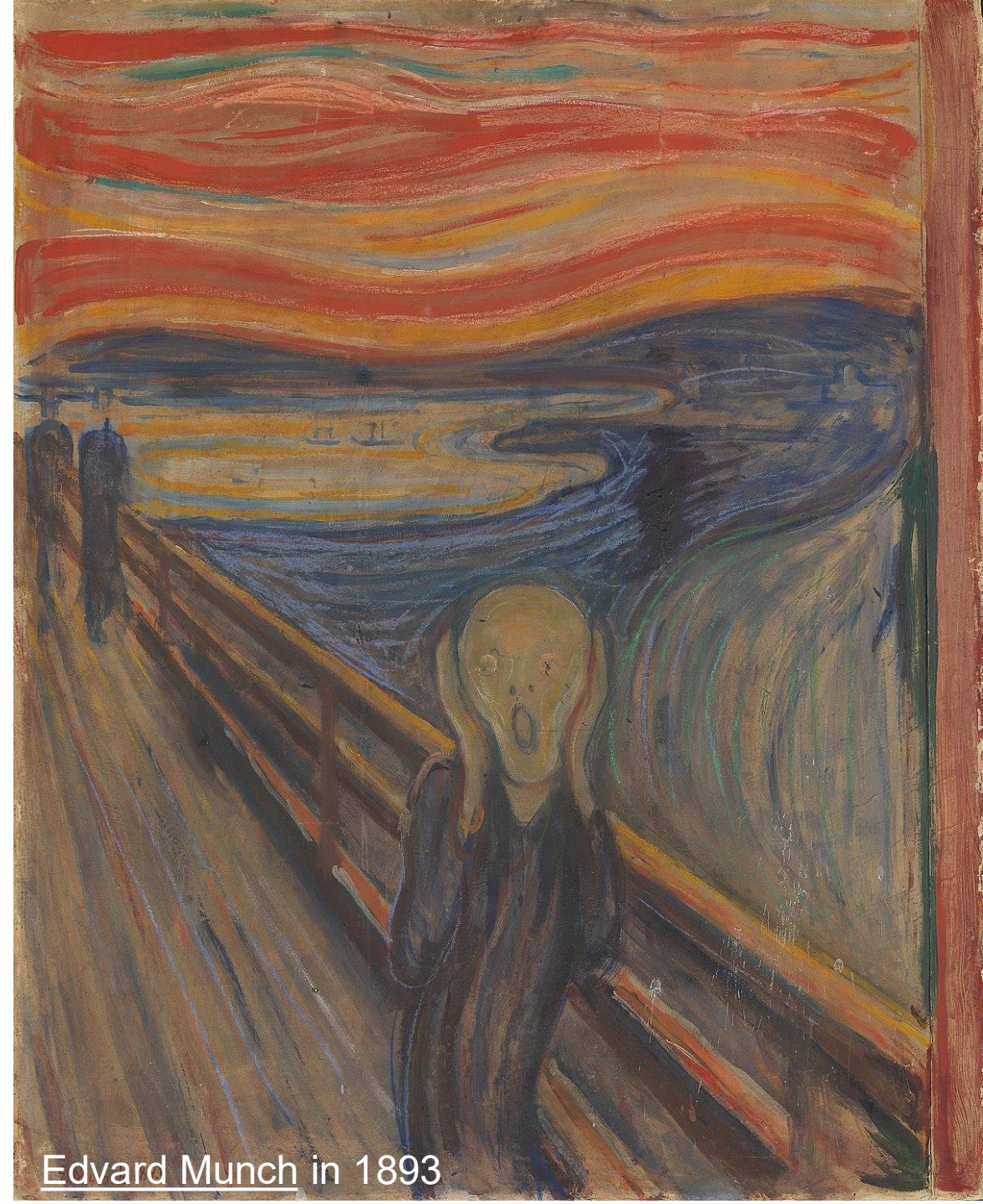


Unit 11: Disorders of the nervous system

Mackenzie Mathis, PhD



Edvard Munch in 1893

Disorders of the nervous system can affect every sensory, memory, and motor system.

A word cloud of various neurological disorders and conditions. The words are arranged in a roughly circular pattern and are color-coded. The colors include shades of orange, yellow, green, blue, purple, and pink. The words are: schizophrenia, neuromuscular, syndrome, cerebral, amyotrophic, septicemia, migraine, dementia, seizures, guillain-barré, palsy, stroke, brain, bipolar, alzheimer's, lateral, sclerosis, meningitis, epilepsy, multiple, acute, ataxia, gravis, neurocutaneous, cord, spinal, dystrophy, aneurysm, tumors, als, parkinson's, bell's, encephalitis, hydrocephalus, myasthenia, syndromes, muscular.

Common terms in neurological disorders:

Dystrophy: a disorder in which an organ or tissue of the body wastes away.
Muscular Dystrophy, wasting of the muscles (implications for NMJ)

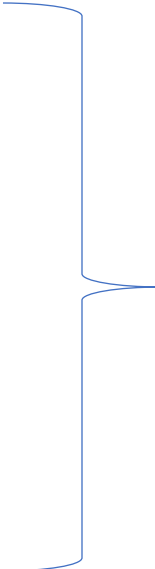
Multiple sclerosis: a disease in which the immune system eats away at the protective covering of nerves. (**sclerosis:** abnormal hardening of body tissue.)

Hydrocephalus: a condition in which fluid accumulates in the brain, typically in young children, enlarging the head and sometimes causing brain damage.

Ataxia: the loss of full control of bodily movements.

Stroke: occurs when the blood supply to part of your brain is interrupted or reduced, preventing brain tissue from getting oxygen.

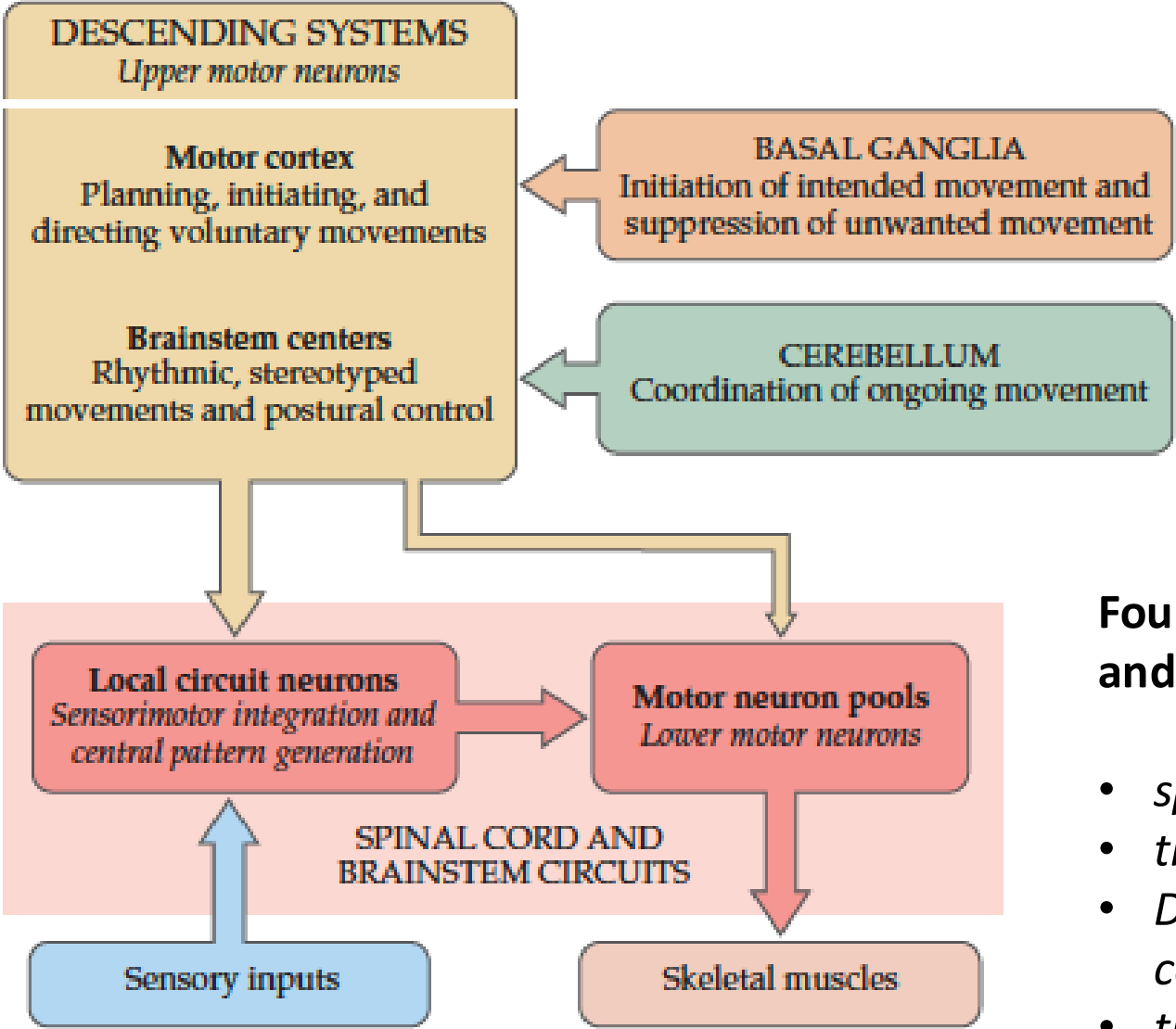
Aneurysm: an excessive localized enlargement of an artery caused by a weakening of the artery wall



Fewer
than 200,000 US
cases per year

More
than 200,000 US
cases per year

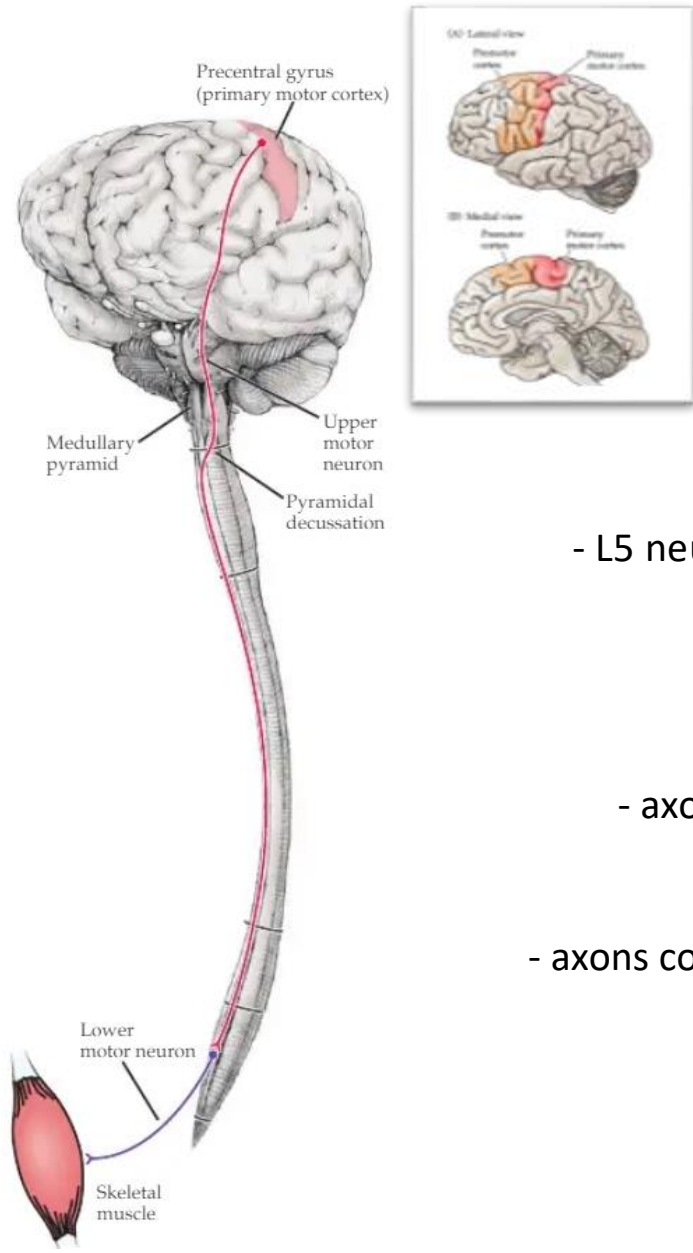
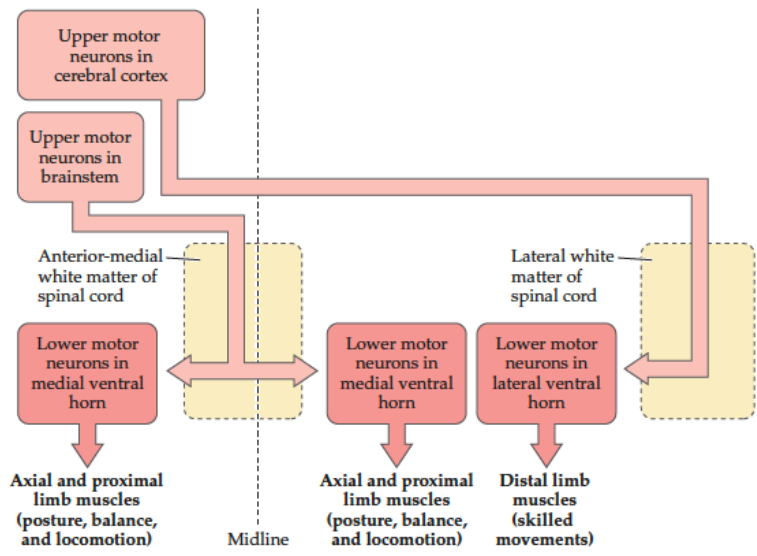
The neural control of movement: sensorimotor system



Four systems make essential and distinct contributions to motor control:

- *spinal cord (and brainstem circuits)*
- *the cerebellum*
- *Descending control centers in the cerebral cortex and brainstem*
- *the basal ganglia*

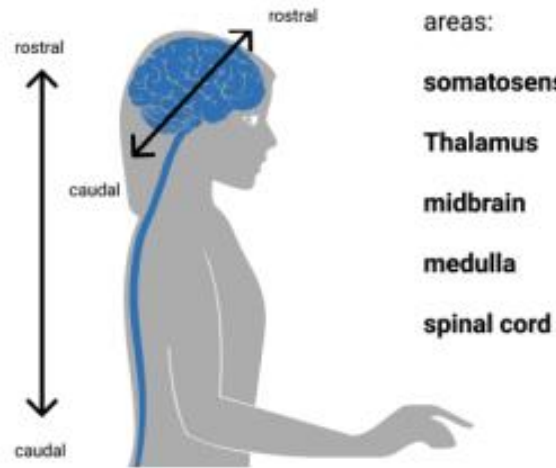
The neural control of movement: primary motor cortex



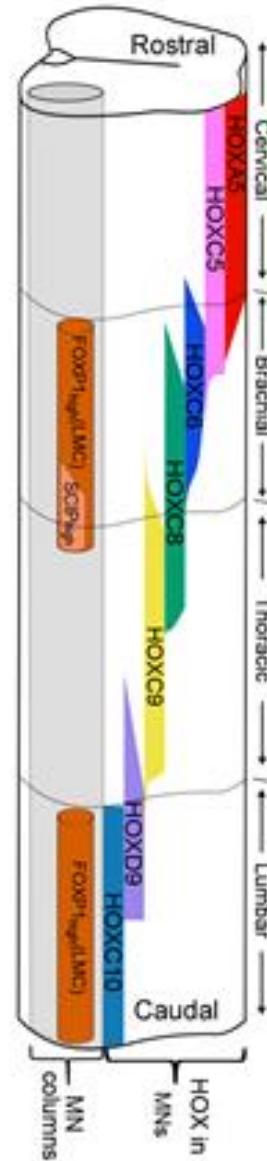
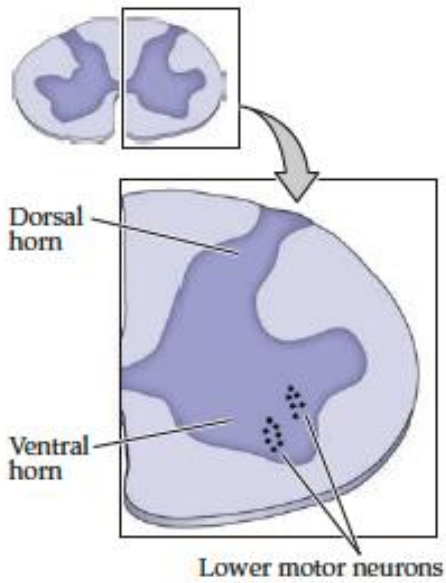
The corticospinal tract:

- L5 neurons in M1 project to motor neurons in the spinal cord (axon length ~ 0.8 m!) (called "**upper motor neuron**")
- axons cross-over to other body side at "pyramidal decussation"
- axons contact motor neurons in the ventral horn in specific segments

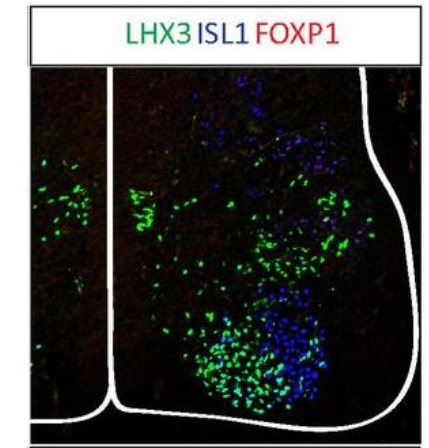
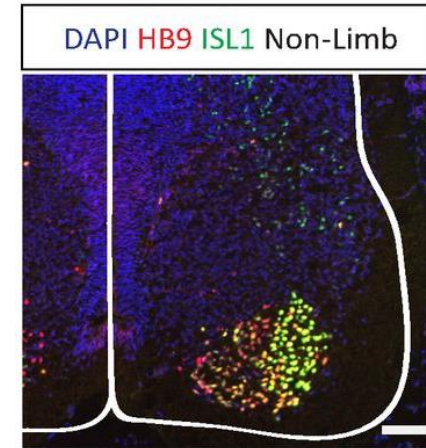
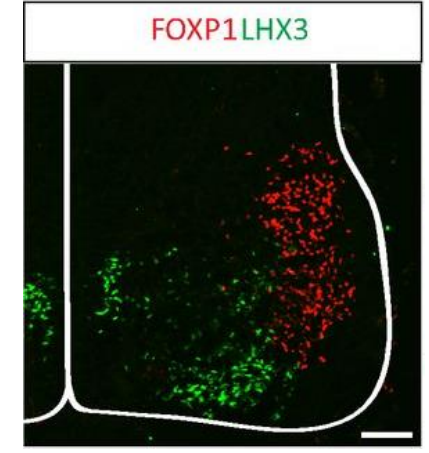
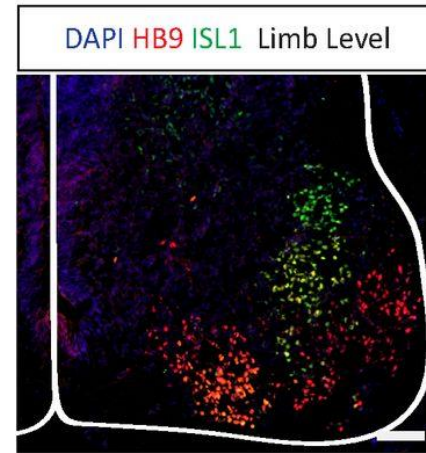
Spinal Cord Neuroanatomy Basics



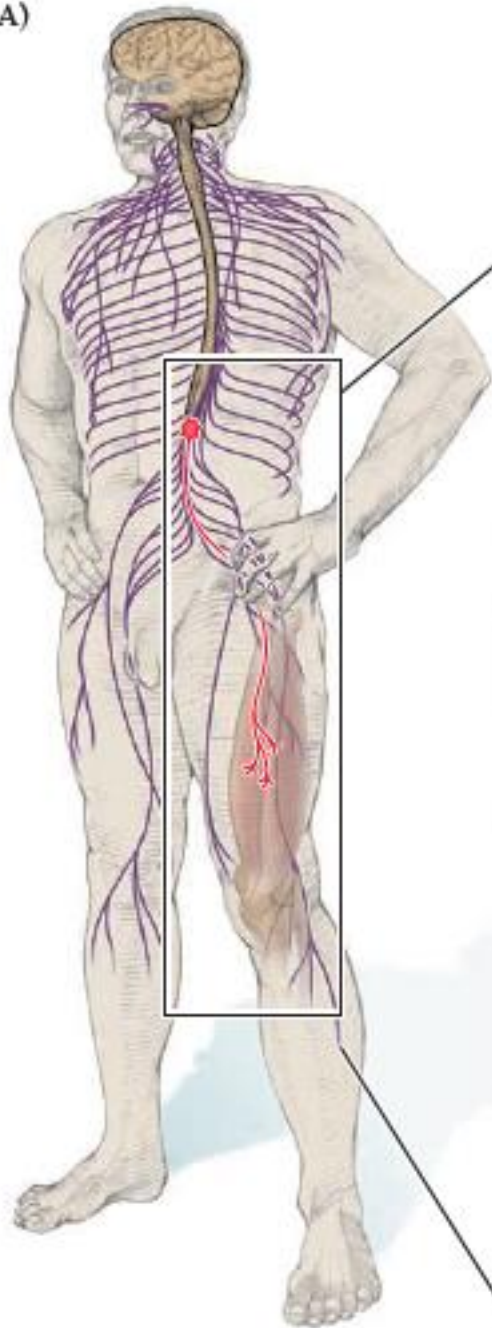
areas:
somatosensory cortex
Thalamus
midbrain
medulla
spinal cord



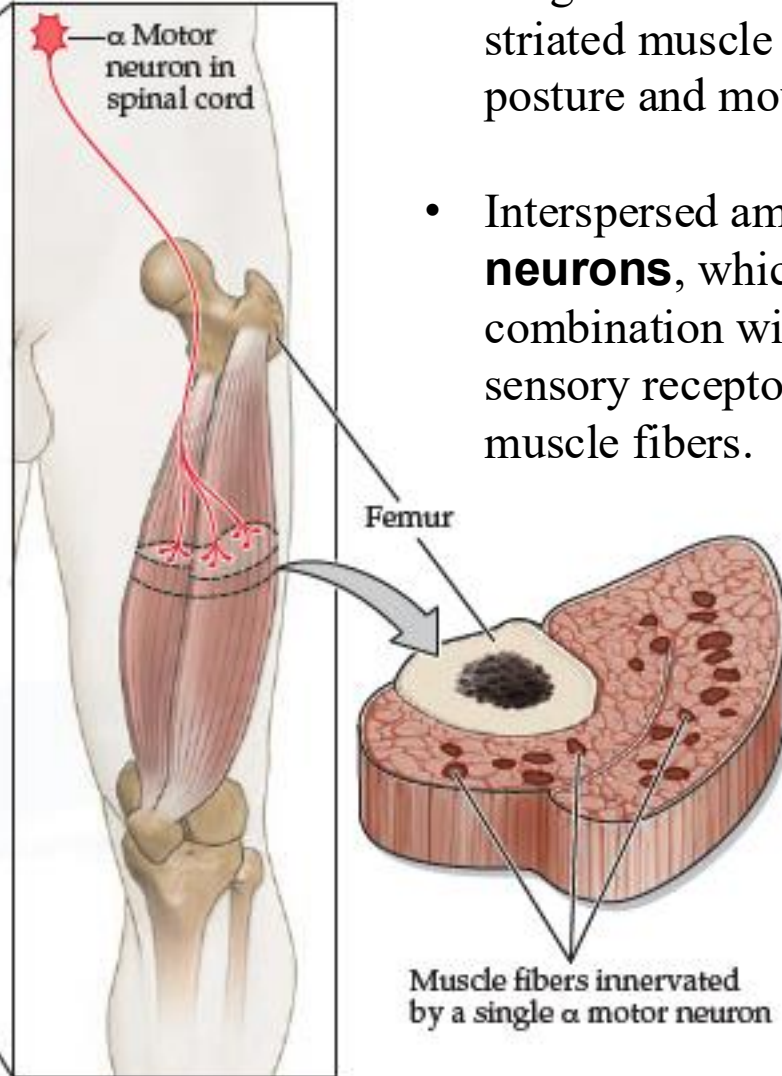
Genes regulate sub-types of motor neurons



(A)



(B)



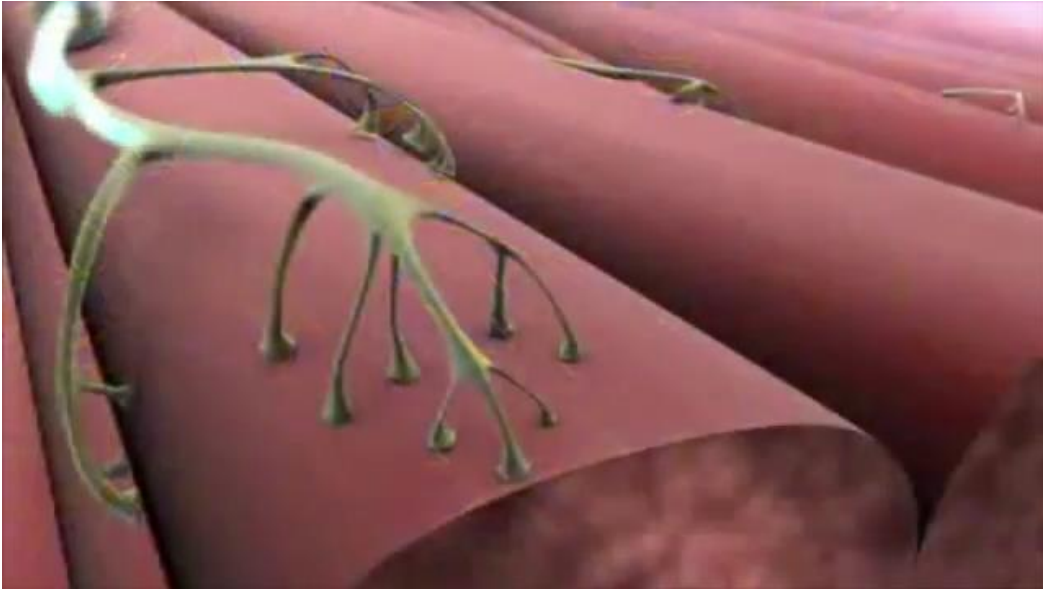
Two types of lower motor neurons are found in the motor neuron pools of the ventral horn:

- Large motor neurons are called **α motor neurons**; they innervate the striated muscle fibers that actually generate the forces needed for posture and movement.
- Interspersed among the α-motor neurons are smaller **γ motor neurons**, which innervate specialized muscle fibers that, in combination with the nerve fibers that innervate them, are actually sensory receptors arranged in parallel with the force-generating striated muscle fibers.

