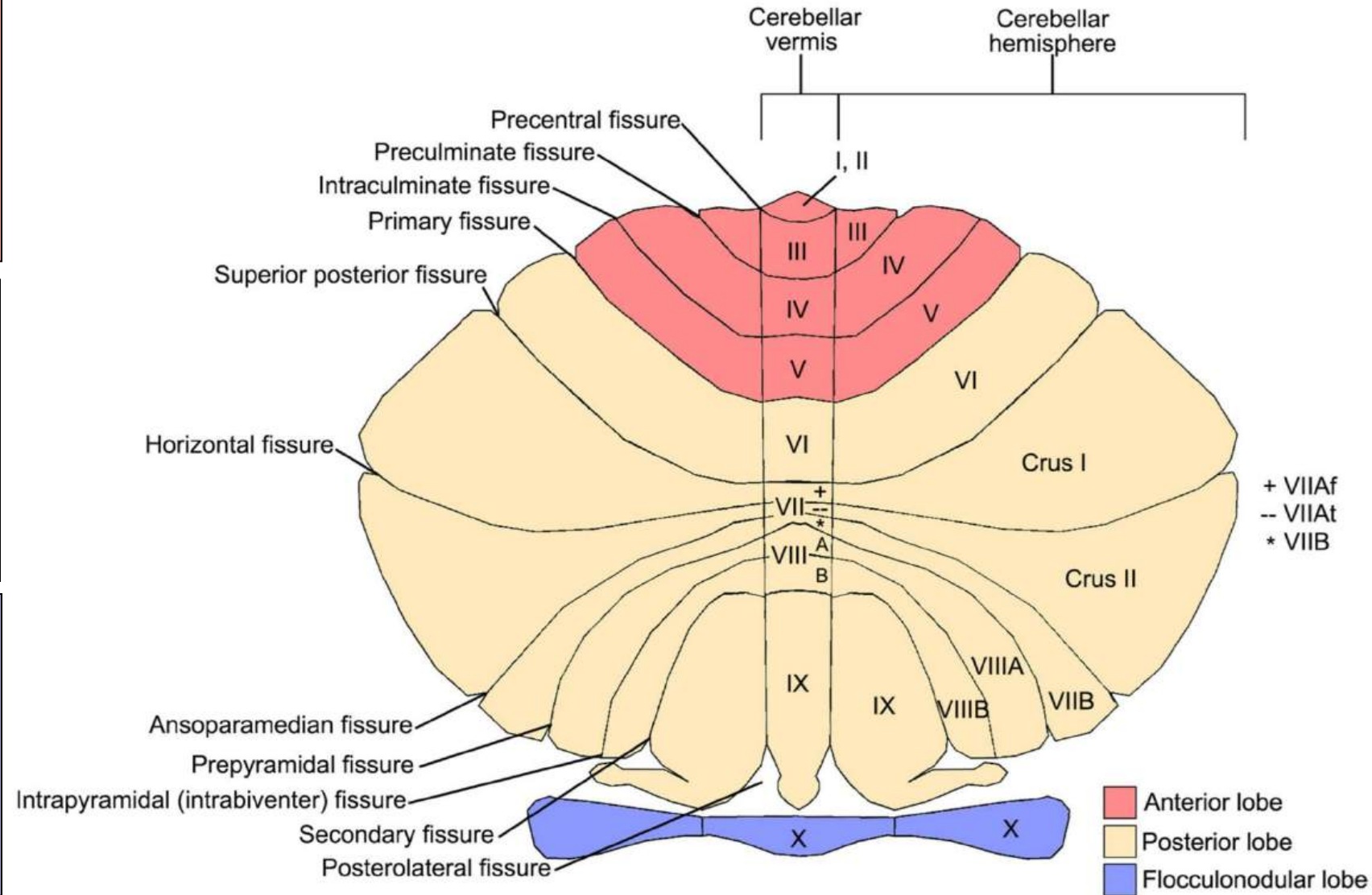
The clinical syndrome that follows lesions of the sensorimotor regions of the cerebellum.

