

Brain presentation

Topographic organization of somatosensory and motor cortex & description of experimental techniques that can be used to test them

Workgroup 3 (Dimana Atanassova)

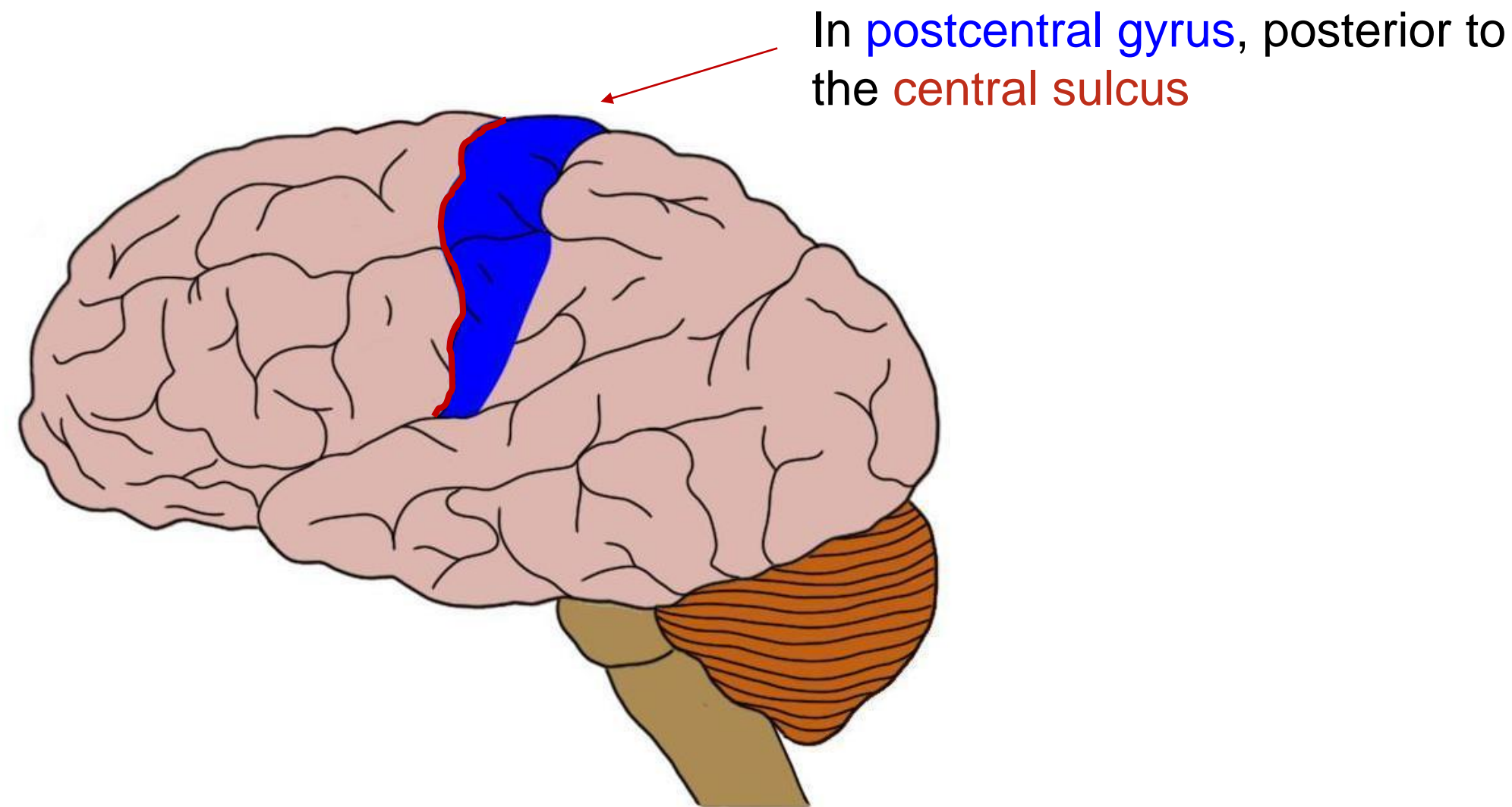
Group 2: Jan Ondruch, Marta Radić, Artur Martins Lazzarini

Agenda

- Topographic Organization of the Somatosensory Cortex
 - Purpose and Function
 - Primary Somatosensory Cortex
- Topographic Organization of the Motor Cortex
 - Purpose and Function
 - Primary Motor Cortex
 - Nonprimary Motor Cortex
- Experimental Techniques to Test Them
 - In Mice upon Damage
 - In Macaques upon Changing Usage Experience
 - In Humans With TMS and Other Techniques

Somatosensory Cortex

Purpose and Location



[1]

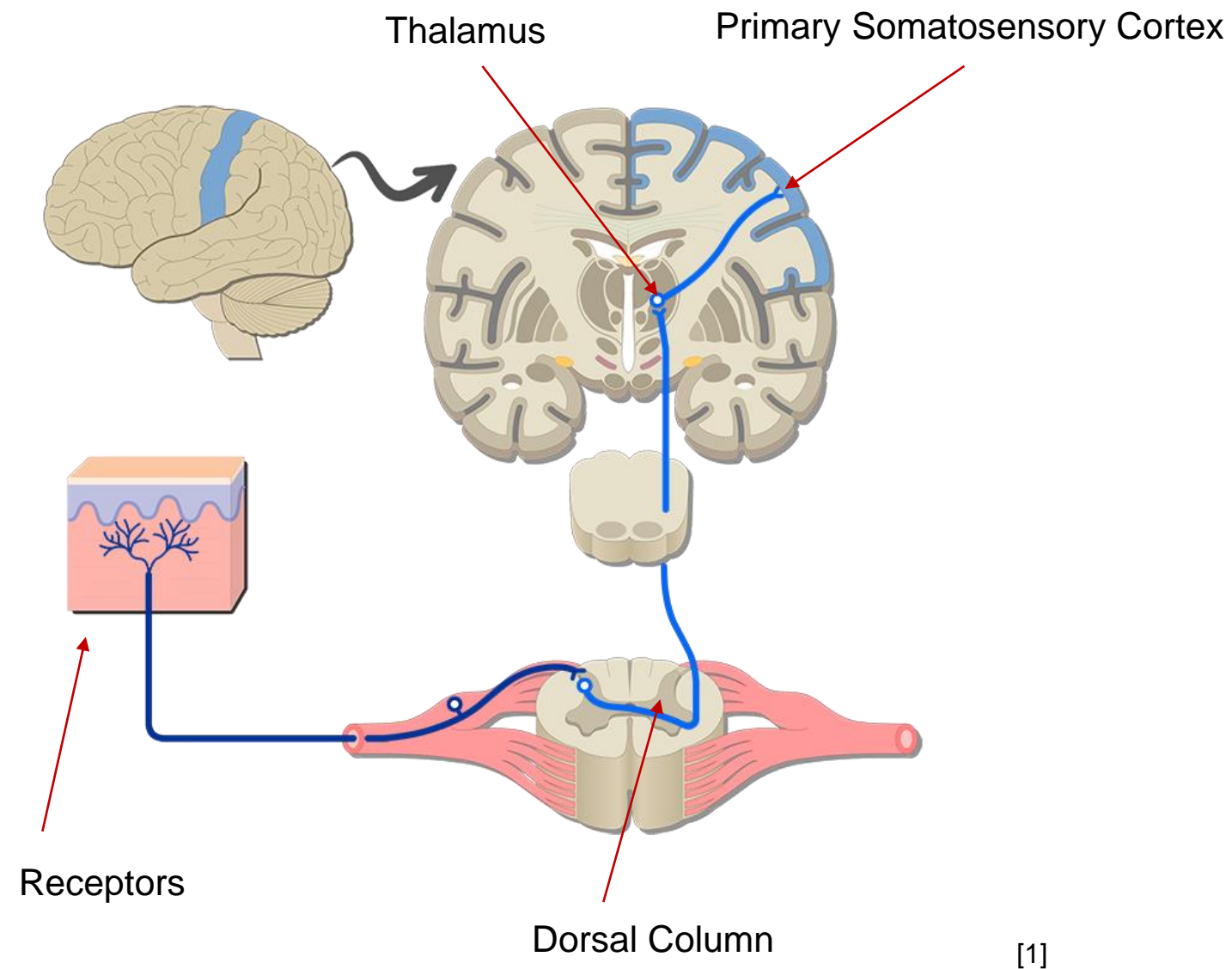
- Receives and processes **sensory information** from the entire body
- Divided into **primary** and **secondary somatosensory cortex** [2]