Motor unit: All muscle fibers innervated by a single motor neuron (~ 3 – 500 muscle fibers)

extrafusal skeletal muscle fibers in mature mammals are innervated by only a **single α motor neuron**

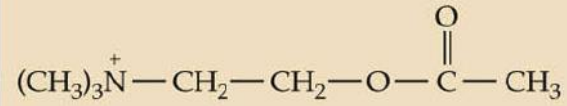
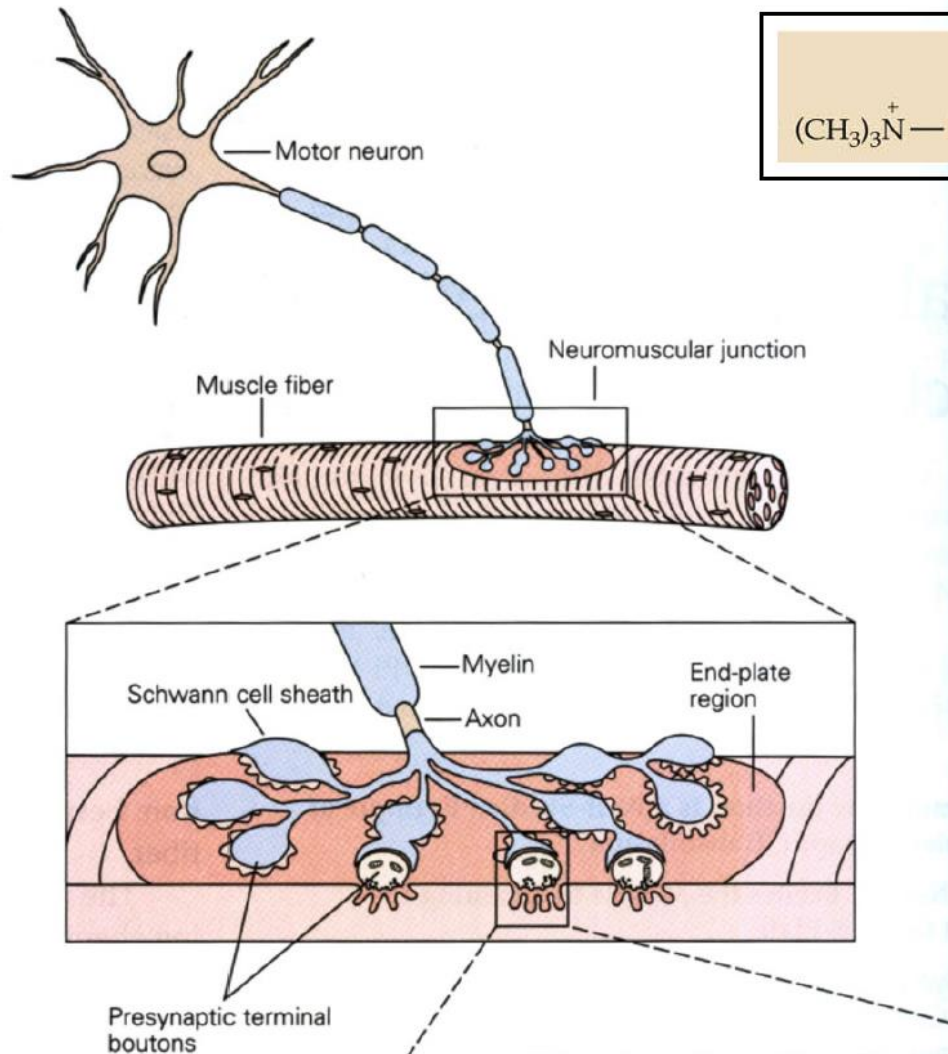
Alpha Motor neurons & The Motor Unit



Because an **action potential** generated by a **motor neuron** typically brings to contraction threshold all of the muscle fibers the neuron contacts, the **single α motor neuron** and its associated muscle fibers constitute the smallest unit of force that can be activated by the muscle.

Sherrington was the first to recognize this fundamental relationship between an α motor neuron and the muscle fibers it innervates, for which he coined the term **motor unit**.

The nerve - muscle synapse, or neuromuscular junction



Acetylcholine

Acetylcholine is the neurotransmitter used at the neuromuscular junction —in other words, it is the chemical that motor neurons of the nervous system release in order to activate muscles.

Kandel, Fig. 11.1

WHAT IS ALS?

ALS, also known as Lou Gehrig's disease, is a brain disease that targets brain cells called motor neurons. Motor neurons send messages from the brain to muscles throughout the body. In ALS, as motor neurons die, a person progressively loses the ability to walk, speak, swallow, and breathe. ALS affects adults of all ages, from teens to seniors, and is usually fatal within 2-5 years of diagnosis.

What are the symptoms of ALS?

With ALS, you may first have weakness in a limb that develops over a matter of days or, more commonly, a few weeks. Then, several weeks to months later, weakness develops in another limb. Sometimes the initial problem can be one of slurred speech or trouble swallowing.

As ALS progresses, though, more and more symptoms are noticed. These are the most common symptoms of ALS:

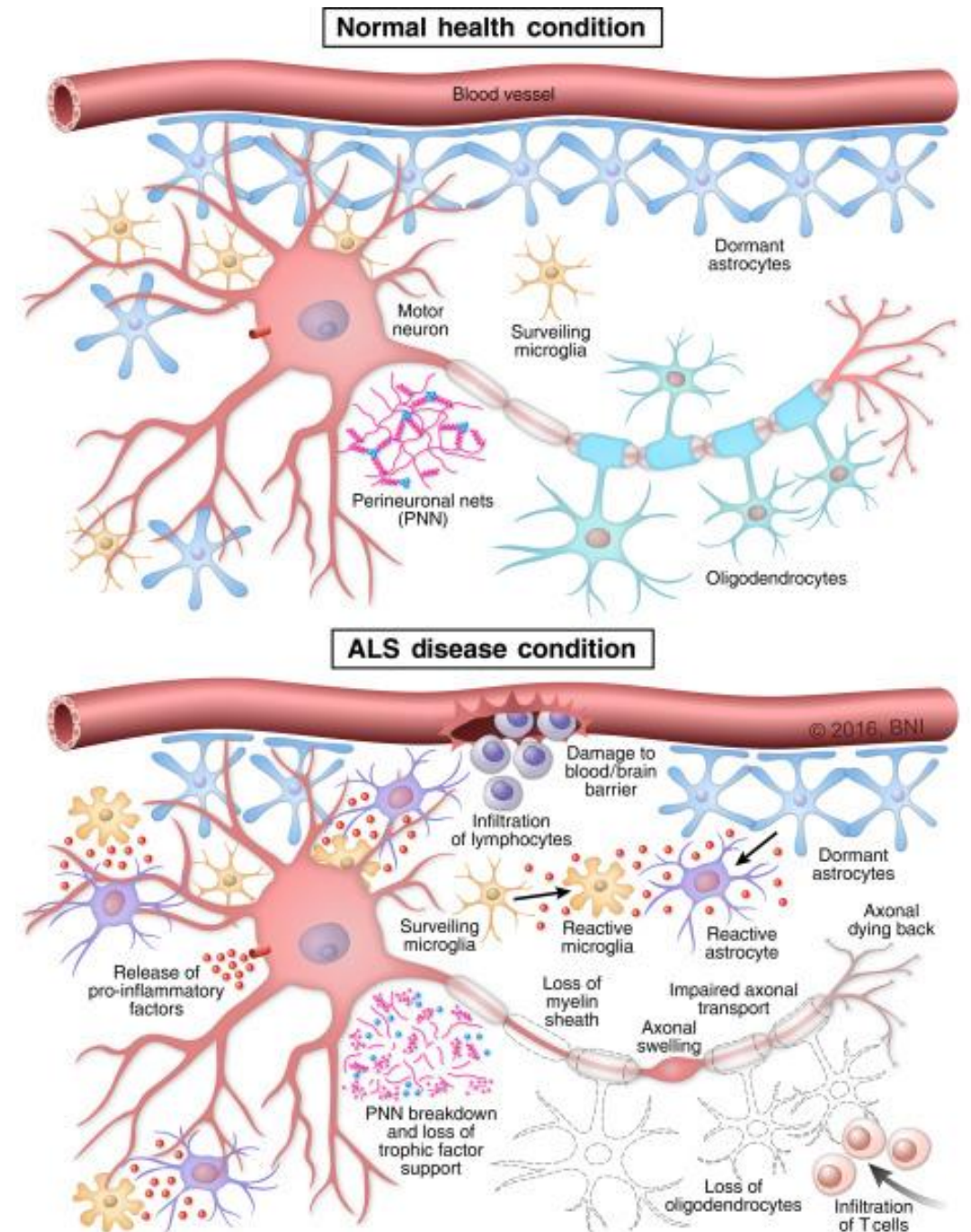
- Twitching and cramping of muscles, especially those in the hands and feet
- Loss of motor control in the hands and arms
- Impairment in the use of the arms and legs
- Tripping and falling
- Dropping things
- Persistent fatigue
- Uncontrollable periods of laughing or crying
- Slurred or thick speech and trouble in projecting the voice

As the disease progresses, symptoms may include:

- Trouble breathing
- Trouble swallowing
- Paralysis

The symptoms of ALS may look like other conditions or medical problems.

Always see your healthcare provider for a diagnosis.



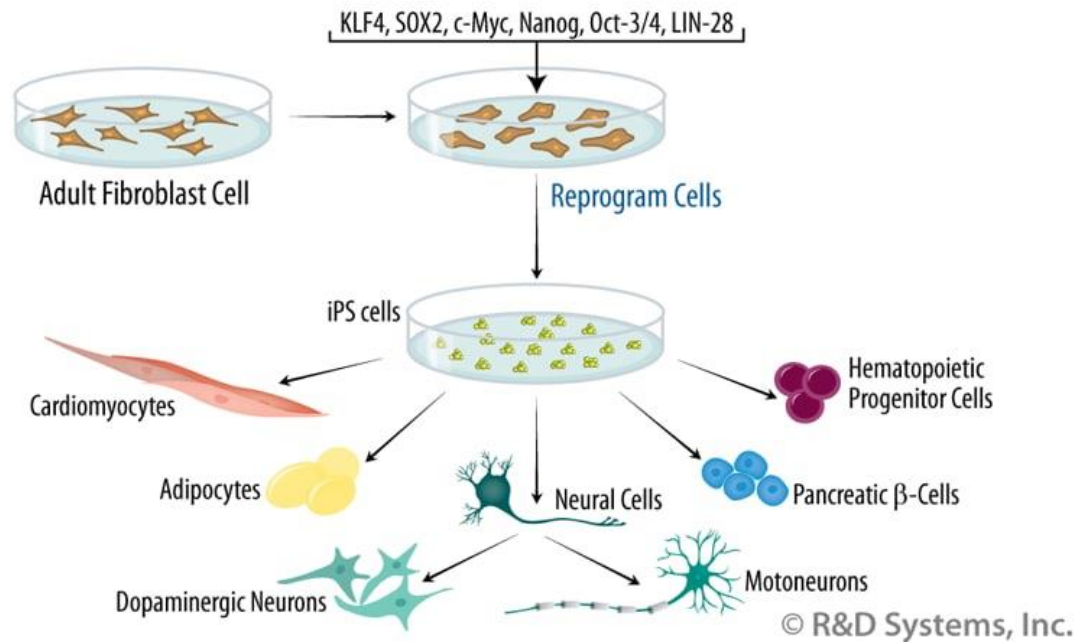
New opportunities for bioengineering: stem cells and organoids to develop high-throughput drug screens

Shinya Yamanaka



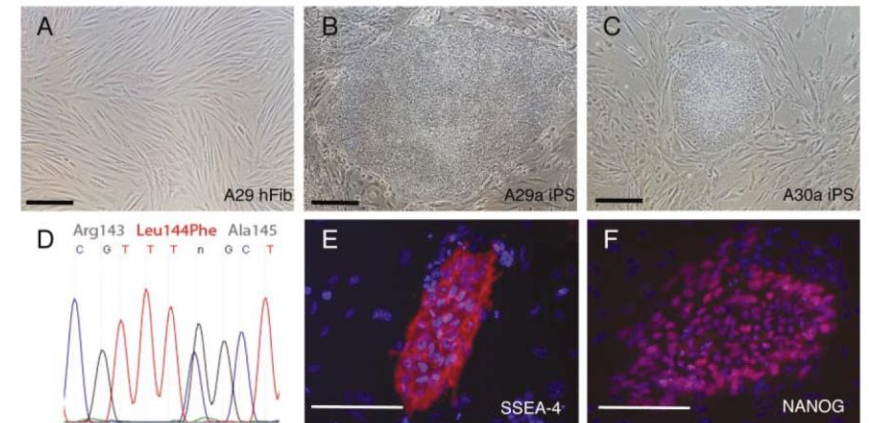
© The Nobel Foundation.
Photo: U. Montan

Discovered four transcription factors (Oct4, Sox2, cMyc, Klf4) that could make adult cells pluripotent

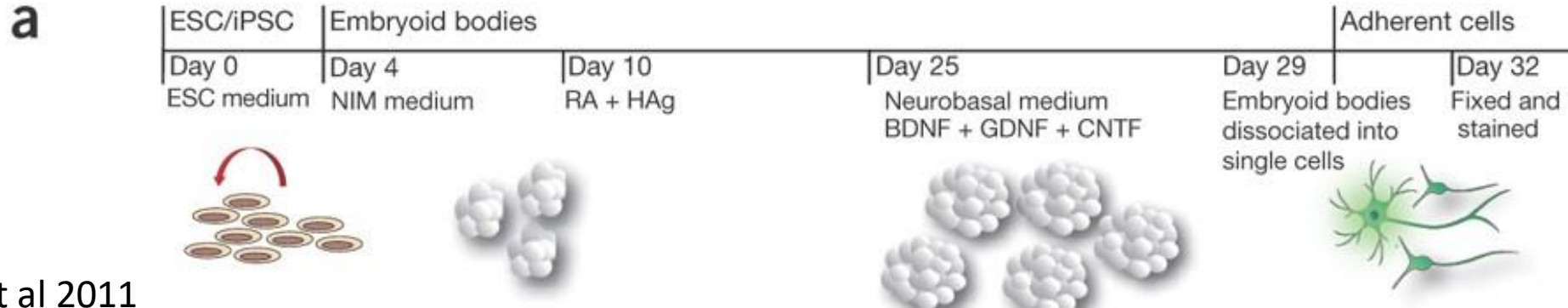


Induced Pluripotent Stem Cells Generated from Patients with ALS Can Be Differentiated into Motor Neurons

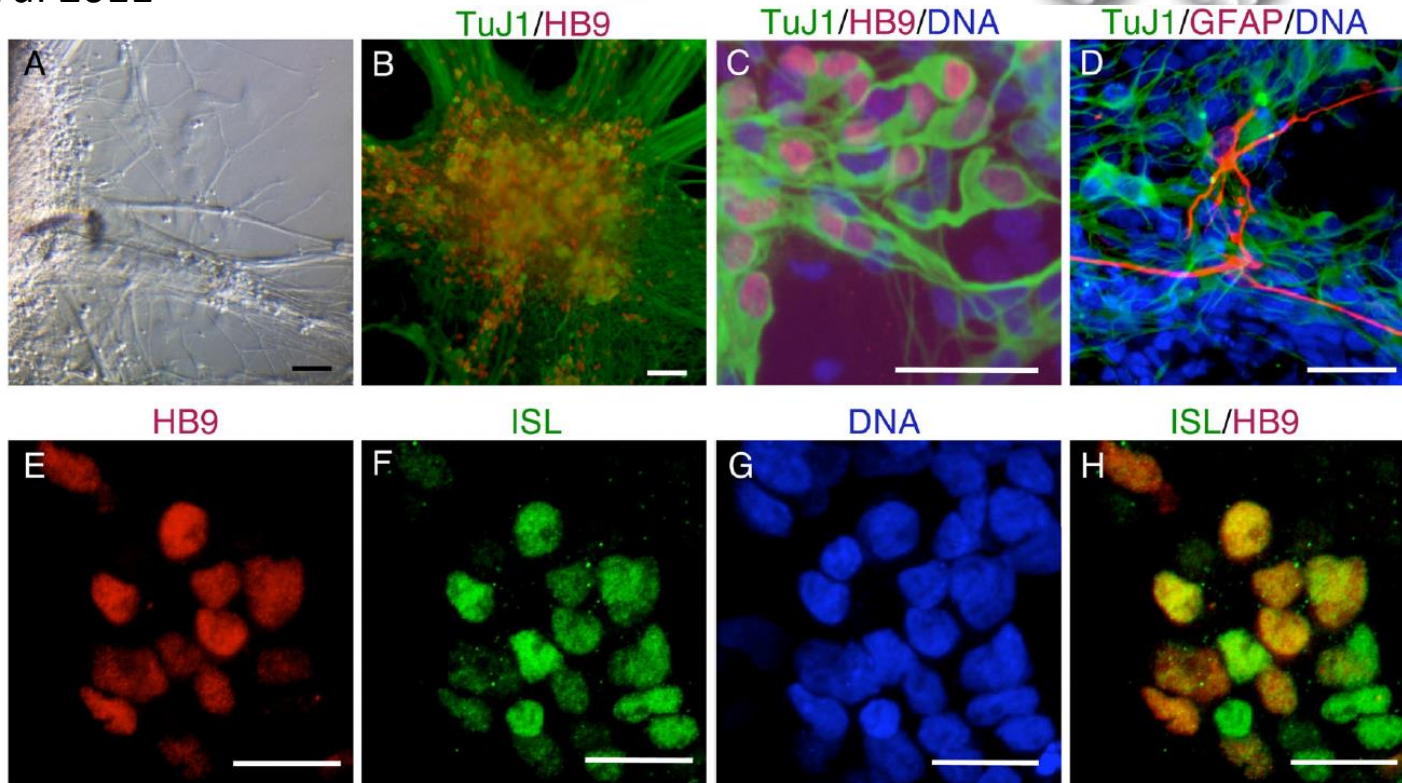
John T. Dimos,^{1*} Kit T. Rodolfa,^{1,2*} Kathy K. Niakan,¹ Laurin M. Weisenthal,¹ Hiroshi Mitumoto,^{3,4} Wendy Chung,^{4,5} Gist F. Croft,^{4,6} Genevieve Saphier,¹ Rudy Leibel,⁵ Robin Goland,⁷ Hynek Wichterle,^{4,6} Christopher E. Henderson,^{4,6} Kevin Eggan^{1†}



New opportunities for bioengineering: stem cells and organoids to develop high-throughput drug screens



Boulting et al 2011



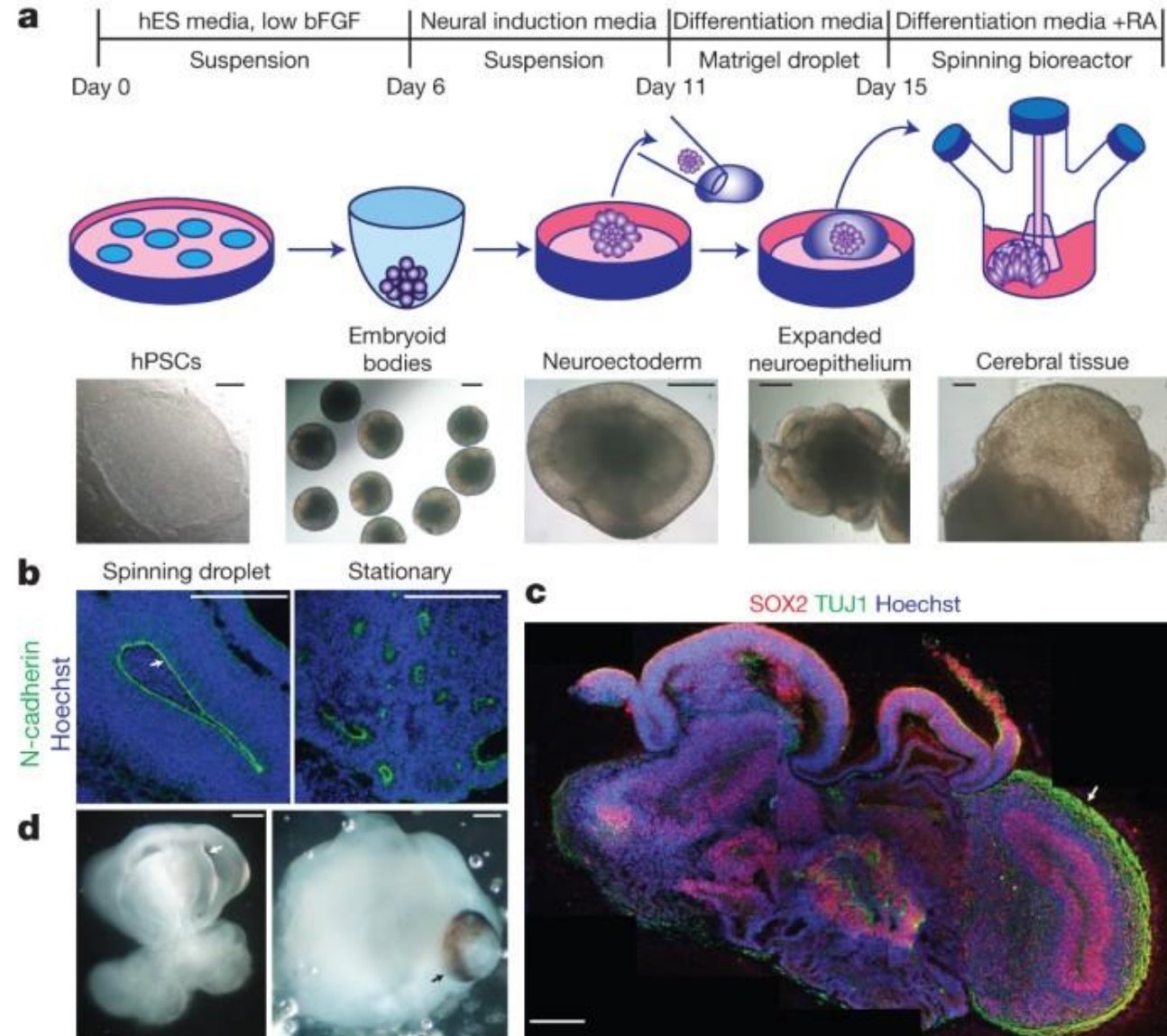
iPSC-based drug discovery is a promising technology for developing novel therapeutics for neurodegenerative diseases lacking useful disease models, such as amyotrophic lateral sclerosis (ALS).

Dimos et al 2008

New opportunities for bioengineering: stem cells and organoids to develop high- throughput drug screens

- *human pluripotent stem cell-derived three-dimensional organoid culture system, termed cerebral organoids, that develop various discrete, although interdependent, brain regions*

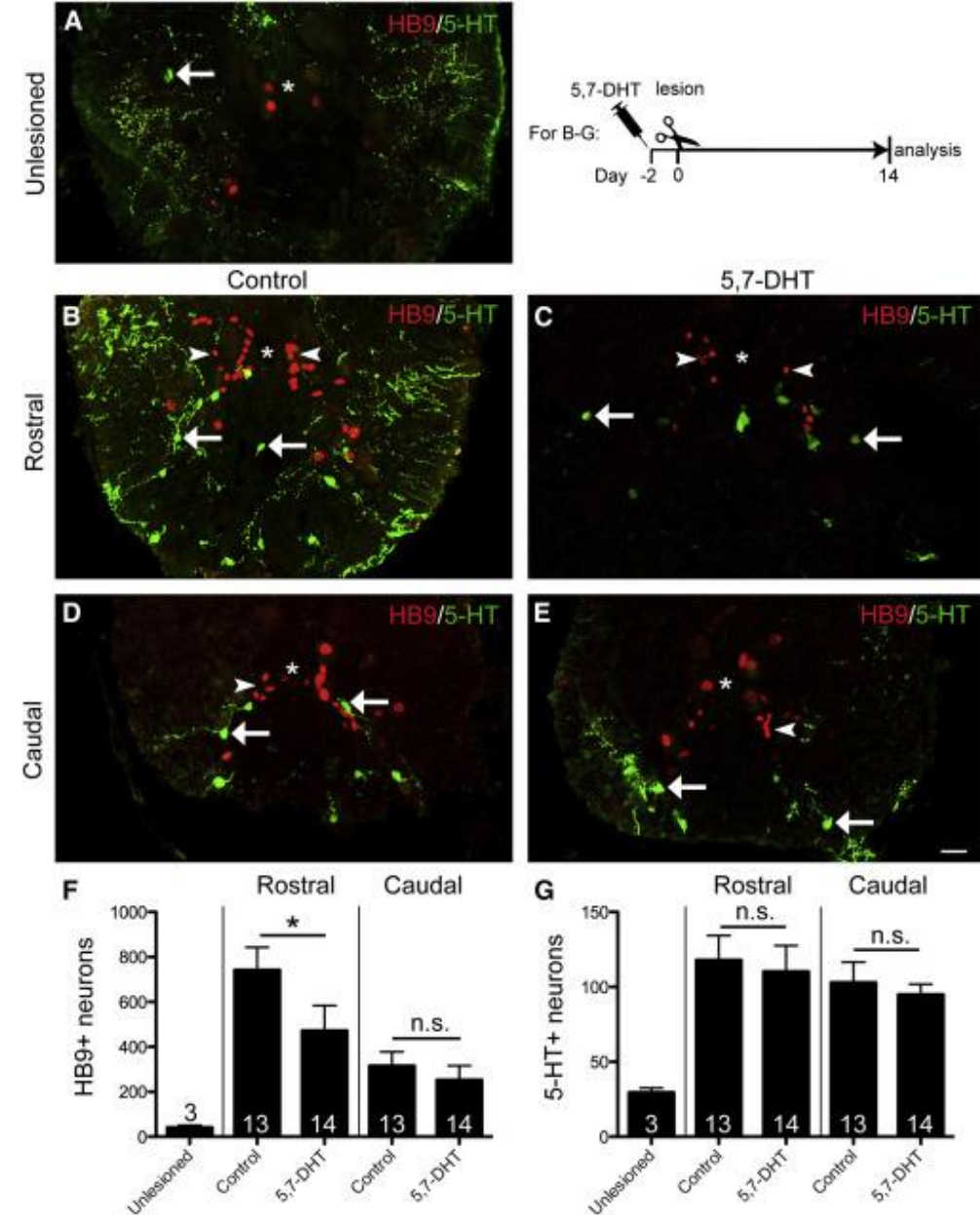
Cerebral organoids model human brain development and microcephaly
[Madeline A. Lancaster](#) et al. [Nature](#) (2013)



New opportunities for bioengineering: stem cells and organoids to develop high- throughput drug screens

Open challenges in iPSC motor neuron
research:

- **Drug discovery** is promising ...
- **Cell replacement therapy** is very hard:
need to remove oncogenes, viral
vectors used for reprogramming
- ***In vivo* regeneration**: no native
regeneration! But, in contrast to
mammals, zebrafish regenerate
spinal [motor neurons](#).