Cerebellar Cognitive Affective Syndrome

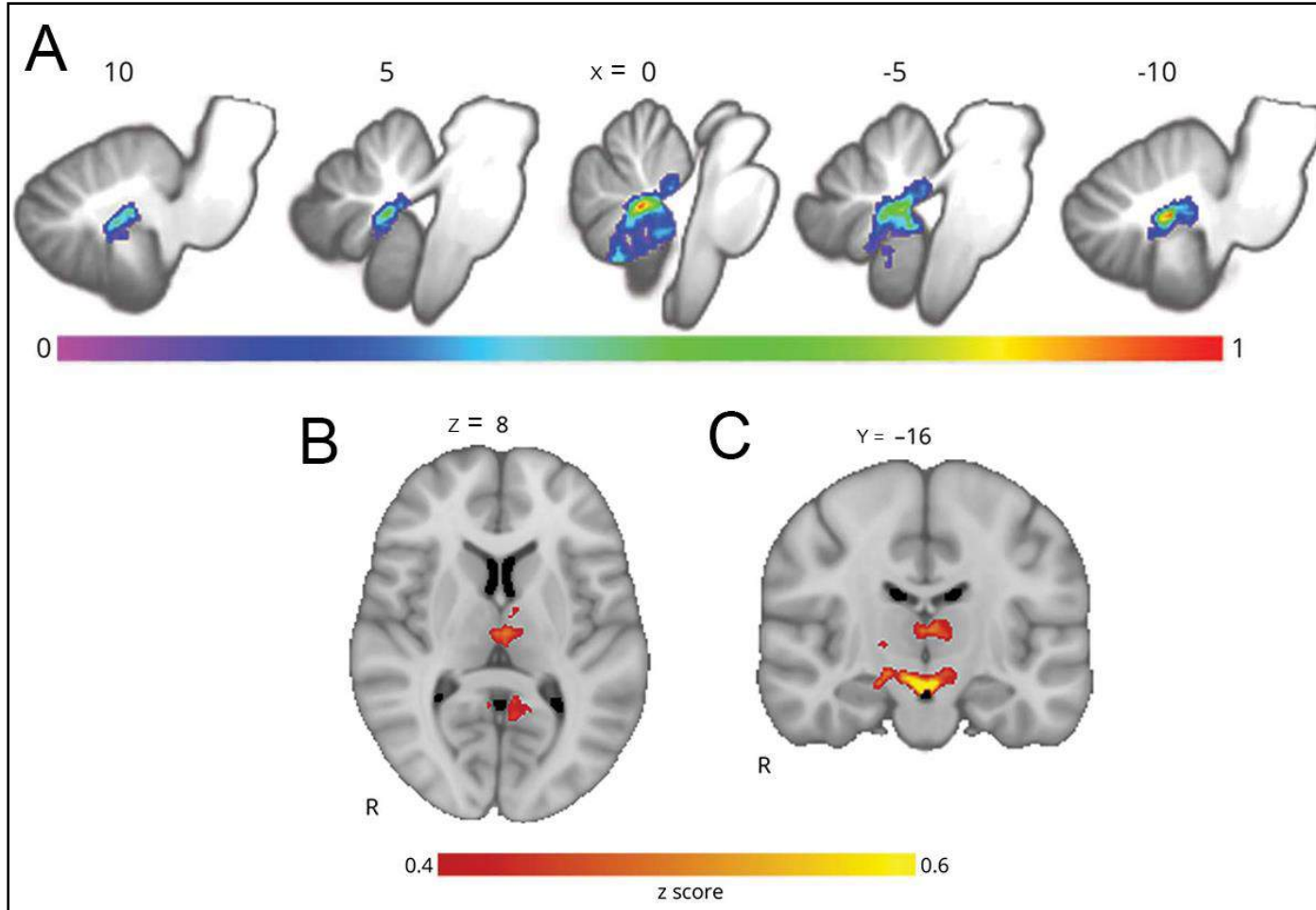
The clinical syndrome that follows lesions of the cognitive and limbic regions of the cerebellum.

Cerebellar Vestibular Syndrome

The clinical syndrome that follows lesions of the vestibular regions of the cerebellum.



Pediatric postoperative cerebellar cognitive affective syndrome follows outflow pathway lesions



