MAPPING HUMAN CORTEX

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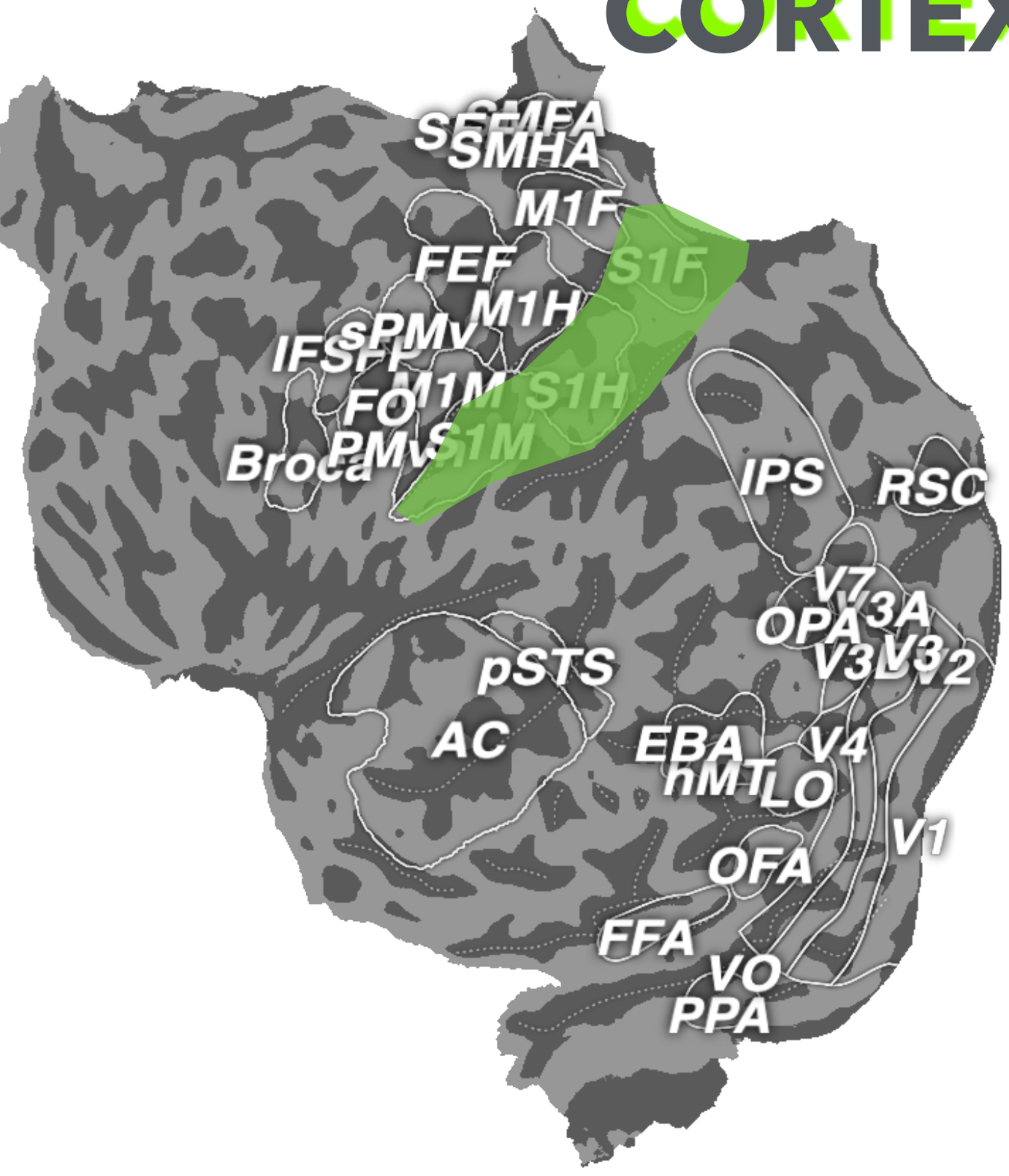
10.22.2020