New opportunities for bioengineering: stem cells for growing patient-specific neurons

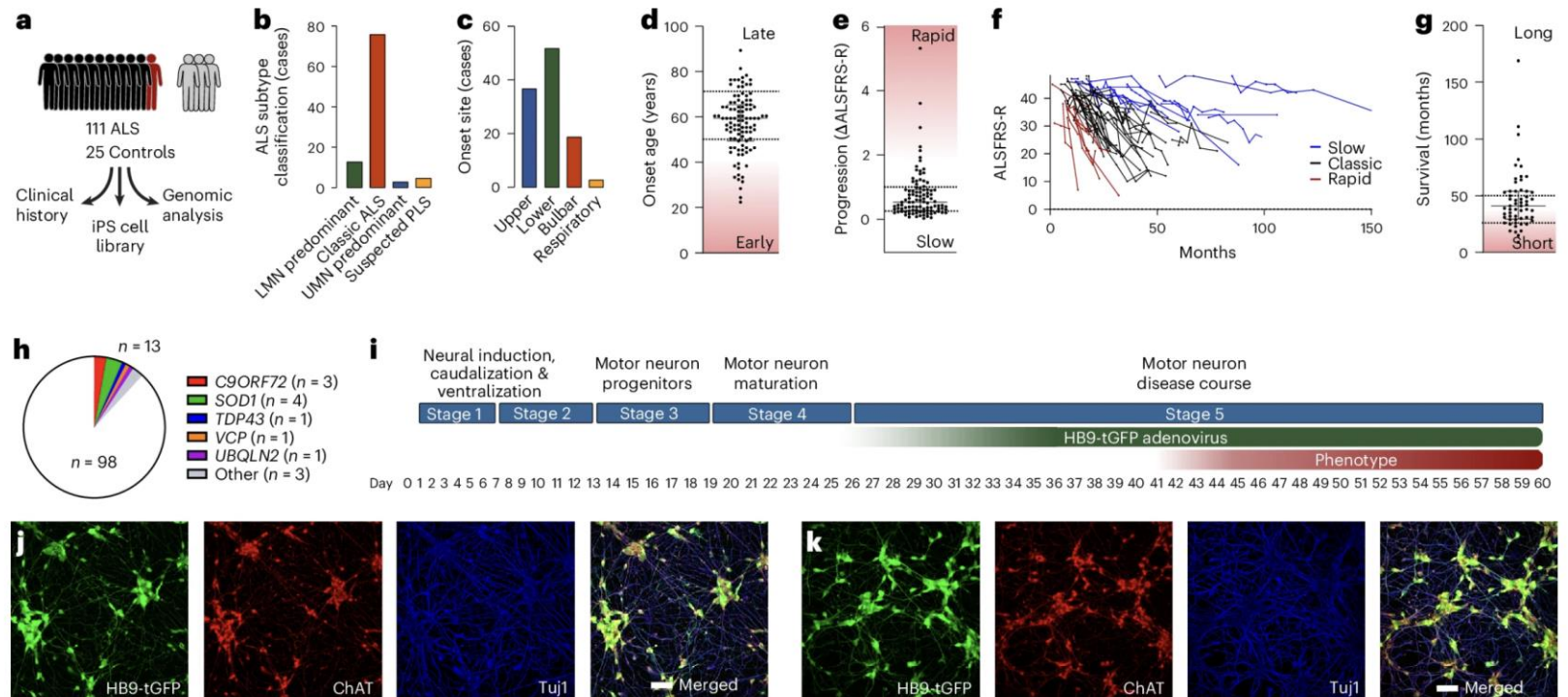
Article | [Open access](#) | Published: 24 November 2025

Large-scale drug screening in iPSC-derived motor neurons from sporadic ALS patients identifies a potential combinatorial therapy

[Christopher R. Bye](#) , [Elizabeth Qian](#), [Katherine Lim](#), [Maciej Daniszewski](#), [Fleur C. Garton](#), [Bào C. Trần-Lê](#), [Helena H. Liang](#), [Tian Lin](#), [John G. Lock](#), [Duncan E. Crombie](#), [Steven Morgan](#), [Yi Hu](#), [Samantha K. Barton](#), [Lucy M. Palmer](#), [Elvan Djouma](#), [Saritha Kodikara](#), [Kim-Anh Lê Cao](#), [Thanuja Dharmadasa](#), [Anjali K. Henders](#), [Laura A. Ziser](#), [Matthew C. Kiernan](#), [Kevin Talbot](#), [Merrilee Needham](#), [Susan Fletcher](#), ... [Bradley J. Turner](#)  [+ Show authors](#)

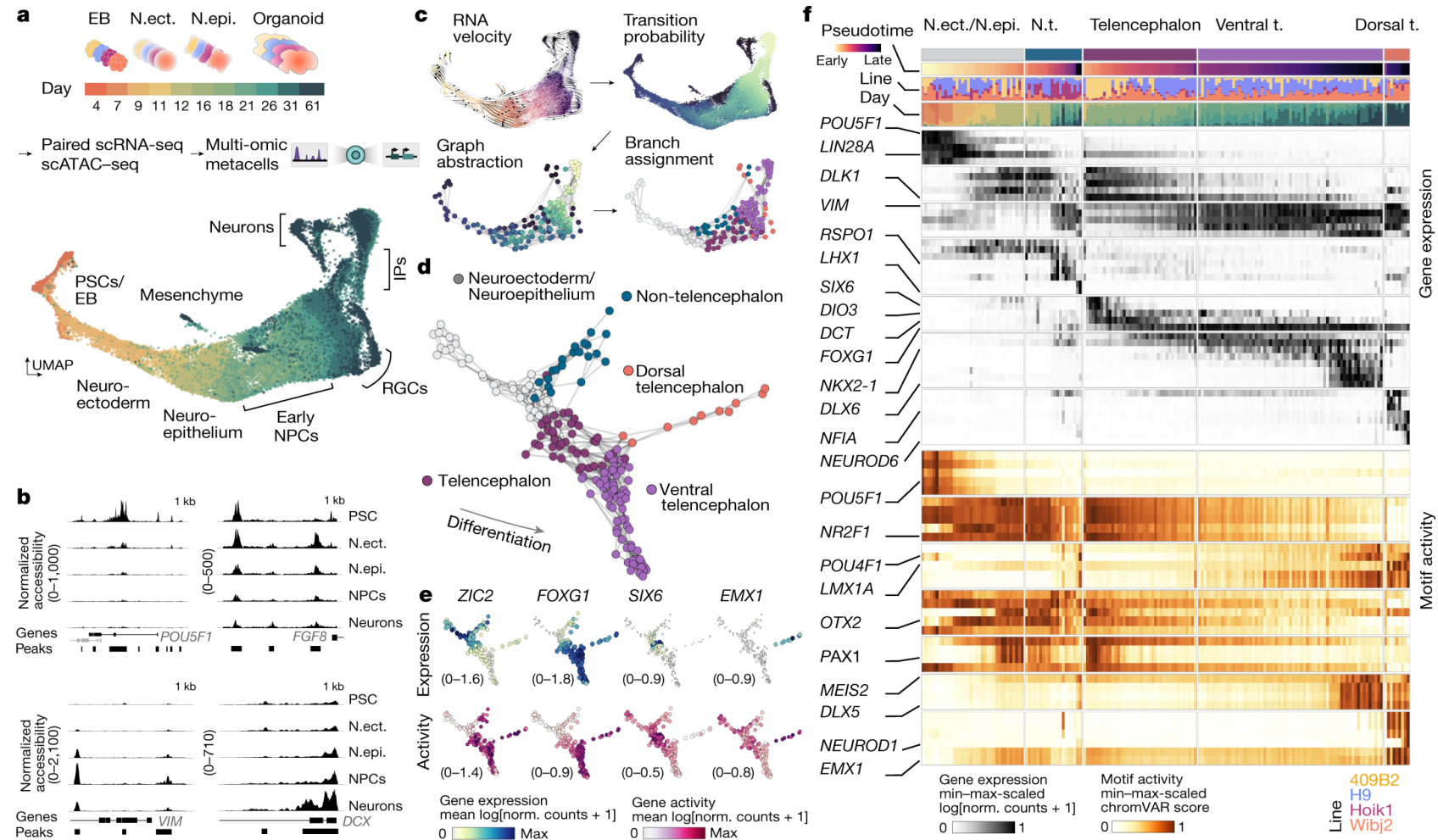
[Nature Neuroscience](#) (2025) | [Cite this article](#)

“These results suggest that motor neurons derived from patients with SALS may provide improved stringency and clinical translatability for ALS drug development and preclinical testing. Only baricitinib, riluzole and memantine significantly increased motor neuron health in the screening.”





Prof. Fides Zenk,
joined EPFL in 2023!



Article | [Open Access](#) | [Published: 05 October 2022](#)

Inferring and perturbing cell fate regulomes in human brain organoids

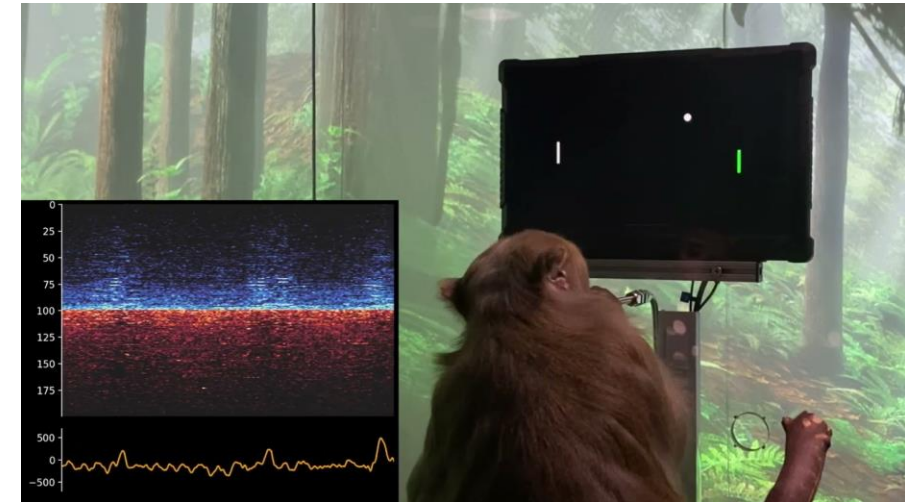
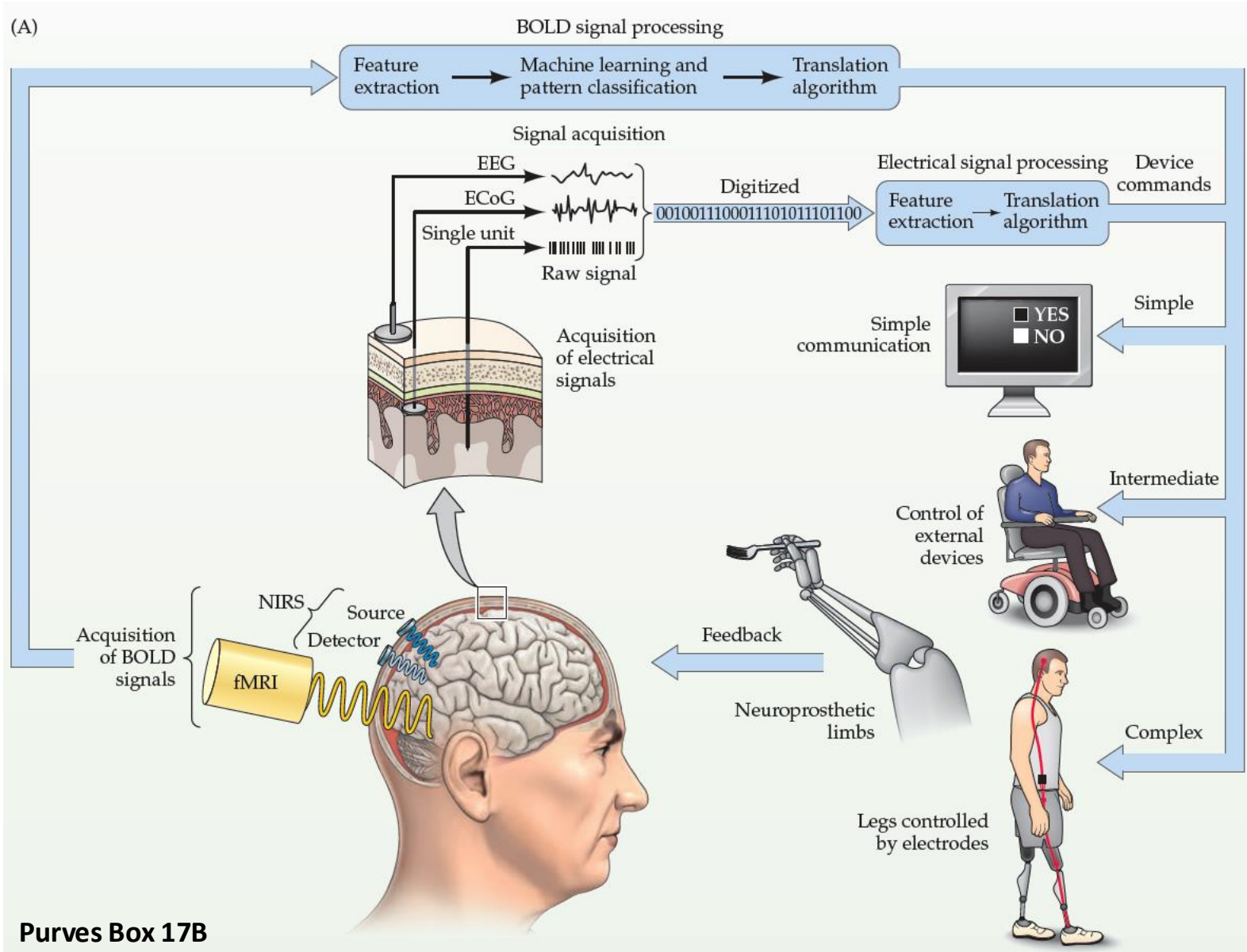
[Jonas Simon Fleck](#), [Sophie Martina Johanna Jansen](#), [Damian Wollny](#), [Fides Zenk](#), [Makiko](#)

[Seimiya](#), [Akanksha Jain](#), [Ryoko Okamoto](#), [Malgorzata Santel](#), [Zhisong He](#) ✉, [J. Gray Camp](#) ✉ &

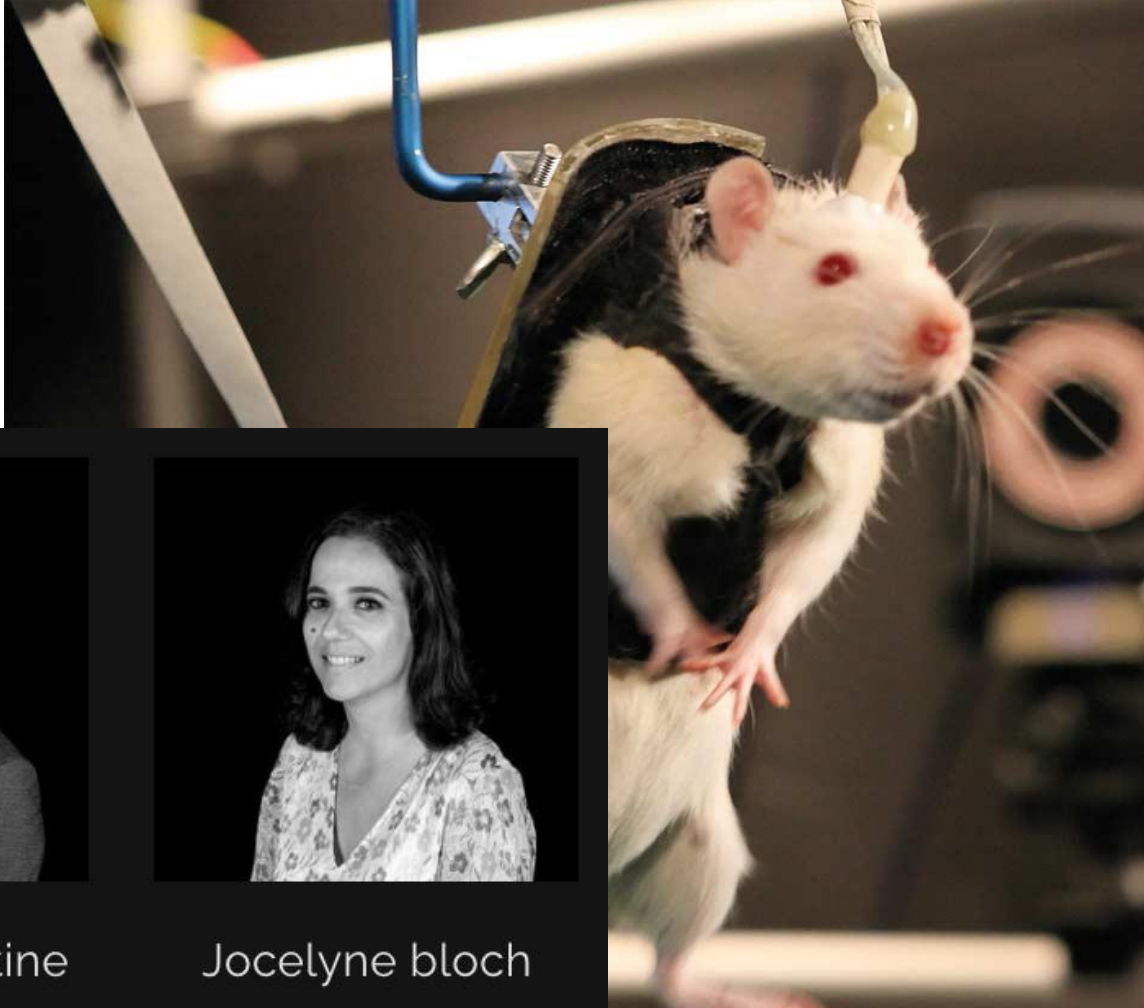
[Barbara Treutlein](#) ✉

[Nature](#) (2022) | [Cite this article](#)

Brain-Machine interface: using brain signals (here from the Motor Cortex) to allow communication, or control of a prosthetic limb



BMI Monkey Pong
Neuralink



Gregoire Courtine



Jocelyne Bloch



1 June 2012

Science

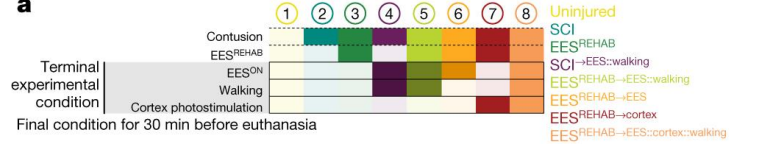
R. van den Brand*, J. Heutschi*, Q. Barraud, J. DiGiovanna, K. Bartholdi, M. Huerlimann, L. Friedli, I. Vollenweider, E.M. Moraud, S. Duis, N. Dominici, S. Micera, P. Musienko, G. Courtine, **Restoring voluntary control of locomotion after paralyzing spinal cord injury**, *Science* (2012).



nature

31 October 2018

F. Wagner*, J.-B. Mignardot*, C. Le Goff-Mignardot*, R. Demesmaeker, S. Komi, M. Capasso, A. Rowald, I. Seáñez, M. Caban, E. Pironcini, M. Vat, L. McCracken, R. Heimgar, Fodor, A. Watrin, P. Seguin, E. Paoles, K. Van Den Keybus, G. Eberle, B. Schurch, E. Pr, F. Becce, J. Prior, N. Buse, R. Buschman, E. Neufeld, N. Kustër, S. Carda, J. von Zitzew, Delattre, T. Denison, H. Lambert, K. Minassian†, J. Bloch†, G. Courtine†, **Targeted neurology restores walking in humans with spinal cord injury**, *Nature* (2018).

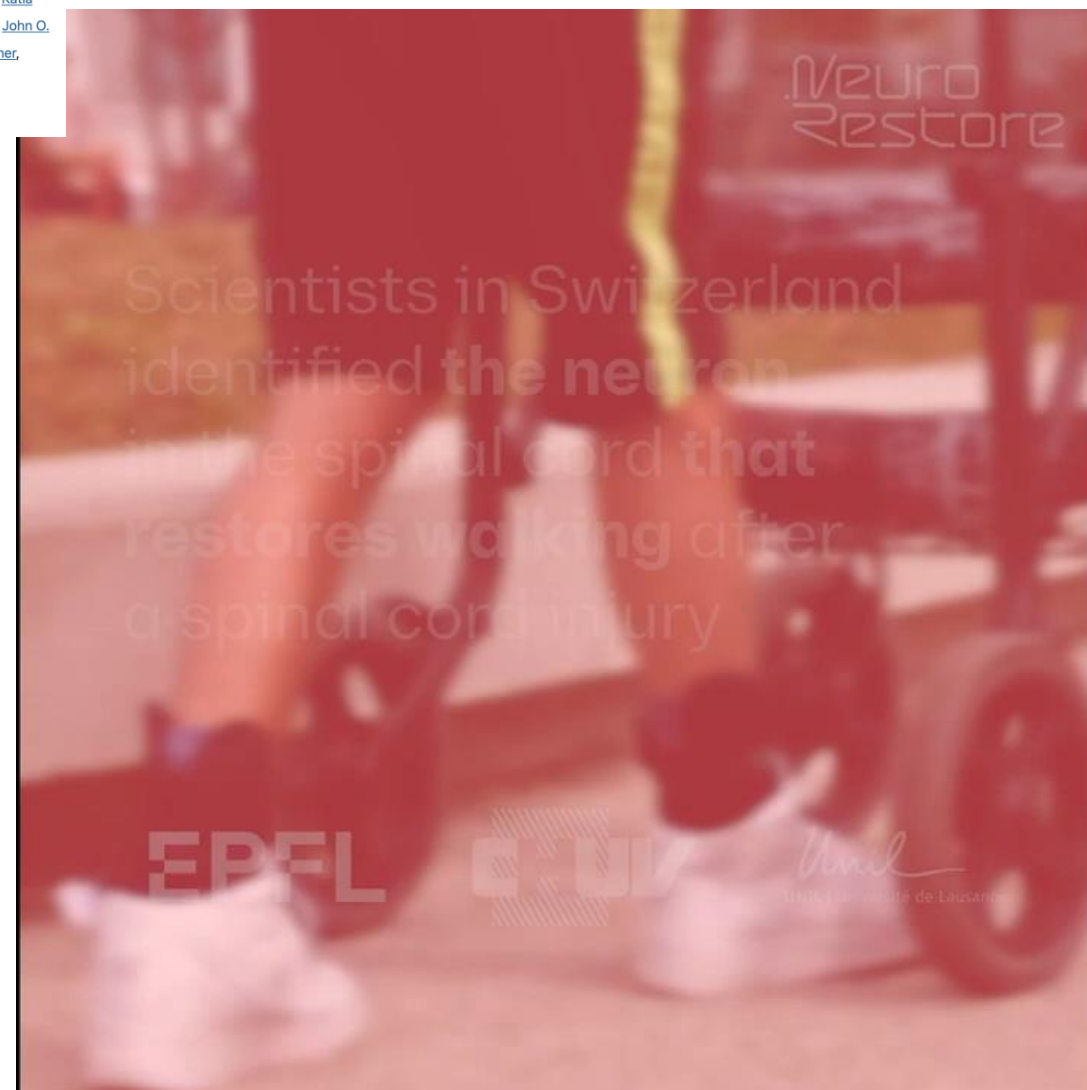
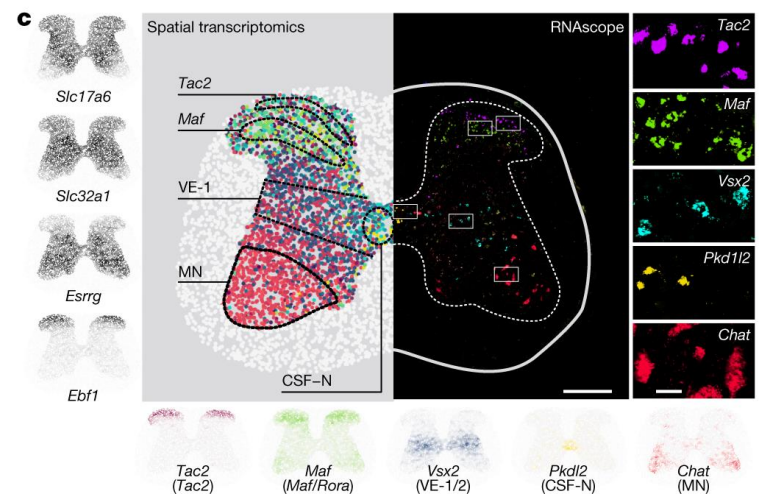
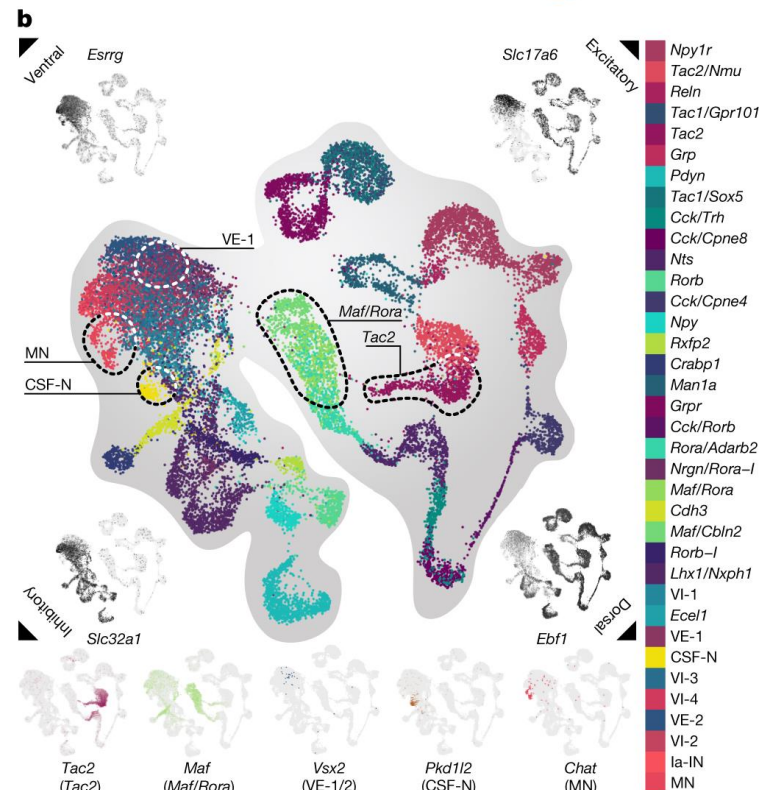