POSTERIOR FOSSA SYNDROME

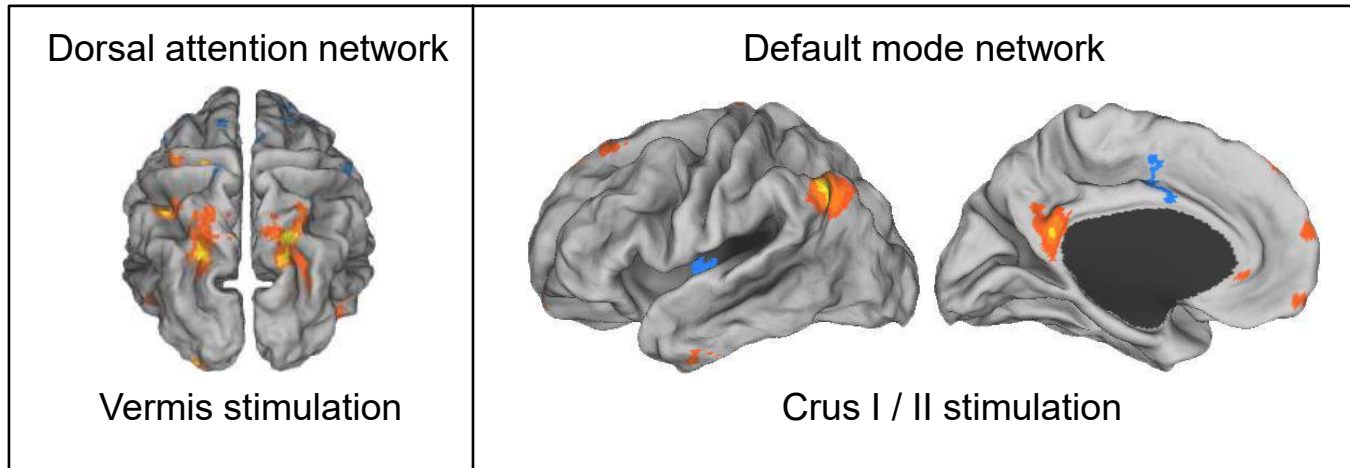
1. CCAS +/- mutism
2. Cerebellar motor ataxia
3. Brainstem syndromes

Cerebral networks modified by Cerebellar TMS

rs-fcMRI affected in a network specific manner



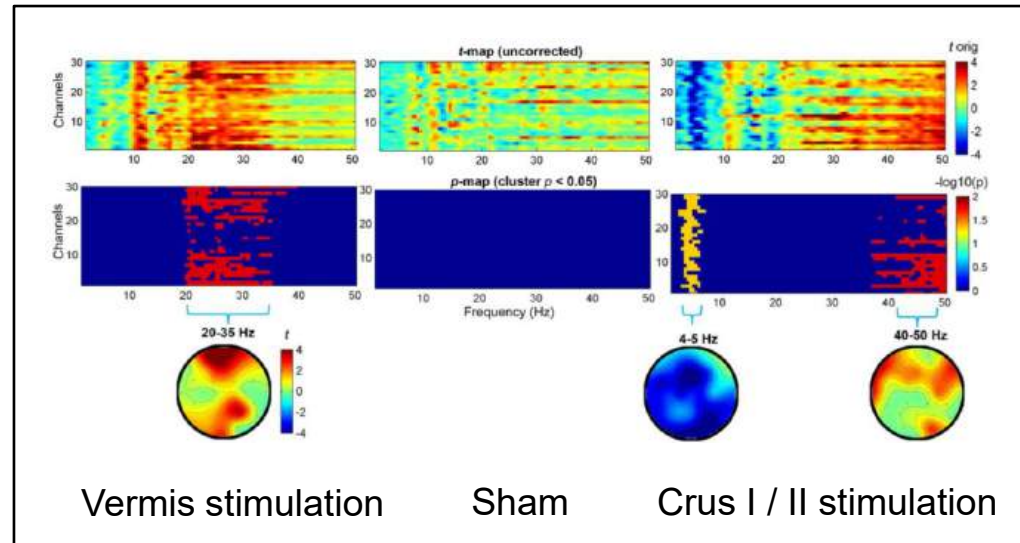
Halko et al.
J Neurosci,
2014



Cerebellar subregions control the temporal dynamics of cerebral networks with which they are interconnected



Farzan et al.
Sci Rep, 2016



Schizophrenia Research 124 (2010) 91–100

Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

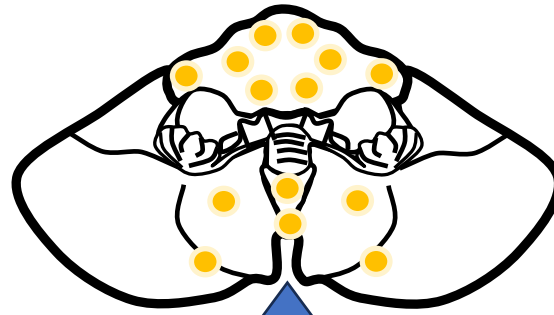
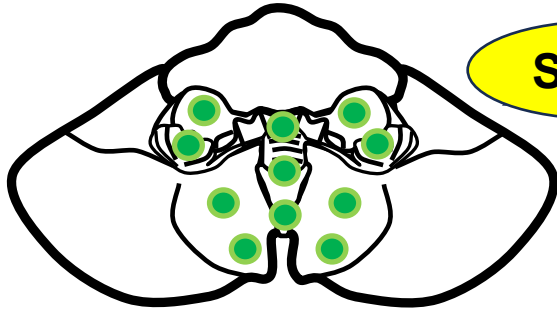
Safety and proof of principle study of cerebellar vermal theta burst stimulation in refractory schizophrenia