[1] Dingman M. (2016, March 11). Know your brain: Primary somatosensory cortex. Retrieved March 9, 2020, from <https://www.neuroscientificallychallenged.com/blog/know-your-brain-primary-somatosensory-cortex>

[2] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.

Primary Somatosensory Cortex

Function and Input



[1]

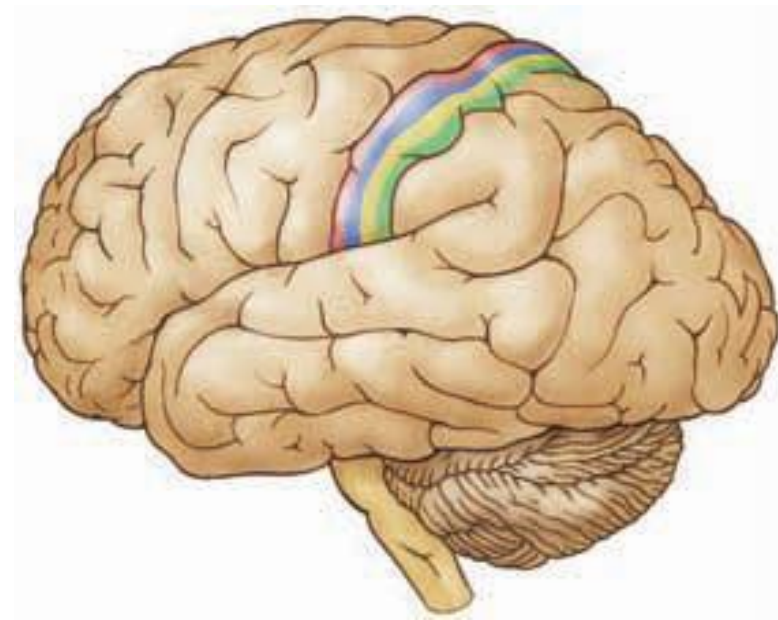
- **Enables us to perceive** things that we describe as pleasant or unpleasant, the shape, weight and texture of objects, pain, temperature etc.
- It receives **sensory input from the opposite side of the body** [2]

[1] https://www.kindpng.com/imgv/iwTbmiJ_an-image-showing-the-sensory-pathway-of-the/

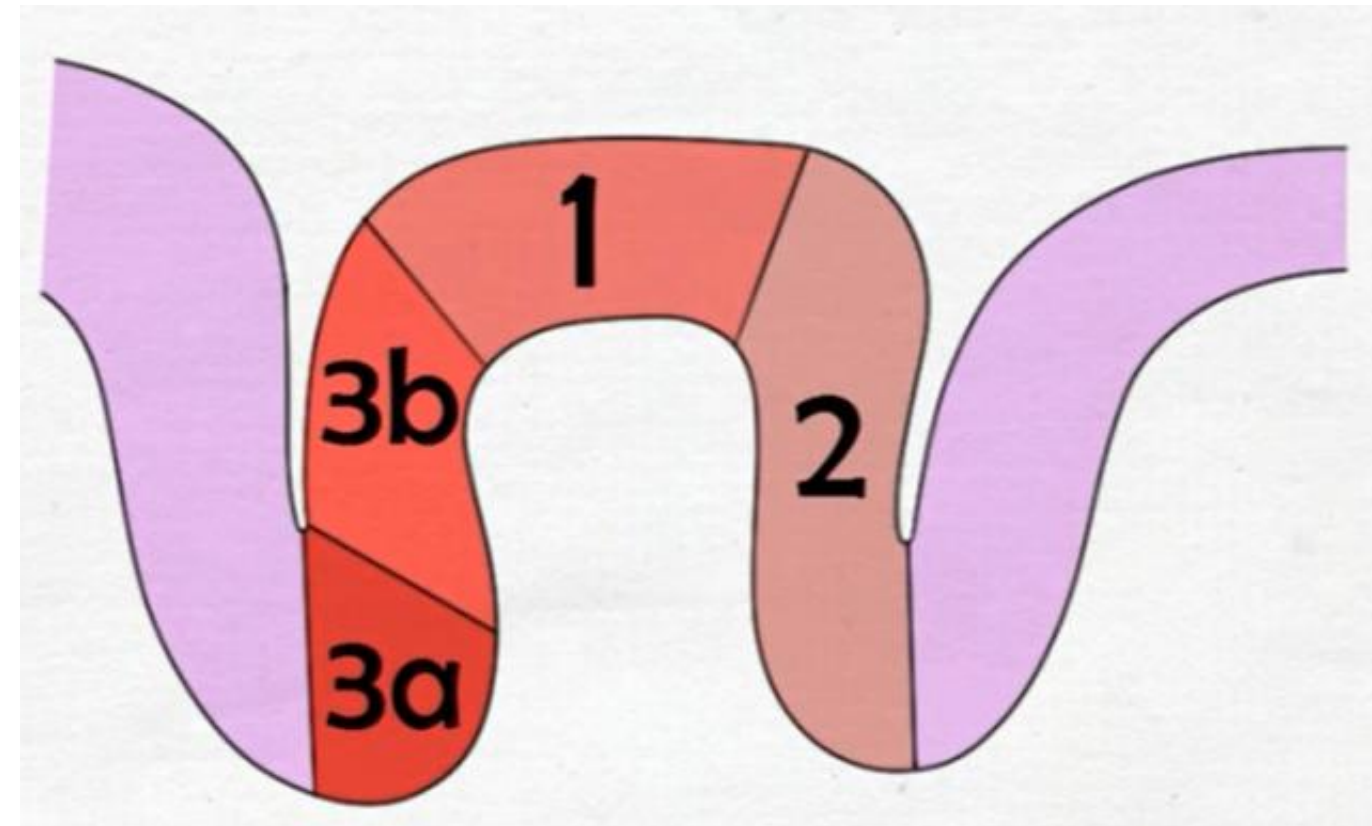
[2] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.