Article | [Open Access](#) | Published: 09 November 2022

The neurons that restore walking after paralysis

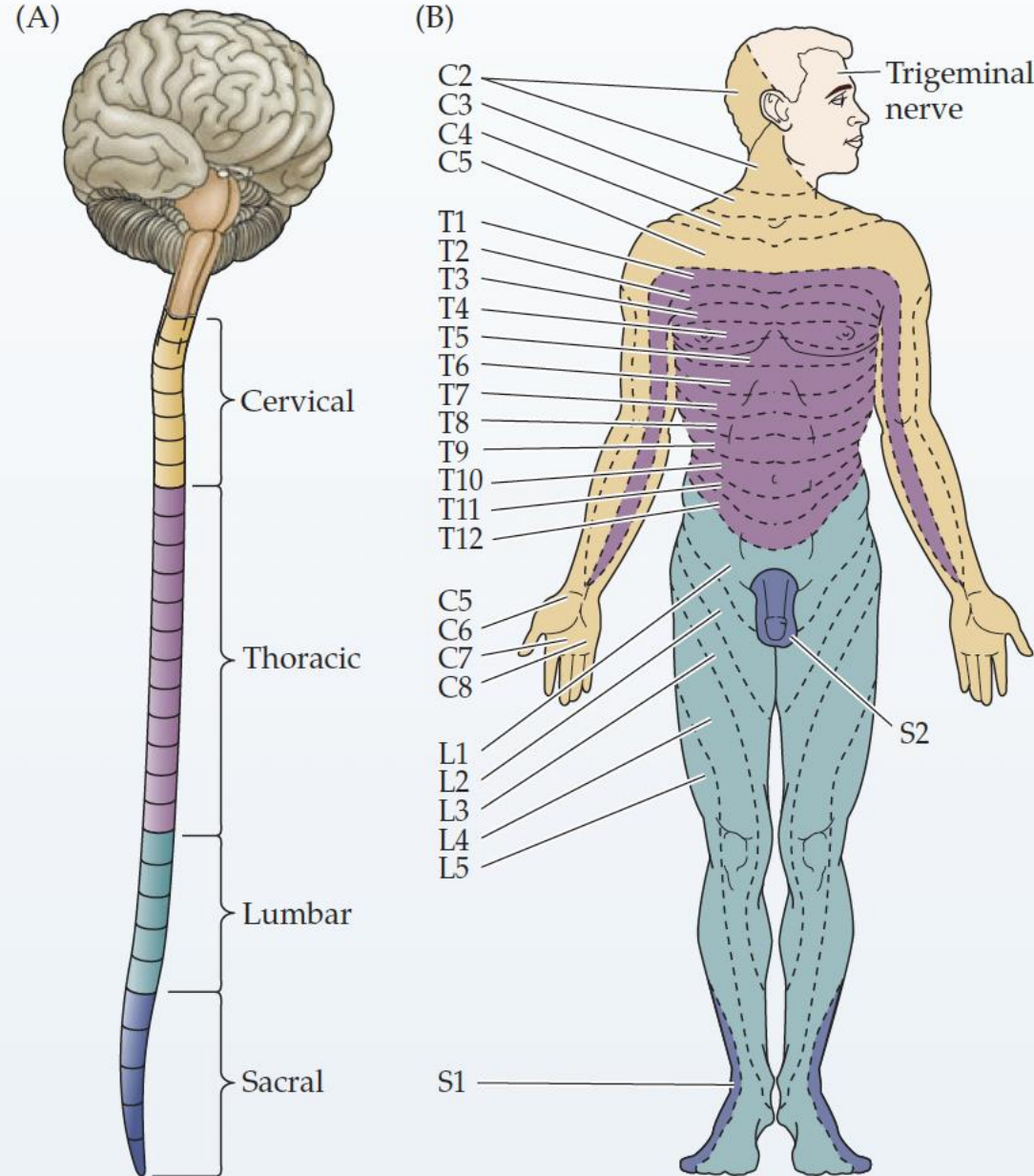
Claudia Kathe, Michael A. Skinnider, Thomas H. Hutson, Nicola Regazzi, Matthieu Gautier, Robin Demesmaeker, Salif Komi, Steven Ceto, Nicholas D. James, Newton Cho, Laetitia Baud, Katia Galan, Kaya J. E. Matson, Andreas Rowald, Kyungjin Kim, Ruijia Wang, Karen Minassian, John O. Prior, Leonie Asboth, Quentin Barraud, Stéphanie P. Lacour, Ariel J. Levine, Fabien Wagner, Jocelyne Bloch, ... Grégoire Courtine

Nature 611, 540–547 (2022) | [Cite this article](#)

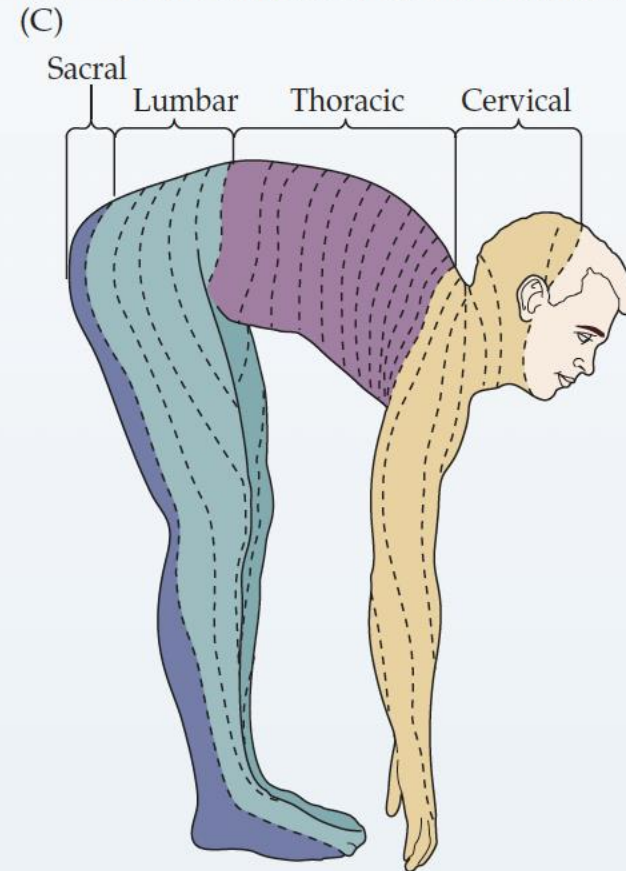


<https://actu.epfl.ch/news/scientists-identify-neurons-that-restore-walking-2/>

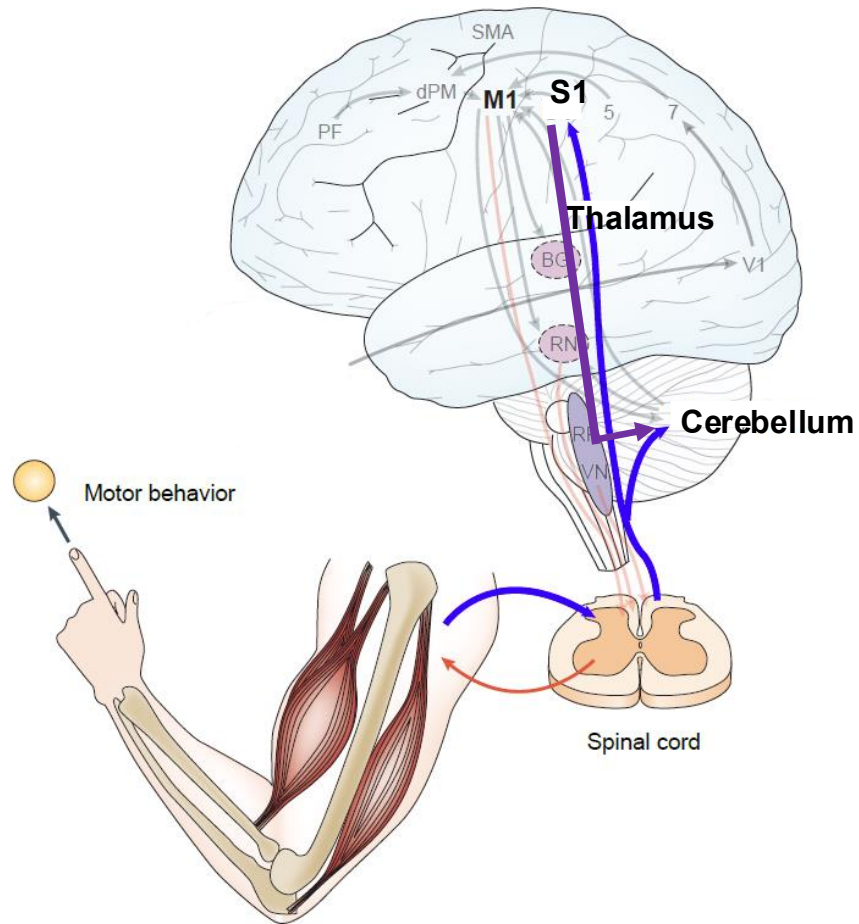
Clinical application: mapping deficits to spinal injury location



The innervation arising from a single dorsal root ganglion and its spinal nerve is called a dermatome. The full set of sensory dermatomes is shown here for a typical adult. Knowledge of this arrangement is particularly important in defining the location of suspected spinal (and other) lesions. The numbers refer to the spinal segments by which each nerve is named. (A,C after Rosenzweig et al., 2005; Haymaker and Woodhall, 1967; B after Haymaker and Woodhall, 1967.)



Clinical application: loss of proprioception

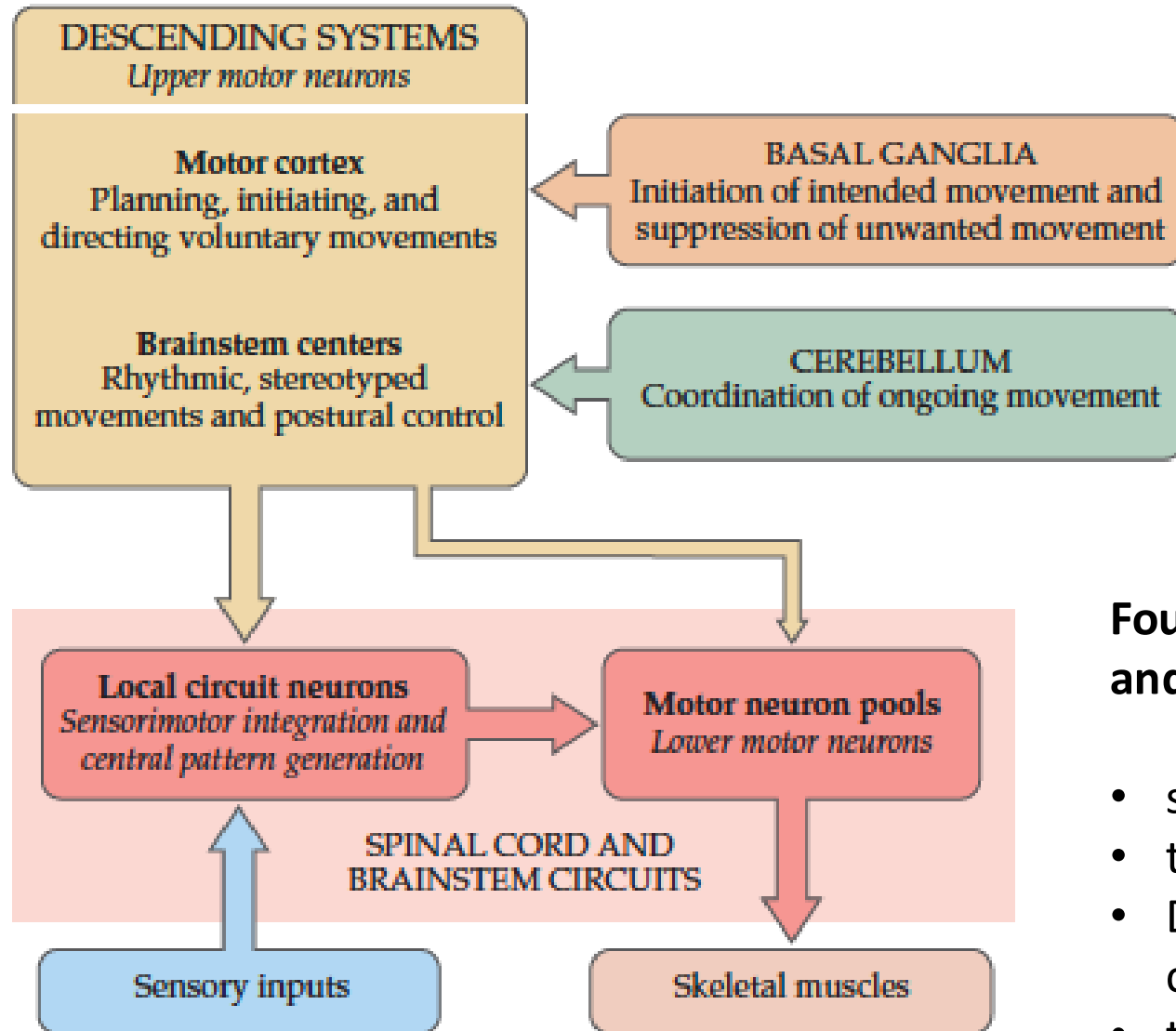


Adapted from Scott, 2004



1997 BBC documentary, [*The Man Who Lost His Body*](#).

<https://www.dailymotion.com/video/x12647t>



Four systems make essential and distinct contributions to motor control:

- spinal cord (and brainstem circuits)
- the cerebellum
- Descending control centers in the cerebral cortex and brainstem
- the basal ganglia

The cerebellum: functional organization

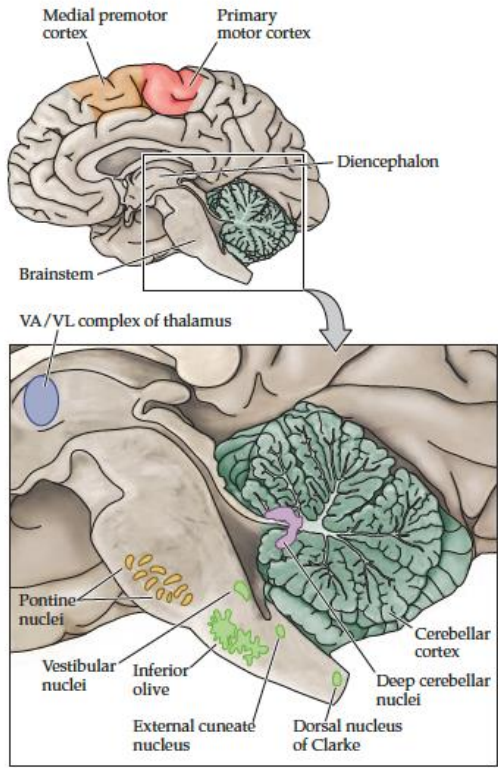
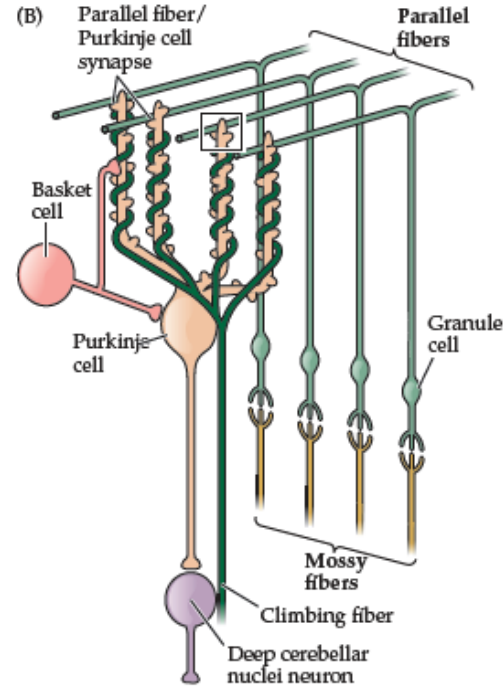
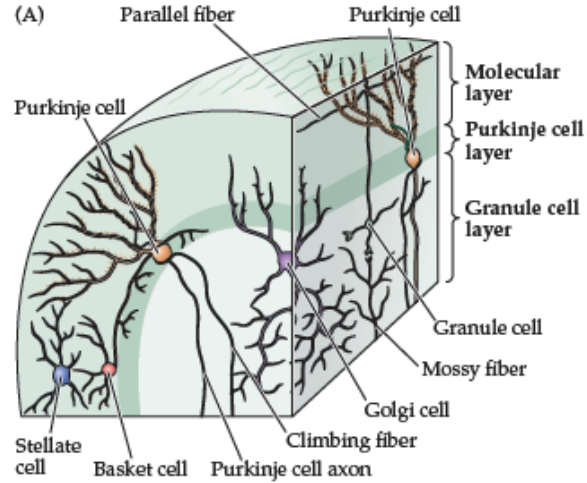
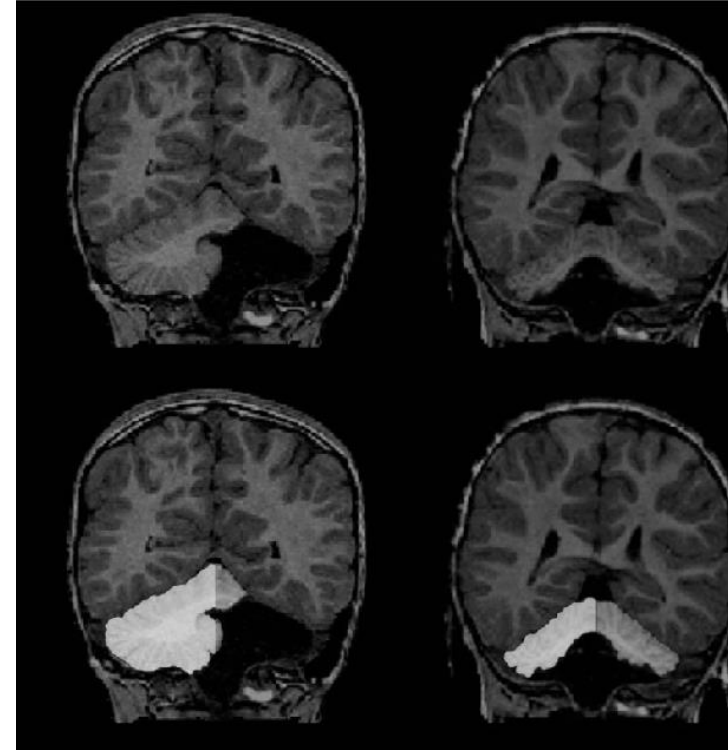


FIGURE 19.2 Components of the brainstem and diencephalon related to the cerebellum. This sagittal section



**Purkinje Neuron:
principle output
of the cerebellar
cortex**



DOI:[10.1093/cercor/bhs354](https://doi.org/10.1093/cercor/bhs354)

Cerebellar damage impairs motor learning & control in humans

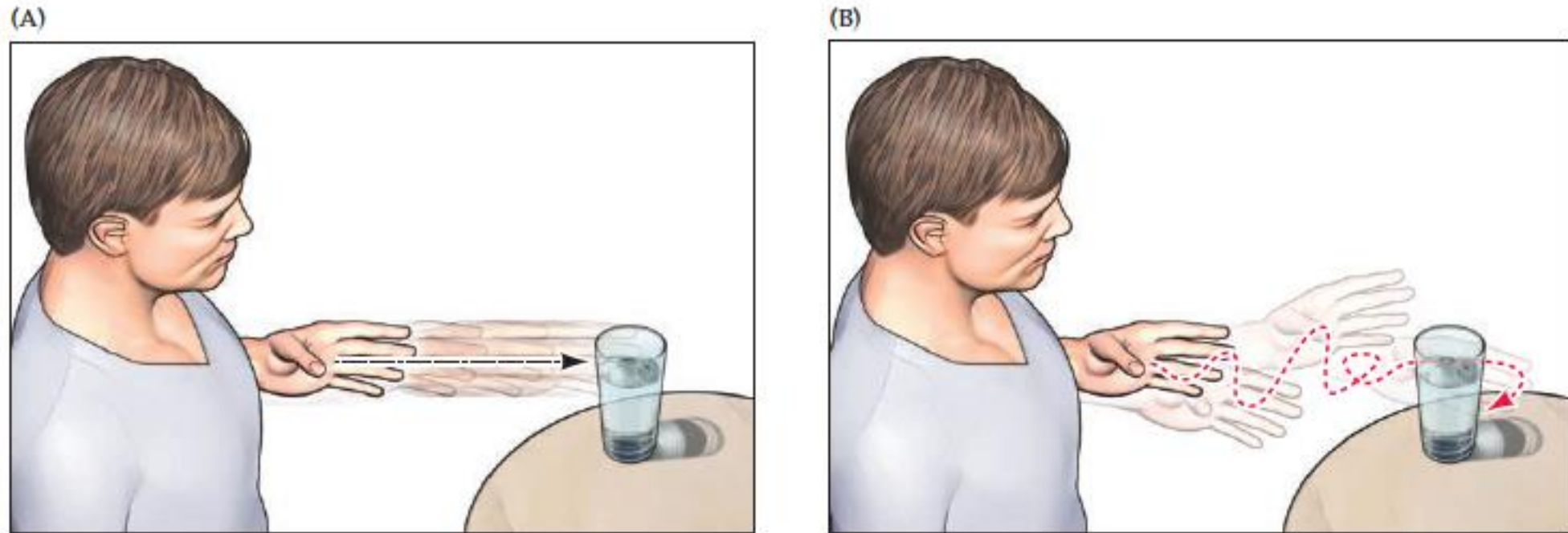


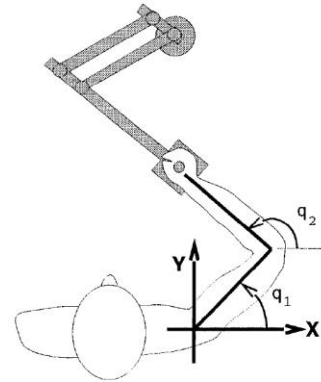
FIGURE 19.16 Illustration of appendicular ataxia with cerebellar damage. (A) Smooth execution of a visually guided reach in an individual with typical cerebellum function. (B) Poorly coordinated visually guided reach (appendicular ataxia) in an individual with cerebellar damage. The hand takes a much less straight trajectory to the target, with irregular movements that typically overshoot or undershoot the visual target and so require frequent corrective movements to execute the intended motor task.

Cerebellar damage impairs motor learning & control in humans

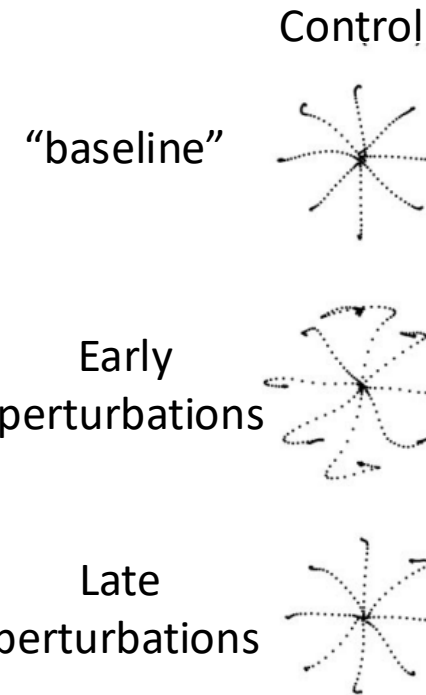
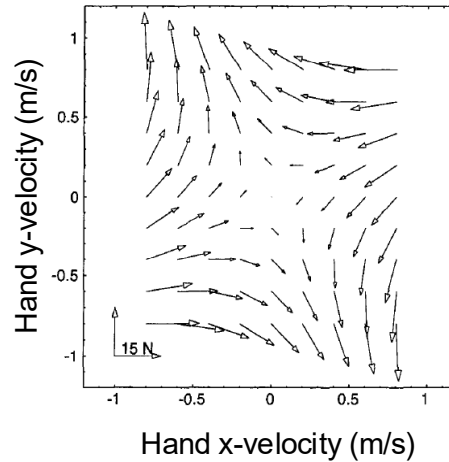


<https://www.youtube.com/watch?v=Txlvu2byUY>

Cerebellar ataxia
affects ~4 in 100,000 people



Shadmehr & Mussa-Ivaldi, 1994



Basal ganglia: Anatomy

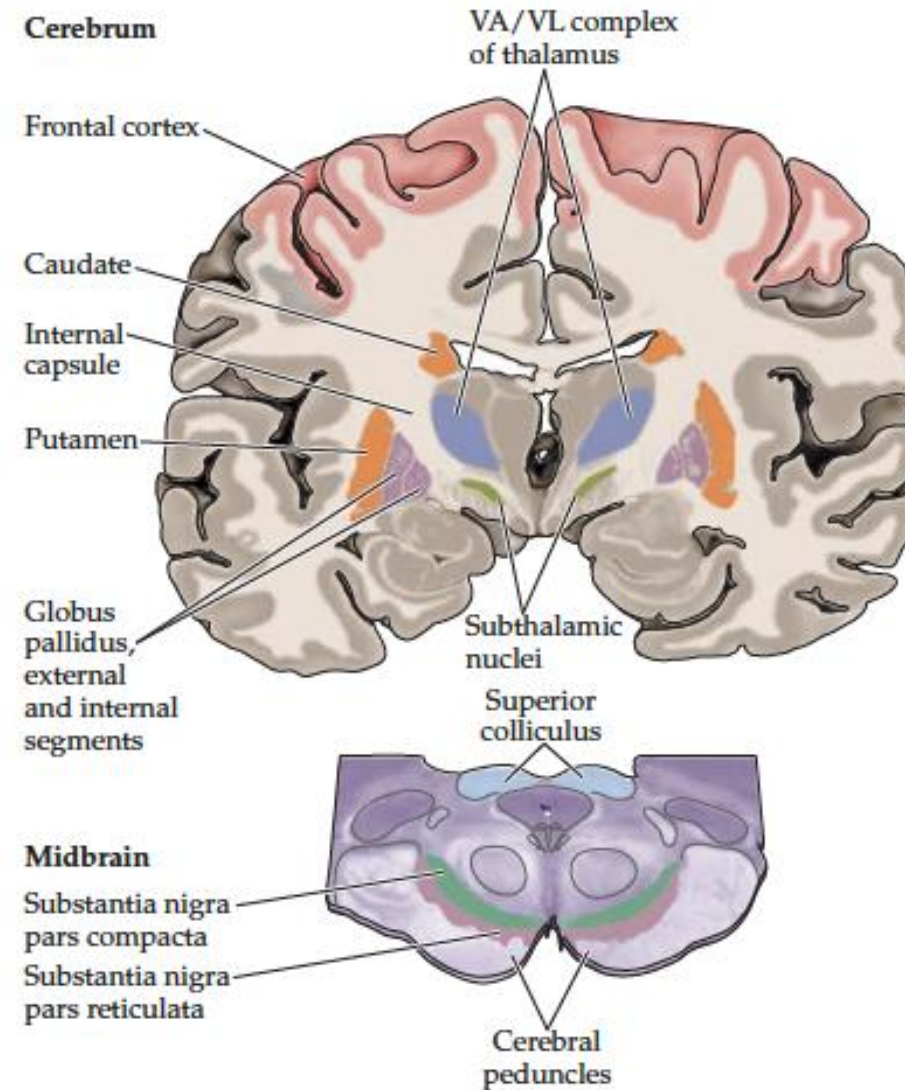
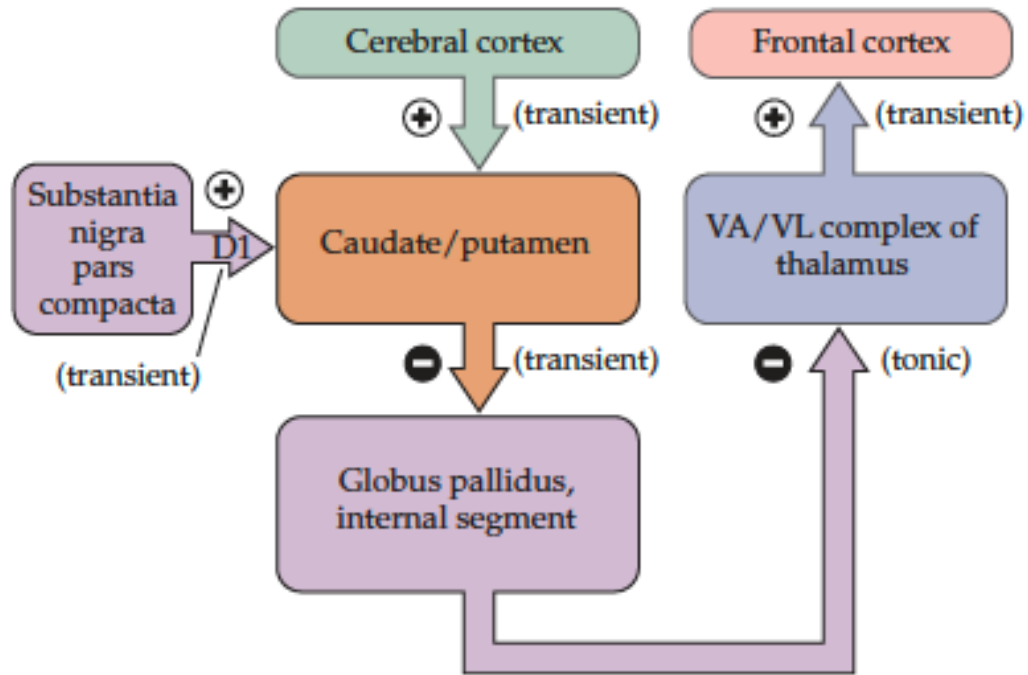


