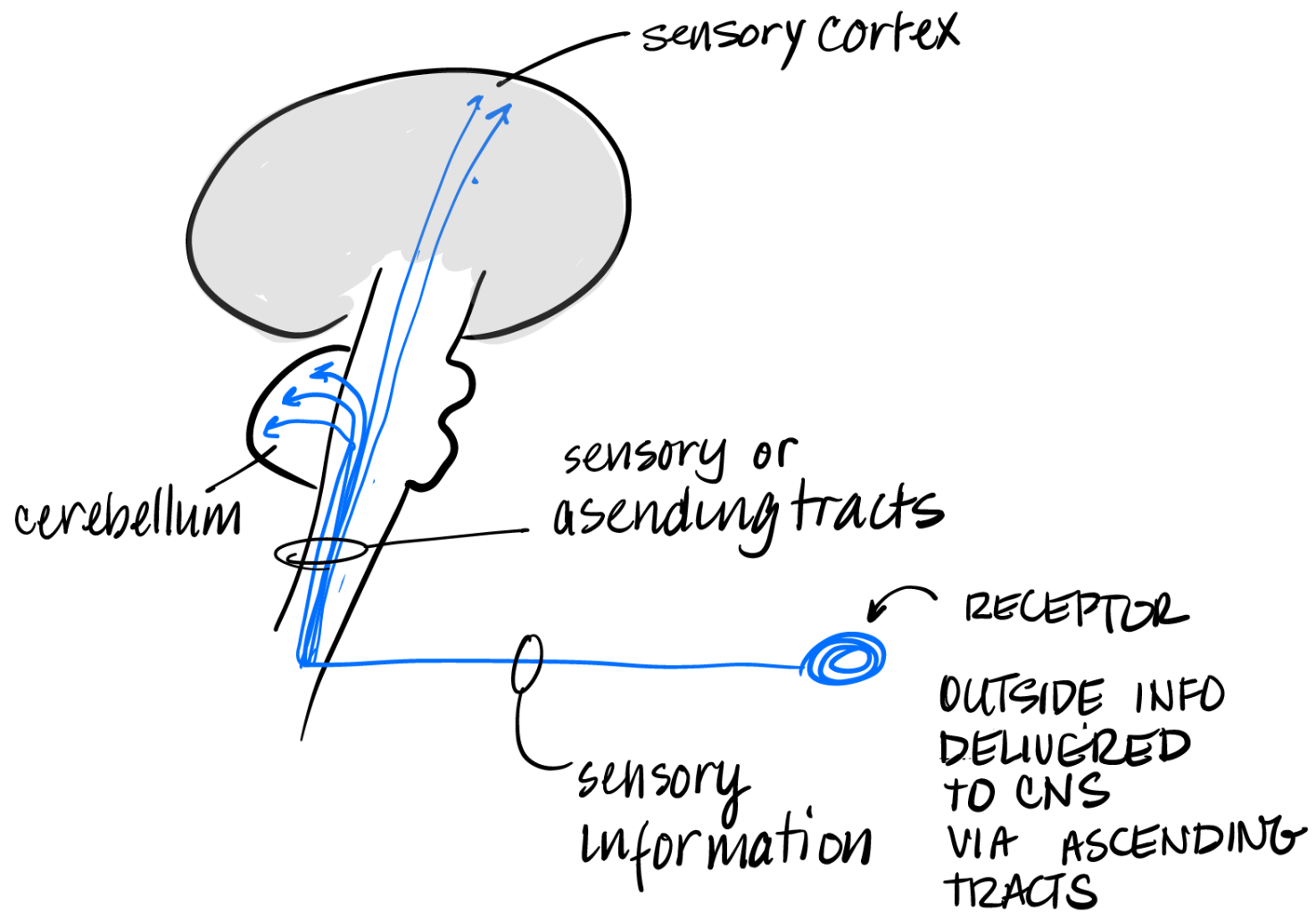
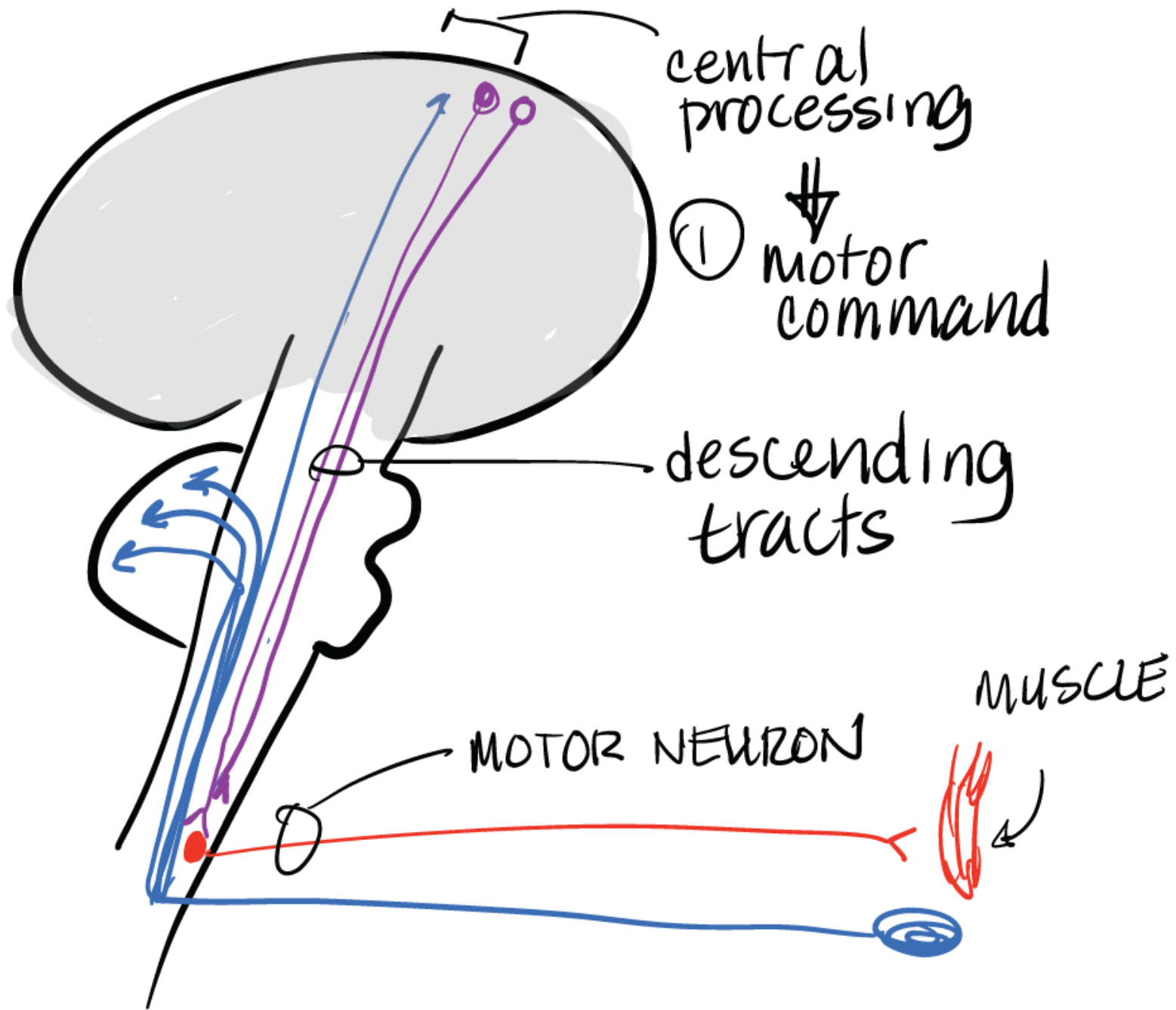
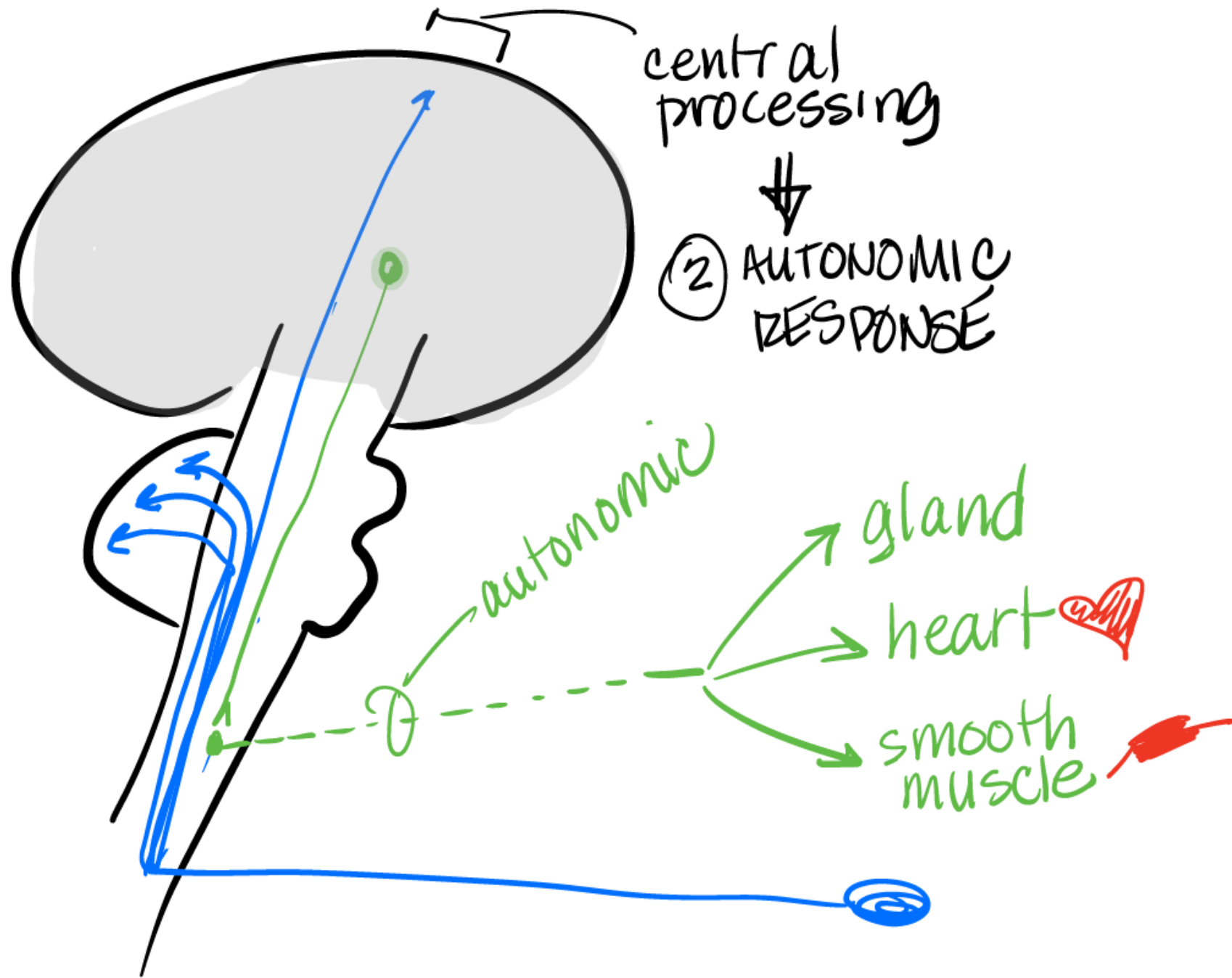