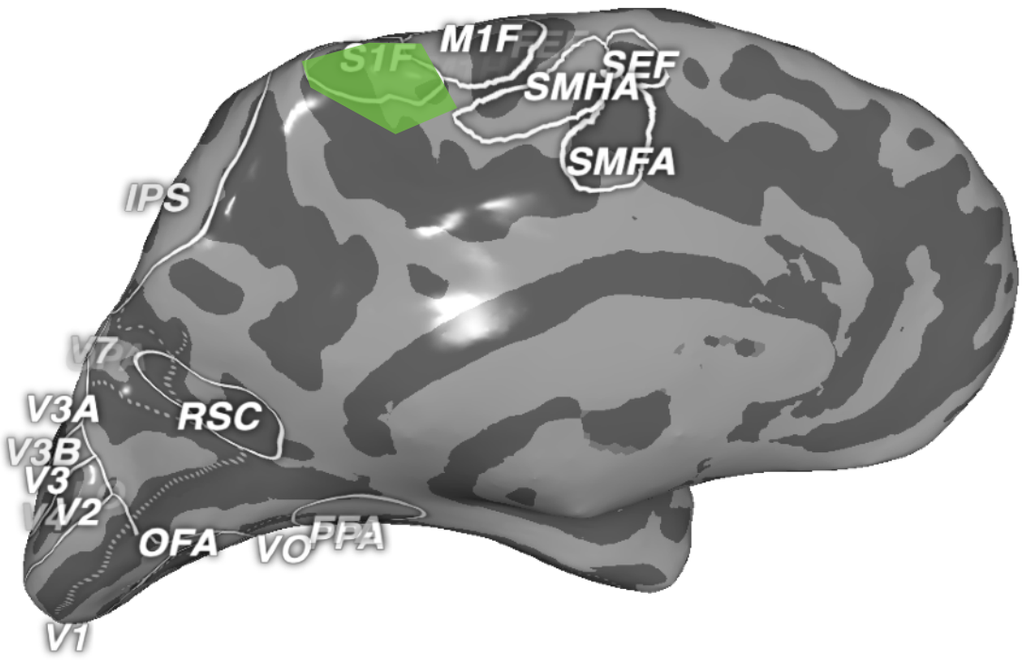
HOMEWORKS

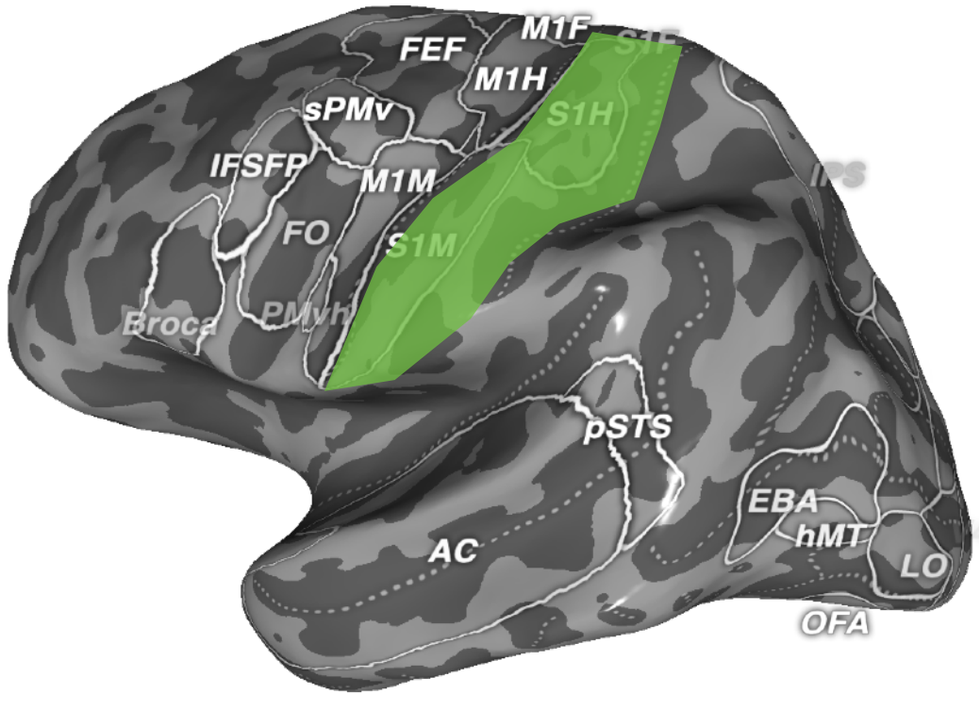
* **Homework 2** (visual ctx.) is due in 1 week (10/29)

* Your annotations for Homework 2 should be **added** to what your turned in for HW1

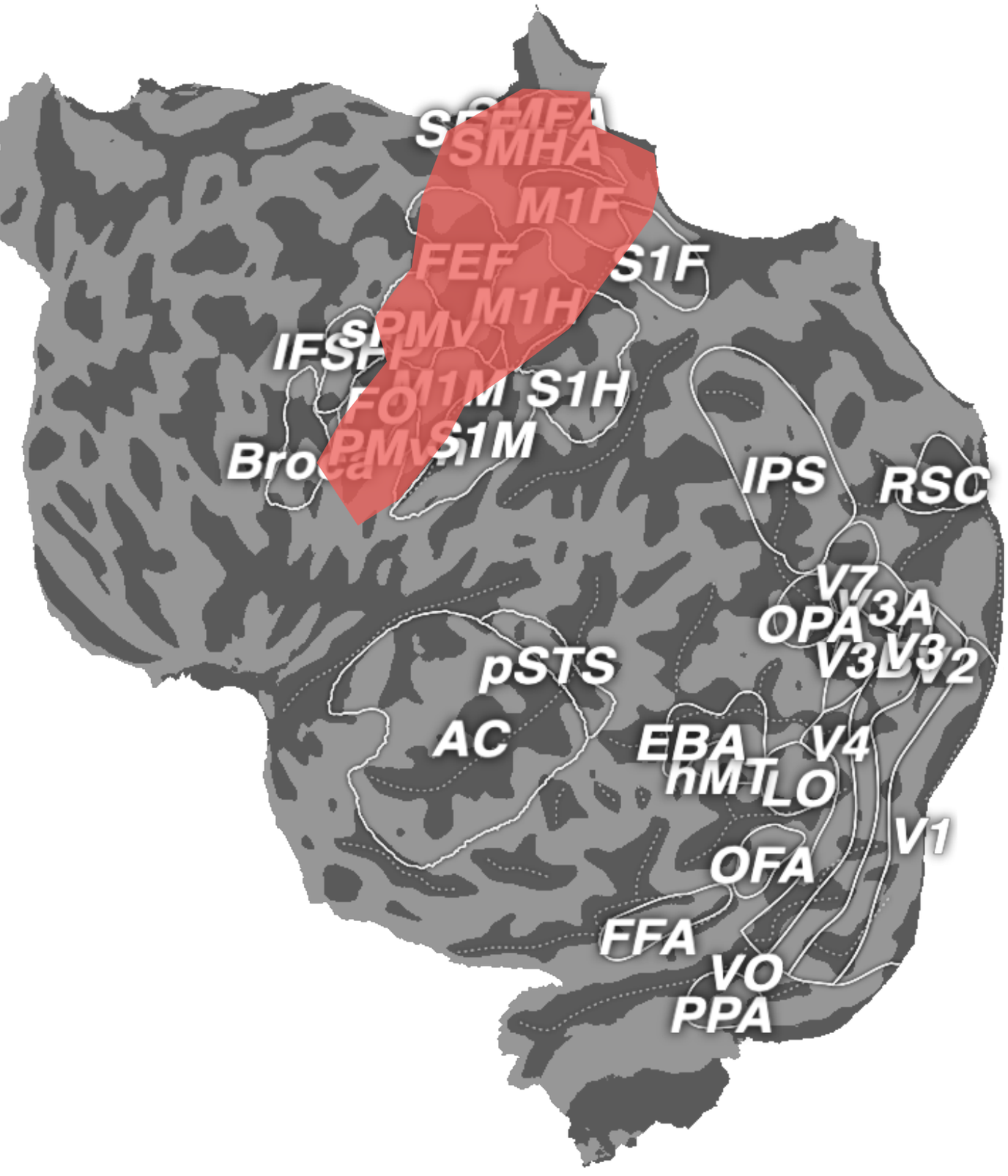
PRIMARY SOMATOSENSORY CORTEX (S1)