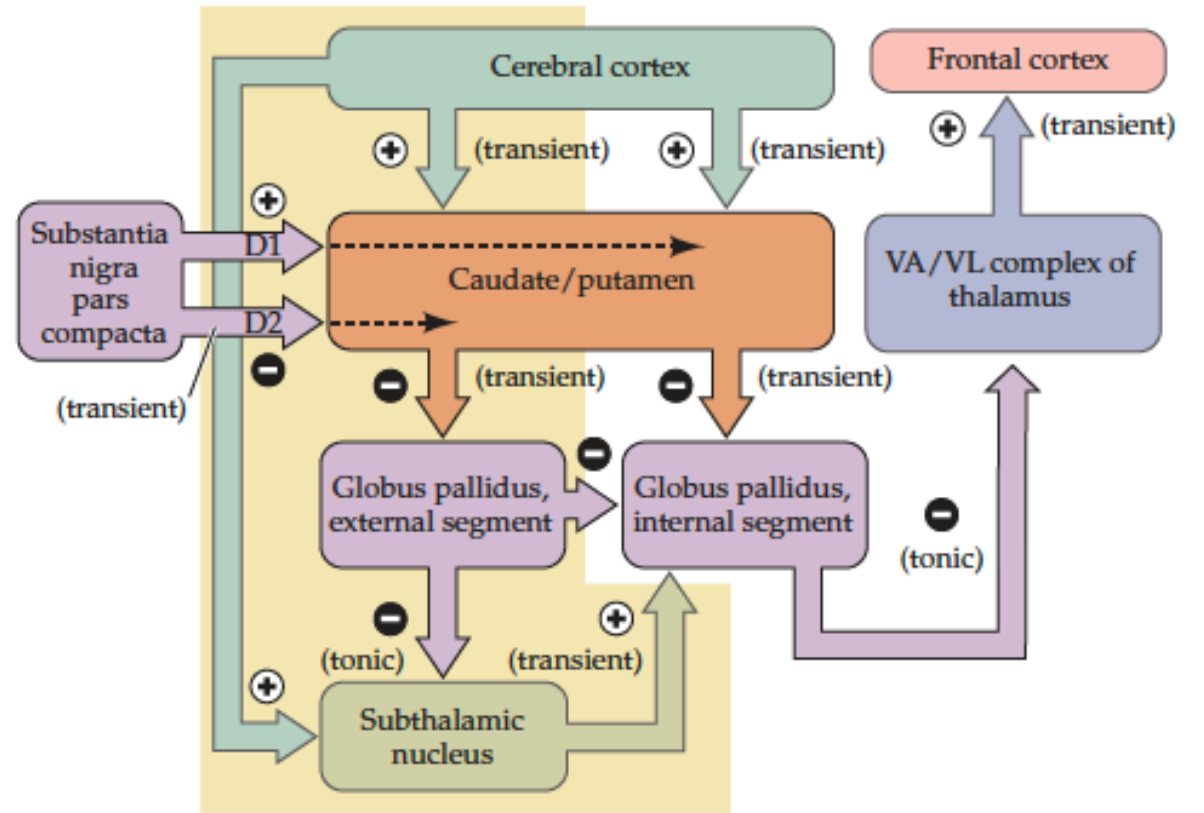
FIGURE 18.1 Motor components of the basal ganglia.

Major BG pathways: indirect & direct

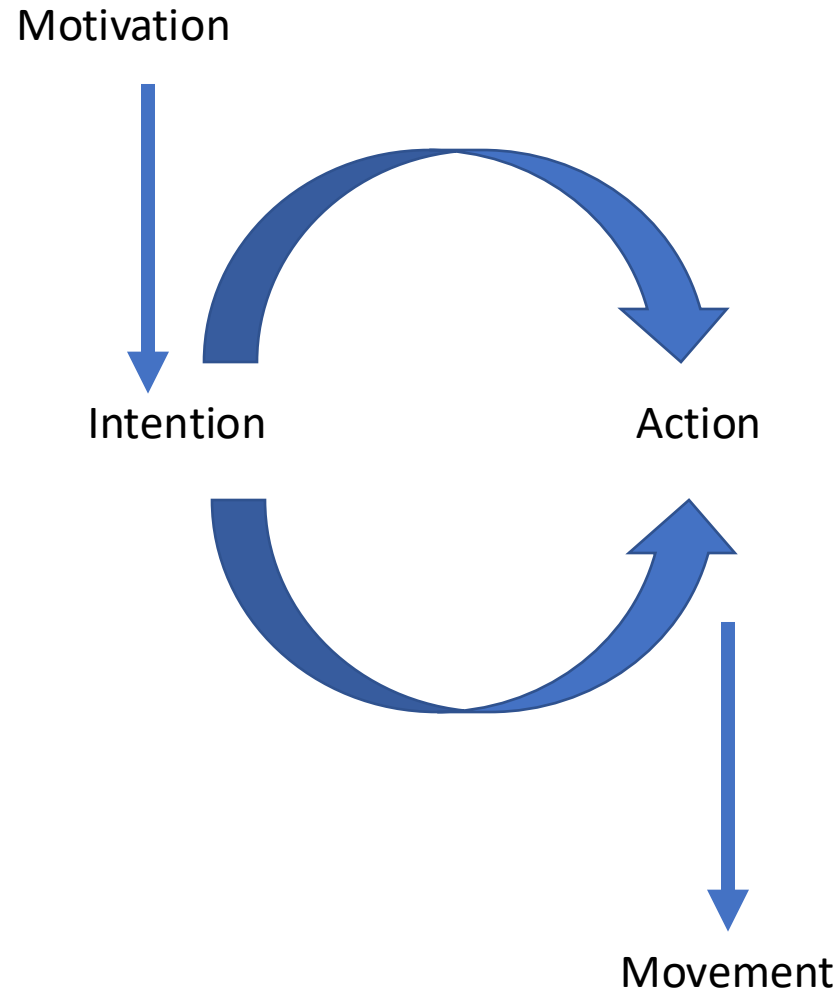
(A) Direct pathway



INDIRECT



Basal ganglia: shaping actions



The Basal Ganglia Have a Powerful Effect on Behavior: Clinical Evidence

Neocortex

Striatum

S. Nigra

Release!

Inhibit!

Motor plus

- Parkinson's disease
- Huntington's disease
- Dystonia
- Cognitive/Emotional

Neuropsychiatric

- OCD/Tourette
- Autism/ADHD
- Anxiety disorders
- Depression

The diagram shows the basal ganglia circuitry. The Neocortex is at the top, connected to the Striatum in the middle. The Striatum is connected to the S. Nigra at the bottom. A red arrow points from the Striatum to the right, labeled 'Release!'. A blue arrow points from the Striatum to the right, labeled 'Inhibit!'. The S. Nigra is shown with two neurons.

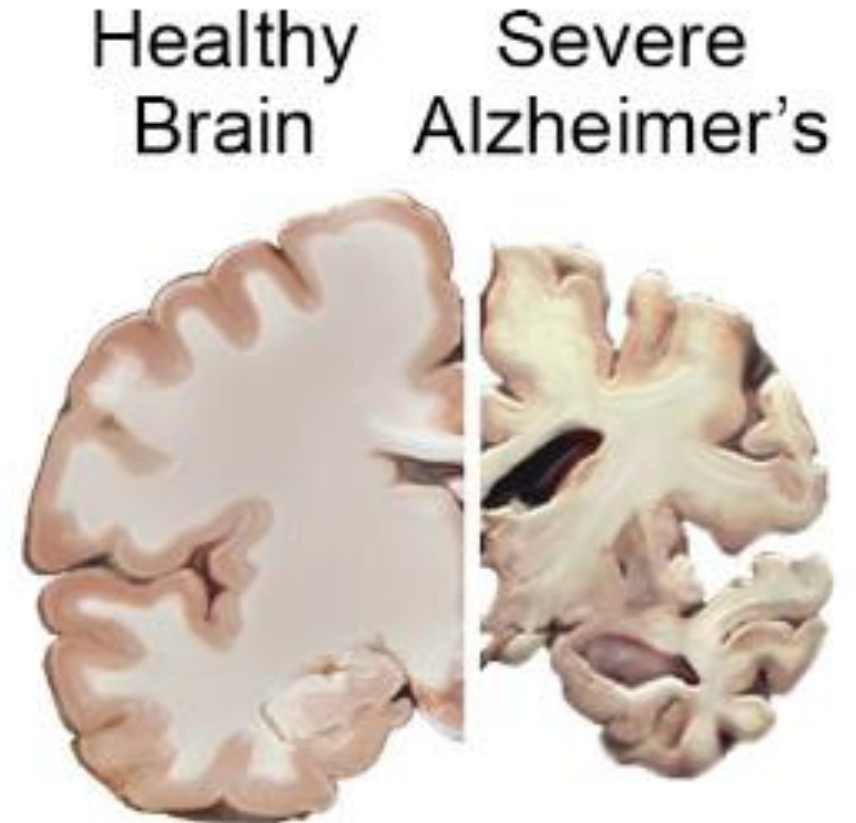
Slide from Prof. Ann Graybiel (MIT)

Alzheimer's disease is one of the most devastating brain disorders of elderly humans.

It was defined by Alois Alzheimer in 1906 using criteria of progressive memory loss, disorientation, and pathological markers (**senile plaques and neurofibrillary tangles**).

4 known genes that cause the familial form of the disease

- APP on chromosome 21
- presenilin-1 [PS 1] on chromosome 14
- presenilin-2 [PS 2] on chromosome 1
- apolipoprotein E (*APOE*, a gene on the long arm of chromosome 19)



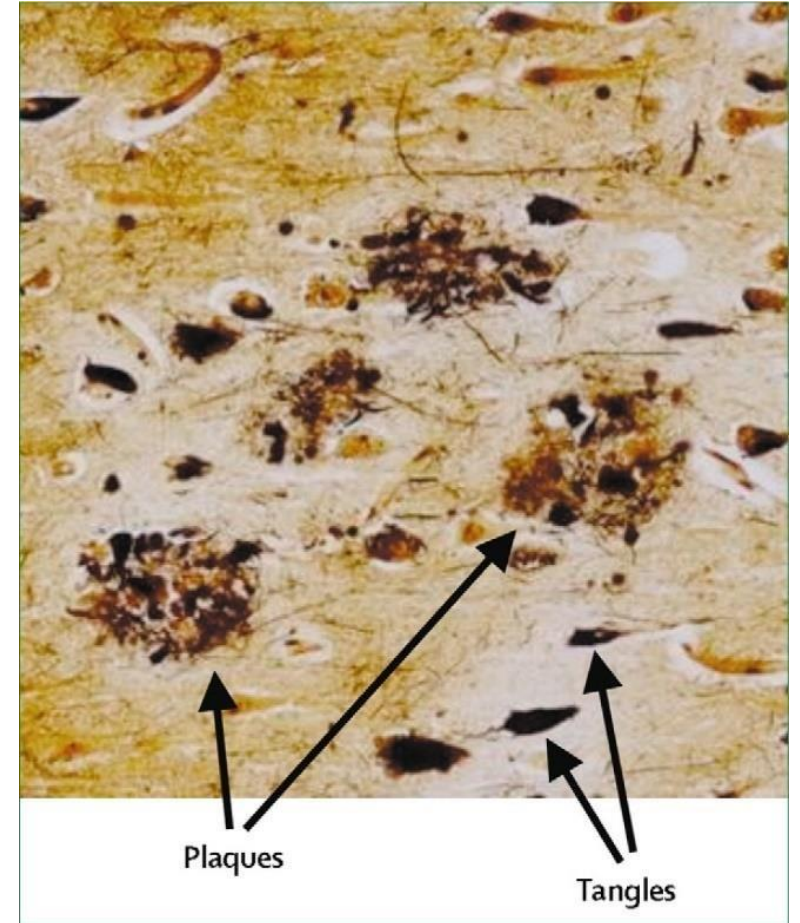
AD currently afflicts nearly half of the people aged 85 years and older.

Alzheimer's disease is one of the most devastating brain disorders of elderly humans.

It was defined by Alois Alzheimer in 1906 using criteria of progressive memory loss, disorientation, and pathological markers (**senile plaques and neurofibrillary tangles**).

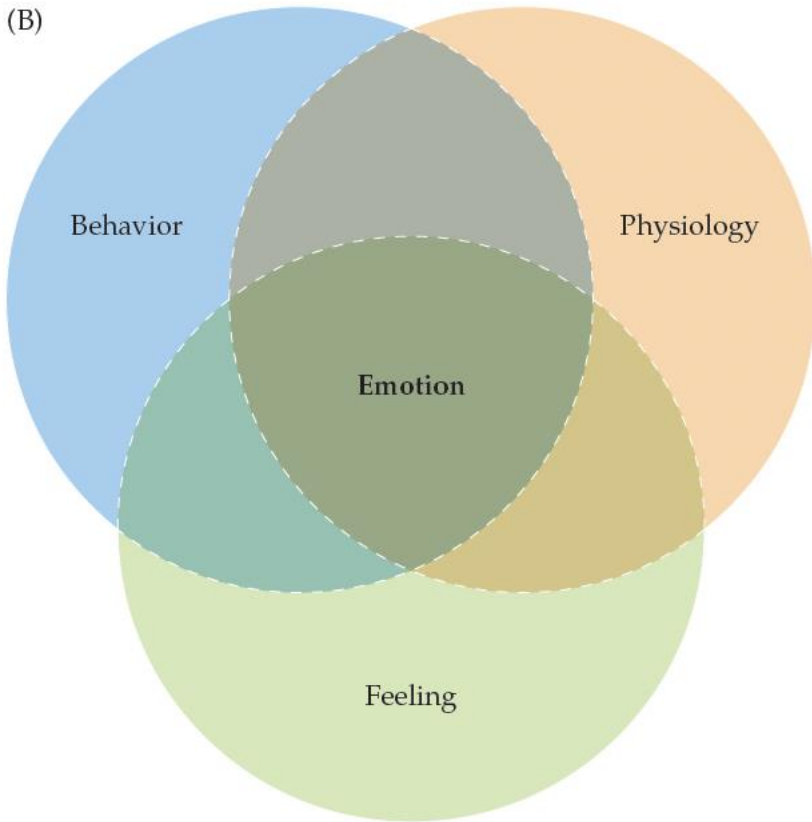
4 known genes that cause the familial form of the disease

- APP on chromosome 21
- presenilin-1 [PS 1] on chromosome 14
- presenilin-2 [PS 2] on chromosome 1
- apolipoprotein E (*APOE*, a gene on the long arm of chromosome 19)



Blennow, K.; de Leon, M. J.; Zetterberg, H.
Alzheimer's disease. *Lancet* 2006, 368, 387-403.

(B)



The link from emotion to motor systems

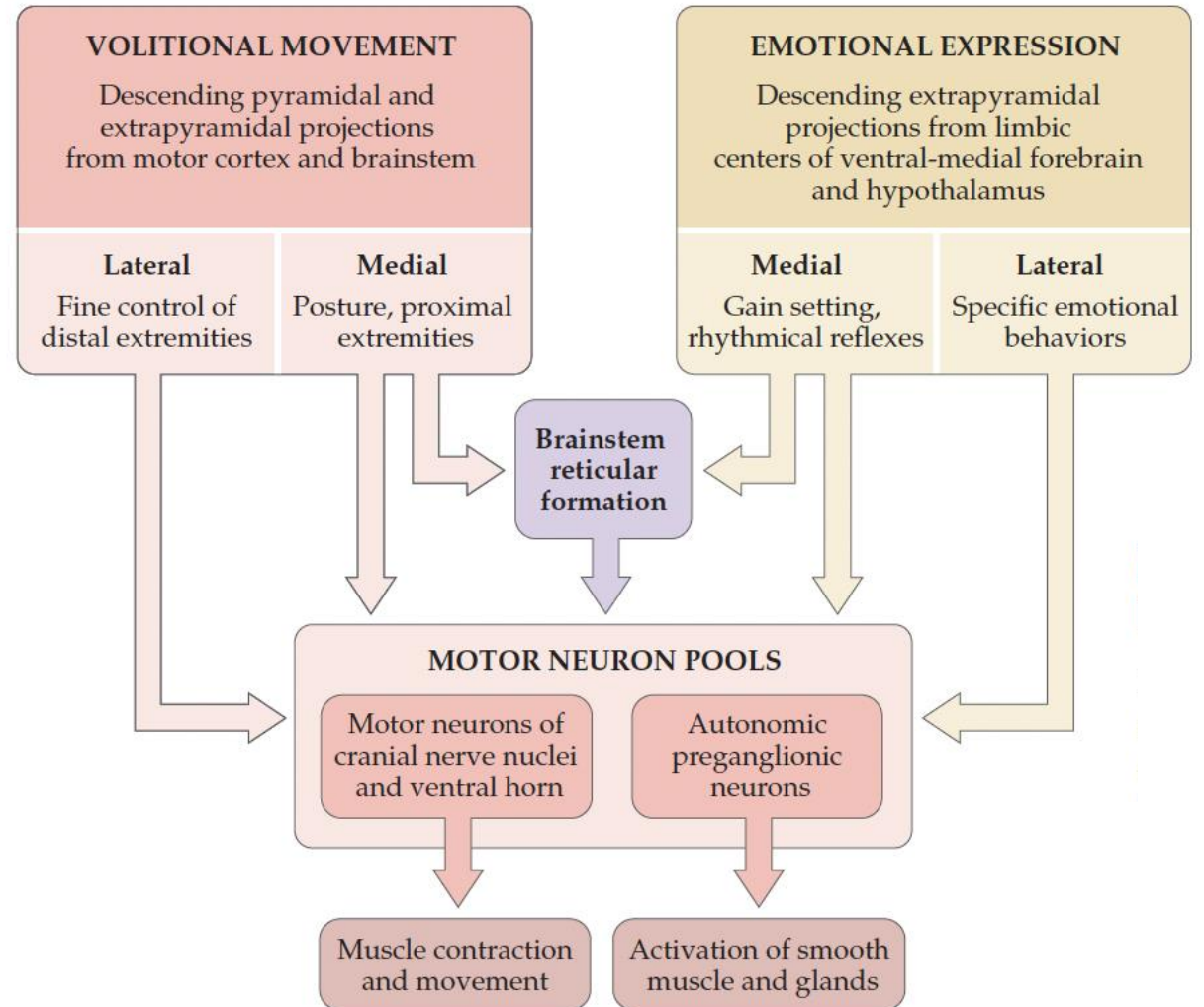


FIGURE 31.3 Components of the nervous system that organize the expression of emotional experience.

The link from emotion to motor systems

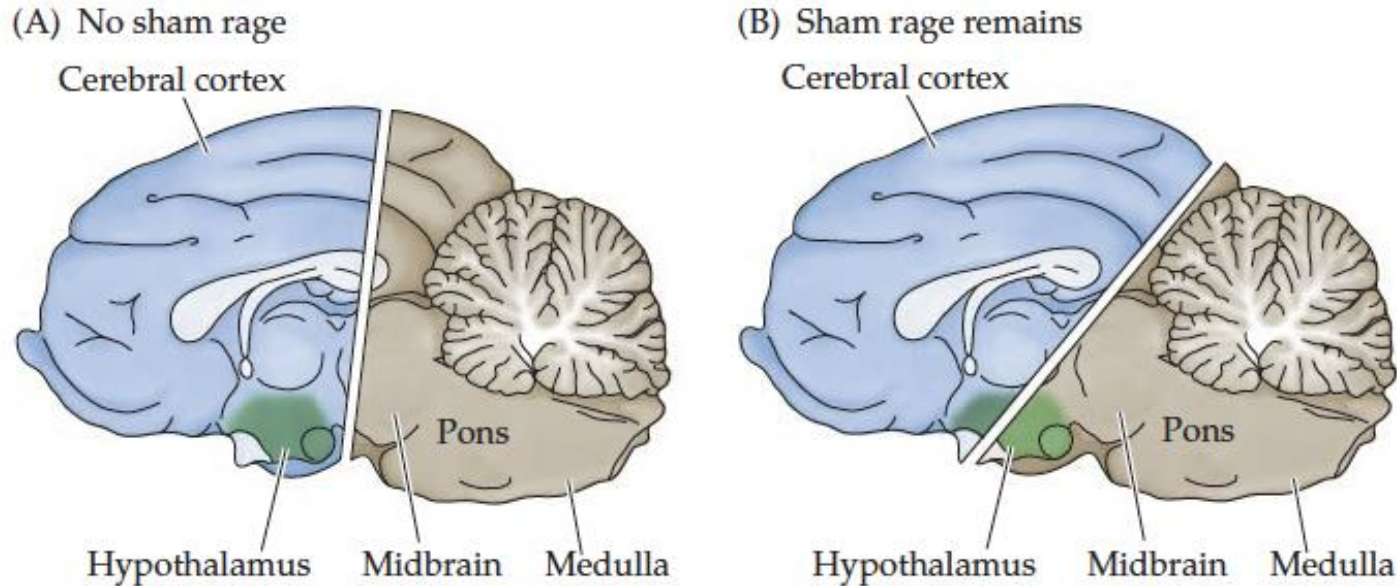


FIGURE 31.2 Midsagittal view of a cat's brain, illustrating the regions sufficient for the expression of emotional behavior. (A) Transection through the midbrain, disconnecting the hypothalamus and brainstem, abolishes sham rage. (B) The integrated emotional responses associated with sham rage survive removal of the cerebral hemispheres as long as the caudal hypothalamus remains intact. (After LeDoux, 1987.)

..... One interpretation of these findings is that when voluntary facial expressions are produced, signals in the brain engage not only the motor cortex but also some of the circuits that produce emotional states.

In short, emotion and sensorimotor behavior are inextricably linked. As William James put it more than a century ago:

What kind of an emotion of fear would be left if the feeling neither of quickened heart-beats nor of shallow breathing, neither of trembling lips nor of weakened limbs, neither of goose-flesh nor of visceral stirrings, were present, it is quite impossible for me to think ... I say that for us emotion dissociated from all bodily feeling is inconceivable.

William James, 1893 (Psychology, p. 379)

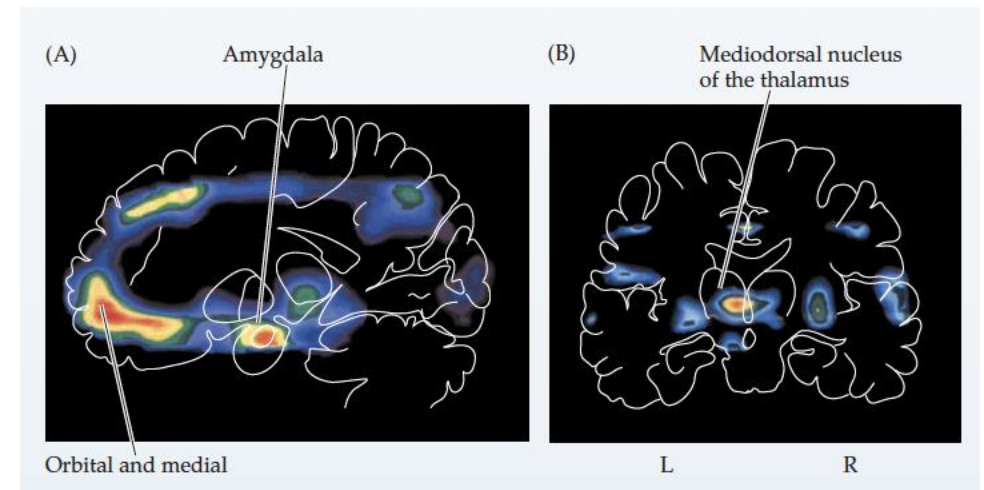
Affective Disorders

Mood disorders center on abnormal regulation of sadness and happiness

- Major forms: **major depression and bipolar disorder** (manic depression)
- Bipolar disorder involves alternating depression and euphoria
- Depression is the most common major psychiatric disorder
- Lifetime prevalence: ~10–25% in women, ~5–12% in men
- Diagnostic features go beyond normal grief or unhappiness
- Core symptoms: persistent sadness, despair, hopelessness

Treatments include several drug classes:

- Tricyclic antidepressants
- Monoamine oxidase inhibitors (MAOIs)
- Selective serotonin reuptake inhibitors (SSRIs)
- SSRIs are the most effective and widely used
- SSRIs block serotonin reuptake selectively
- Key SSRIs: fluoxetine (Prozac), sertraline (Zoloft), paroxetine (Paxil)



Areas of increased blood flow in the left amygdala and orbital and medial prefrontal cortex (A) and in a location in the left medial thalamus consistent with the mediodorsal nucleus (B) from a sample of patients diagnosed with unipolar clinical depression. (From Drevets and Raichle, 1994.)