# Brain Control of Movement

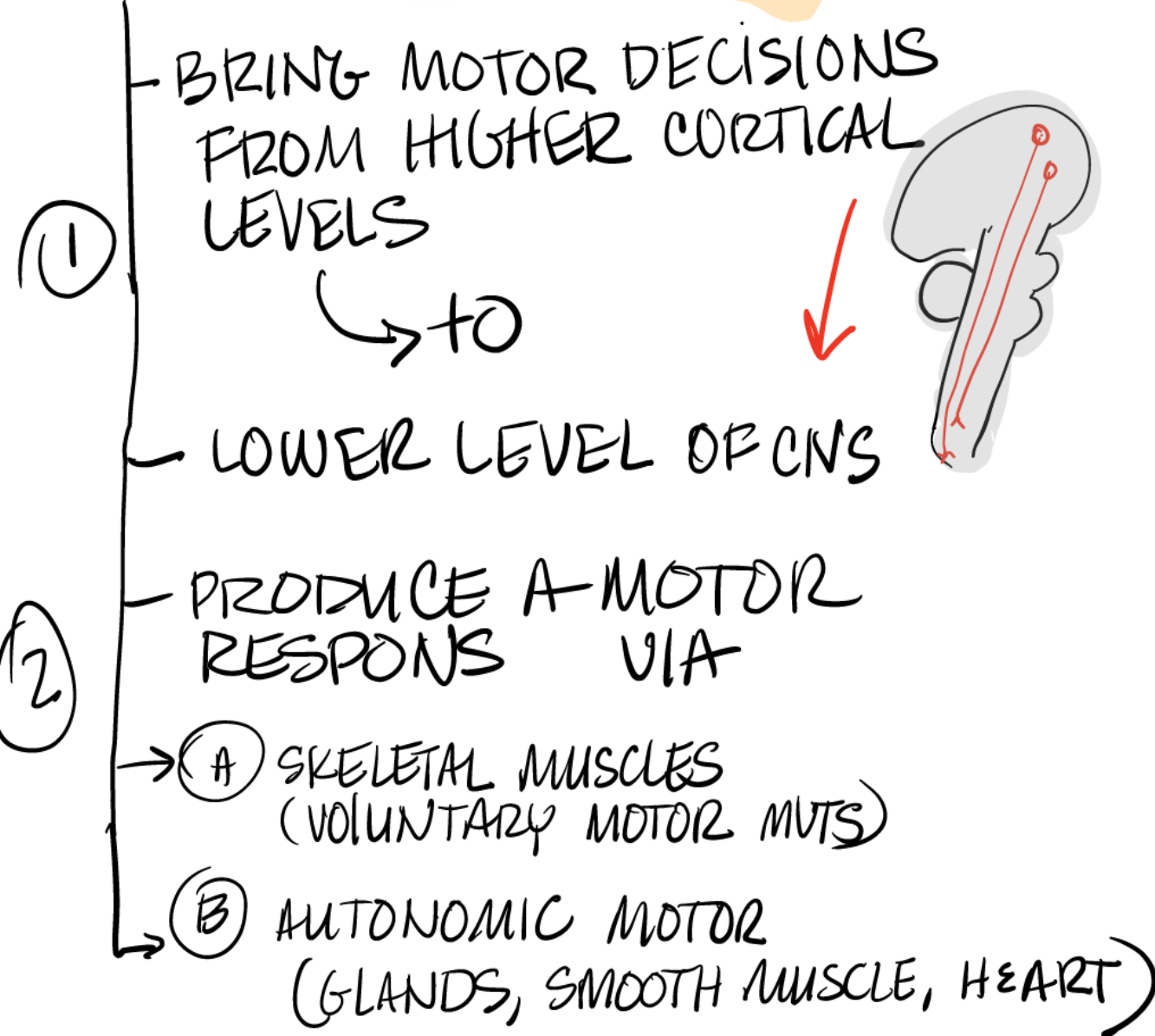








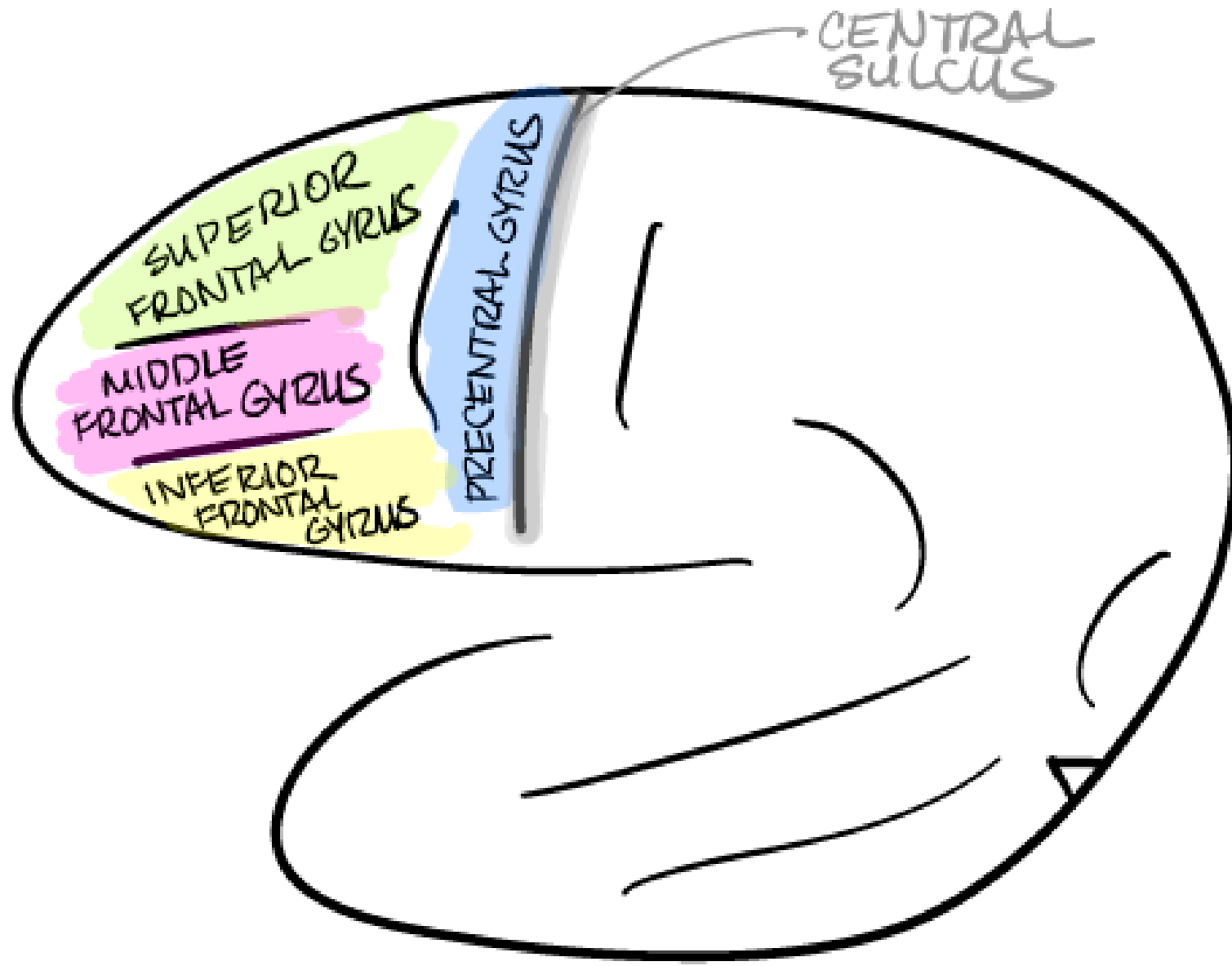
# DESCENDING TRACTS

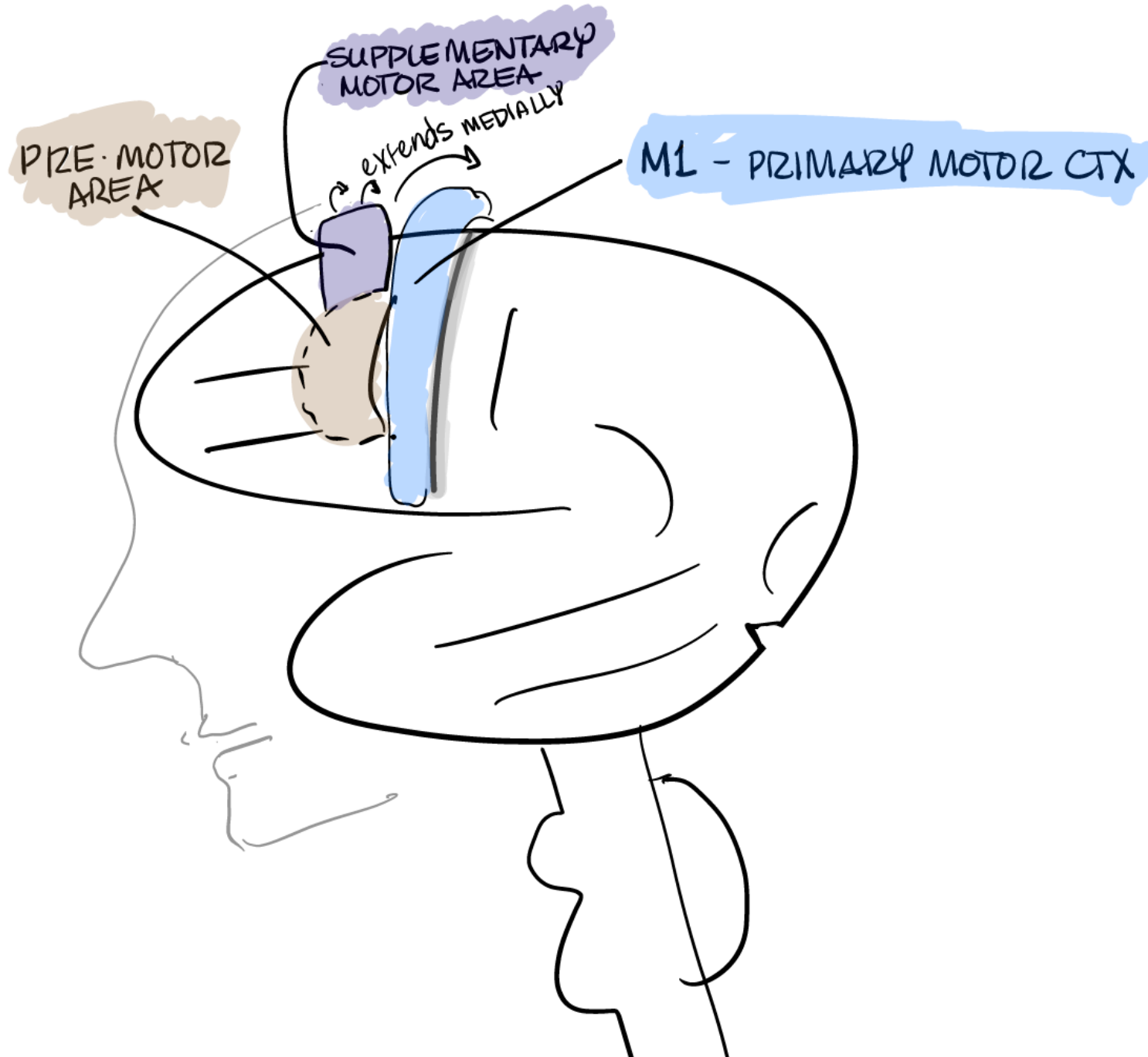


MOTOR CORTEX



HIGHEST CENTER CONCERNED  
WITH MOTOR ACTIVITY  
→ VOLUNTARY







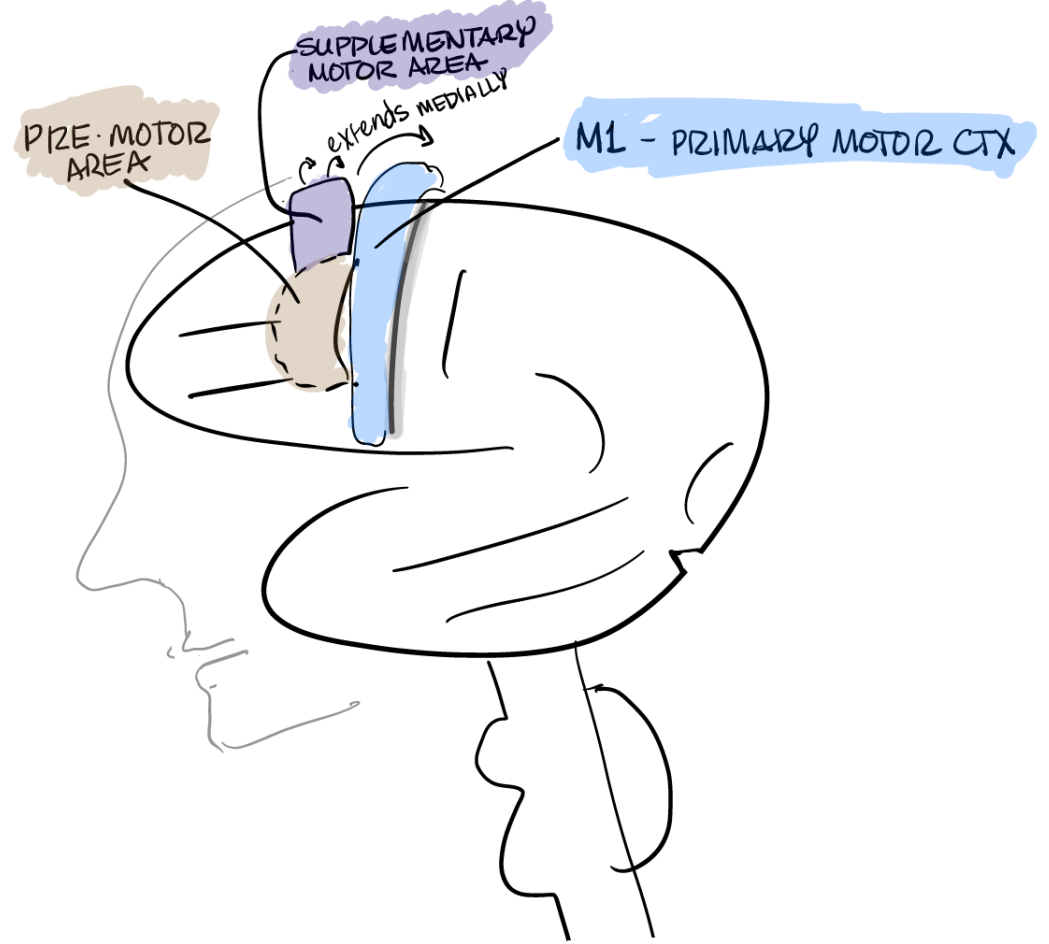
# ① PRE MOTOR AREA

PLANS THE MOTOR ACTIVITY

MOTOR PLAN INCLUDES SPATIAL INFO



HOW TO PICK UP TEA CUP & DRINK TEA



IDEA TO DRINK TEA

PRE MOTOR AREA

eg. INITIAL HAND POSITION