Primary Somatosensory Cortex

Four-homunculus Model



[1]



[2]

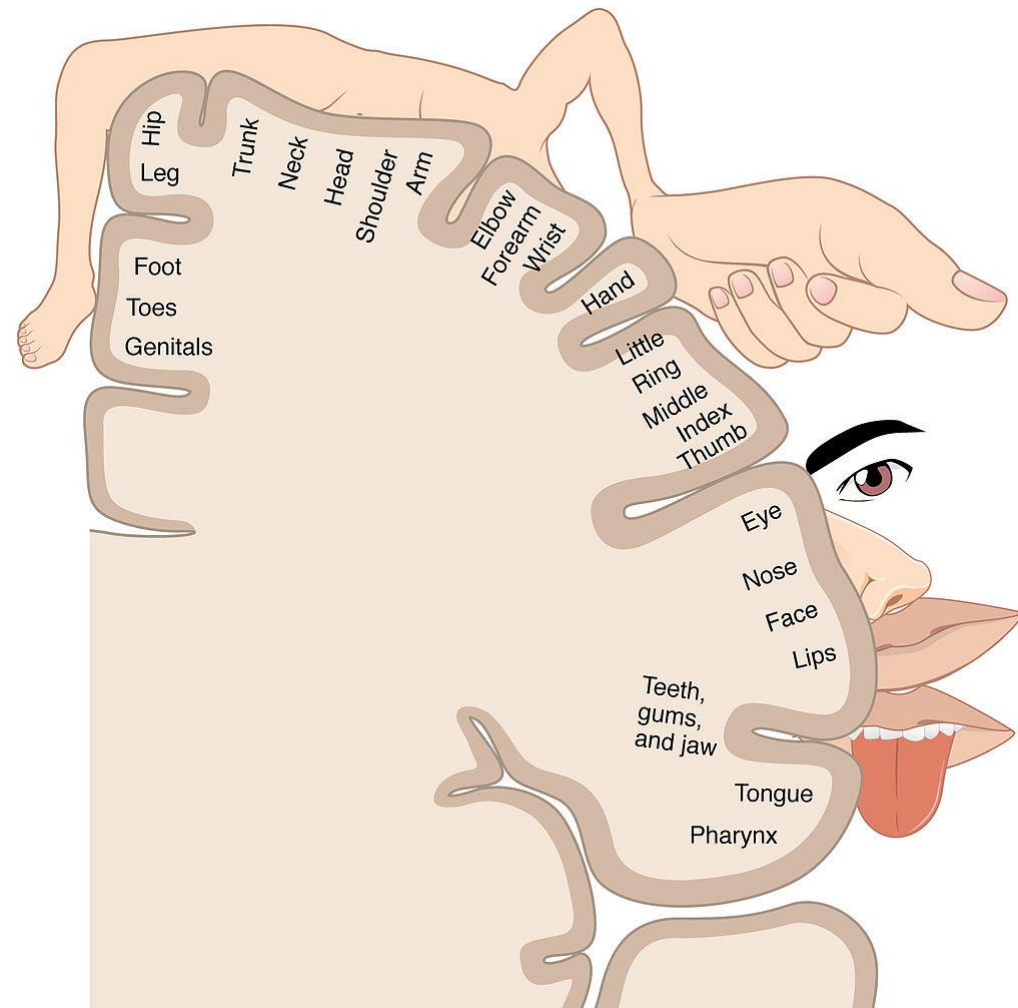
- **Area 3**: initial information processing
- **Area 3a**: position of body in space (proprioceptors)
- **Area 3b**: basic processing of touch sensations, sends information to areas 1 and 2
- **Areas 1 and 2**: more complex processing of touch information [2]

[1] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.

[2] Neurosci. (2016, March 11). Know your brain: Primary somatosensory cortex. Retrieved March 9, 2020, from <https://www.neuroscientificallychallenged.com/blog/know-your-brain-primary-somatosensory-cortex>

Primary Somatosensory Cortex

Somatotopic Arrangement



[1]

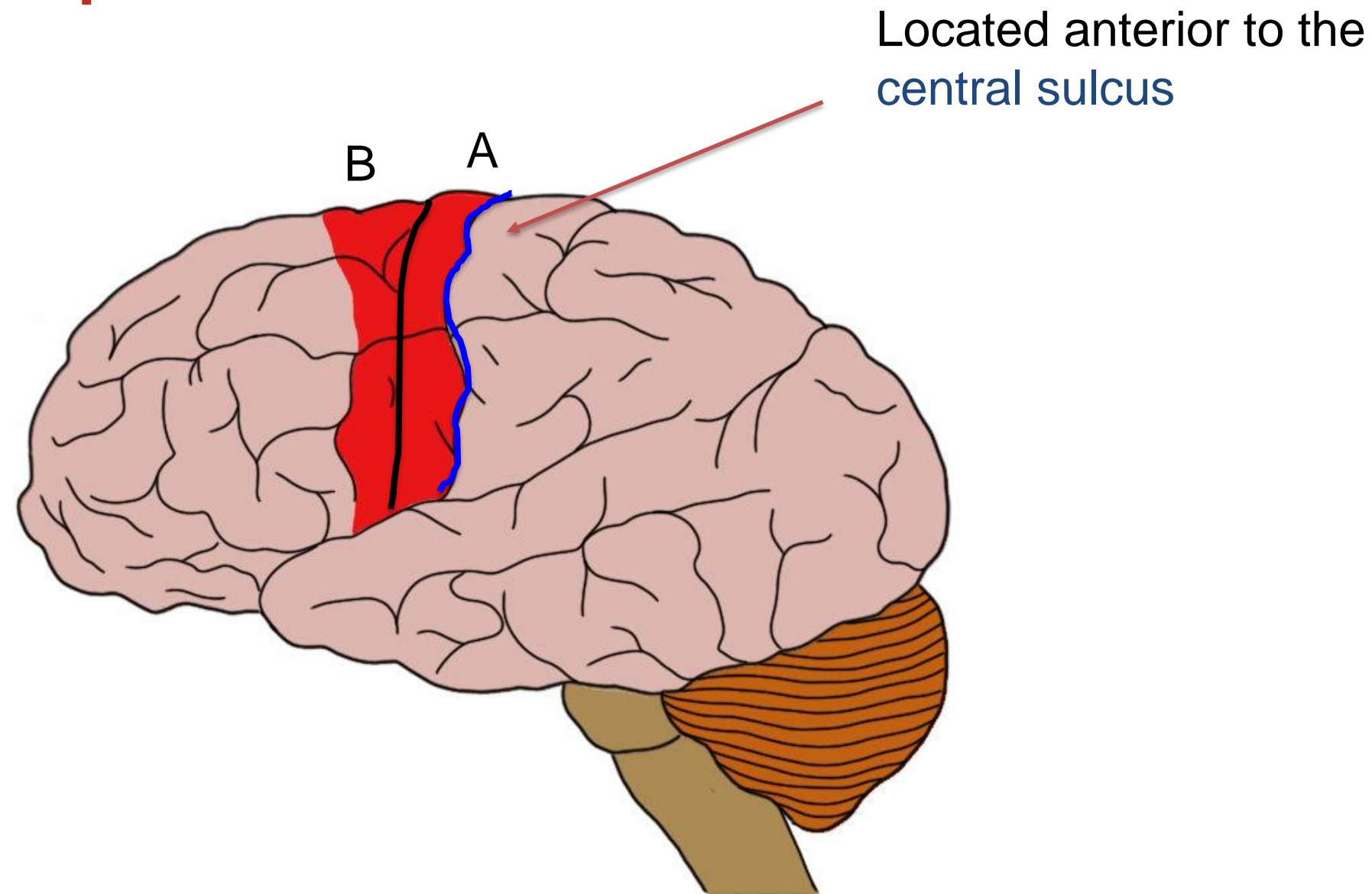
- Each of the four areas of the primary somatosensory cortex **receives information from different body parts**
- **More sensitive areas** of the body **take up a disproportionate amount of space** [2]