The Limbic System

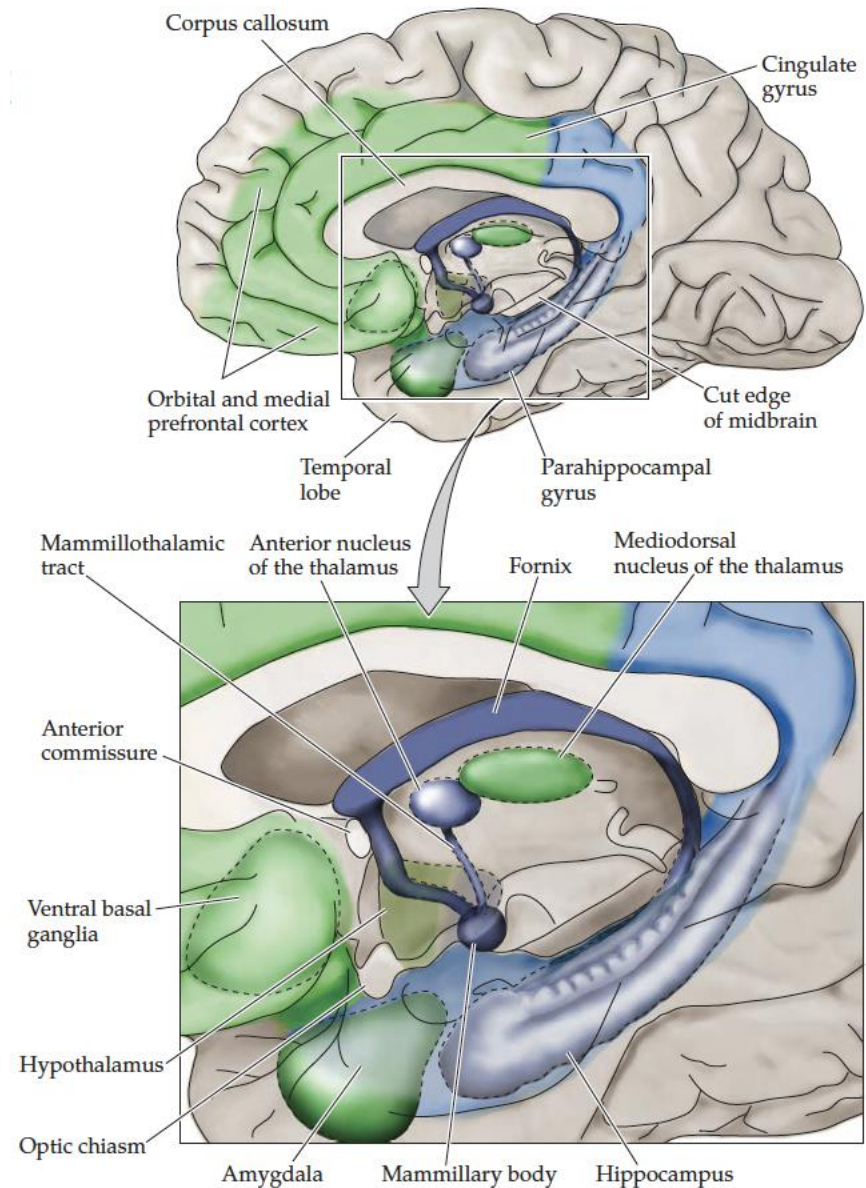


FIGURE 31.5 Modern conception of the limbic system. Two especially important components of the limbic system not emphasized in early anatomical accounts are the orbital and medial prefrontal cortex and the amygdala. These two telencephalic regions, together with related structures in the thalamus, hypothalamus, and ventral striatum, are especially important in the experience and expression of emotion (green). Other parts of the limbic system, including the hippocampus and the mammillary bodies of the hypothalamus, are no longer considered important neural centers for processing emotion (blue).

The limbic system and the Default Mode Network (DMN)

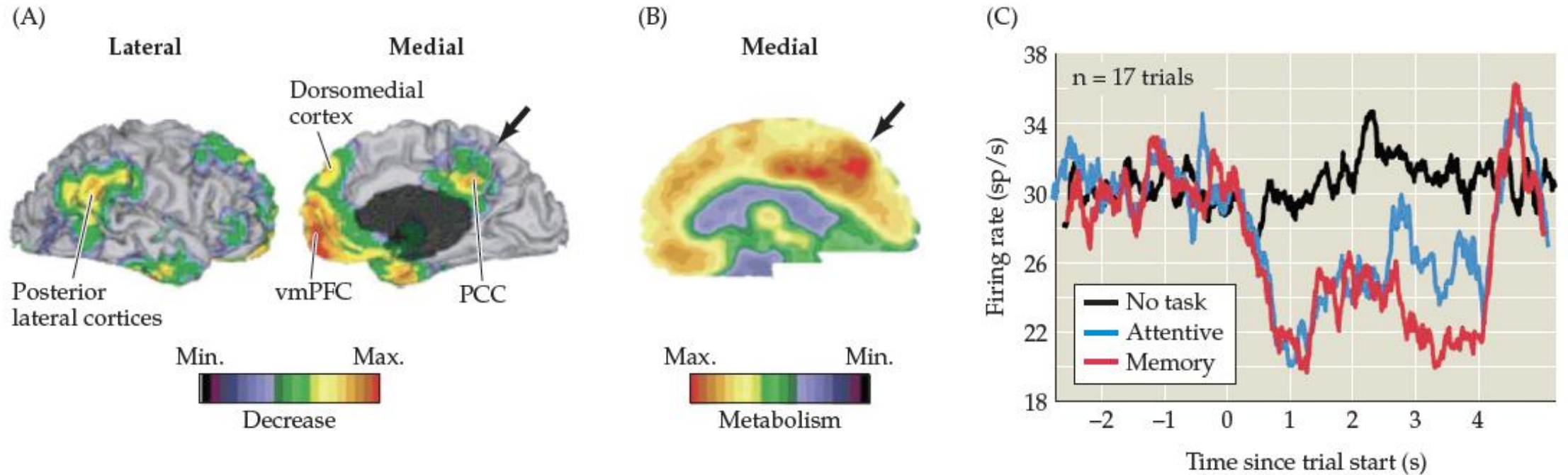


FIGURE 32.13 Default-mode function and the posterior cingulate cortex.

Schizophrenia

- The most prevalent form of psychosis is schizophrenia, which affects approximately 1% of the world's population
- Antagonists of dopamine receptors serve as antipsychotic drugs that reduce the **positive (psychotic) symptoms** of many schizophrenia patients.

Psychotic symptoms
(Delusions, Hallucinations)



Schizophrenia

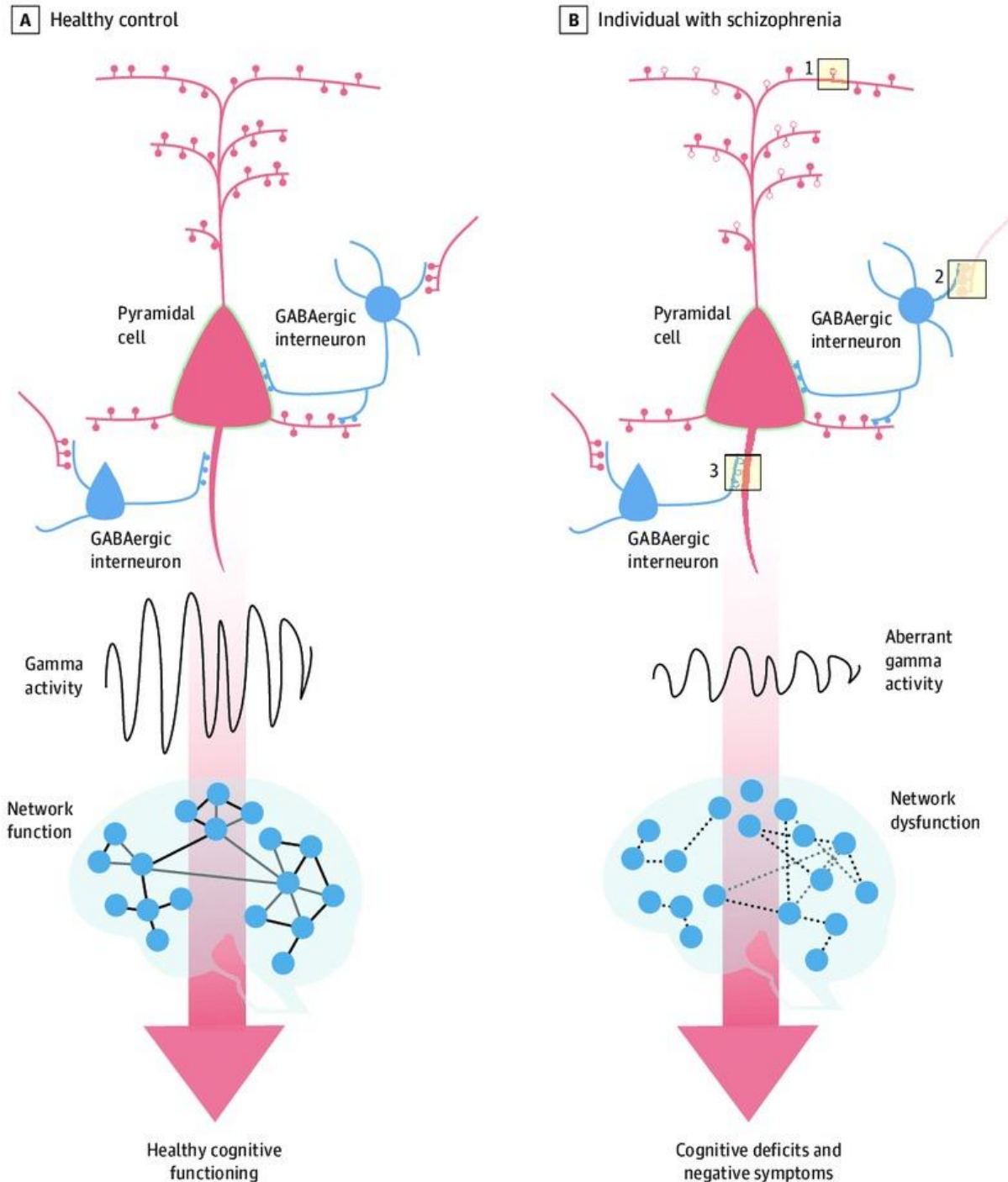
Negative symptoms
(Apathy, Diminished expression)



Prof. Dr. Indrit Bègue
Department of Psychiatry
University of Geneva & University Hospitals of Geneva

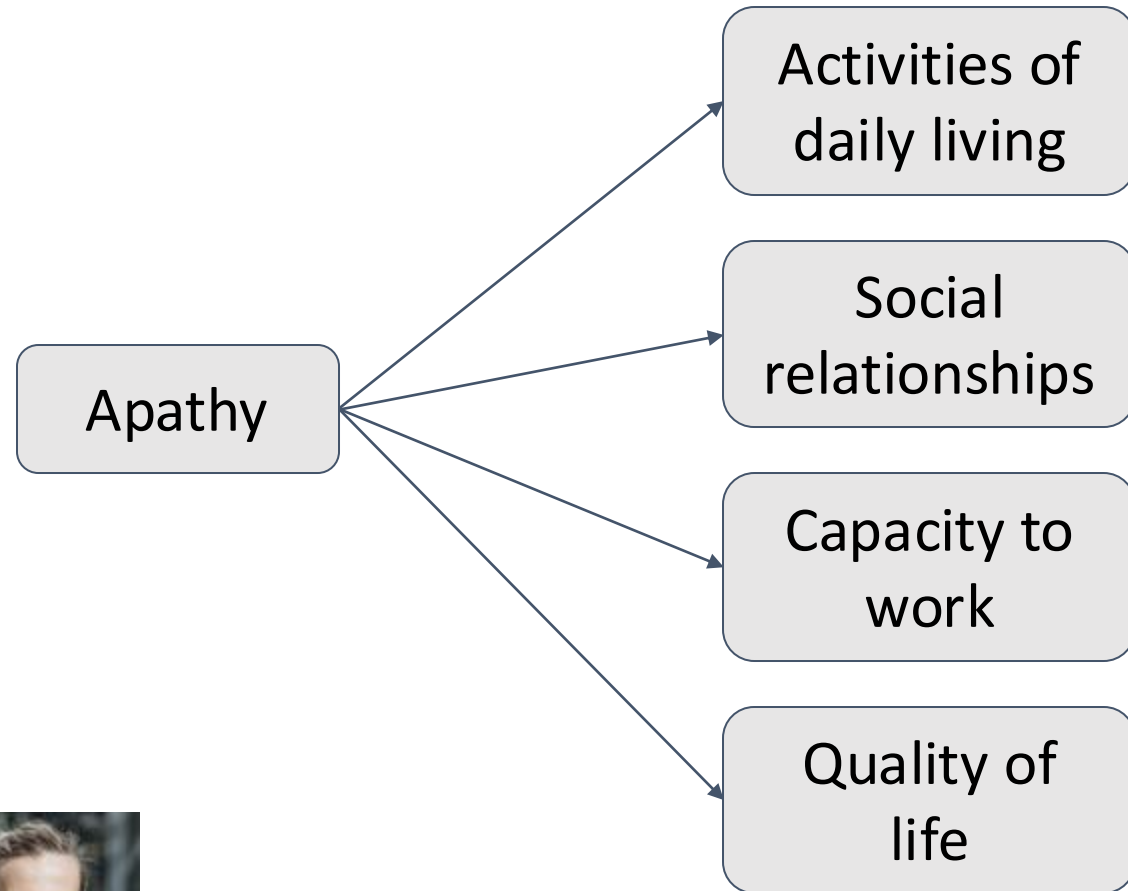
Schizophrenia

- The most prevalent form of **psychosis** is schizophrenia, which affects approximately 1% of the world's population
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Prof. Dr. Indrit Bègue
Department of Psychiatry
University of Geneva & University Hospitals of Geneva

Apathy is present in > 50% of patients and is strongly related to patient-relevant outcomes



... and thus contributes to the high societal and economic burden of schizophrenia

Total economic burden the US in 2019:

- 343.2 Billion US \$
- > 1 % of the US GDP
- Same order of magnitude as diabetes

(Kalakia et al, 2022)



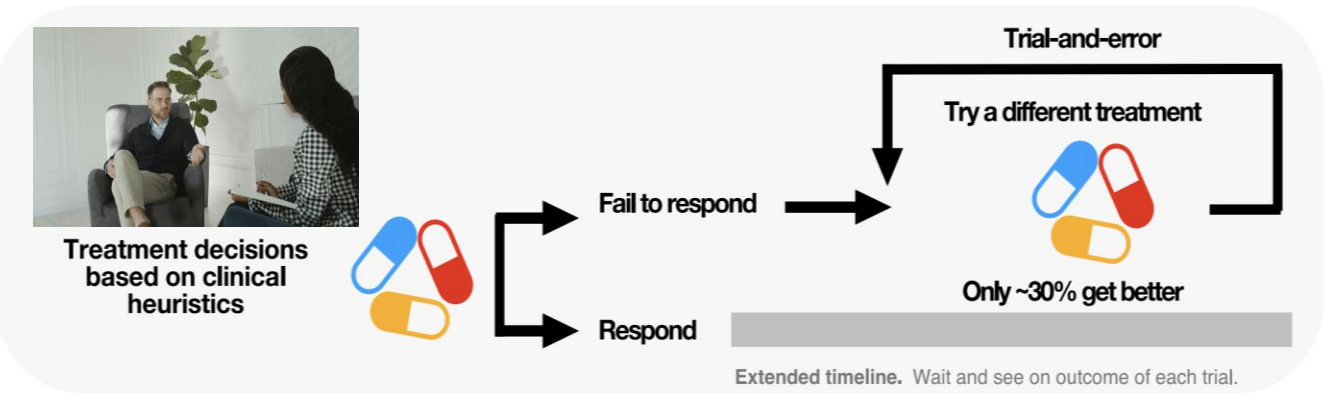
Major unmet need!



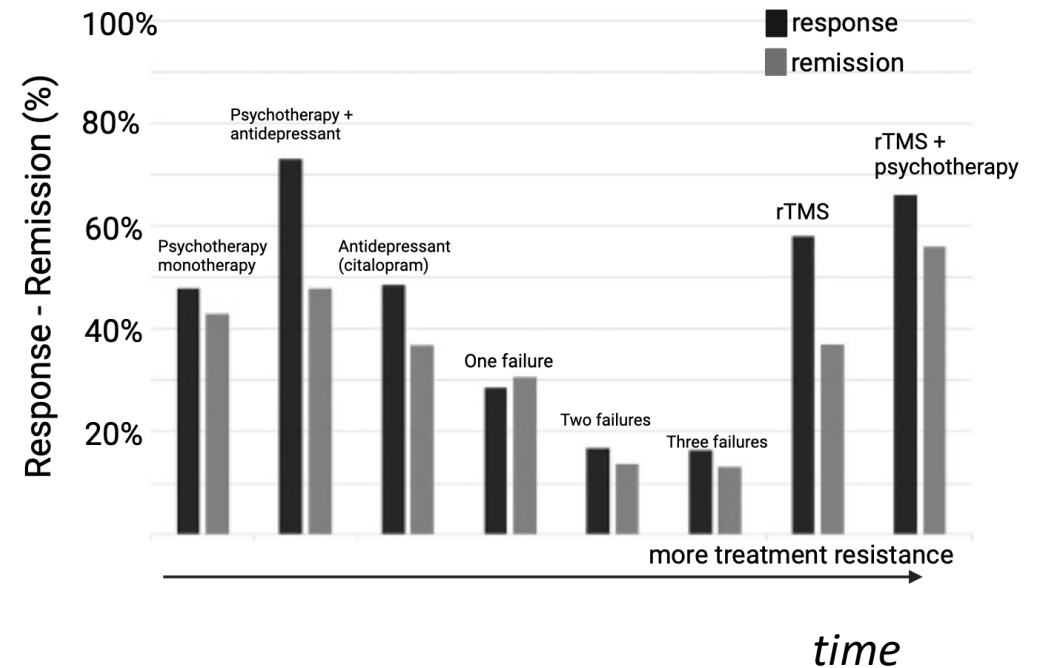
From trial and error to precision psychiatry

What if we could use advanced neuroimaging and non-invasive brain stimulation to understand individual brain circuits and personalize treatment to achieve better outcomes?

Current Process



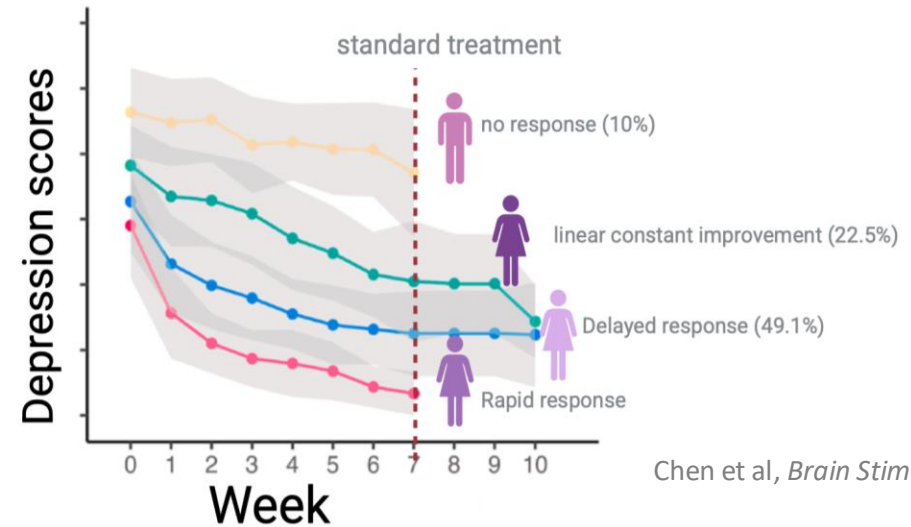
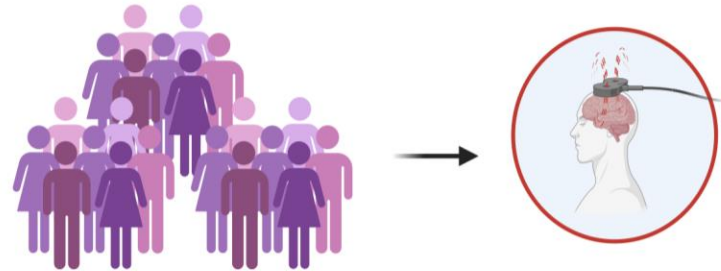
Adapted from Song et al, *Biol Psychiatry* (2024), PMID: 38552866



Baeken et al, *Curr. Opin Psych* (2019) PMID:31145145

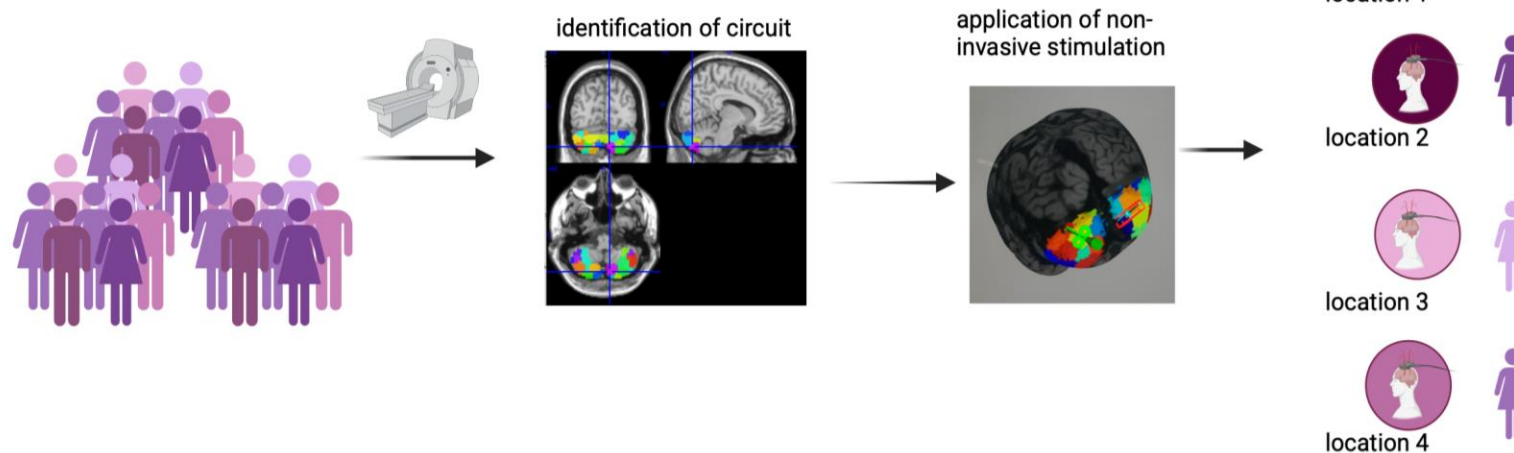
From trial and error to precision psychiatry

Current process “One size fits all”

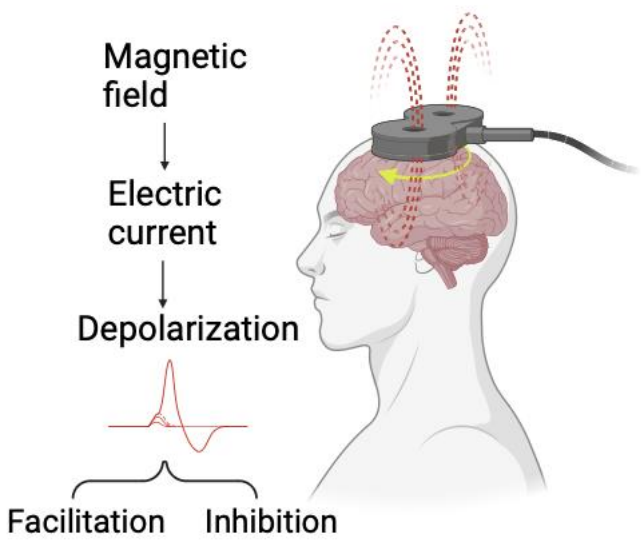


Chen et al, *Brain Stimul.* 2024, PMID: 38641170

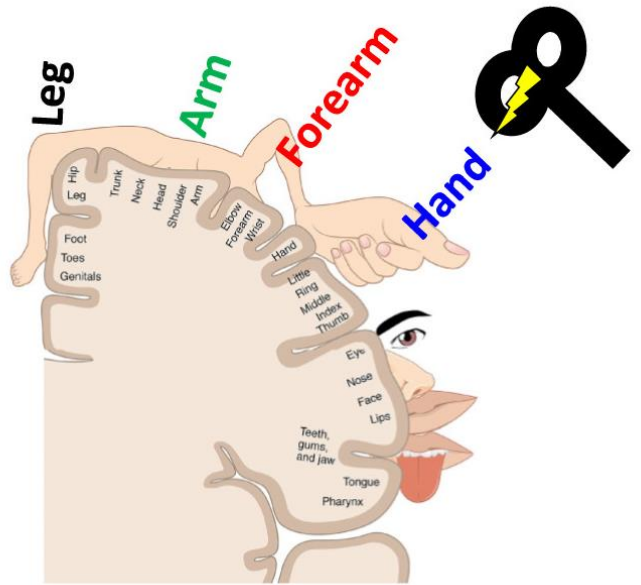
Incorporating neuroimaging for a precision psychiatry approach



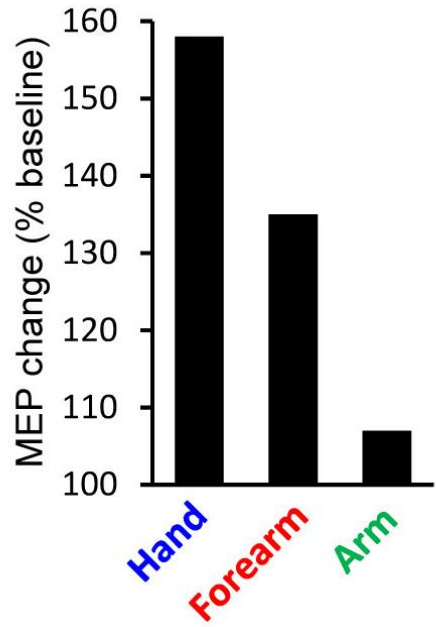
TMS: a causal link between brain activity and function