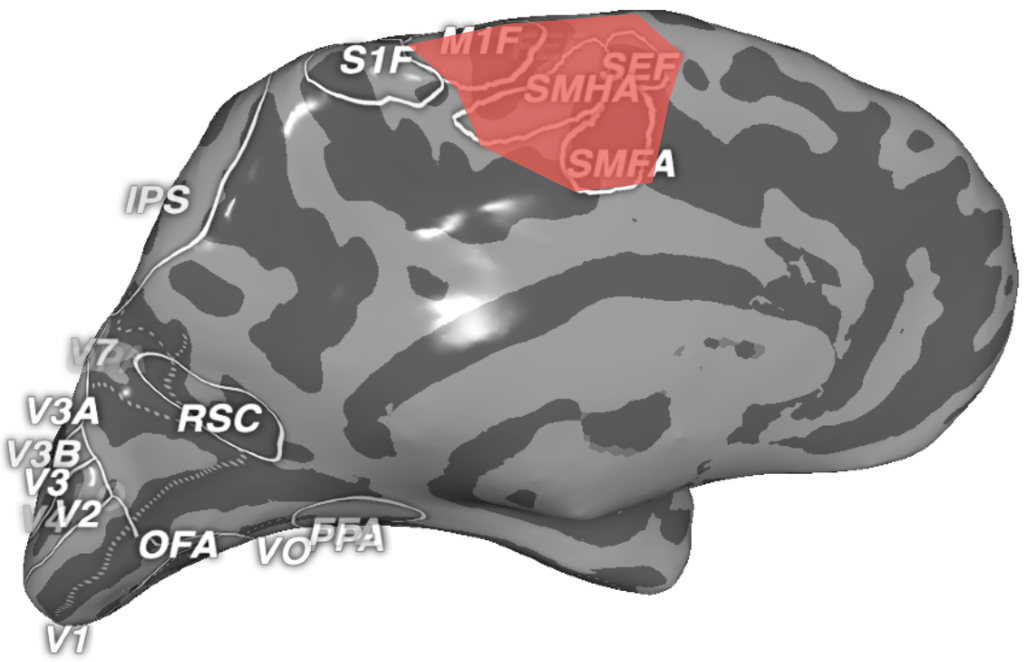


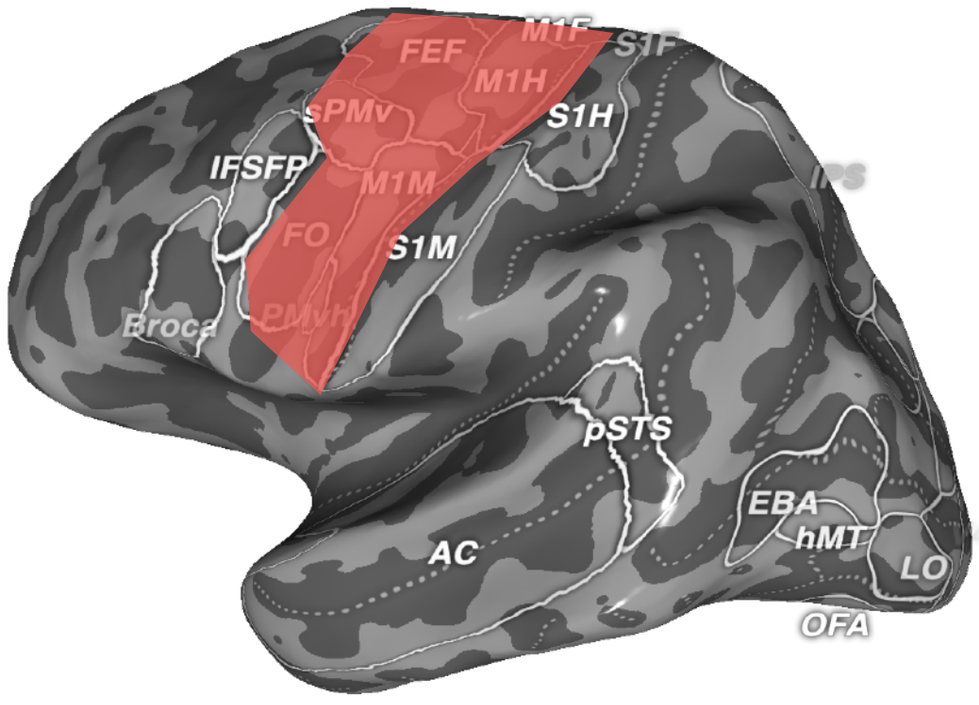




MOTOR CORTEX

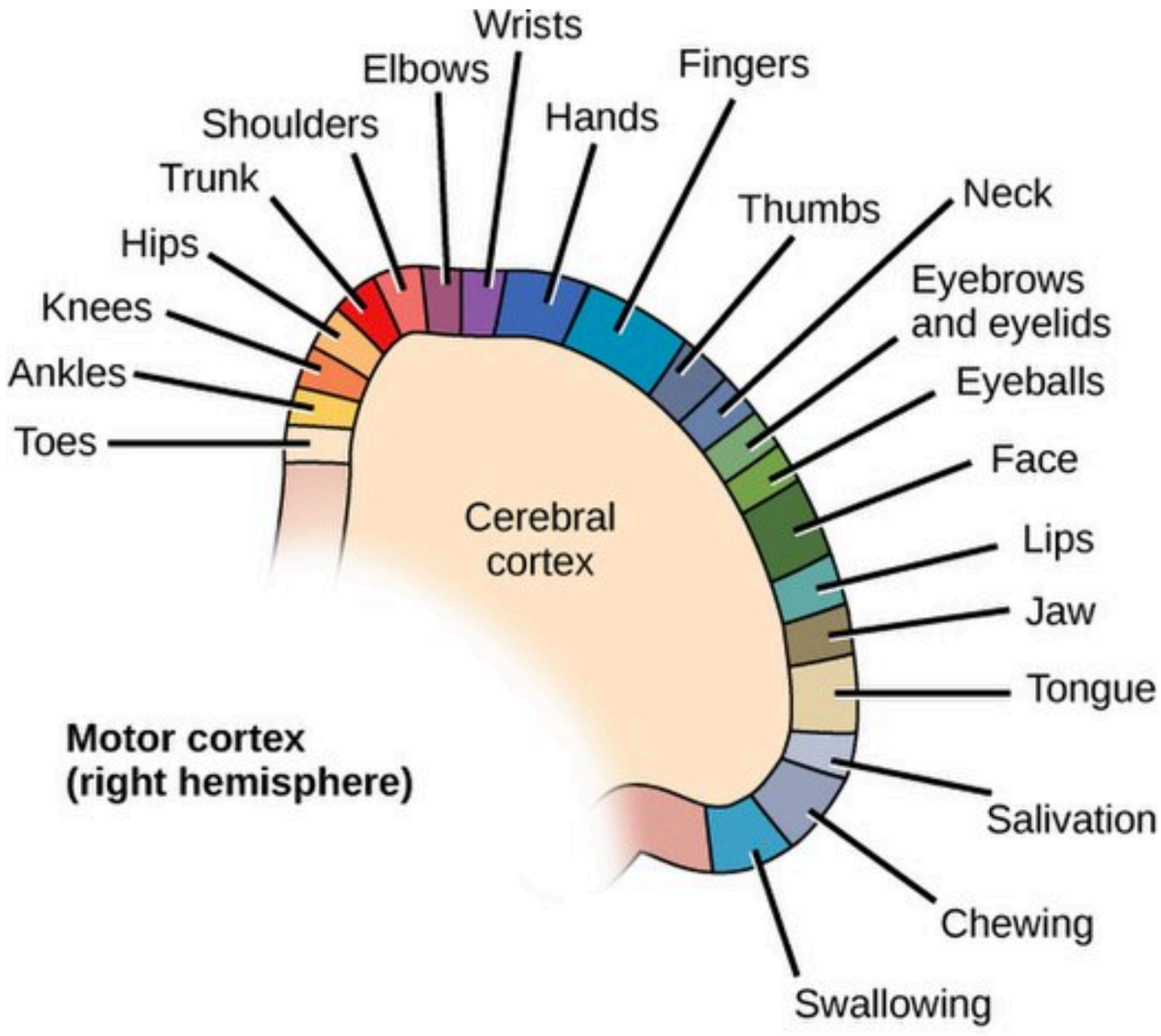






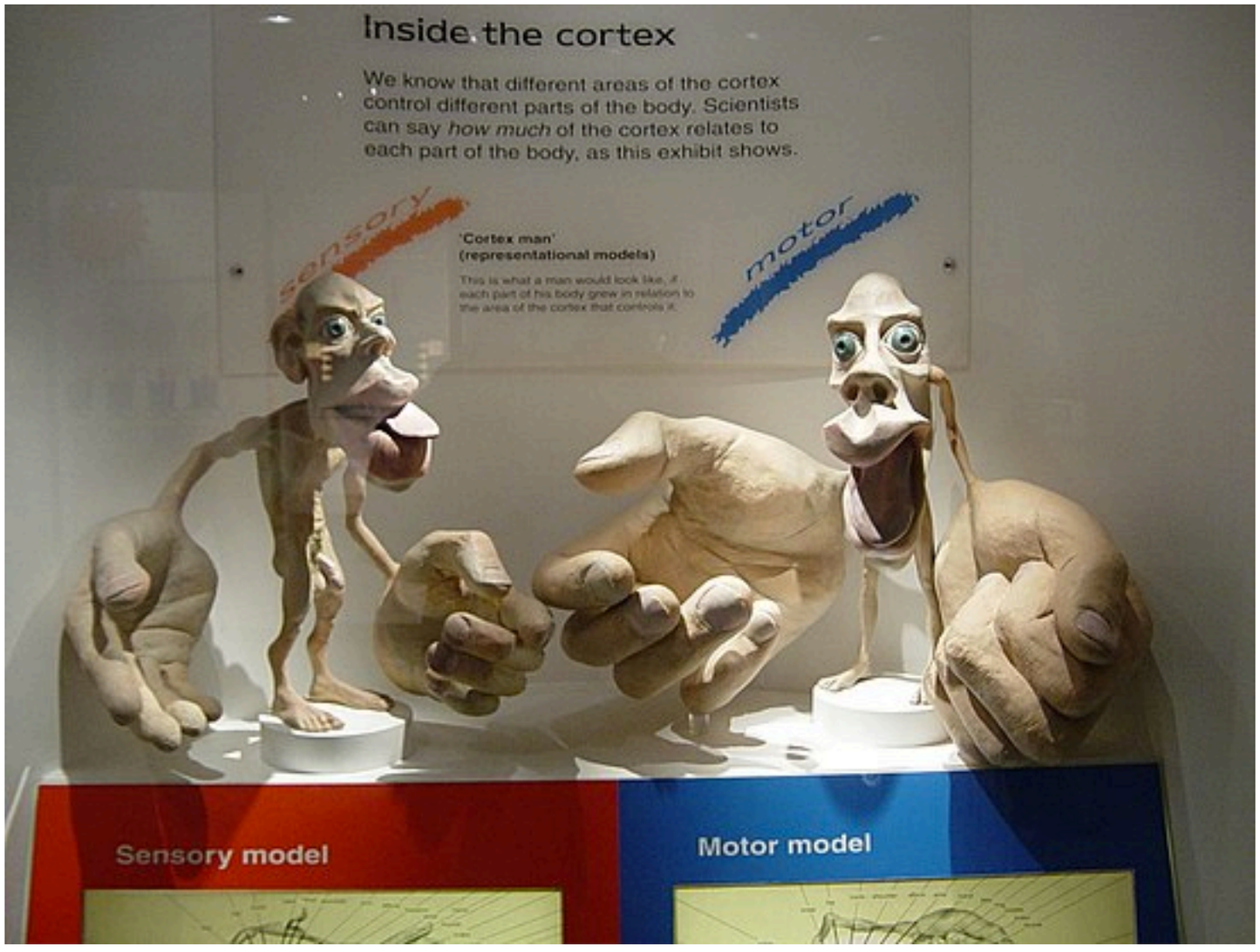
SOMATOTOPY AGAIN