[1] https://en.wikipedia.org/wiki/Cortical_homunculus#/media/File:1421_Sensory_Homunculus.jpg

[2] Dingman M. (2016, March 11). Know your brain: Primary somatosensory cortex. Retrieved March 9, 2020, from <https://www.neuroscientificallychallenged.com/blog/know-your-brain-primary-somatosensory-cortex>

Motor Cortex

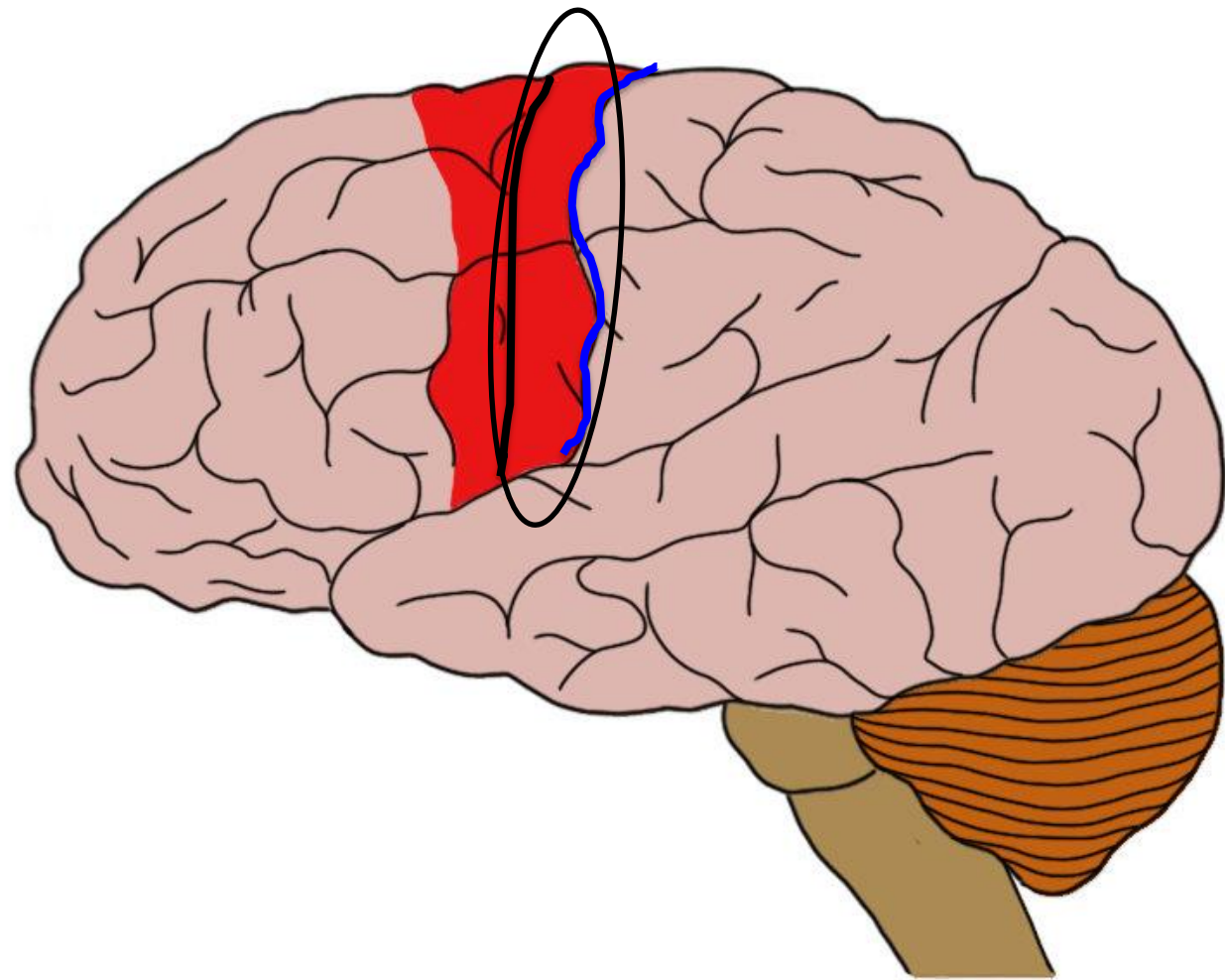
Purpose and Location



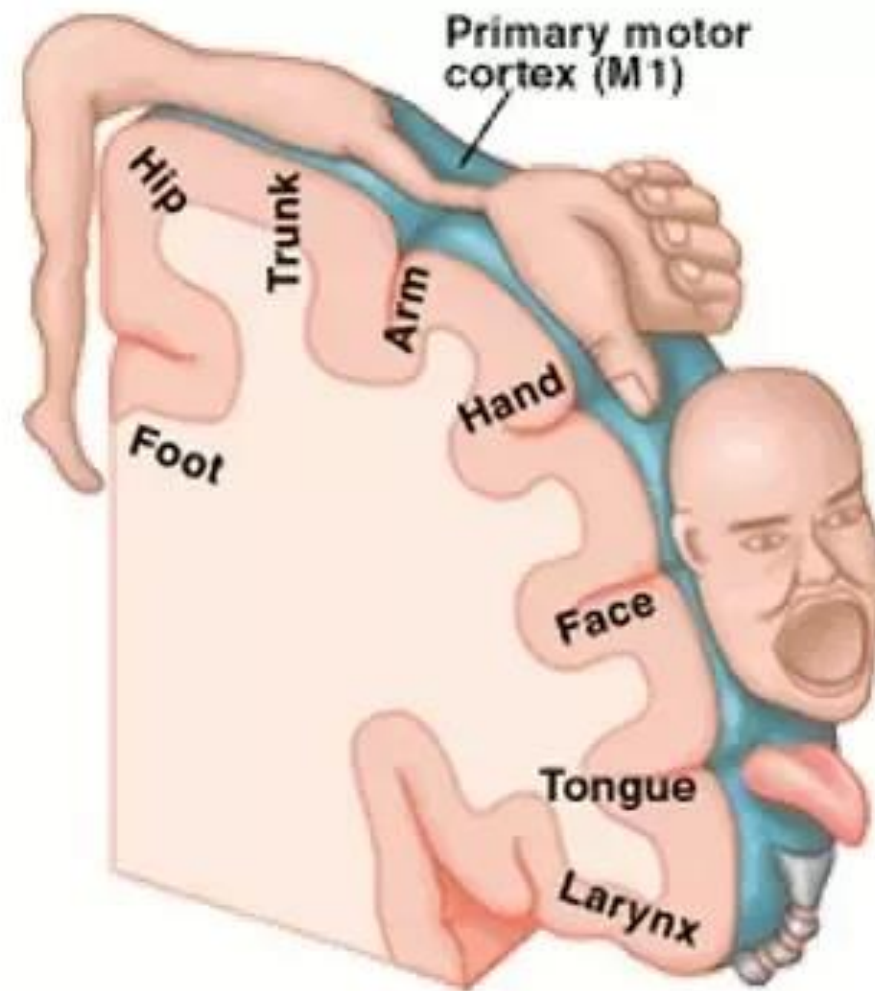
- Involved with **voluntary movement**
- Divided into two major regions: the **primary motor cortex (A)** and the **nonprimary motor cortex (B)**
- The nonprimary motor cortex (B) divided into the **supplementary motor cortex** and the **premotor cortex**