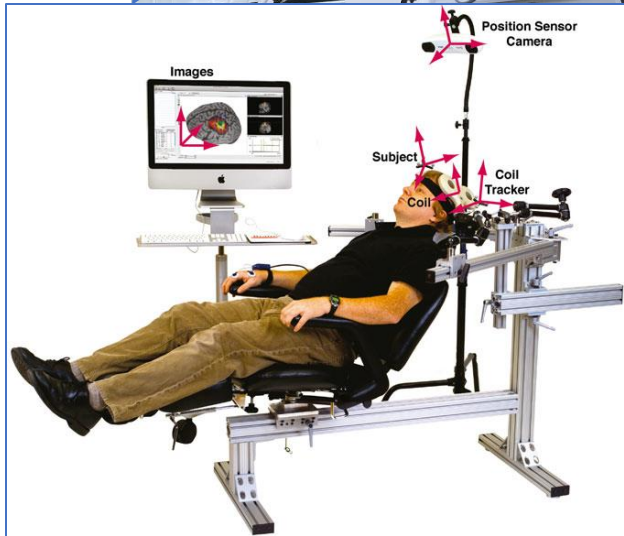
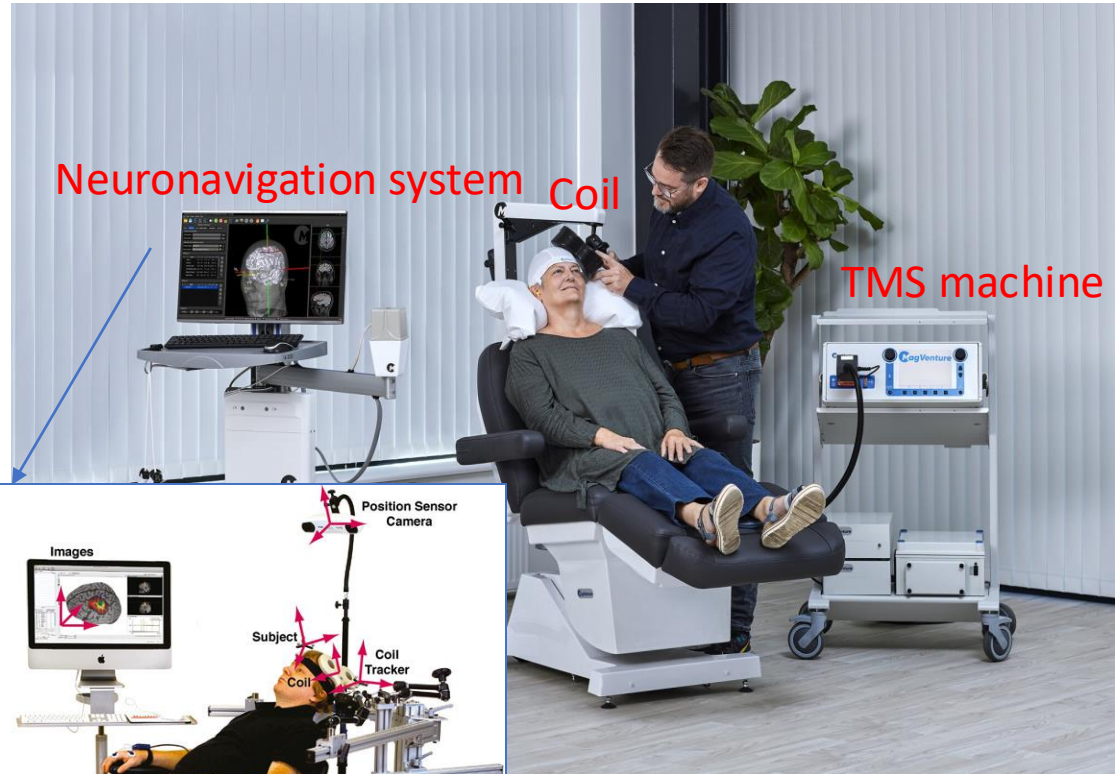
Impact of targeting M1



Neuromodulatory impact

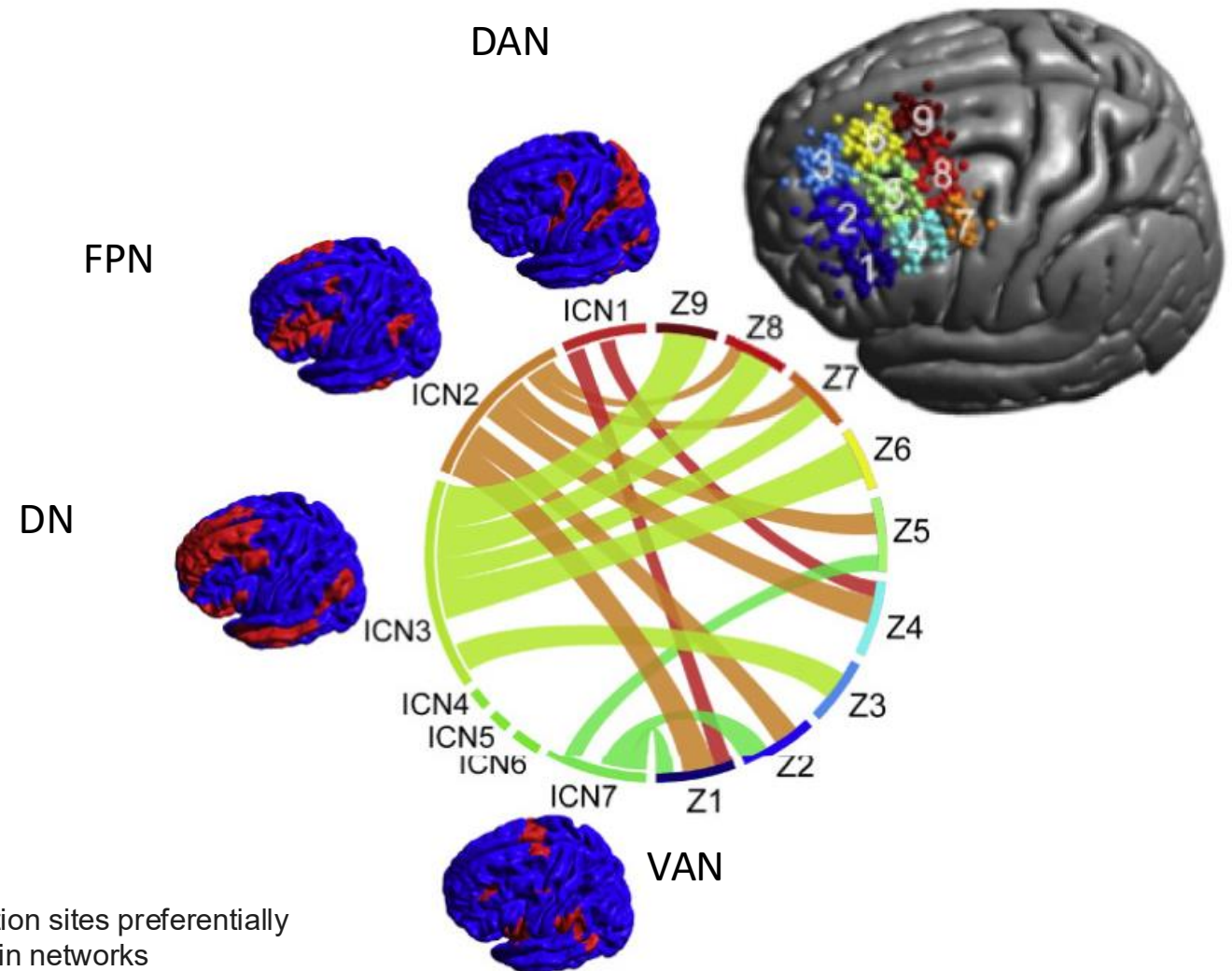


TMS: set-up and demonstration



TMS engages large-scale circuitry beyond local effects

Impact on targeted networks



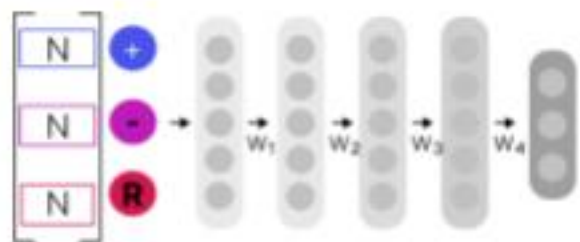
Within the PFC, different stimulation sites preferentially modulate different subsets of brain networks

(Opitz et al, *Neuroimage*, 2016, PMID: 26608241)

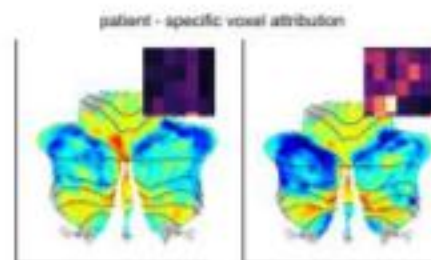
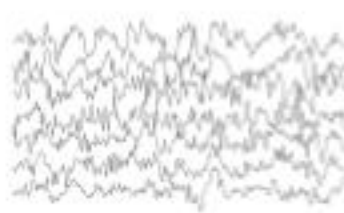


Exploring personalized efficacy and impact of cerebellar-TMS in Schizophrenia using CEBRA 2.0

Apply unsupervised CEBRA on fMRI data to extract latent trajectories of neural dynamics



Provide an interpretable framework to analyze TMS-induced shifts of neural dynamics



xCEBRA



Use latent trajectory shifts to decode personalized efficacy of TMS



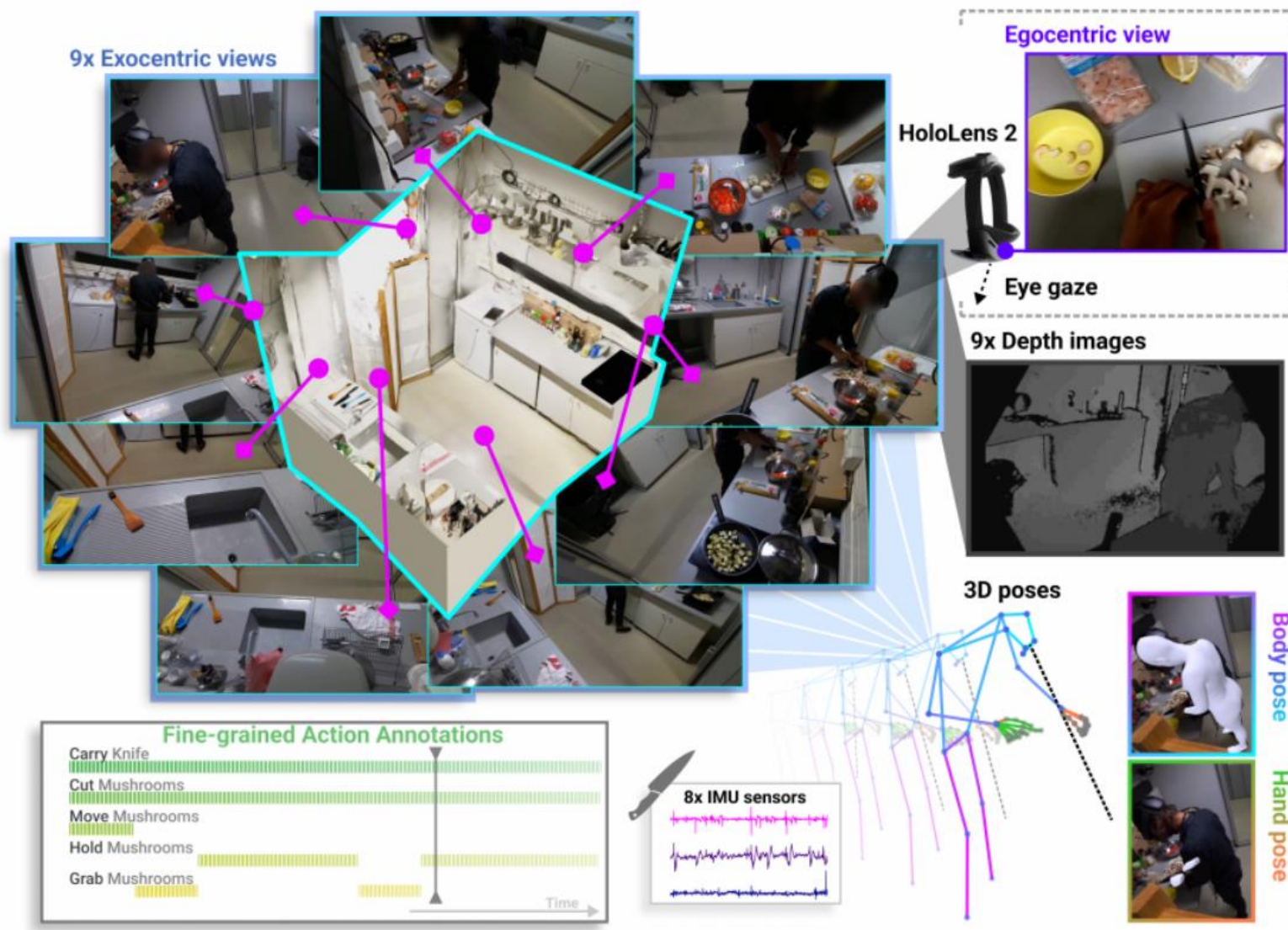
Technological Innovations that enable more
Ecological Neuroscience for clinical applications

Beyond simple tests to practical tools in clinical applications

Fugl-Meyer Assessment (standard for stroke)



EPFL-Smart-Kitchen Platform: towards ethological assays



EPFL-Smart-Kitchen Platform: towards ethological assays

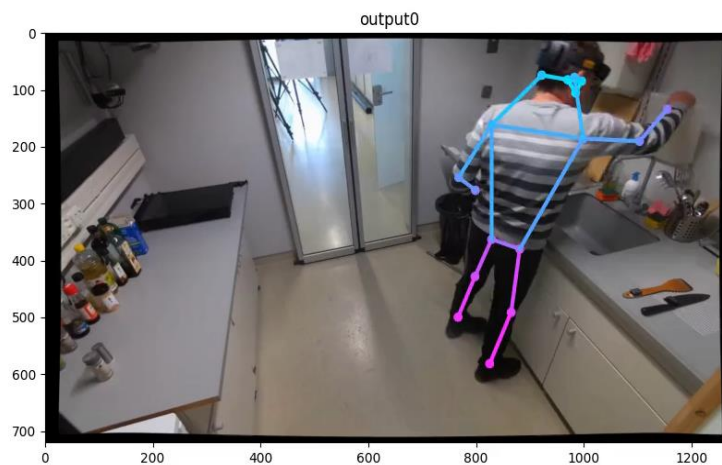
Body Mesh fitting



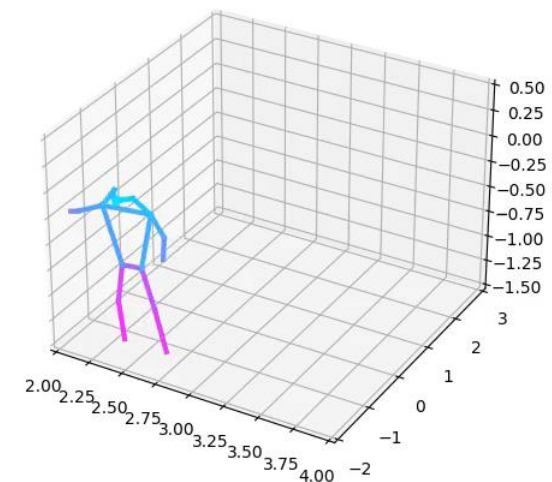
Hand Mesh fitting



Rendered 3D meshes



Projected 3D poses

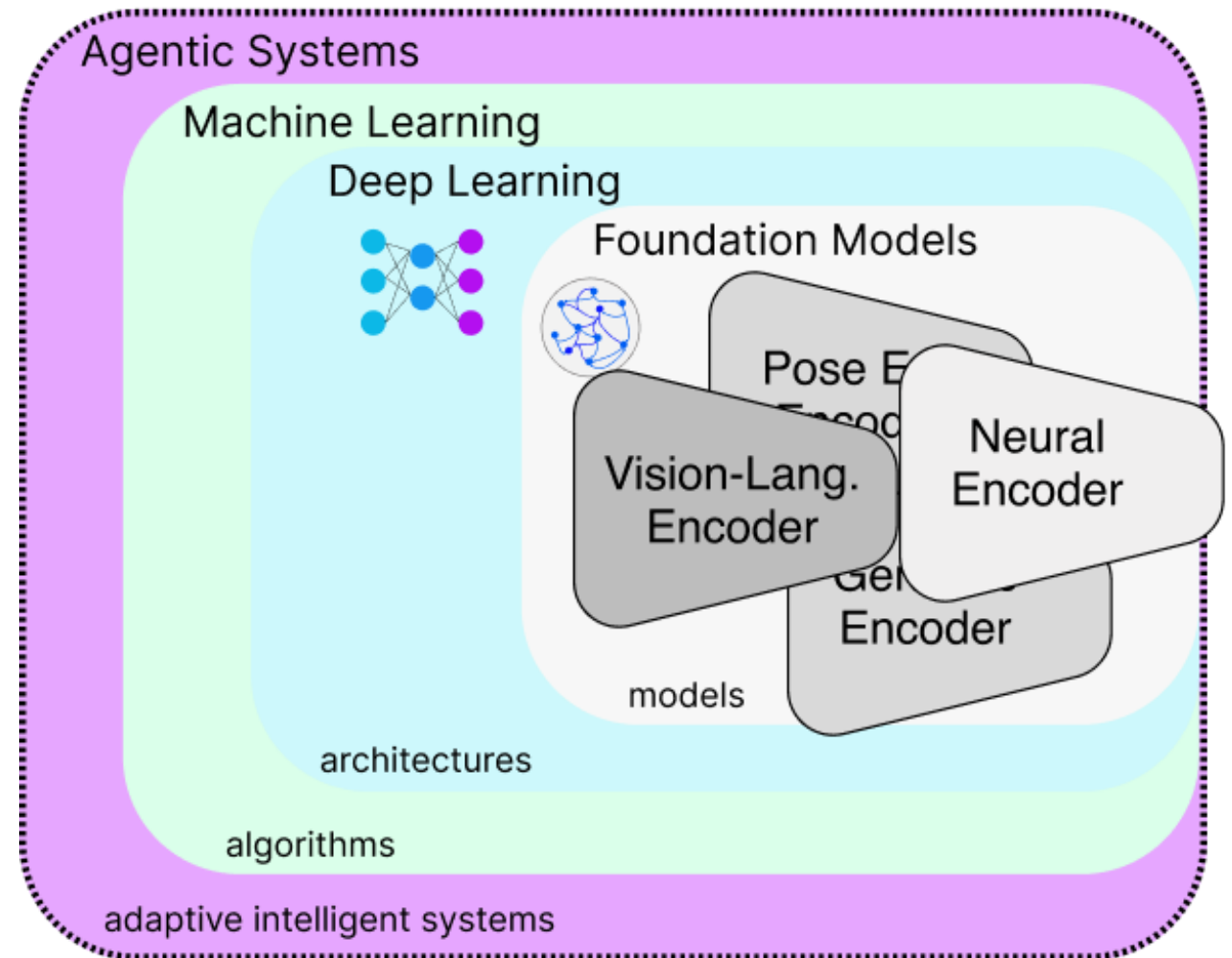


3D poses

**Beyond deep learning, and
foundation models ...**

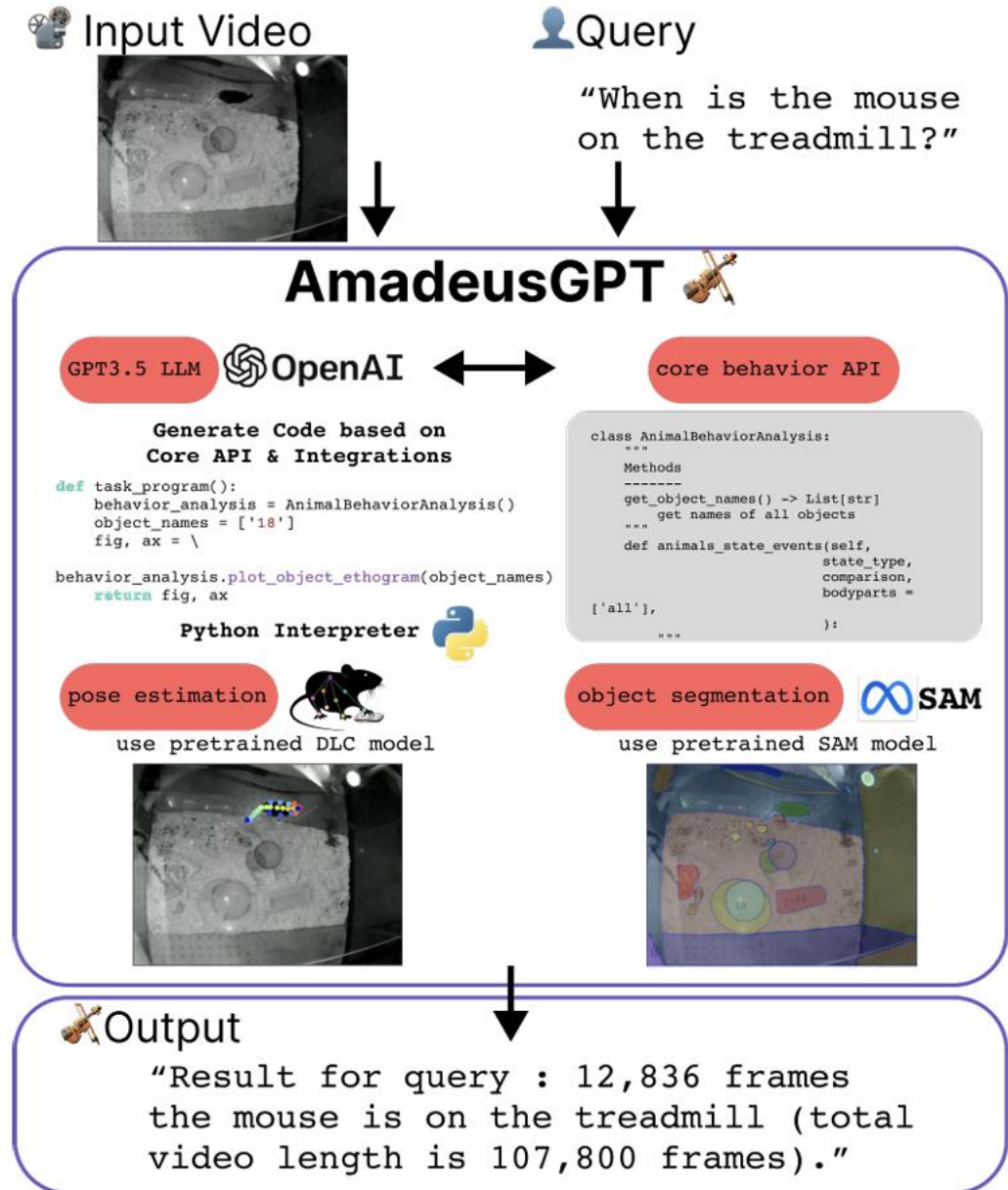
Agentic Systems

development of AI systems




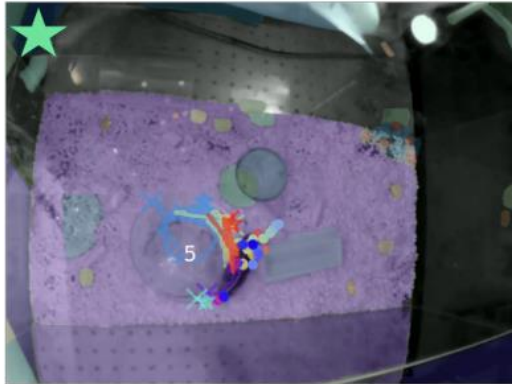
Highlights:


- AmadeusGPT leverages LLMs, such as GPT3.5 or 4
- Its an “OS”: a systems architecture approach to combing LLMs for encoding, rephrasing, and explaining results
- Leverages SOTA models, such as SAM (MetaAI) and SuperAnimals (DeepLabCut)
- Can match human-level performance at quantifying animal behavior

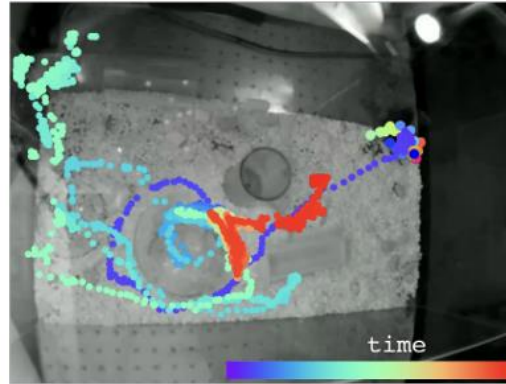



AmadeusGPT benchmarked on several common scenarios in neuroscience

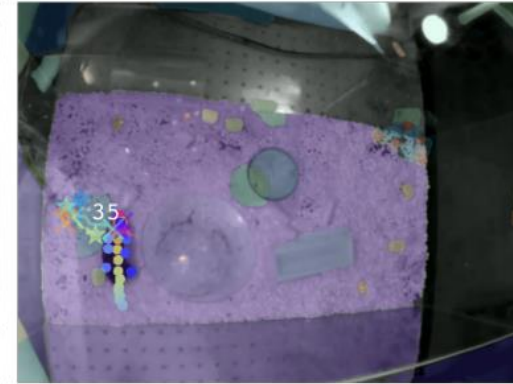
★  Query: "When is the animal on the treadmill, which is object 5?"



 Query: "Plot the trajectory of the animal."

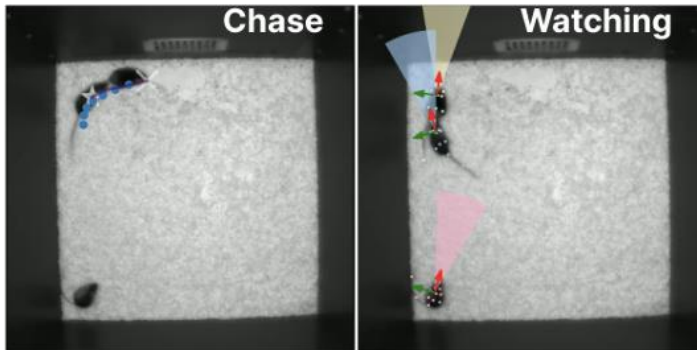


 Query: "When is the animal close to the object 35, if I define close as less than 50 pixels?"



```
def task_program():
    behavior_analysis = AnimalBehaviorAnalysis()
    overlap_object_5_events = behavior_analysis.animals_object_events('5', 'overlap', bodyparts=['all'])
    fig, ax = behavior_analysis.plot_trajectory(bodyparts=['all'], events=overlap_object_5_events)
    return fig, ax
```

(c) MABE Challenge dataset



Official definition

Chase: Mice are moving above 15 cm/sec, with closest points less than 5 cm apart, and angular deviation between mice is less than 30 degrees, for at least 80% of frames within at least one second. Merge bouts less than 0.5 seconds apart.