* Like somatosensory cortex, motor cortex is **somatotopic**
    * i.e. nearby areas of motor cortex control nearby muscle groups in the body
* This is known from the same sources we talked about last time: intra-surgical stimulation experiments *(Penfield & Boldrey, 1937)* and animal experiments *(Ferrier, 1886)*



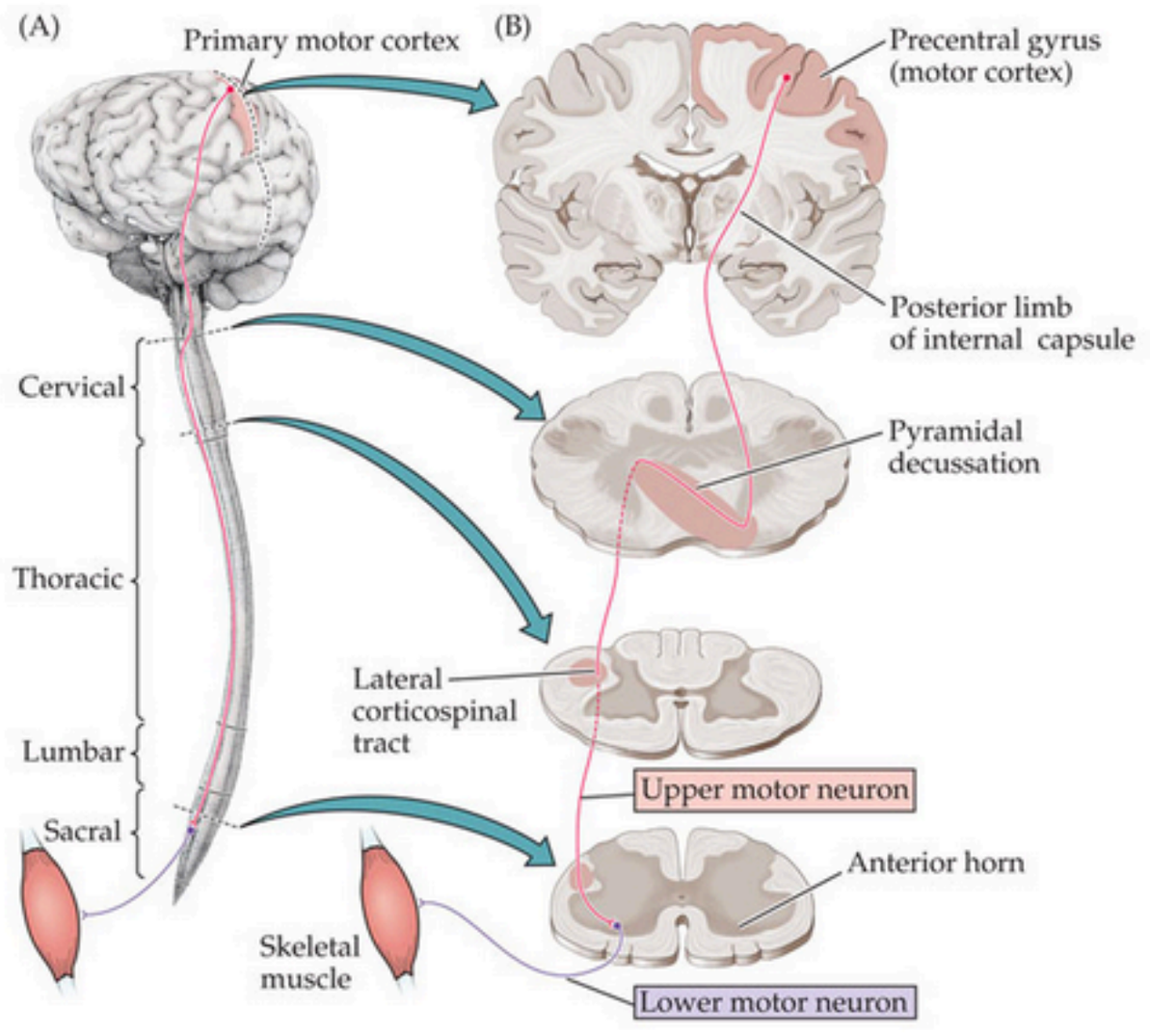
SOMATOTOPY AGAIN

* But body parts are “magnified” to different degrees than in somatosensory cortex