Asli Demirtas-Tatlidede^{a,b}, Catarina Freitas^{a,b}, Jennifer R. Cromer^{a,c}, Laura Safar^{a,c}, Dost Ongur^{a,d}, William S. Stone^{a,e}, Larry J. Seidman^{a,e}, Jeremy D. Schmahmann^{a,f}, Alvaro Pascual-Leone^{a,b,*}

The vestibulocerebellar syndrome disrupts gait because the vestibular gyroscope is damaged

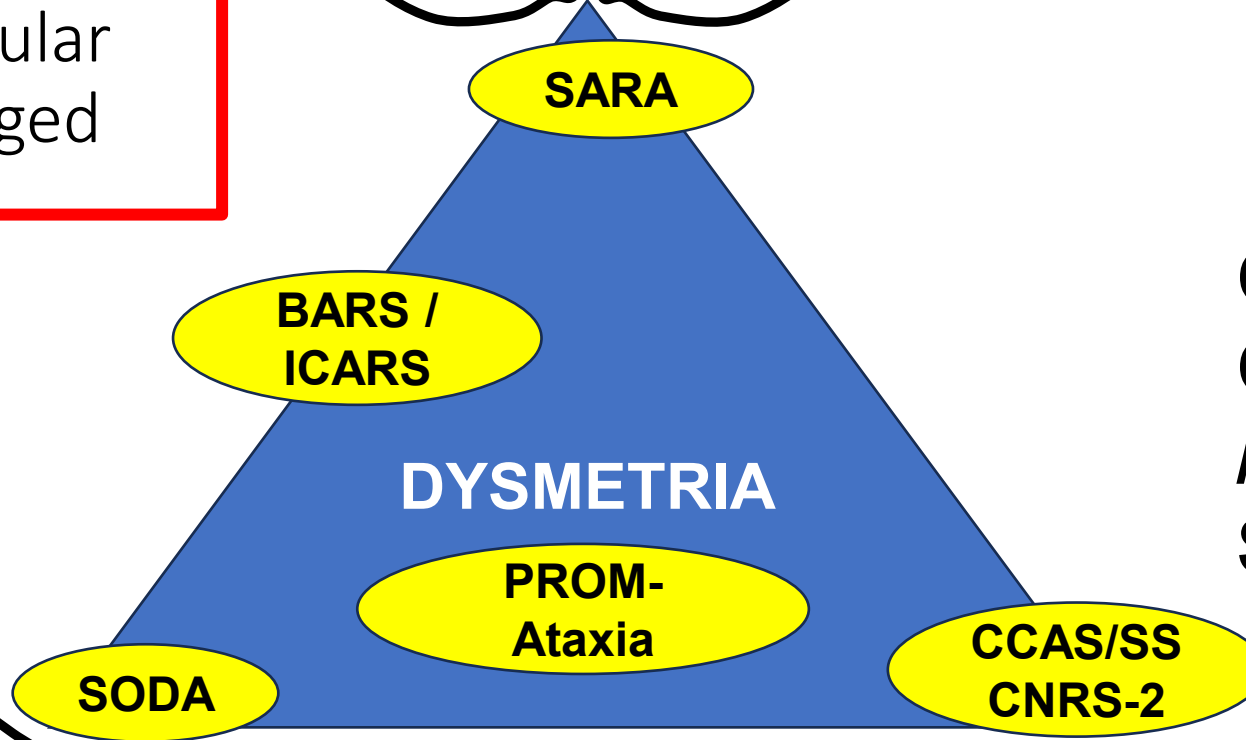
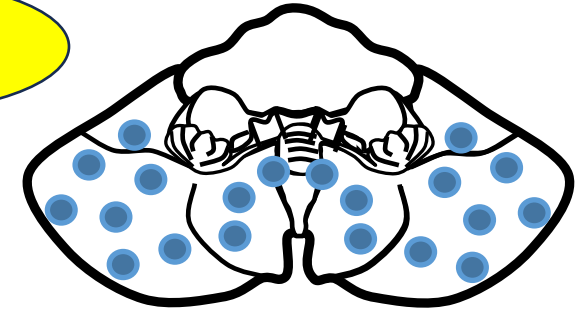