Primary Motor Cortex

Function



[1]



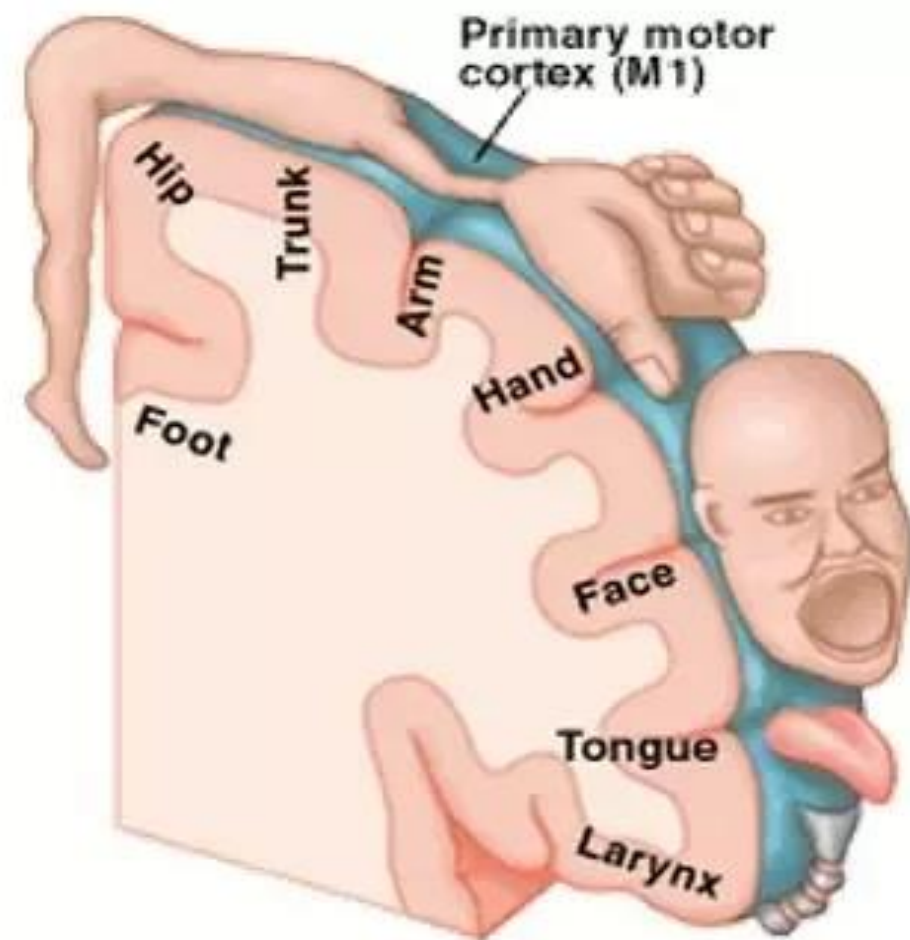
[2]

- Different parts of the region are associated with motor control of different parts of the body
- **Motor map** of the body

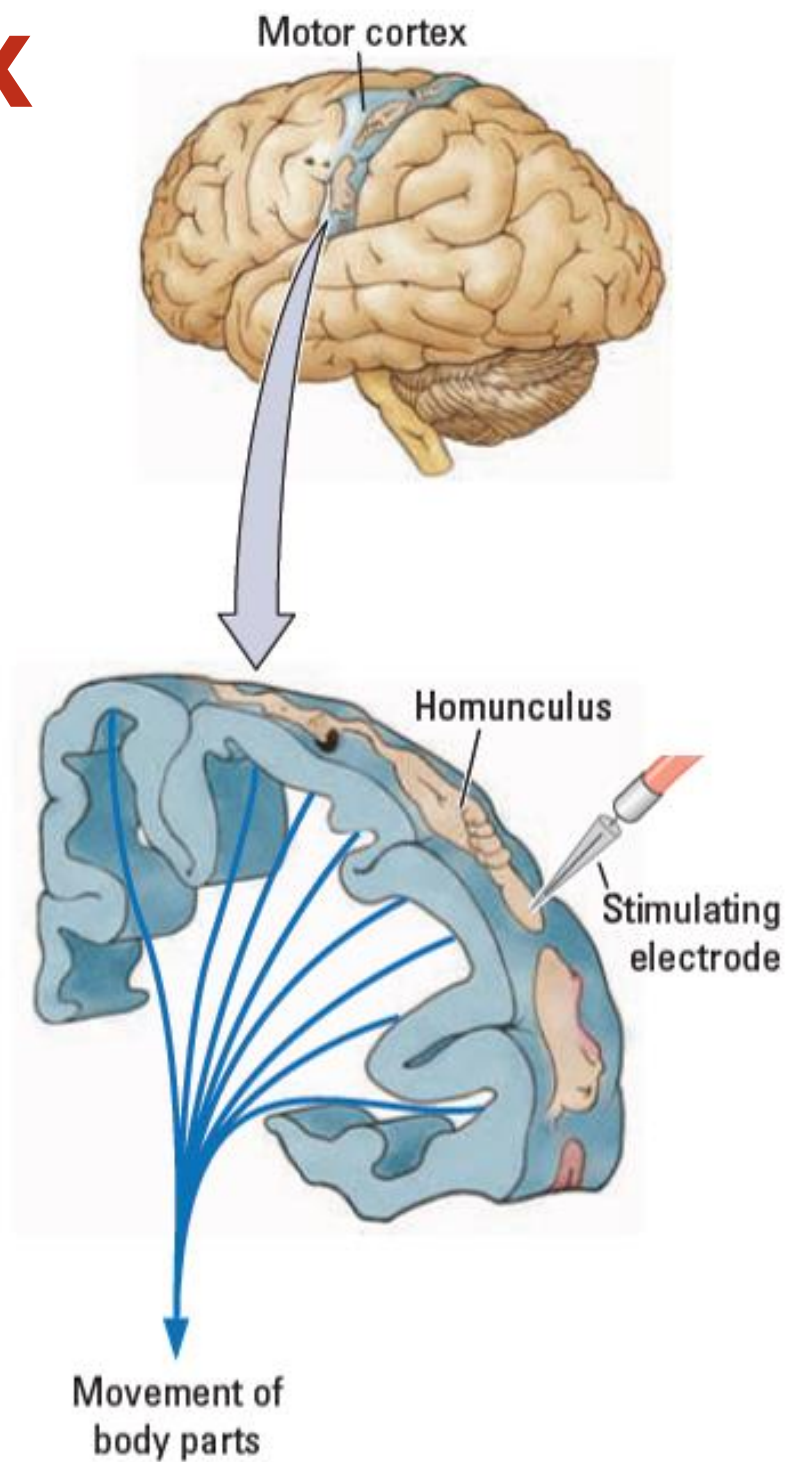
[1] <https://www.pngfuel.com/free-png/dyigi/download>