COMPUTE THE MOVEMENTS

FINAL HAND POSITION

PLAN THE EXECUTION OF EVENT

INPUT INTO PMA

PROPRIOCEPTIVE INFORMATION

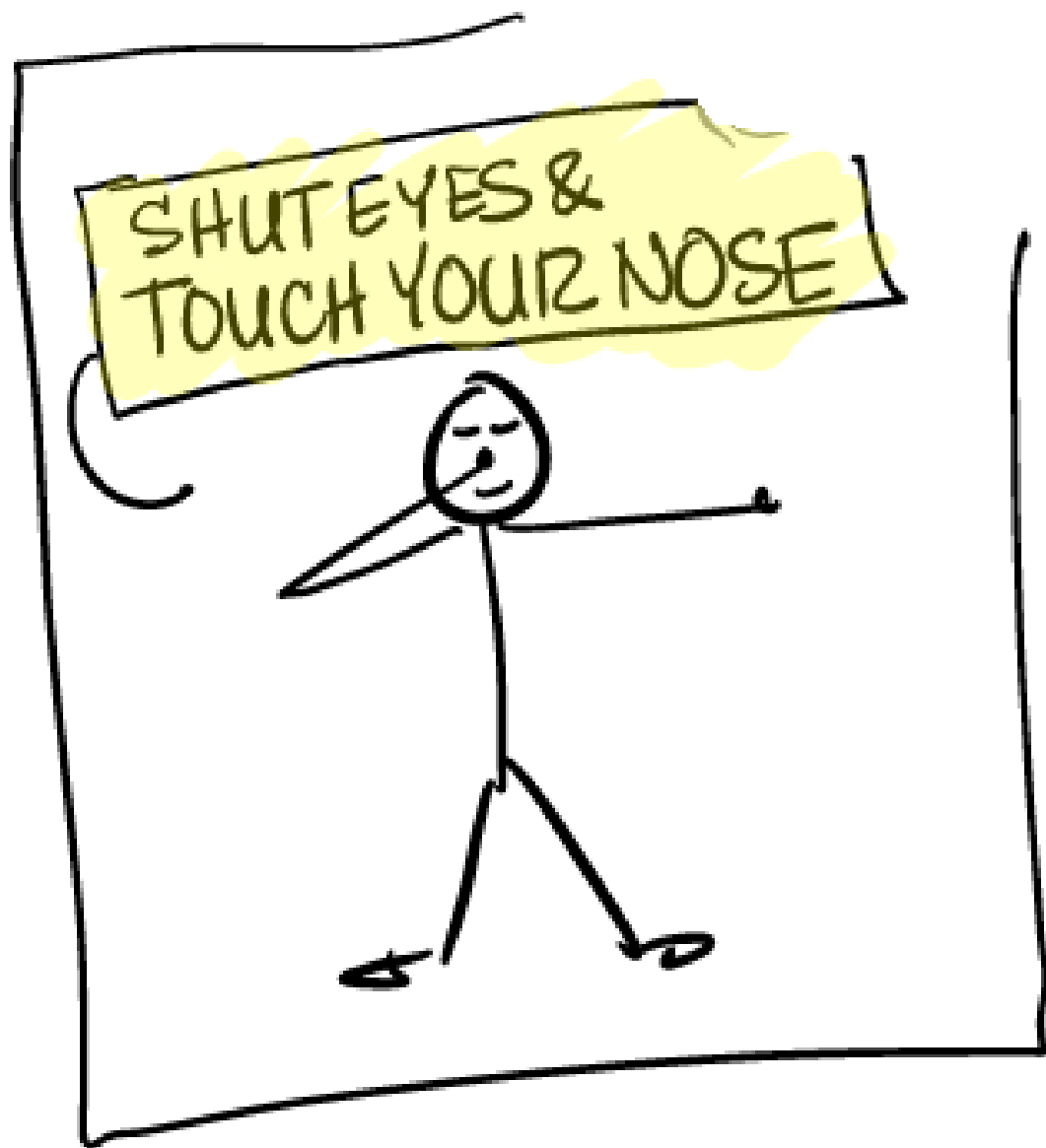
① PRE MOTOR AREA

PLANS THE MOTOR ACTIVITY

MOTOR PLAN INCLUDES SPATIAL INFO

HOW TO PICK UP TEA CUP & DRINK TEA



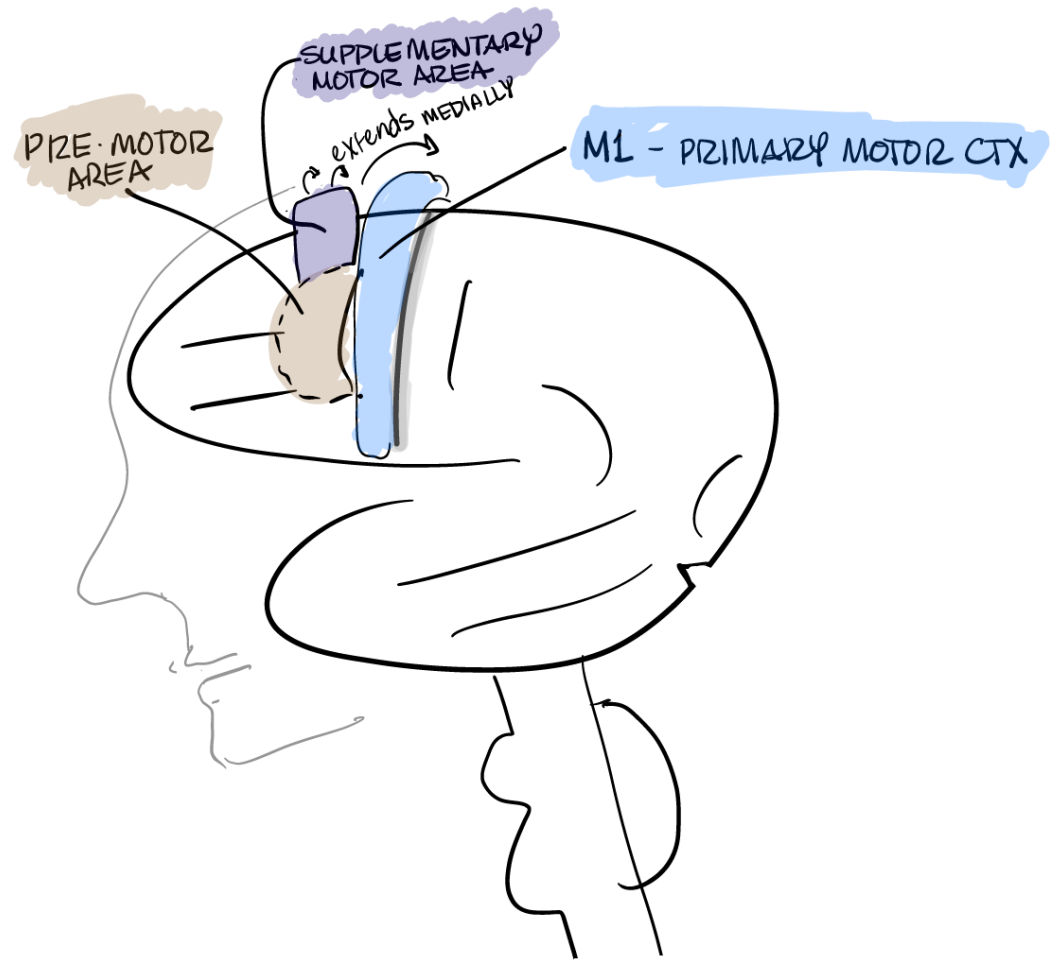


VIA ASCENDING  
TRACTS

- (CNS) ↓
- ① MOTOR SYSTEM ALWAYS HAS POSITION OF BODY
  - ② CNS - SHOULD HAVE AN "IMAGE" ABOUT THE FINAL POSITION (THOUGHT COMMAND)