Watching: Mice are more than 5 cm apart but less than 20 cm apart, and gaze offset of one mouse is less than 15 degrees from body of other mouse, for a minimum duration of 3 seconds. Merge bouts less than 0.5 seconds apart.



Our prompt

"Define <|chases|> as a social behavior where closest distance between this animal and other animals is less than 40 pixels and the angle between this and other animals have to be less than 30 and this animal has to travel faster than 2 pixels. When do chases happen?"

"Define <|watching|> as a social behavior where distance between animals is less than 260 pixels and larger than 50 and head angle between animals is less than 15. The smooth_window_size is 15. When does watching happen?"

AmadeusGPT Mathis Laboratory of adaptive motor control | EPFL




Elevated plus maze (EPM) is a widely used behavioral test. The mouse is put on an elevated platform with two open arms (without walls) and two closed arms (with walls). In this example we used a video from <https://www.nature.com/articles/s41386-020-0776-y>.

-  On the left you can see the video data auto-tracked with DeepLabCut and keypoint names (below). You can also draw ROIs to ask questions to AmadeusGPT  about the ROIs. You can drag the divider between the panels to increase the video/image size.
- We suggest you start by clicking 'Generate Response' to our demo queries.
- Ask additional questions in the chatbox at the top of the page. Note that you need to scroll down to see the outputs!
- Here are some example queries you might consider: 'The <|open arm|> is the ROI0. How much time does the mouse spend in the open arm?' (NOTE here you can re-draw an ROI0 if you want. Be sure to click 'finish drawing') | 'Define head_dips as a behavior where the mouse's mouse_center and neck are in ROI0 which is open arm while head_midpoint is outside ROI1 which is the cross-shape area. When does head_dips happen and what is the


Left click to draw a polygon. Right click to confirm the drawing. After that, click finish drawing button. Refresh the page if you need a new ROI Or if the ROI canvas does not display



<https://github.com/AdaptiveMotorControlLab/AmadeusGPT>

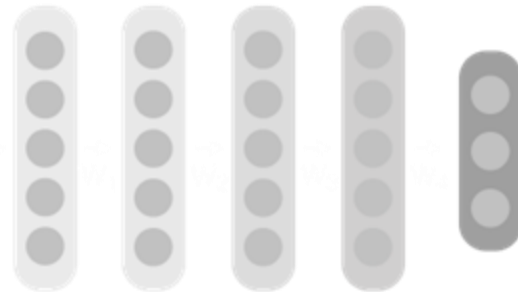
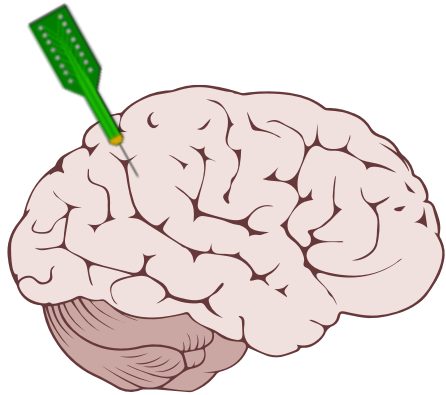
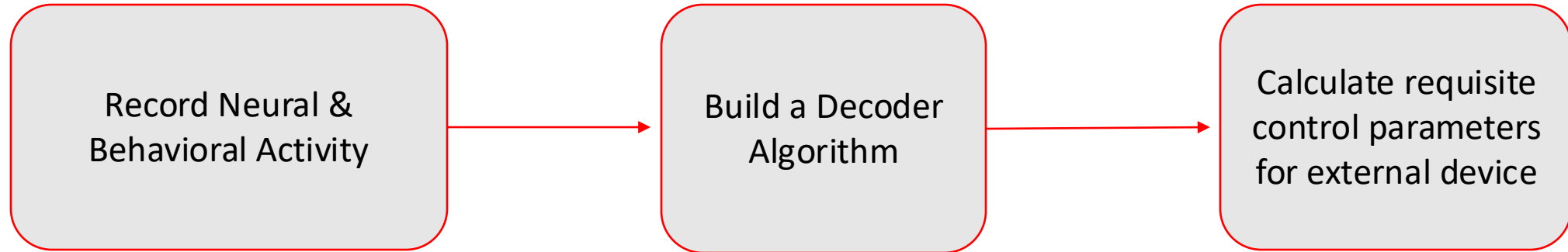




downloads 3k | downloads/month 641 | pyPI package 0.0.2 | Star 192

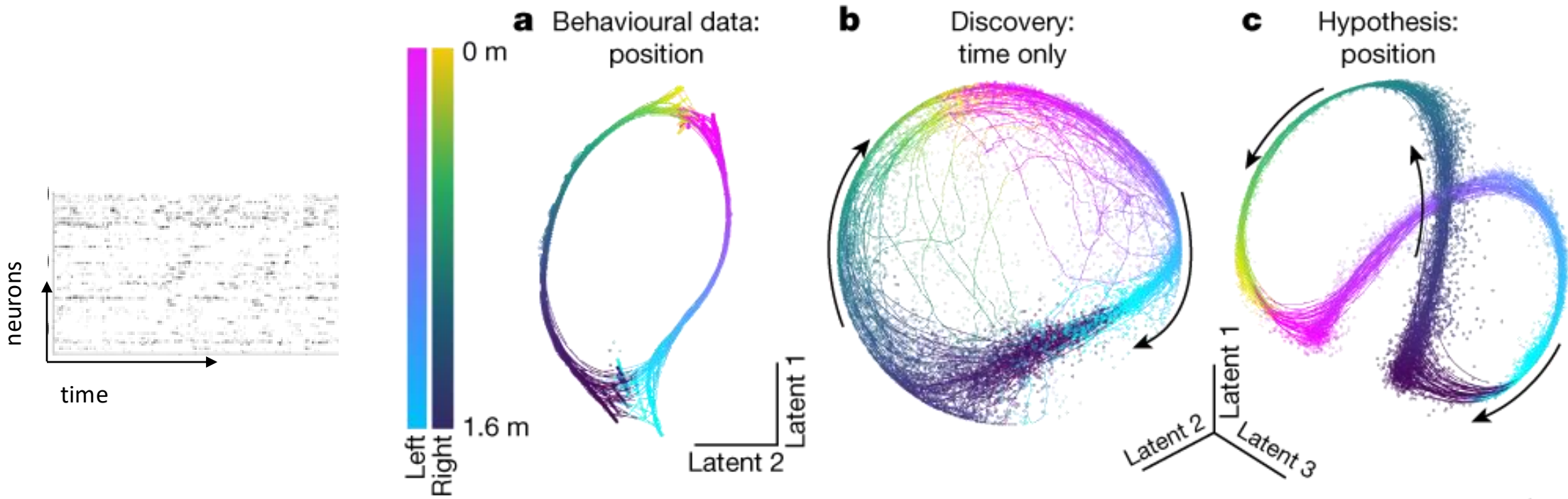
 We turn natural language descriptions of behaviors into machine-executable code.

[🔧 Installation](#) | [🏠 Home Page](#) | [📰 News](#) | [🐛 Reporting Issues](#) | [💬 Discussions!](#)

Decoding the Brain by merging behavior & neural data



CEBRA : an algorithm for joint modeling of neural & behavioral data







©nature



Building on contrastive learning:
Hyvärinen et al. 2019
Zimmermann et al. 2021

Schneider, Lee, M.W. Mathis Nature 2023

a Movement decoding cohorts and tasks

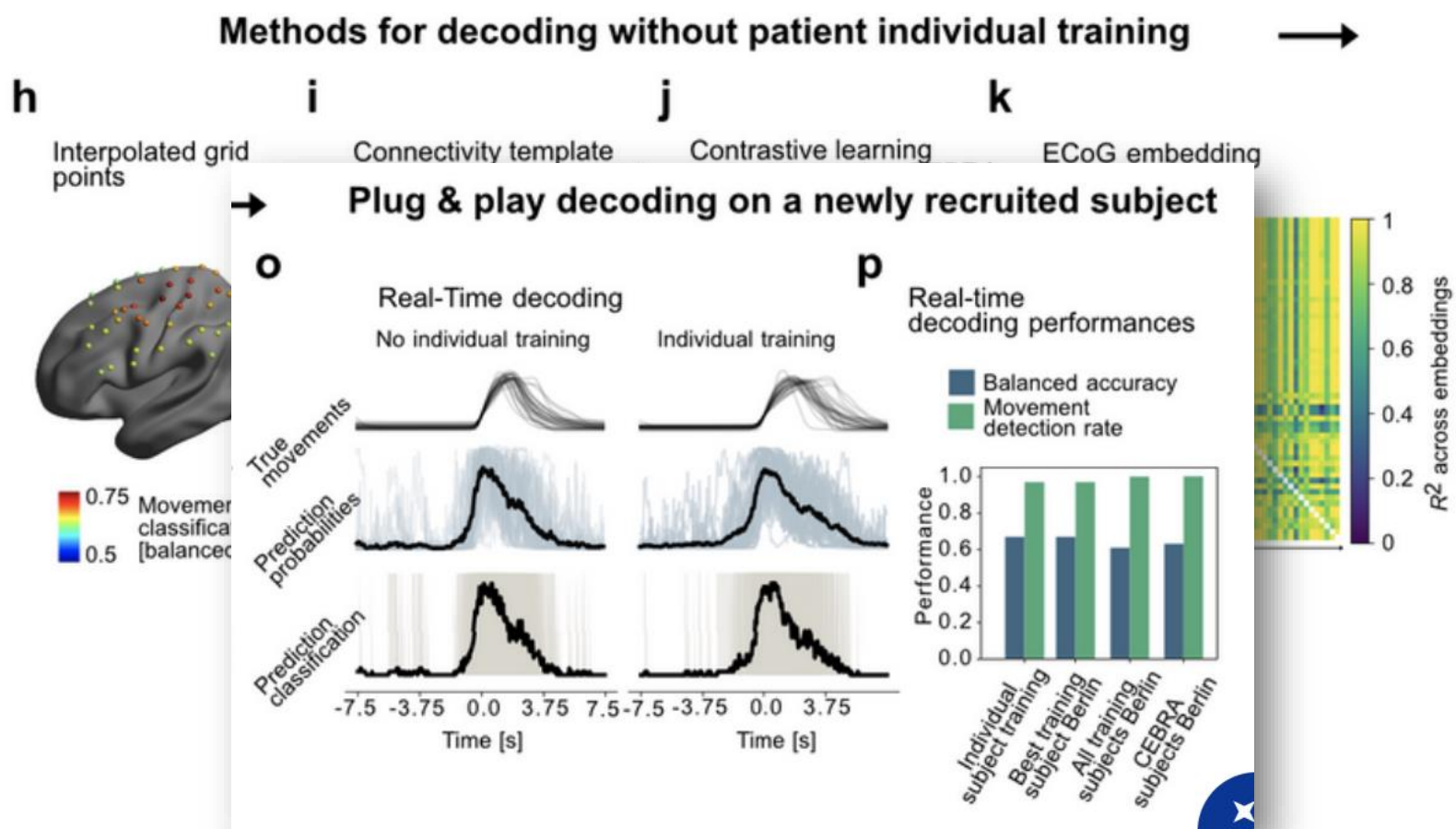
Center	Berlin	Beijing	Pittsburgh	Washington
Subjects	12 PD	10 PD	16 PD	18 Epilepsy
Task	 Rotation	 Button press	 Grip force	 Clench & release

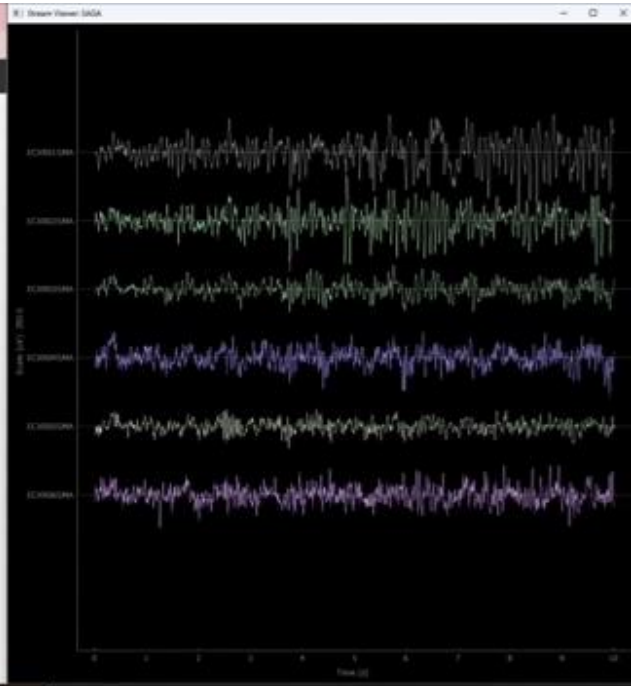
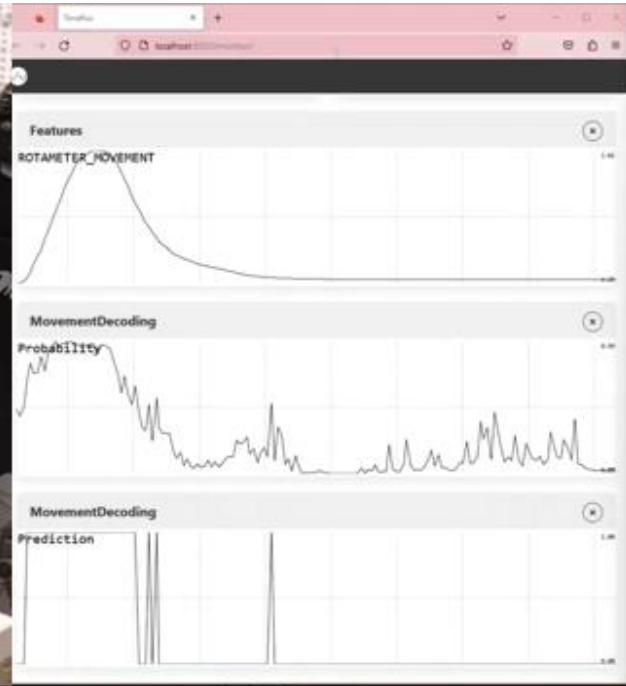
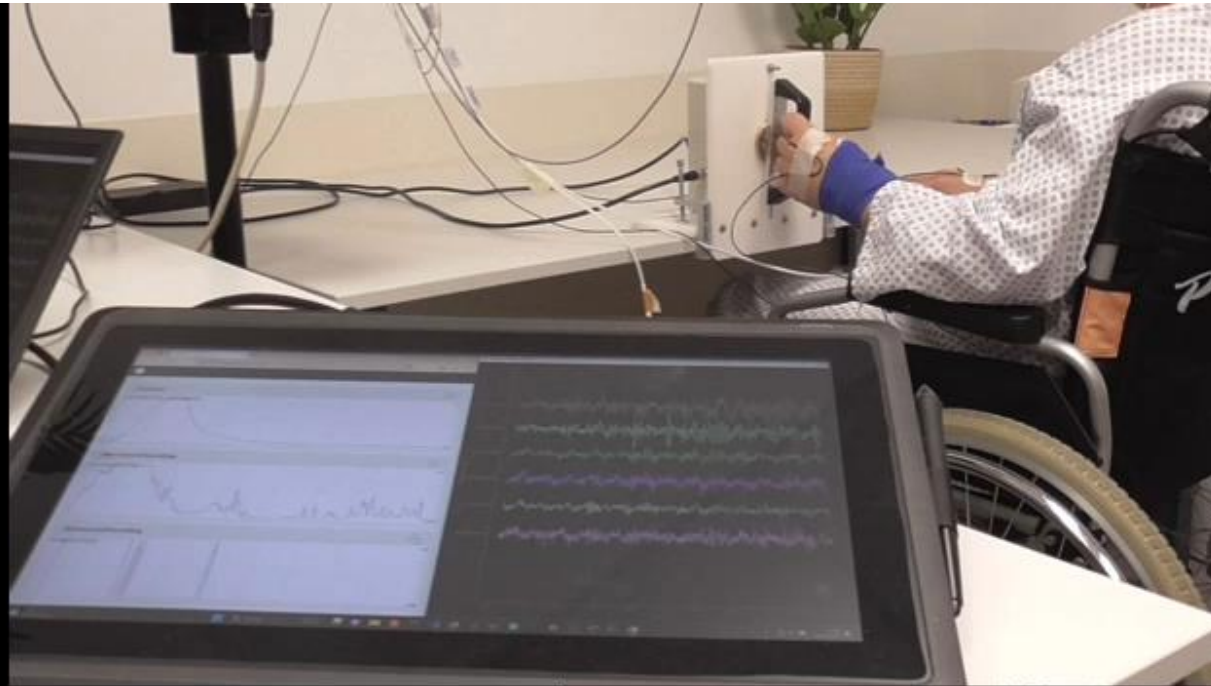


Wolf-Julian Neumann

Merk et al. 2023

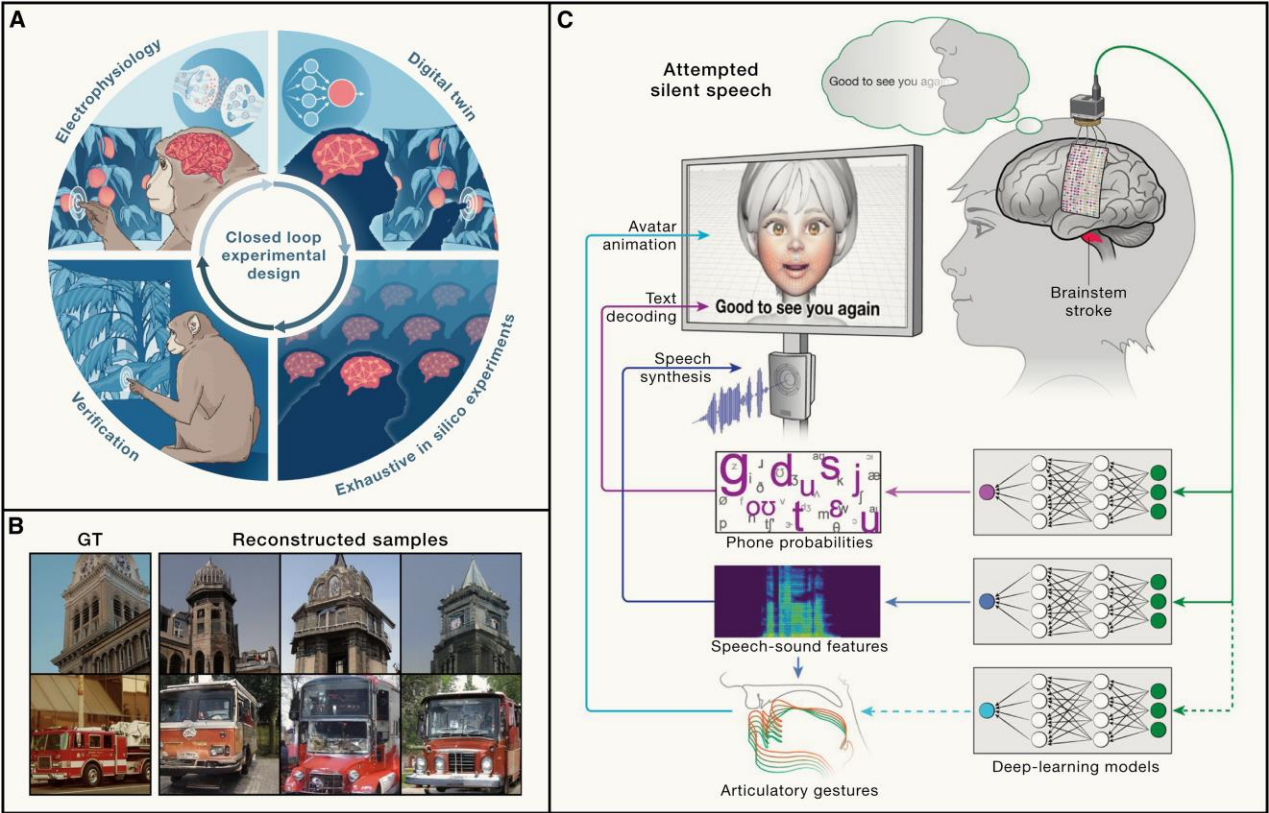
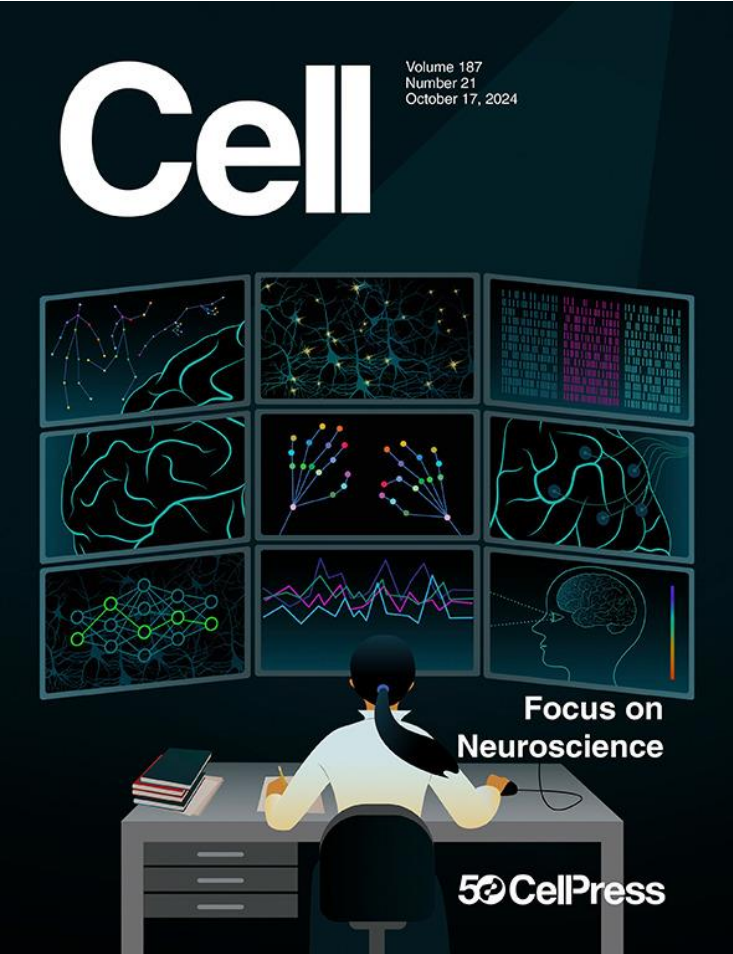
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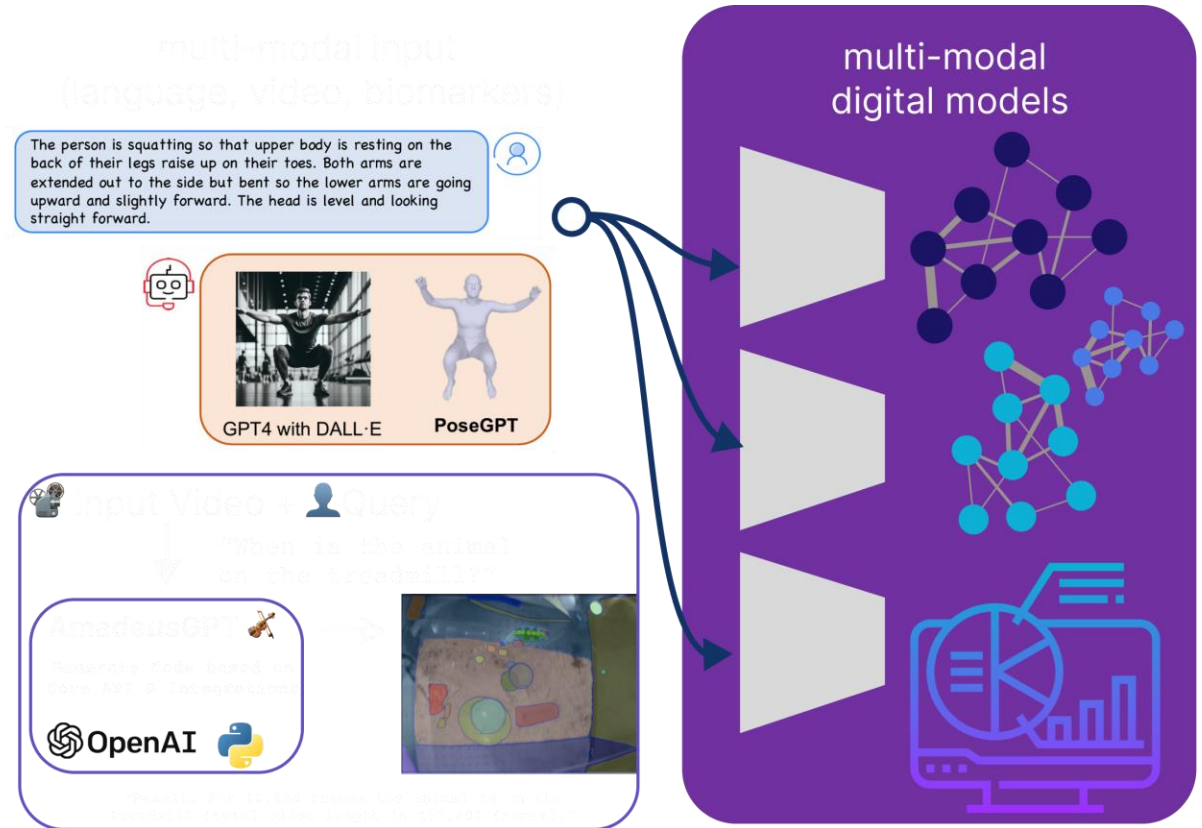
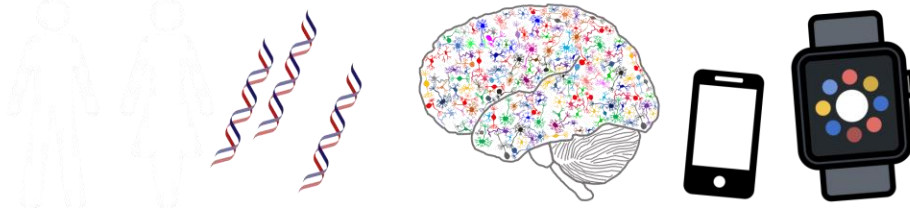


Neumann

Decoding the brain: towards linking computation to mechanisms



Measuring & Modeling Adaptive Behavior: from the bench to clinical applications



ClinicalTrials.gov

4 ongoing using DeepLabCut including 1 in Bern!

Ethological computational psychiatry: Challenges and opportunities. **Current Opinion in Neurobiology, 2024**
Ilya E. Monosov*, Jan Zimmermann*, Michael J. Frank*, **Mackenzie W. Mathis***, Justin T. Baker* (*equal contributions)