[2] <https://www.quora.com/Why-is-the-primary-motor-cortex-in-the-cortex-and-not-in-an-older-part-of-the-brain>

Primary Motor Cortex



[1]



[2]

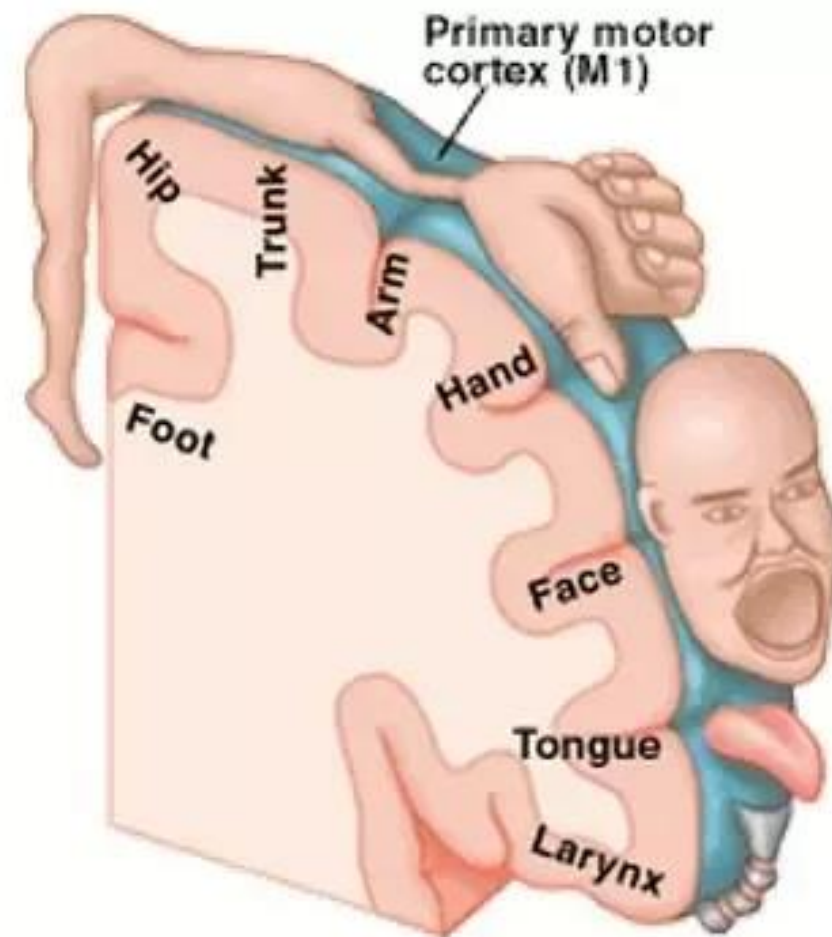
- Electrical stimulation of the motor cortex elicits movements of body parts corresponding to the **map of the body**.

[1] <https://www.quora.com/Why-is-the-primary-motor-cortex-in-the-cortex-and-not-in-an-older-part-of-the-brain>

[2] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.
<https://www.pngfuel.com/free-png/dyigi/download>

Primary Motor Cortex

Homuncular man



[1]



[2]

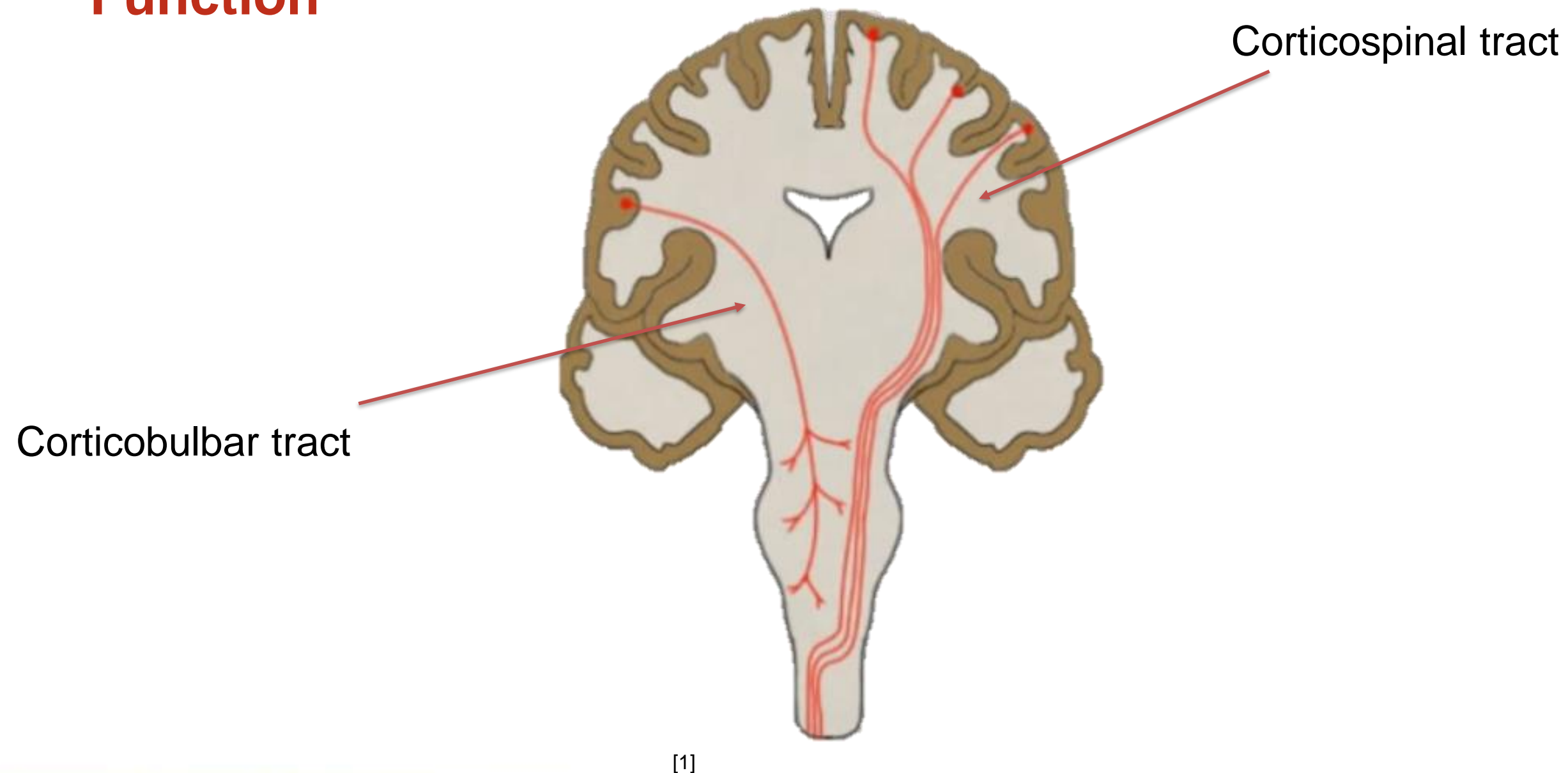
- The homuncular man shows the **disproportionate relative sizes** of different body parts compared with the relative sizes of actual parts of the human body [2]
- Relatively **large areas** of the brain control the body parts we use to make **the most skilled movements**