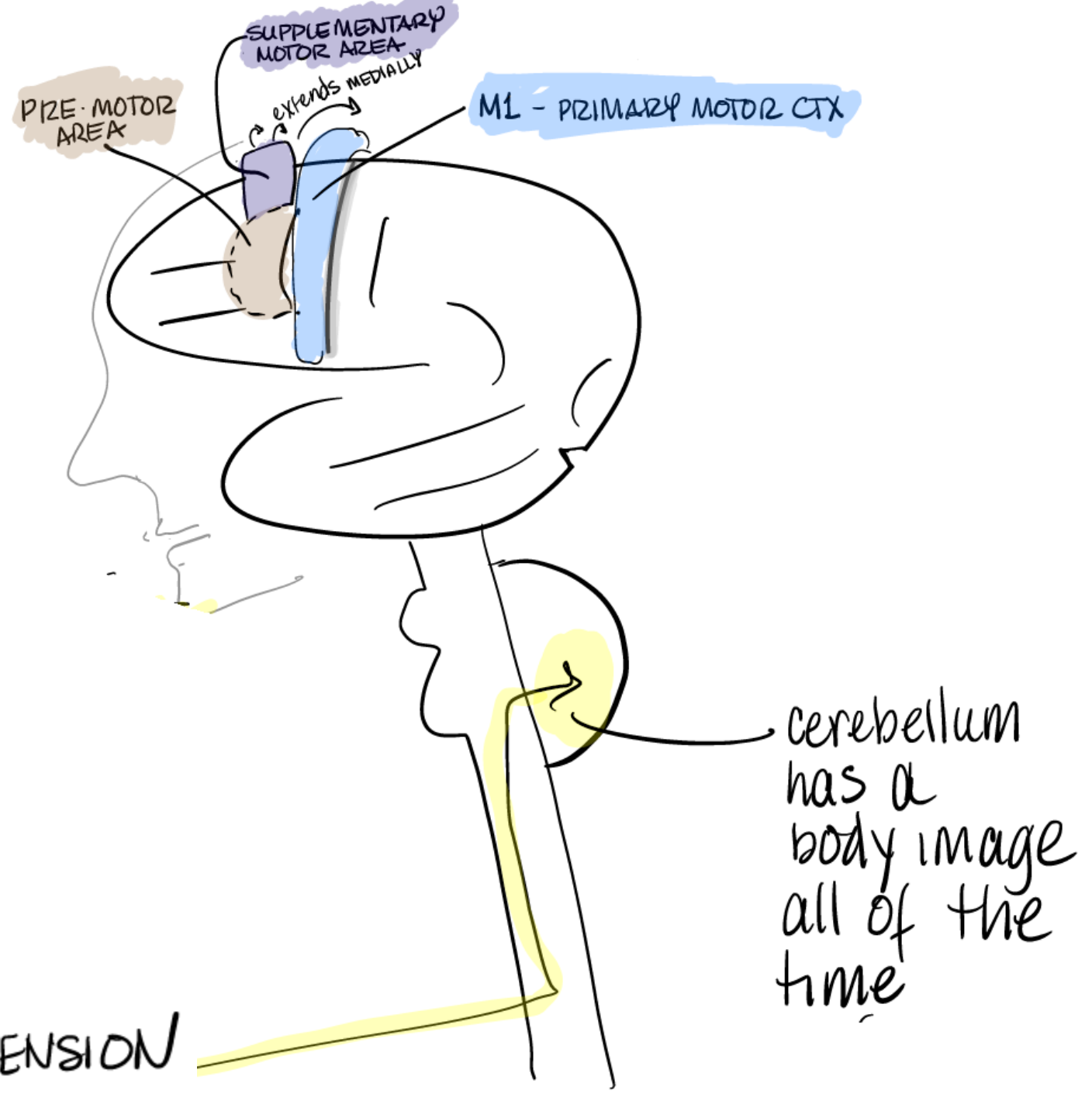



# PMA PLANS LIMB & FINE MVTS



PMA → ③ USING THE PMA'S PLAN  
CONSULTS WITH THE CEREBELLUM  
& SENSORY CORTICAL REGIONS. THE DESCENDING  
FIBERS WILL EXECUTE IT  
↳ SPEED & TENSION

PMA  
CONSULTS  
WITH THE  
CEREBELLUM  
& SENSORY  
CORTICAL REGIONS.



MUSCLE &  
JOINT info  
going to  
cerebellum  
\* BODY POSITIONS  
& TENDON/MUSCLE TENSION

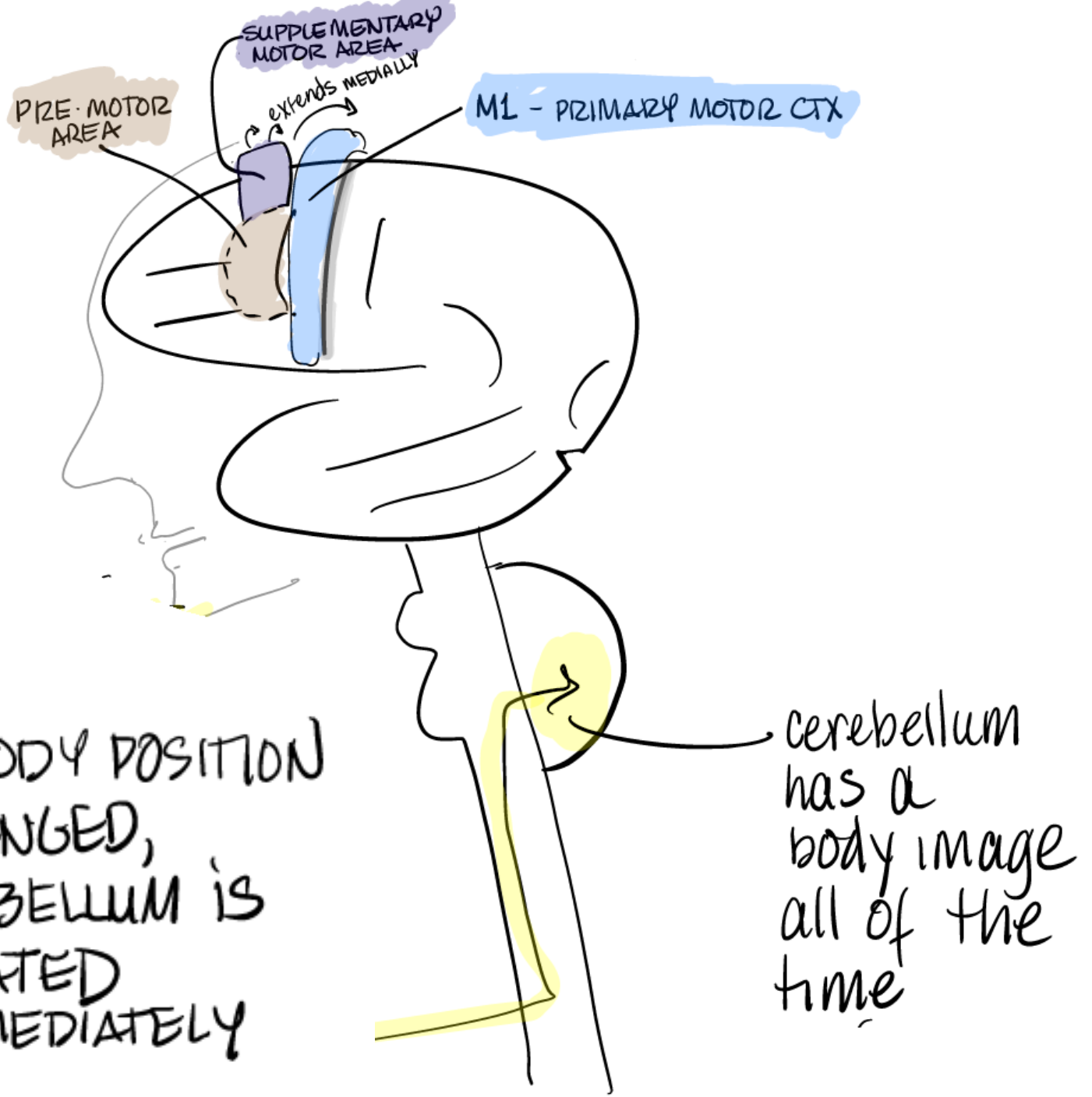
cerebellum  
has a  
body image  
all of the  
time

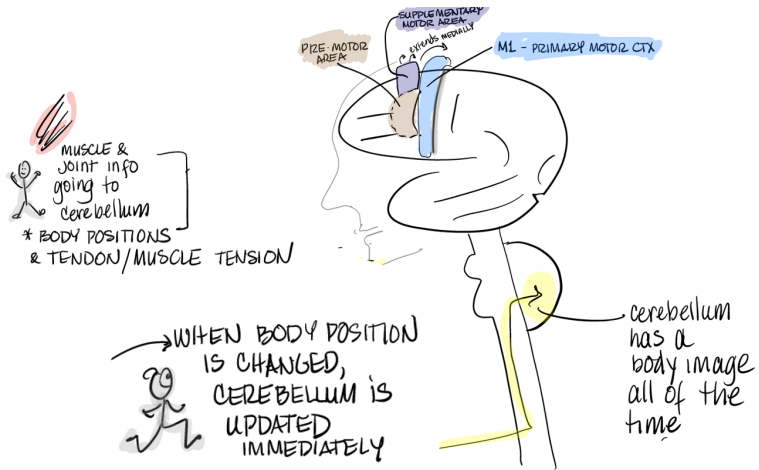


\* BODY POSITIONS & TENDON/MUSCLE TENSION

PMA CONSULTS WITH THE CEREBELLUM & SENSORY CORTICAL REGIONS.

→ WHEN BODY POSITION IS CHANGED, CEREBELLUM IS UPDATED IMMEDIATELY





\* POSTURE INFORMATION & TONE CHANGE  
BACKGROUND INFO PROCESSED



\* POSTURE INFORMATION & TONE CHANGE  
BACKGROUND INFO PROCESSED

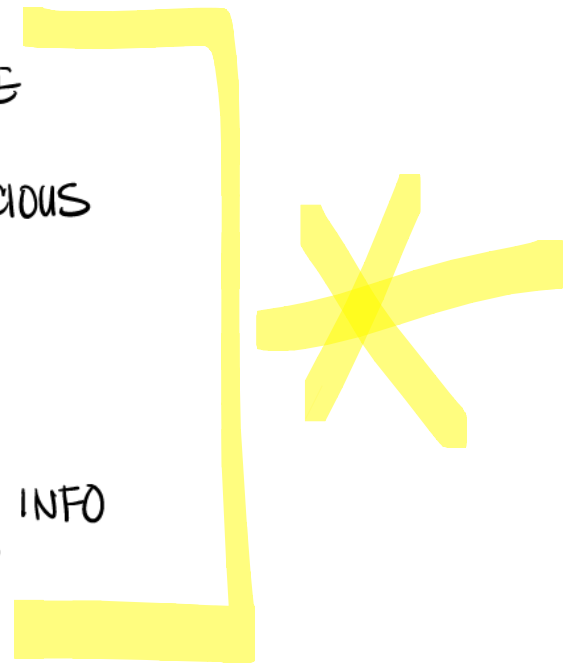
P12E-MOTOR AREA  
SUPPLEMENTARY MOTOR AREA  
extends MEDIANLY  
M1 - PRIMARY MOTOR CTX