MOTOR CORTEX

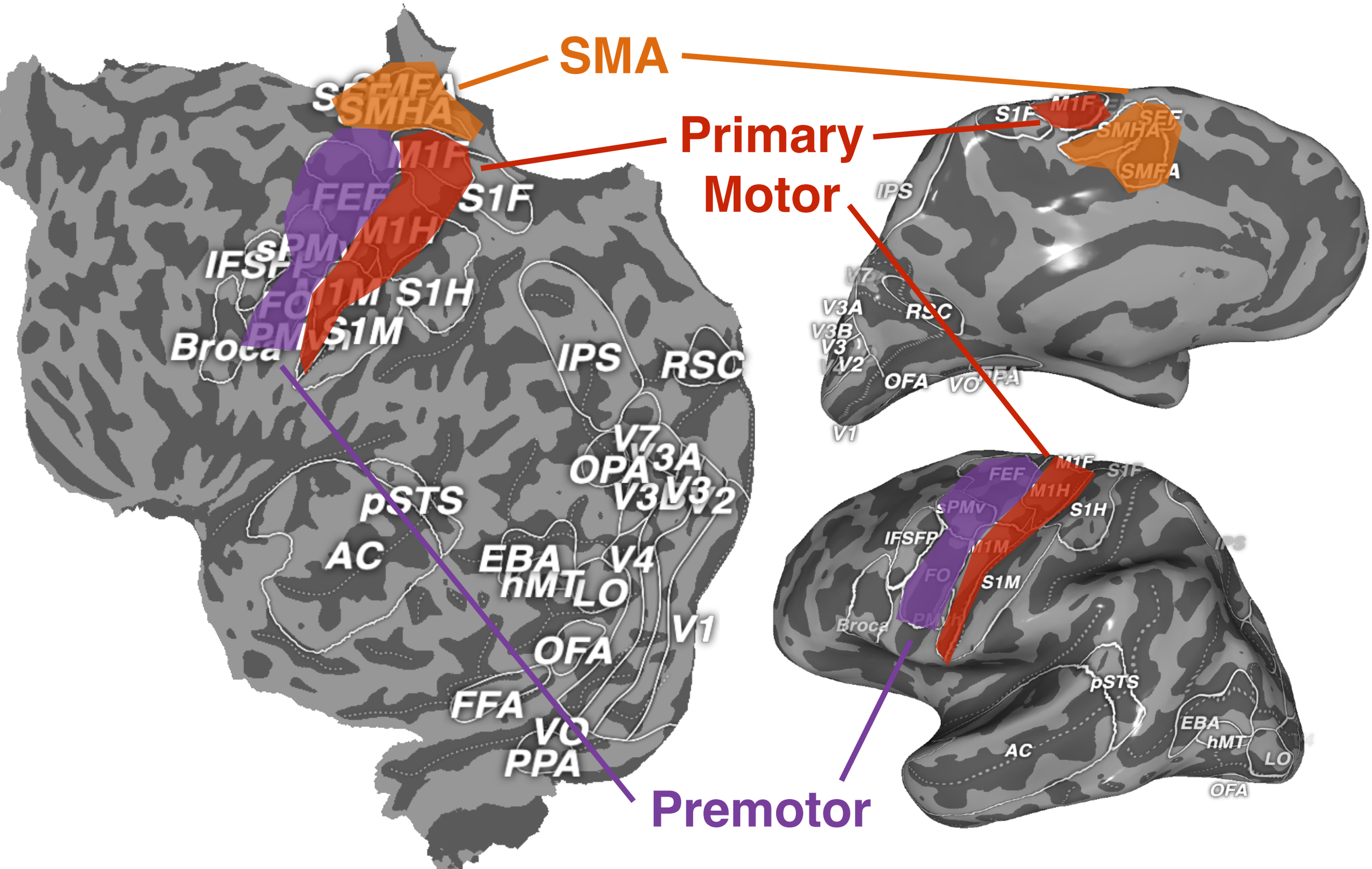
* (Some) neurons in the motor cortex have axons that extend out of the brain and down the **spine**, synapsing onto other neurons that carry signals directly to the muscles



MOTOR SUBDIVISIONS

* Motor cortex comprises **3 parts**, each containing a separate (coarse) somatotopic map
    * **Primary motor cortex** (sometimes aka M1)
    * **Premotor cortex** (PM)
    * **Supplementary motor area** (SMA)

MOTOR SUBDIVISIONS



MOTOR SUBDIVISIONS

* Commonly accepted story: these areas differ in **complexity:**
    * Neurons in **primary motor cortex** code for relatively simple movements
    * Neurons in **premotor cortex** code for more complex sequences or combinations of movements
    * Neurons in **supplementary motor areas** code for even more complex & bilateral movements

MOTOR SUBDIVISIONS

* Early on it was thought that these areas were organized hierarchically, with **PM** and **SMA** sending signals to **M1**, which then signals muscles