[1] <https://www.quora.com/Why-is-the-primary-motor-cortex-in-the-cortex-and-not-in-an-older-part-of-the-brain>

[2] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.
<https://www.pngfuel.com/free-png/dyigi/download>

Primary Motor Cortex

Function



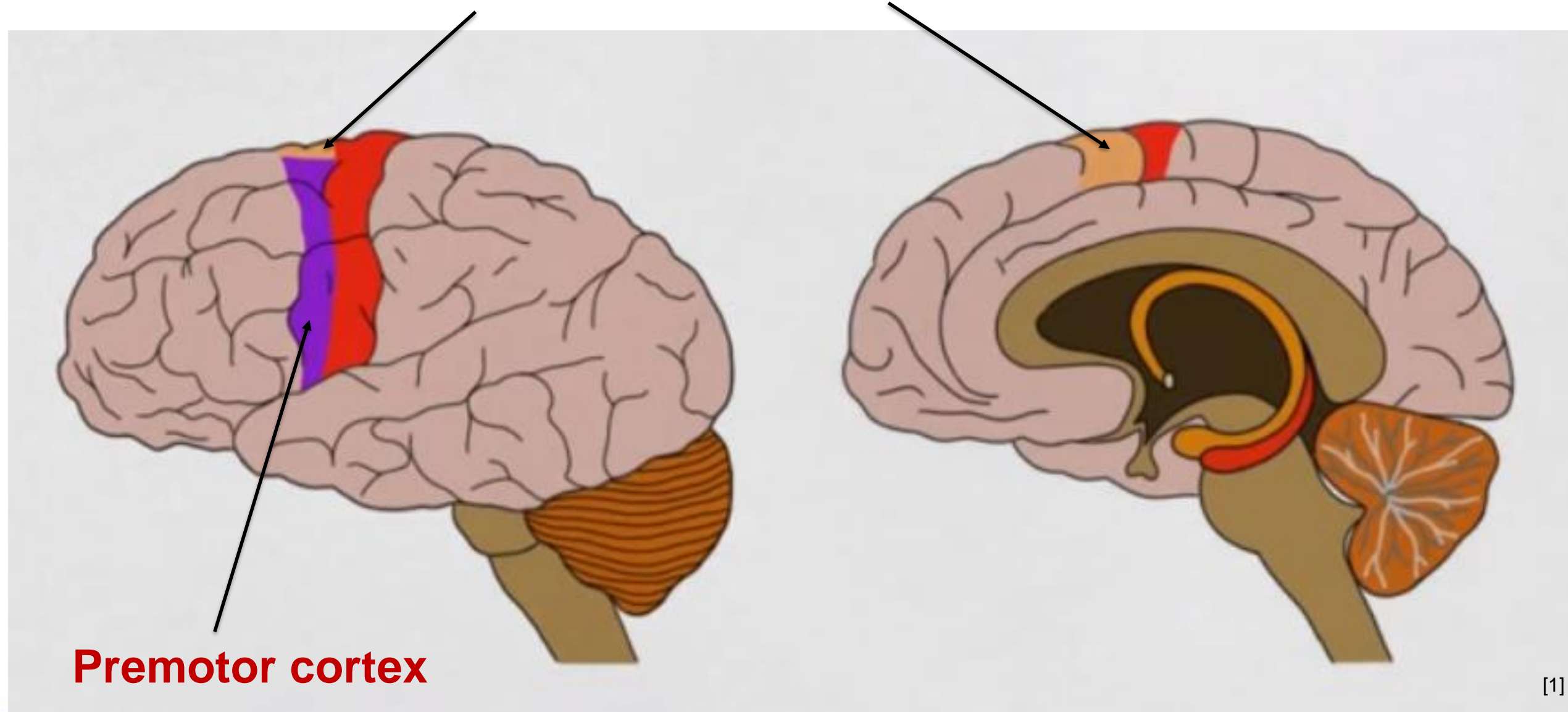
- Neurons from the primary motor cortex carrying signals regarding movement enter one of two major motor pathways:
- **Corticospinal** tract causes movement of the body
- **Corticobulbar** tract causes movement of head, neck and face [2]

[1] Dingman M. (2015, October 23). Know your brain: Motor cortex. Retrieved March 9, 2020, from <https://www.neuroscientificallychallenged.com/blog/know-your-brain-motor-cortex>

[2] Kolb, B., Whishaw, I. Q., & Teskey, C. G. (2016). An Introduction to Brain and Behavior (Fifth ed.), New York, United States: Worth.

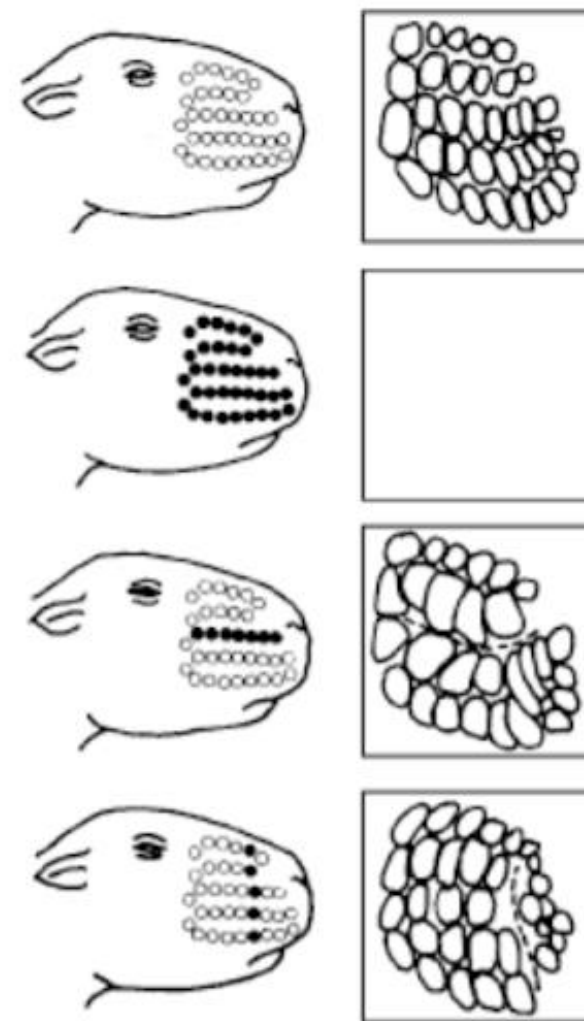
Nonprimary Motor Cortex

Supplementary motor cortex



- Divided into **supplementary motor cortex** and **premotor cortex**
- Supplementary motor cortex may be involved with:
 - execution of **sequences of movement**
 - attainment of **motor skills**
 - **selection of movements** based on incoming sensory information
- Premotor cortex is active during planning of movements