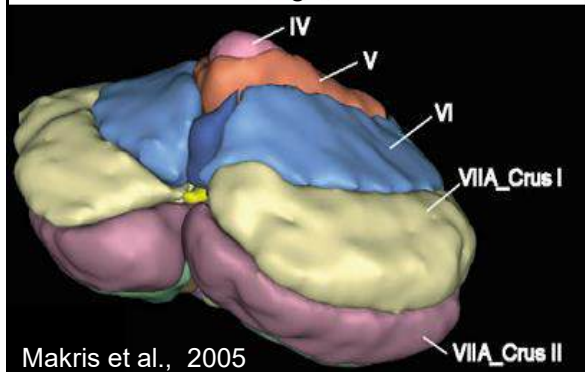
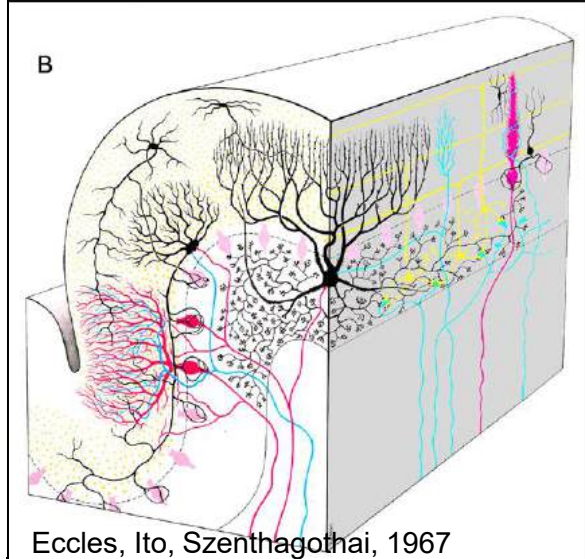
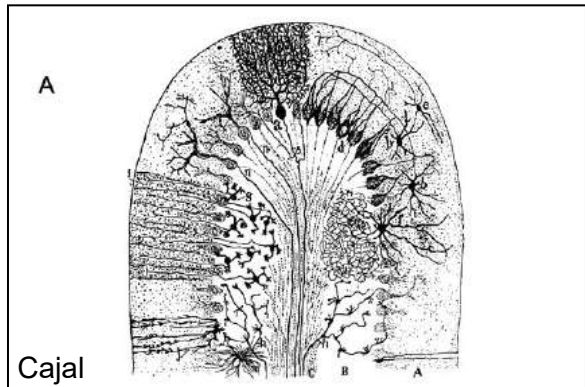
Cerebellar Vestibular Syndrome



Cerebellar Motor Syndrome

Cerebellar Cognitive Affective / Schmahmann Syndrome





Dysmetria of Thought Theory

Cerebellum is an integral node in the distributed neural circuits subserving sensorimotor, vestibular, cognitive, limbic and autonomic function.

Predicated on two complementary anatomical realities:

- Invariant architecture of cerebellar cortex
- Topographic arrangement of connections

An Emerging Concept

The Cerebellar Contribution to Higher Function

Schmahmann. Arch Neurol, 1991; 48:1178-87

Human Brain Mapp 1996; J Neurolinguistics 2000; J Neuropsychiatry Clin Neurosci 2004

Dysmetria of Thought

Universal Cerebellar Transform Theory

Cerebellum optimizes performance by
modulating behavior
around a homeostatic baseline
automatically, implicitly, and according to context



Schmahmann. Archiv Neurol 1991; Human Brain Mapp 1996;
J Neurolinguistics 2000; J Neuropsychiatry Clin Neurosci 2004