WHEN PROPRIOCEPTIVE INFO IS SENT TO CORTEX — IT BECOMES CONSCIOUS

@ THIS LEVEL PROPRIOCEPTIVE INFO IS UNCONSCIOUS

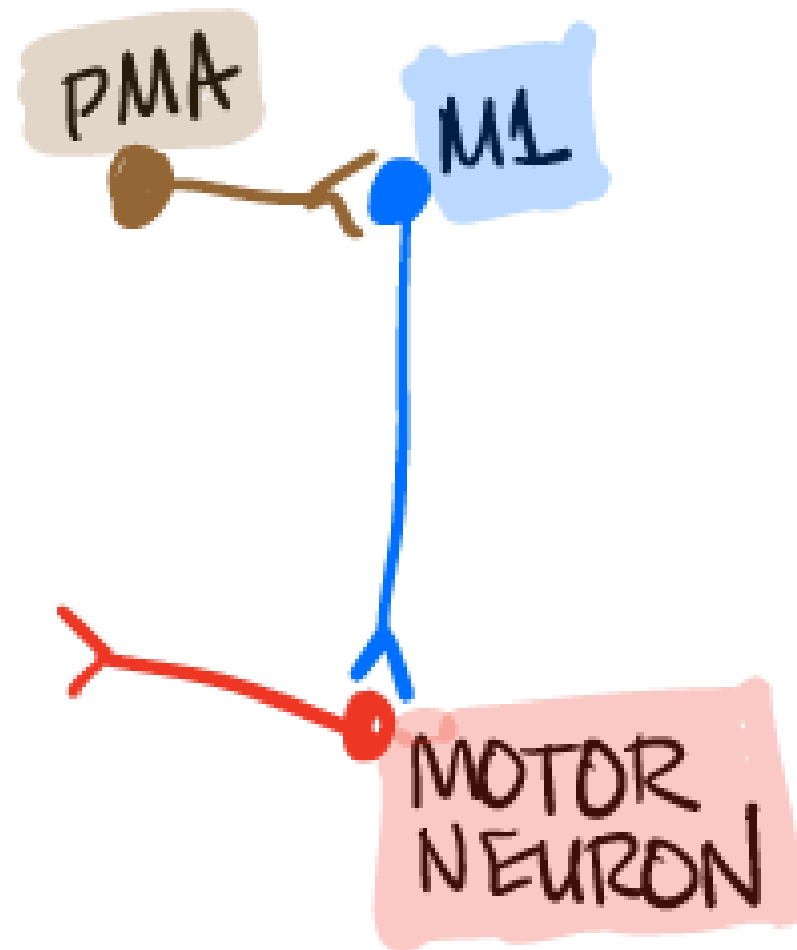
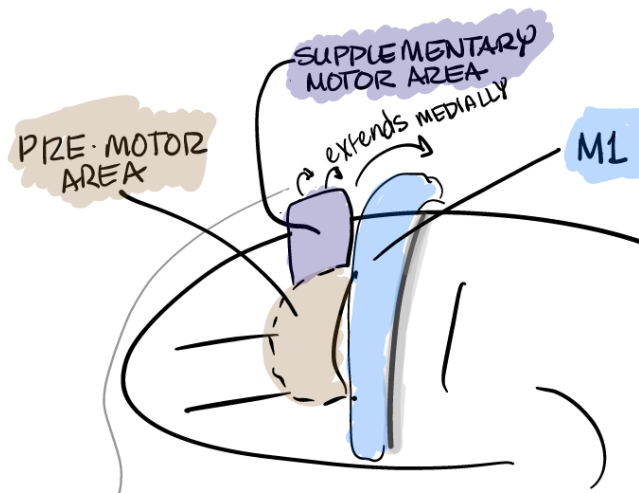
cerebellum has a body image all of the time

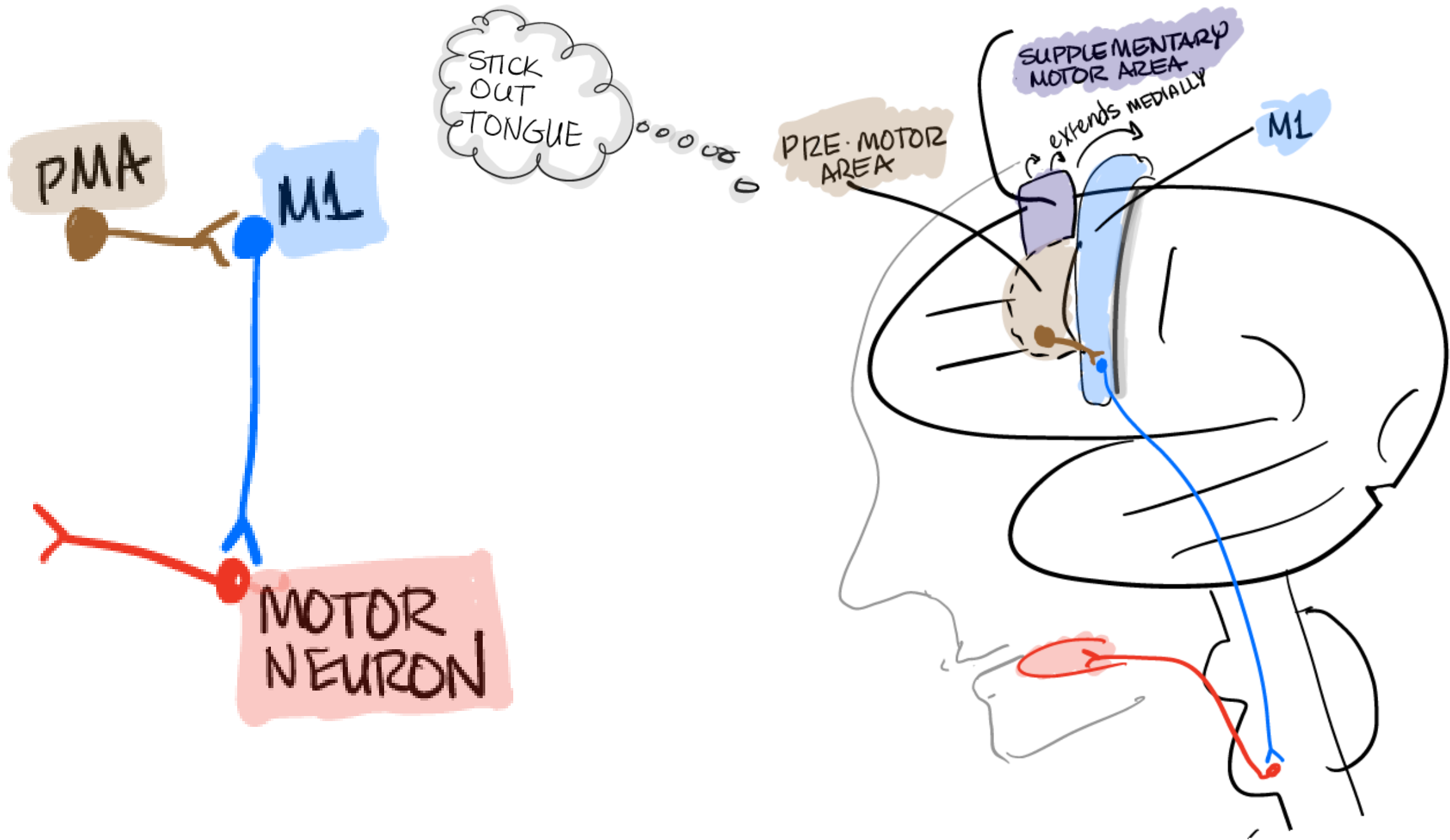




## PMA neurons

1. DO NOT HAVE A DIRECT CONNECTION TO THE MUSCLES
2. MOTOR PROGRAMS IN PMA STIMULATE M1 NEURONS
3. M1 NEURONS DO NOT HAVE PLANNING CAPACITY  $\Rightarrow$  THEY ARE ORCHESTRATED BY PMA
4. BI-LATERAL PRIMITIVE SMA SUPPLEMENTARY MOTOR AREA

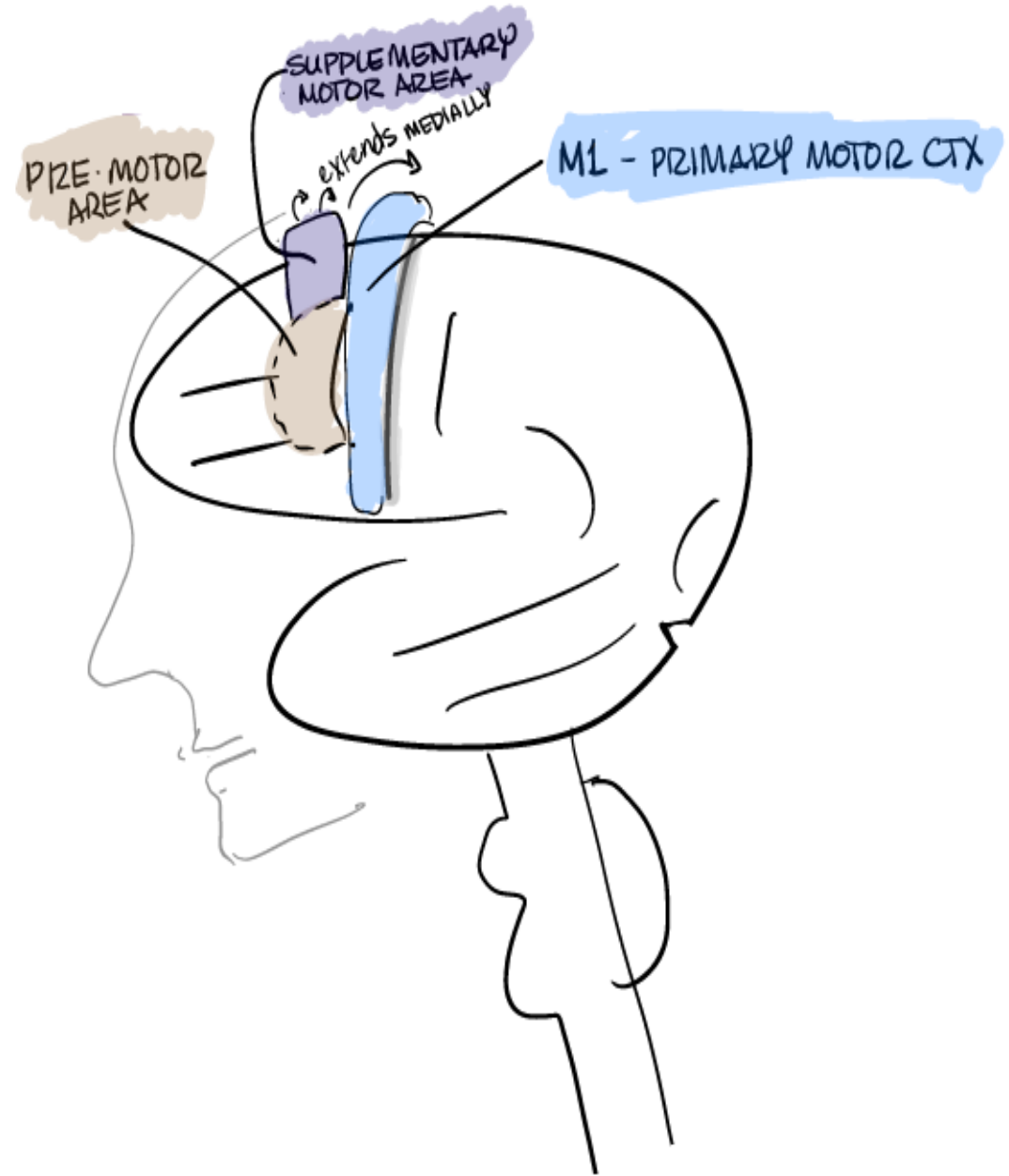




# SUPPLEMENTARY MOTOR AREA SMA PLANS

- CONCERNED WITH VERY PRIMITIVE MVMTS
- LOWER ANIMAL MVMTS
  - ↳ TRUNK CONTROL
- LOWER SPINE & HIP MOVEMENTS
- BILATERAL MOVEMENT IS ELICITED WHEN SMA IS STIMULATED

AXIAL  
MUSCLES



# ELECTRICAL STIMULATION

VS.