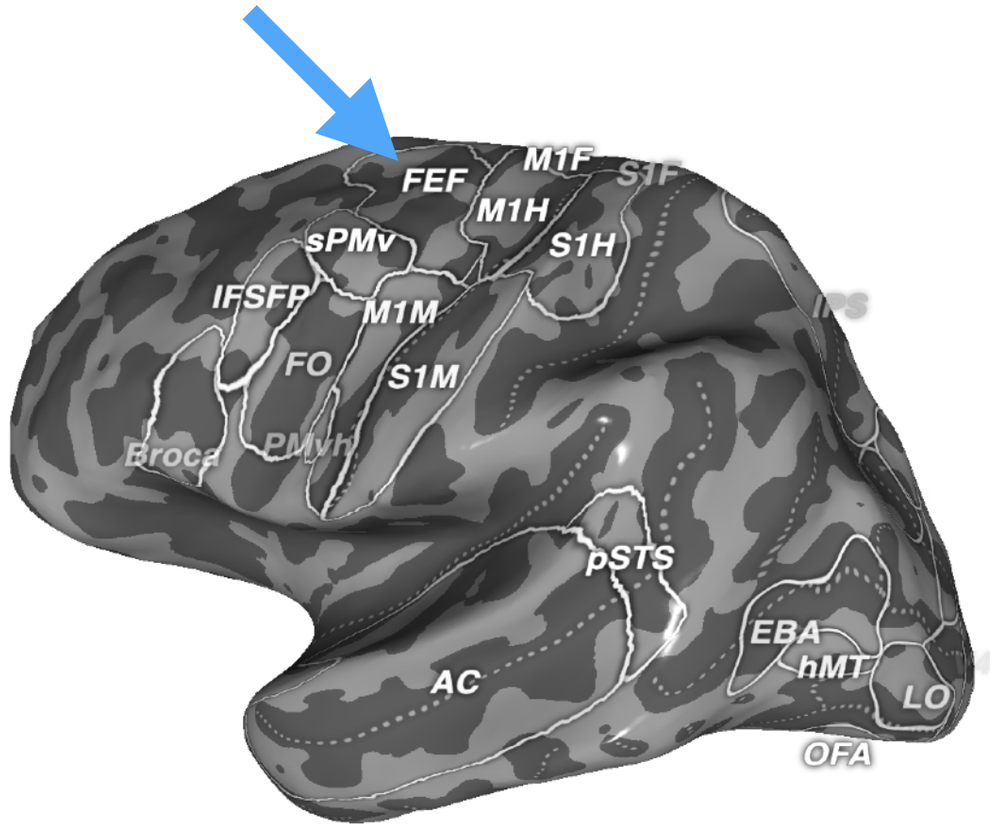
* This seems ~true in some mammal species

* But in primates & humans, all 3 areas can send signals directly down the spine

FRONTAL EYE FIELDS

* The **frontal eye fields (FEF)** are the motor area that controls eye movements (saccades)

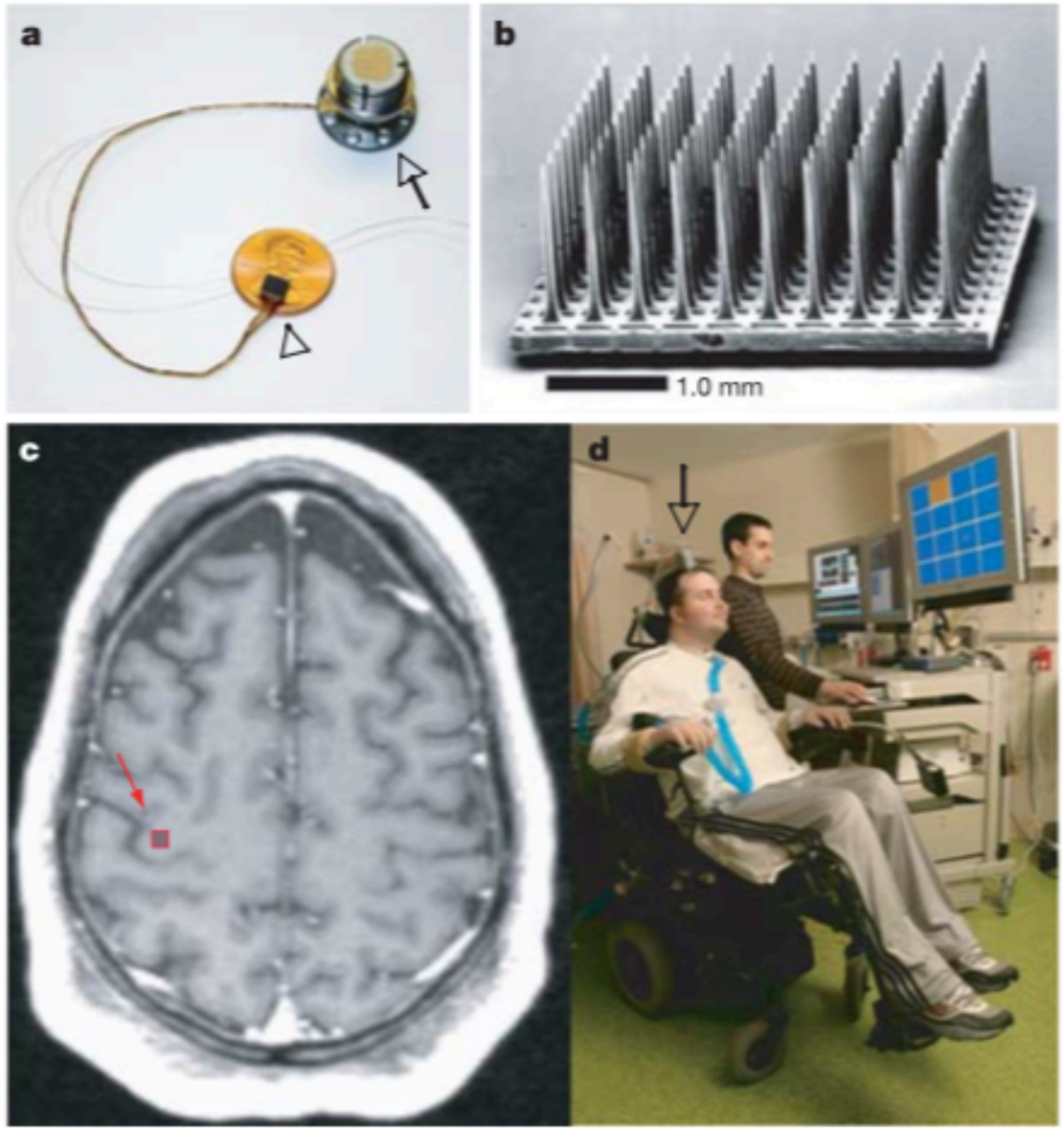
* It's part of the motor system, but also responds strongly to **visual input**, and its neurons have **retinotopic** receptive fields