Dysmetria of Thought

Universal Cerebellar Impairment

= Dysmetria

Lesions of sensorimotor cerebellum

Dysmetria of movement

The cerebellar motor syndrome

Lesions of cognitive – limbic cerebellum

Dysmetria of thought and emotion

The cerebellar cognitive affective syndrome

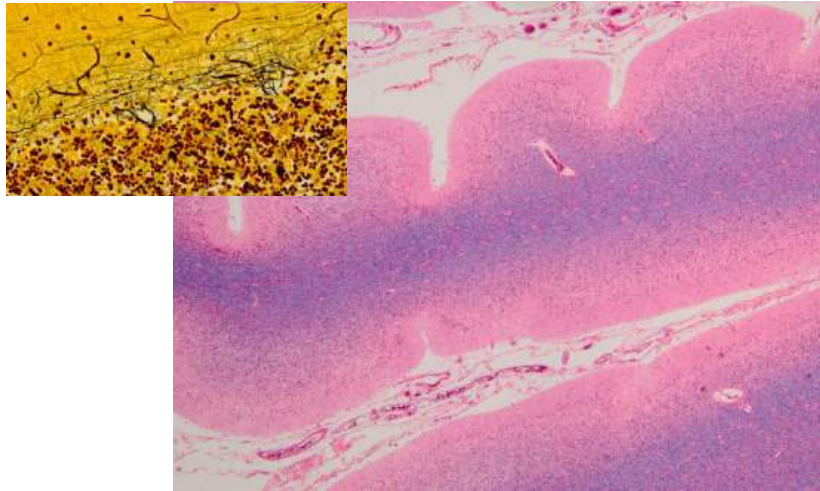


Schmahmann. Archiv Neurol 1991; Human Brain Mapp 1996;
J Neurolinguistics 2000; J Neuropsychiatry Clin Neurosci 2004