- A COORDINATED MVMT WILL OCCUR
- MEANINGFUL MVMTS

- A SINGLE OR A COUPLE OF MUSCLES WILL MOVE

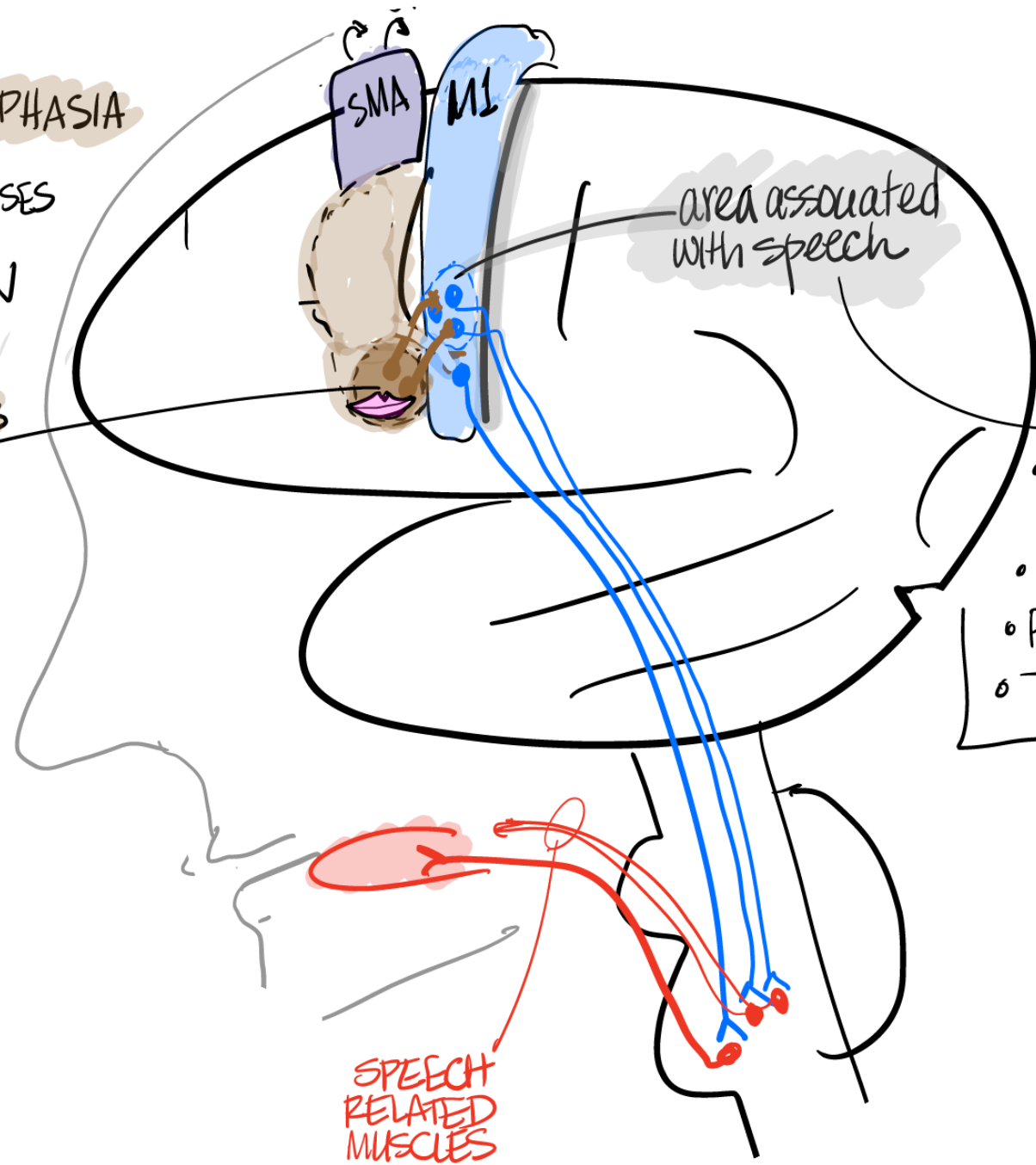


# BROCA'S APHASIA

DAMAGE CAUSES  
SPEECH  
PRODUCTION

## BROCA'S AREA

↳ PLAN  
SPEECH



## FAUCAL EXPRESSION

- LARYNX
- PHARYNX
- TONGUE

STIM  
CONTRALATERAL  
FEF

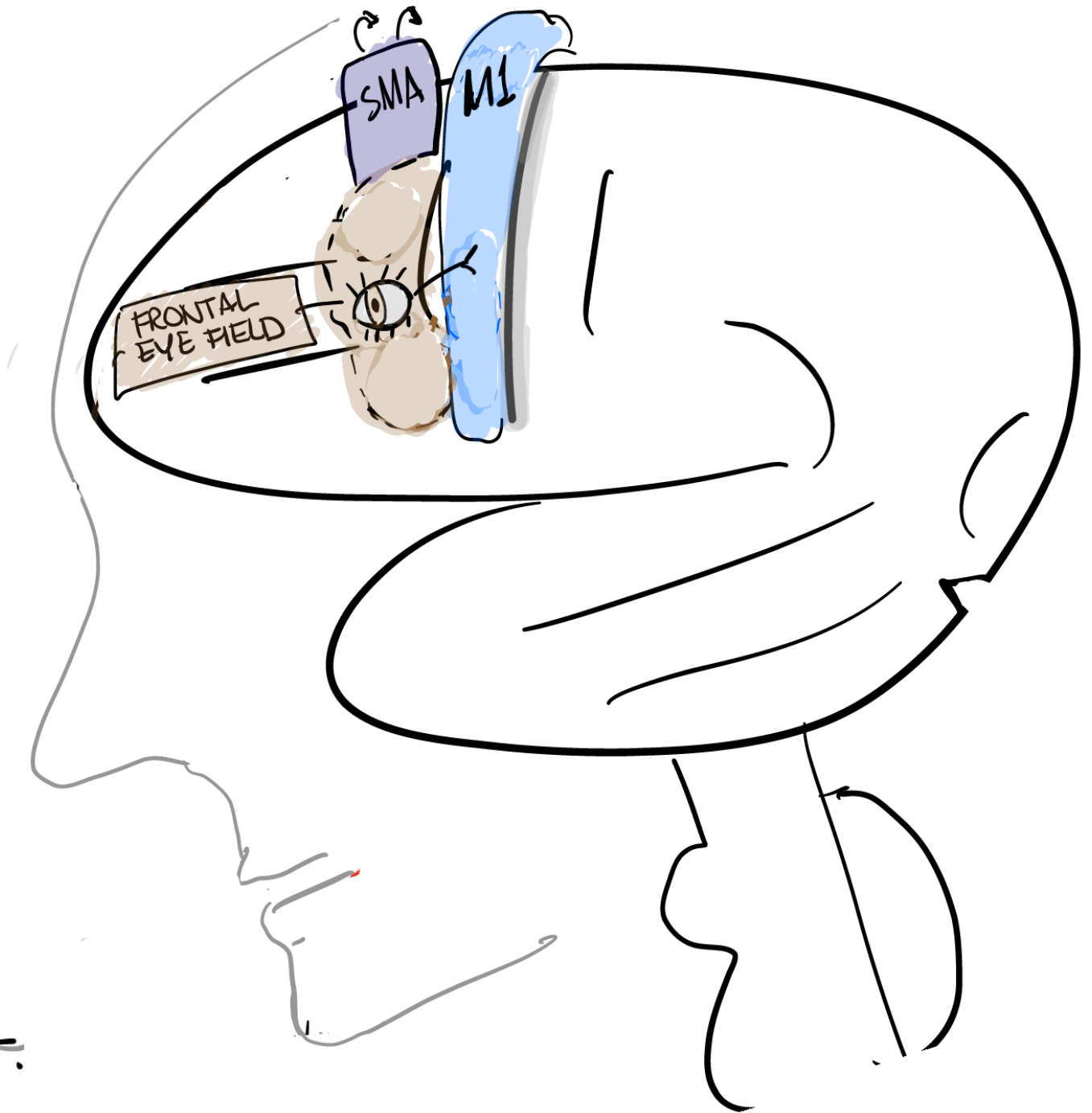


← EYE GAZE  
UP & OPPOSITE  
SIDE

FEF: CONJUGATE MVMT  
TO CONTRALATERAL  
SIDE - EPILEPSY  
- CANCER  
TUMORS



BOTH FEF ARE  
STIMULATED  
WHEN LOOKING STRAIGHT.



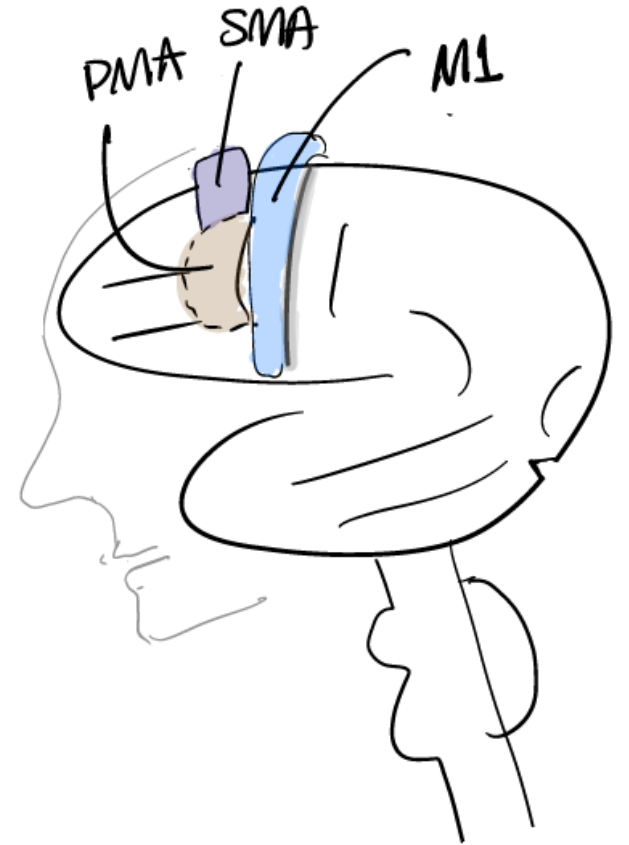
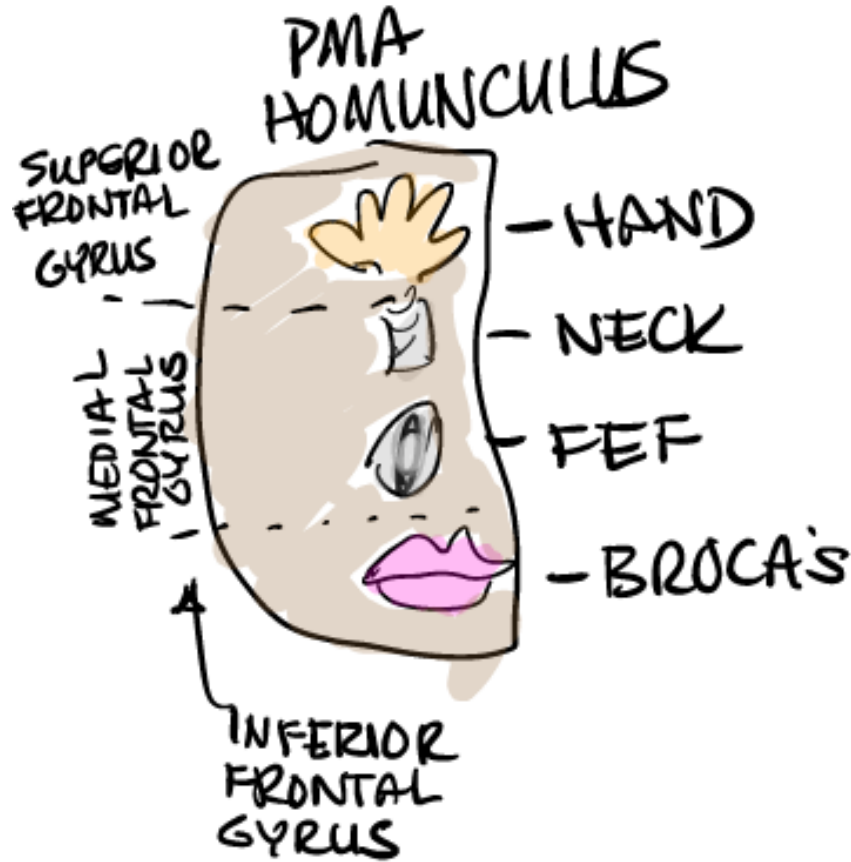