PROSTHETICS: BRAIN-MACHINE INTERFACES

* For people who are **paralyzed** due to spinal cord injury, motor cortex is unaffected

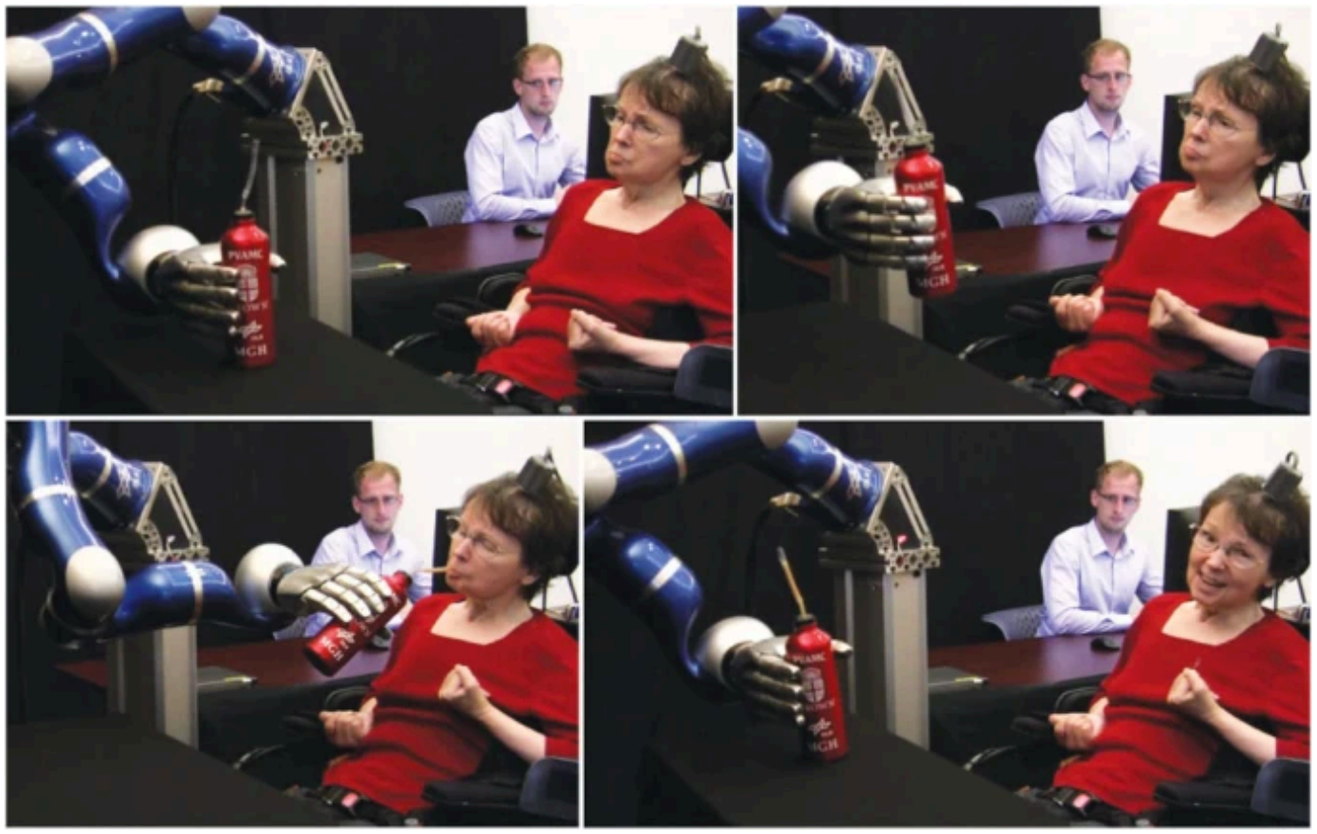
* So motor cortex activity can be **read out** (e.g. using implanted electrodes) and then used to control a **prosthesis** (e.g. a computer cursor)



Hochberg et al., Nature (2006)

PROSTHETICS: BRAIN-MACHINE INTERFACES

* More recent versions of the same technology allow people to control **robot arms**



Hochberg et al., Nature (2012)

PROSTHETICS: BRAIN-MACHINE INTERFACES

* Interestingly, one alternative is to instead implant electrodes in the **intraparietal sulcus (IPS)**

* Recall: IPS represents **attention** or **goals** of arm movements

* This also enables really effective robot arm control!

Aflalo et al., Science (2015)

see: https://www.youtube.com/watch?v=KhNLh-j973o

MIRROR NEURONS

* Some neurons in **premotor cortex** respond both when performing an action, and **observing** someone else perform that action (*Rizzolatti, 1992*)

* These **mirror neurons** became a hot topic for decades

    * Do they explain **autism**? Empathy? Theory of mind?

* But more recently there is a **backlash** against this idea…

UNTIL NEXT TIME