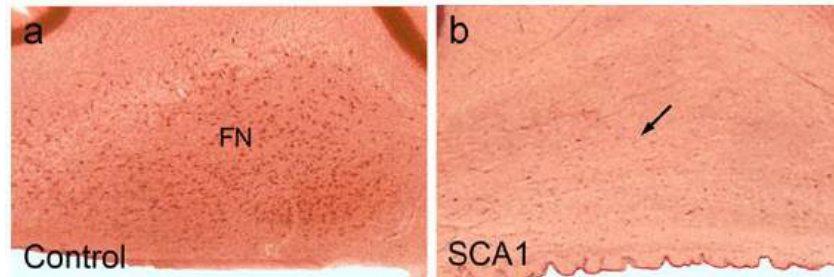


Neuropathology in ataxias / SCA = spinal cord

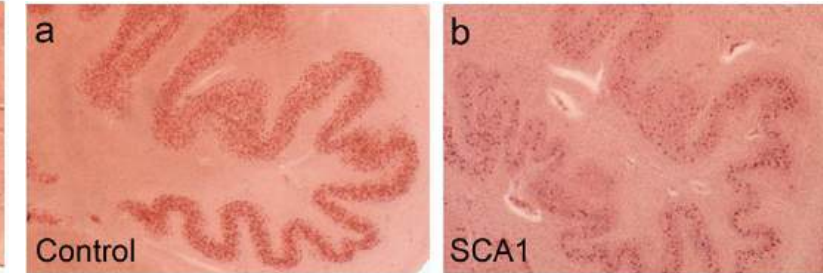
Cerebellar folium; empty baskets



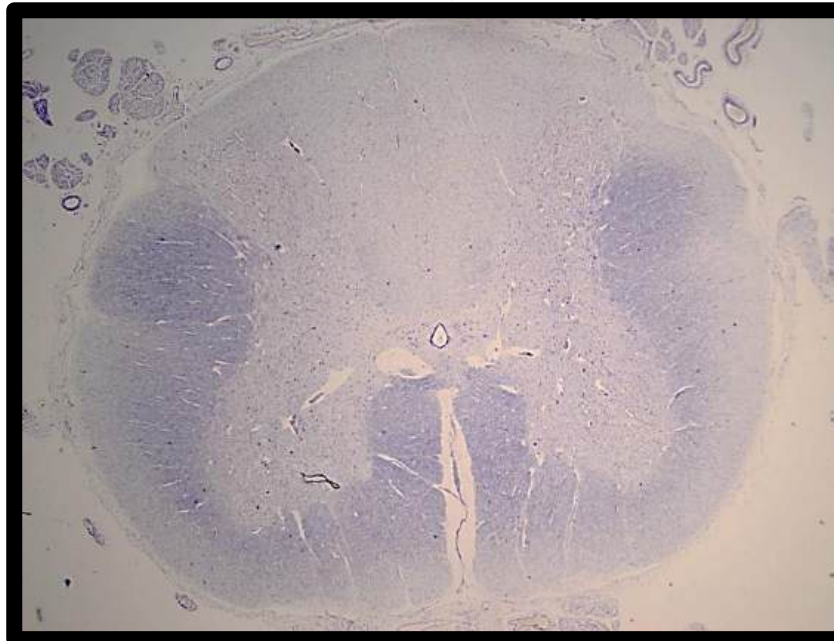
Fastigial nucleus



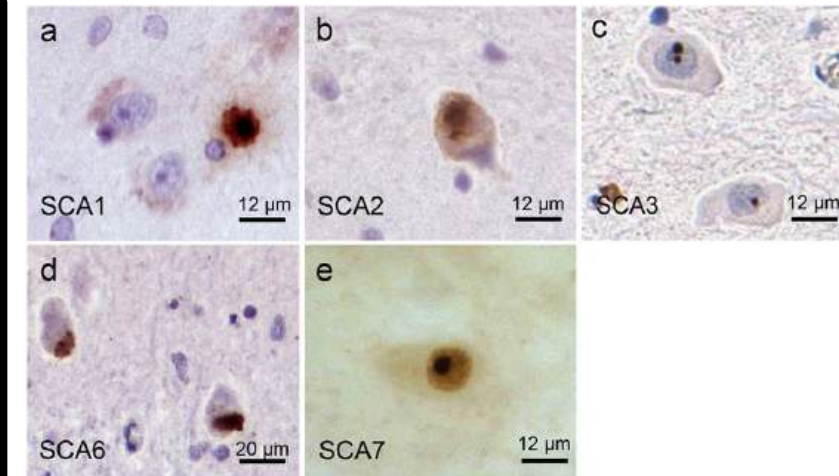
Inferior olivary nucleus



Cervical spinal cord



Neuronal intranuclear inclusions



Seidel K, Siswanto S, Brunt ER, den Dunnen W, Korf HW, Rüb U. Brain pathology of spinocerebellar ataxias. *Acta Neuropathol.* 2012 Jul;124(1):1-21.

Horton LC, Frosch MP, Vangel MG, Weigel-DiFranco C, Berson EL, Schmahmann JD. *Cerebellum.* 2013 Apr;12(2):176-93.

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Neuroanatomy

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Raquel Gardner
Anna Goodheart
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Rudy Tanzi
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Mark Vangel
Nagagopal Venna
Charles Lin
Jason MacMore

Clinical Consortia

Ataxia Global Initiative (AGI)
Clinical Research Consortium for the Study of
Cerebellar Ataxia (CRC-SCA)
Posterior Fossa Society (PFS)
Multiple System Atrophy Global Working Group

Cerebellar TMS

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Dost Ongur
Alvaro Pascual Leone
Laura Safar
Larry Seidman
William Stone



Funding:

NIMH, Harvard CTSC, AT Children's Project, Raynor Cerebellum Project,
National Ataxia, Great Oaks, Once Upon A Time, MINDLink Foundations, Mission MSA

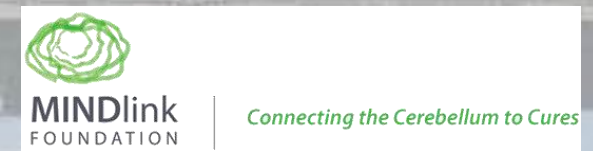


Photo by Jinny Sagorin

MGH Ataxia Center Noon Conferences

email me: jschmahmann@mgh.harvard.edu

_Schmahmann Ataxia Teaching Presentations

-  2021_04_15_Cerebellar and brainstem malformations - a pattern recognition approach_Eugen Boltshauser
-  2024_02_01 papers_Gaucher disease and supranuclear gaze palsy
-  2024-09-19 12.06.00 Ataxia Center Noon Conference
-  2024-12-05 12.05.01 Ataxia Center Noon Conference
-  2025_03_06_A patient with diagnostic challenges_Schmahmann
-  2025-01-16 12.05.22 Ataxia Center Noon Conference
-  2025-01-30 12.03.43 Ataxia Center Noon Conference
-  2025-03-20 12.04.59 Ataxia Center Noon Conference
-  Selected publications
-  2020_04_16_Cerebellar cognitive affective syndrome_HMS Undergraduates Mize and Reynolds
-  2020_07_16_Cases of Ataxia with Neuropathy_differential diagnosis_Schmahmann
-  2020_12_17_Cerebellar cognition_in children_Lecture to TNC at Boston Children's Hospital_Schmahmann
-  2021_01_21_Shrimp sign in Cerebellar PML_Anna Goodheart
-  2021_02_04_Immune mediated and paraneoplastic ataxias_Kevin Kyle
-  2021_02_18_SCA3_History Neurology and Neurobiology_Emily Ferenczi
-  2021_02_18_SCA3_Emily Ferenczi slide deck
-  2021_03_04_Lithium toxicity and Cerebellotoxic agents_Spencer Hutto
-  2021_03_12 Ataxia in Children_2nd Brazilian Congress on Neurogenetics_Schmahmann
-  2021_03_18 Ataxia in Children_Schmahmann
-  2021_04_01 Downbeat nystagmus_ataxia evaluation_CANVAS_Julien Cavanagh
-  2021_04_15_Cerebellar and brainstem malformations_Eugen Boltshauser
-  2021_04_29 Langerhans Cell Histiocytosis_Grace Crotty_Eli Diamond
-  2021_07_01_Gerstmann Straussler Scheinker disease_Sharan Srinivasan
-  2021_07_15_CANVAS_David Szmulewicz
-  2021_12_02 MR Imaging in Ataxia_Otto Rapalino
-  2021_12_16_Exploring the CCAS around the world with the CCAS Scale_Louisa Selvadurai
-  2022_01_06_SCAR4 and SCA15_Case presentation_Sylvia Josephy
-  2022_01_06_SCAR4 and SCA15_eye movements discussion for the email group
-  2022_01_20_Friedreich's Ataxia_Patient interview & Prof Massimo Pandolfo
-  2022_01_29_Friedreich's Ataxia_Two master classes with Neuropathology link
-  2022_02_03_ARCA1 with Drs Dupre_Brais_& Rouleau
-  2022_02_03_Follow up email_ARCA1 Not so straight-forward_with attached papers
-  2022_02_17_SCA1_Kyle Harrold
-  2022_03_03_PNPLA6_ataxia_Boucher Neuhauser_Gordon Holmes_Schmahmann