# PREMOTOR AREA HOMUNCULLUS

→ BODY MAPPED WITH MOTOR PURPOSE

eg  $\rightarrow$  STIMULATE HAND AREA  $\rightarrow$  WAVING OR TYPING  
WANT

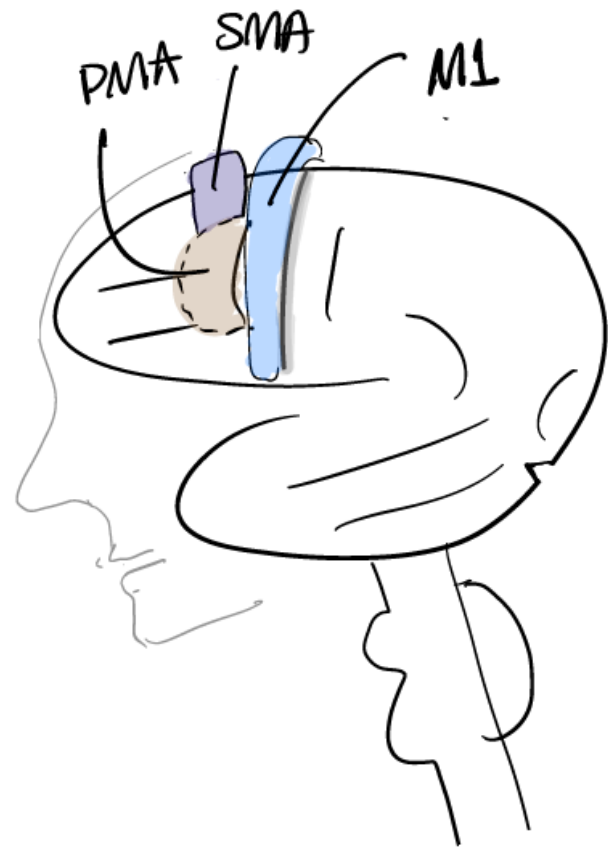
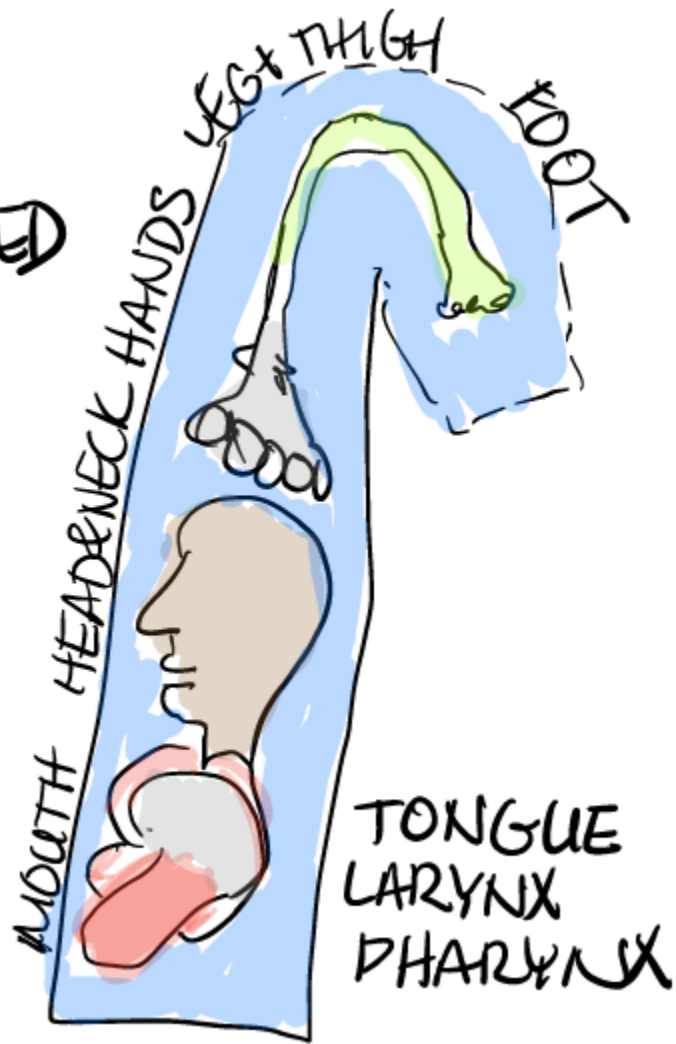




# HOMUNCULUS

PRIMARY  
MOTOR  
HOMUNCULUS

DETAILED



# SUPPLEMENTARY MOTOR AREA HOMUNCULUS

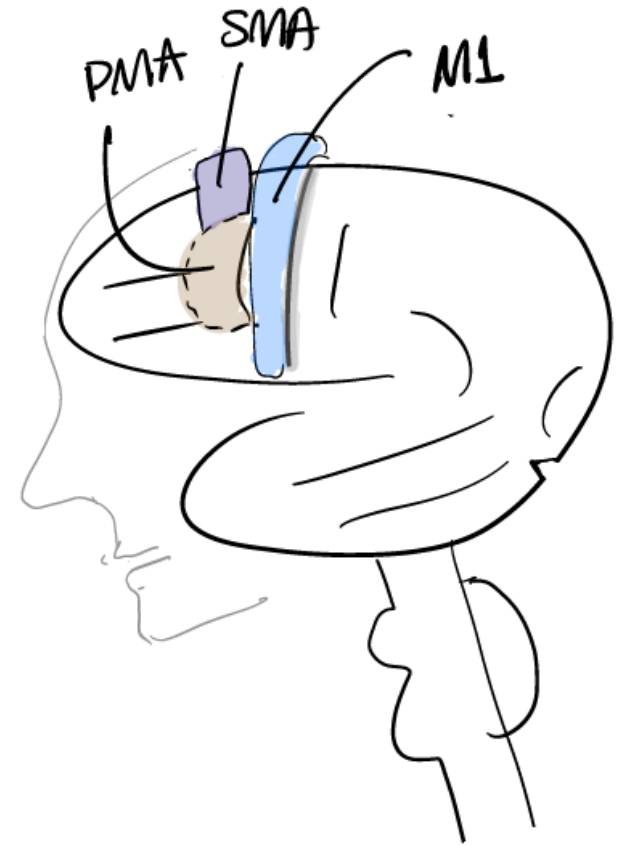
eg → HAND AREA STIMULATED  
⇒ BILATERAL PRIMITIVE MOVTS