Experimental Techniques to Test the Topographic Organization

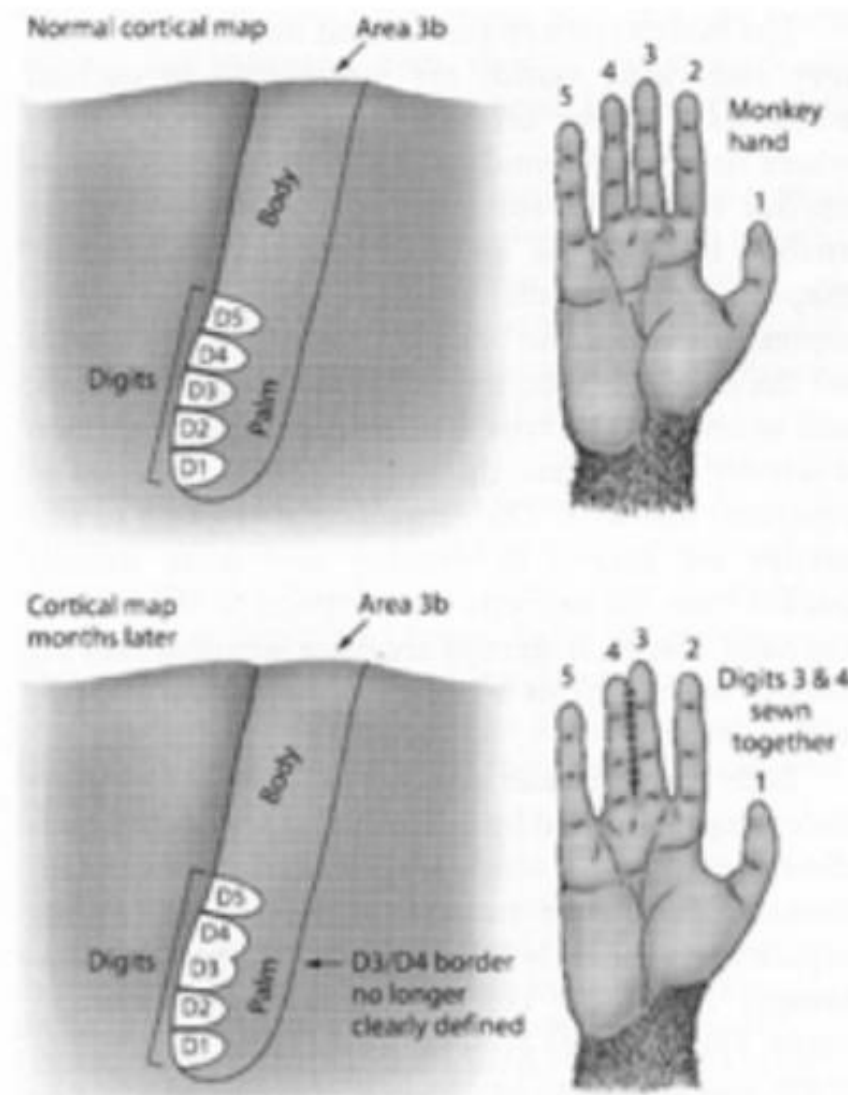


Upon Damage

- Animal studies: two ways to test it
 - Upon damage
 - Upon changing usage experience
- Upon damage experiment that cuts whiskers of a mice
- In mice, Somatosensory cortex represent whiskers or barrel cortex
- Each whisker has a topographic correspondence with each barrel

Experimental Techniques to Test the Topographic Organization

Changing Usage Experience



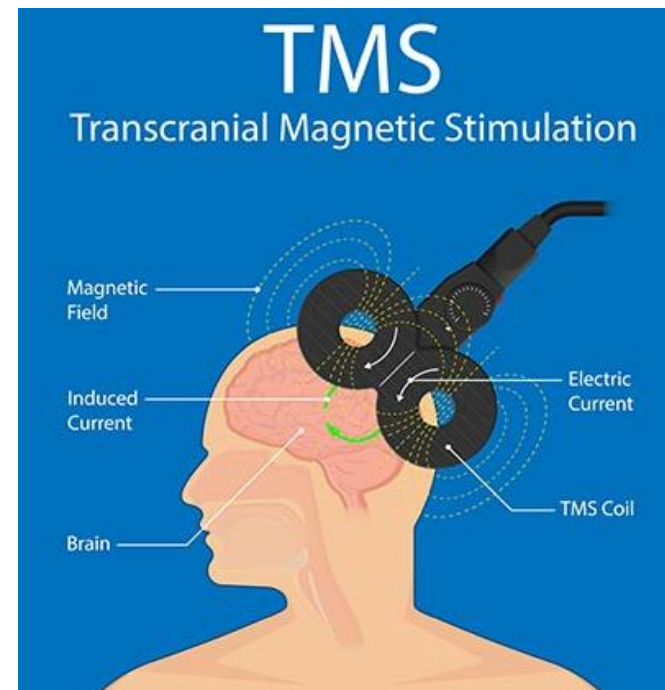
- How about other animals that has a more complex somatosensory and motor cortex? Macaques for example
- Upon changing usage experience experiment that sewn two fingers of macaque together
- “The internal topography of the map of the fused digits resembled that of a normal single digit.” [1]
- Experiences shapes the way the cortex is organized and responds

[1] Clark, S., Allard, T., Jenkins, W. *et al.* Receptive fields in the body-surface map in adult cortex defined by temporally correlated inputs. *Nature* 332, 444–445 (1988). <https://doi.org/10.1038/332444a0>

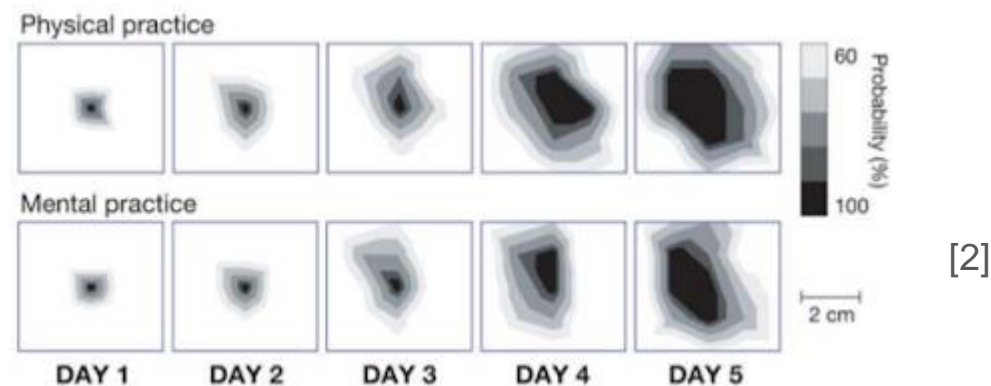
[2] Brain_Lecture5_plasticity_pdf

Experimental Techniques to Test the Topographic Organization

TMS and Other Techniques



[1]



[2]

- TMS for motor-mapping
- TMS + other techniques
- Experiment trains people press a sequence of keys in a piano in the correct rhythm. TMS used for estimate the size of cortical representations
- “This experiment reveals that **acquisition of the necessary motor skills** to perform a five-finger movement exercise correctly **is associated with reorganization in the cortical motor outputs to the muscles involved in the task.**” [2]

[1] <https://www.dartmouth-hitchcock.org/psychiatry/transcranial-magnetic-stimulation-tms.html>

[2] Pascual-Leone, Alvaro & Amedi, Amir & Fregni, Felipe & Merabet, Lotfi. (2005). The plastic human brain. Annual review of neuroscience. 28. 377-401. 10.1146/annurev.neuro.27.070203.144216.

Discussion

- Has the homuncular man changed during the evolution of human species? If yes, how and why?
- How may the topography change in the future with new technology such as Neuralink?