2022_03_17_Unusual movement disorders

-  2022_03_17_Unusual Movement Disorders_Christopher Stephen
-  2022_03_31 Ataxia Oculomotor Apraxia type 2_Giovanna Manzano
-  2022_04_07_Apraxia of Speech_Keith Joseph
-  2022_04_21_Progressive Ataxia with Palatal Tremor_Denis Balaban
-  2022_05_05_Neuropsychiatry of Mutism_Anna Maria Rivas Grajales
-  2022_06_02_Two MGH Ataxia Center Cases_Downbeat nystagmus_FXTAS_Schmahmann
-  2022_06_30_Sagging Brain Syndrome_Schmahmann
-  2022_10_06_Case presentation_Autosomal dominant cerebellar ataxia_Schmahmann
-  2022_10_20_Case conference_4 patients 4 diagnoses_SCA8_FXTAS_SCA5_CANVAS_Schmahmann
-  2022_11_17_SCA 2 case presentation and discussion_Schmahmann_Rapalino
-  2022_12_01_What's up with the vermis. Cases and systems neuroscience_Schmahmann
-  2022_12_15_Downbeat Nystagmus_Case presentation_Dr Bernard Brais_FGF14
-  2023_01_19_MSA-C Case presentation_Schmahmann
-  2023_02_02_Neuropsychiatric syndrome in the setting of a cerebellar injury_Takeiya Lynch
-  2023_02_16_Follow up to Adult Onset Alexander Disease case
-  2023_03_02_Opsoclonus myoclonus syndrome_with Dr. Mark Gorman
-  2023_03_16_Adult Onset Alexander Disease_Tolu Tofade_Otto Rapalino_JDS
-  2023_04_06 Approach to Recessive Ataxias_Schmahmann Lecture
-  2023_05_04 Periodic Alternating Nystagmus_Schmahmann_Aasef Shaikh
- ☒ 2023_05_18 Paraneoplastic (anti-Hu and VGCa channel) opsoclonus and tremor_Caleb McEntire and Jenny Lin
-  2023_05_18_Paraneoplastic cerebellar degeneration and related disorders_Caleb MacEntire with Jenny Linnoli
-  2023_06_01_Late Onset Friedreich's Ataxia and Hereditary Spastic Paraplegias_Aditi Varma-Doyle
-  2023_06_22_Understanding Cerebellar Ataxia Human Pathology to Mouse Models_Chieh-Chun (Charles) Lin
-  2023_06_29_Catatonia and the cerebellum_Nathan Praschan
-  2023_08_01_Neuroimaging Markers and Mechanisms of Neurodegeneration in Hereditary Cerebellar Ataxias
-  2023_08_14_Cerebellar Orchestration of Motor Behaviour and Cognition (BrainMap Seminar)_Chris De Zeeuw
-  2023_9_21 Severe cerebellar motor syndrome immediately following COVID_Schmahmann
-  2023_11_02_Sagging Brain Syndrome_Schmahmann+Schievink
-  2023_11_16_Hereditary Spastic Paraplegia, type 8_Schmahmann+Blackstone
-  2023_12_07_SCA6 presentation_Christopher Gomez
-  2023_12_21_The arc of ataxia in one family_SCA27B_with Dr. Bernard Brais
-  2024_01_18_Primary aphasia and apraxia of speech, a comparative review_Horta
-  2024_02_01_Supranuclear horizontal gaze palsy_cognitive change_ataxia_Schmahmann case presentation_Gai
-  2024_02_15_A 65 year old gentleman at the intersection of ataxia and motor neuron disease_with Dr. Mark Gai