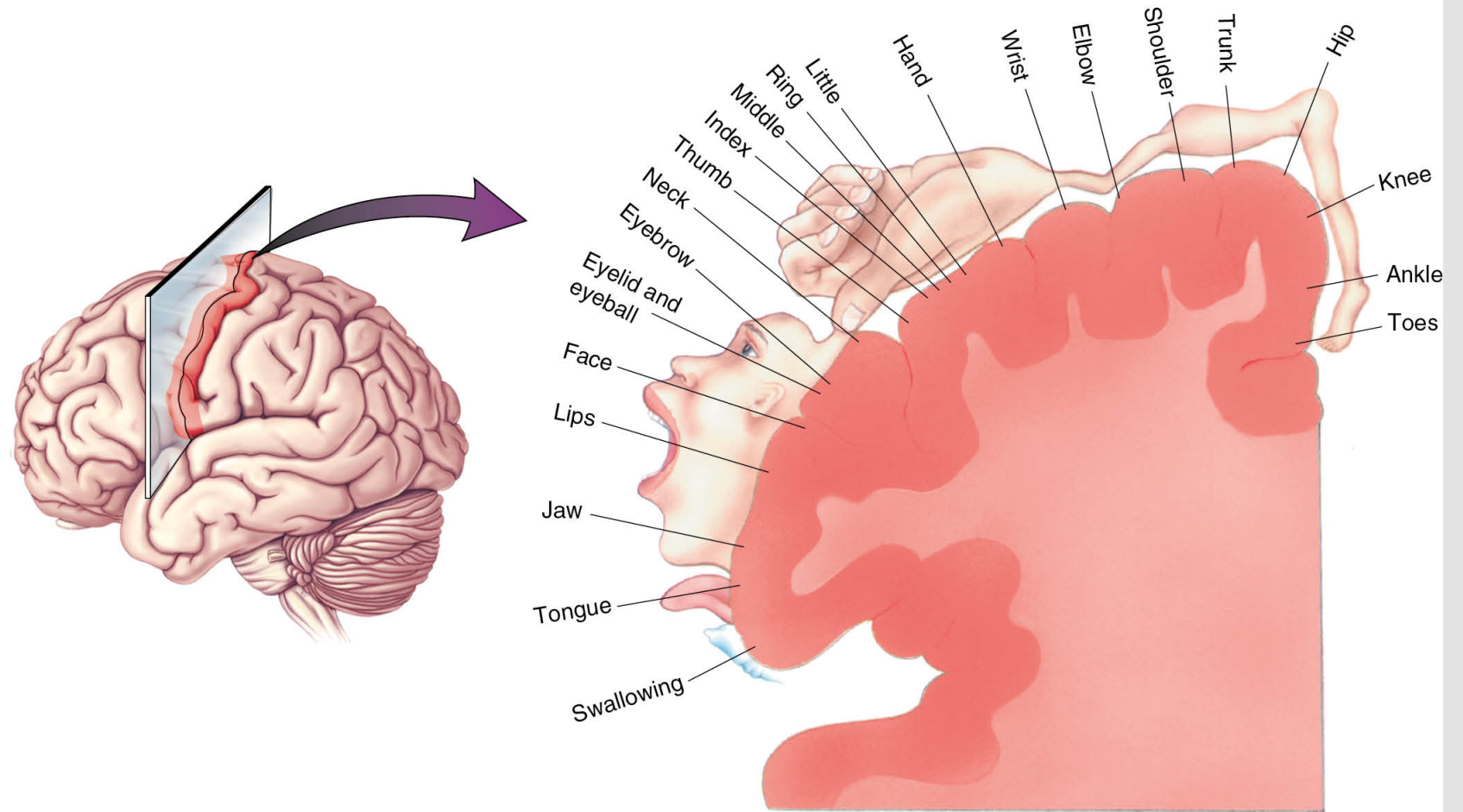
BILATERAL MOVTS  
- CLIMBING A ROPE



SWINGING  
HANGING  
MOVEMENTS

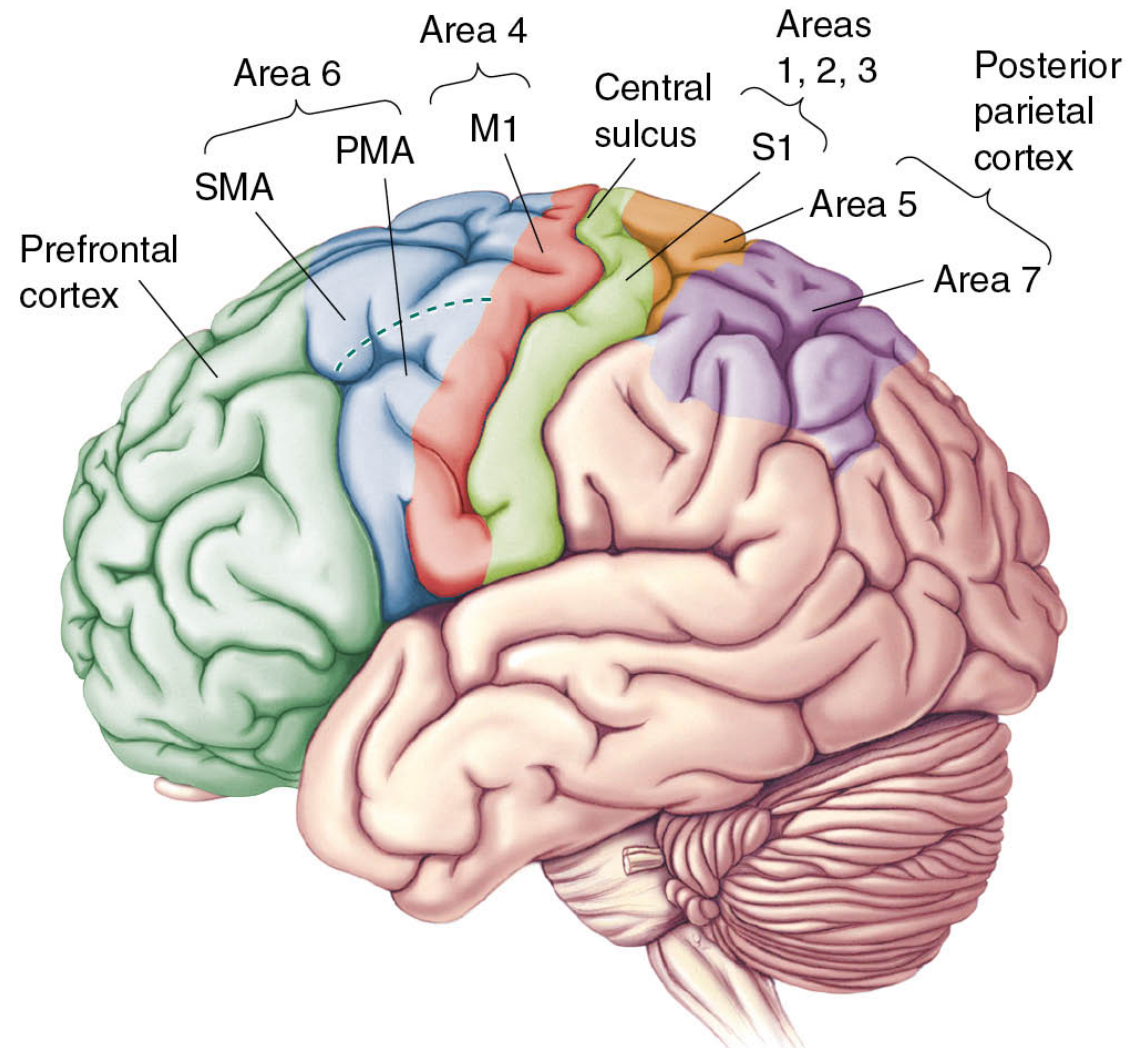


# Somatotopic Motor Map of Precentral Gyrus



## The Planning of Movement by the Cerebral Cortex

- Motor cortex: areas 4 and 6 of the frontal lobe



# Motor Cortex— Penfield's Research

- Area 4: primary motor cortex, or M1
- Area 6: “higher” motor area (Penfield)
  - Lateral region → premotor area (PMA)
  - Medial region → supplementary motor area (SMA)
  - Motor maps in PMA and SMA
    - Similar functions, different groups of muscles innervated



# Thought to Action



## hierarchy of control levels

- The brain influences motor activity of the spinal cord.
  - Initiates voluntary movements
- Sensorimotor system
  - Sensory information used by all levels of the motor system

HIGHEST LEVEL

STRATEGY

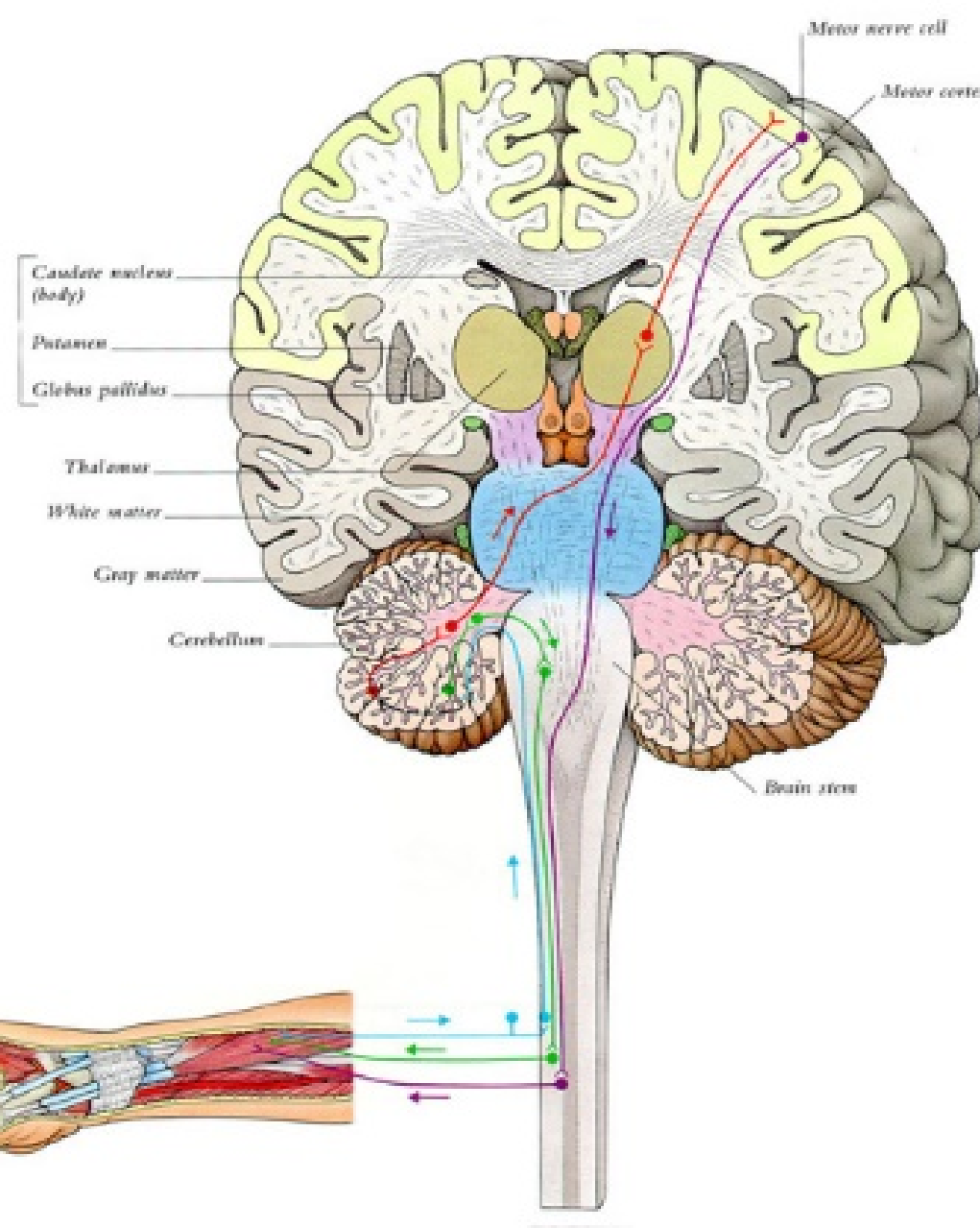
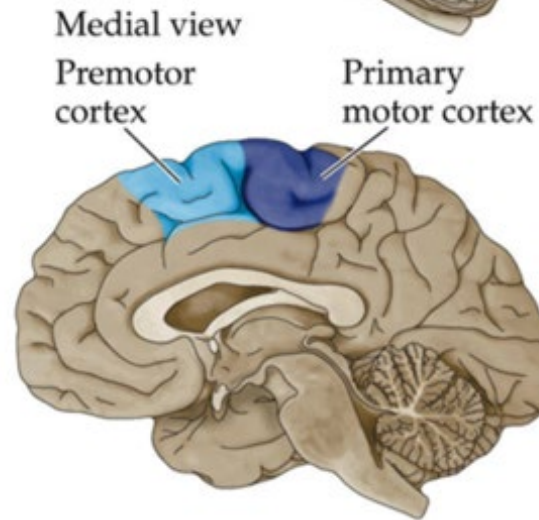
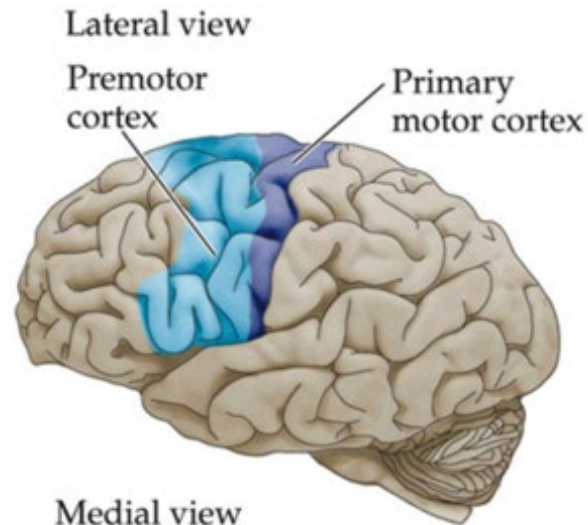
MIDDLE LEVEL

TACTICS

LOWEST LEVEL

EXECUTION





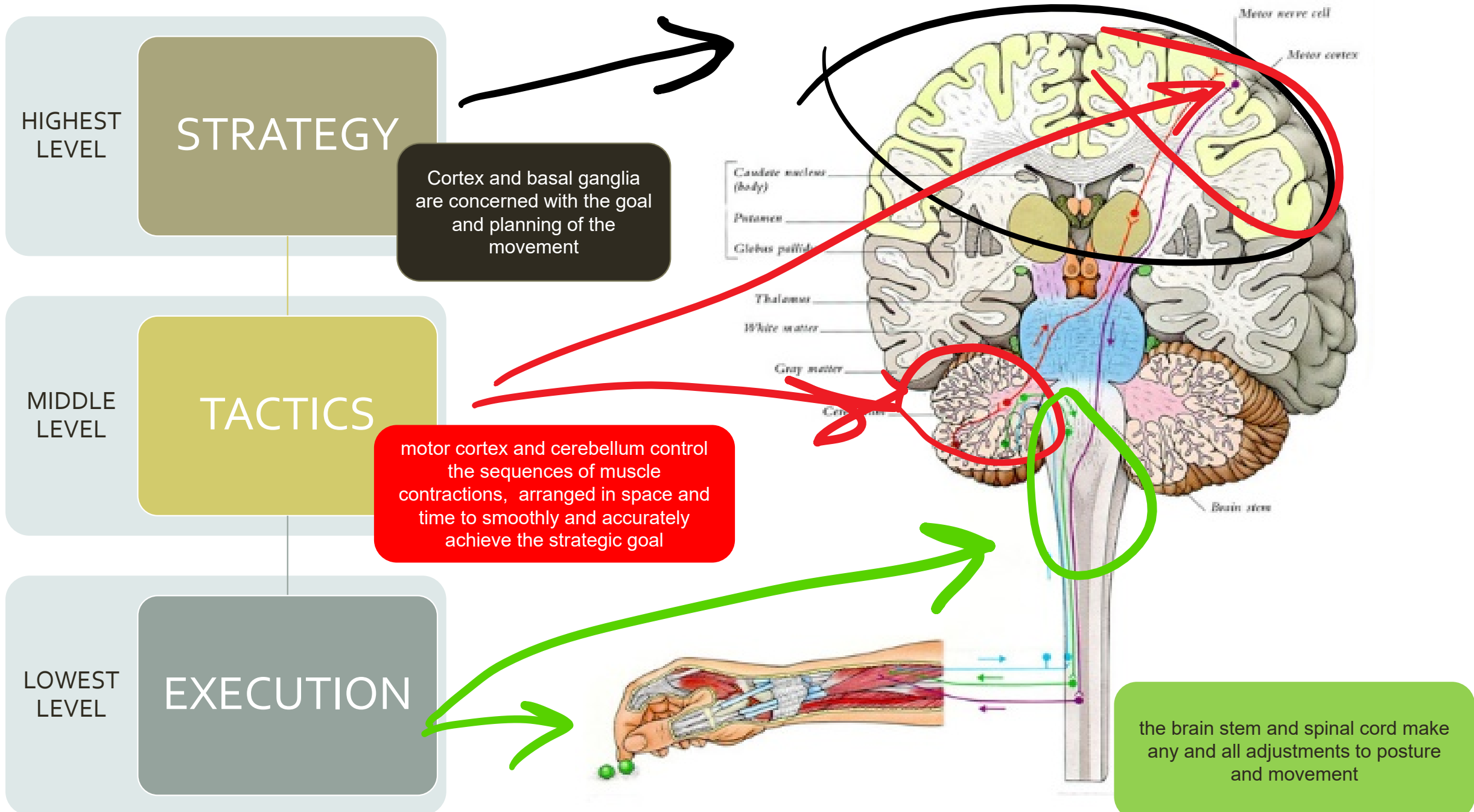
Cortex sends motor message to muscles

Sensory cell in muscle (monitoring movement) sends message to cerebellum

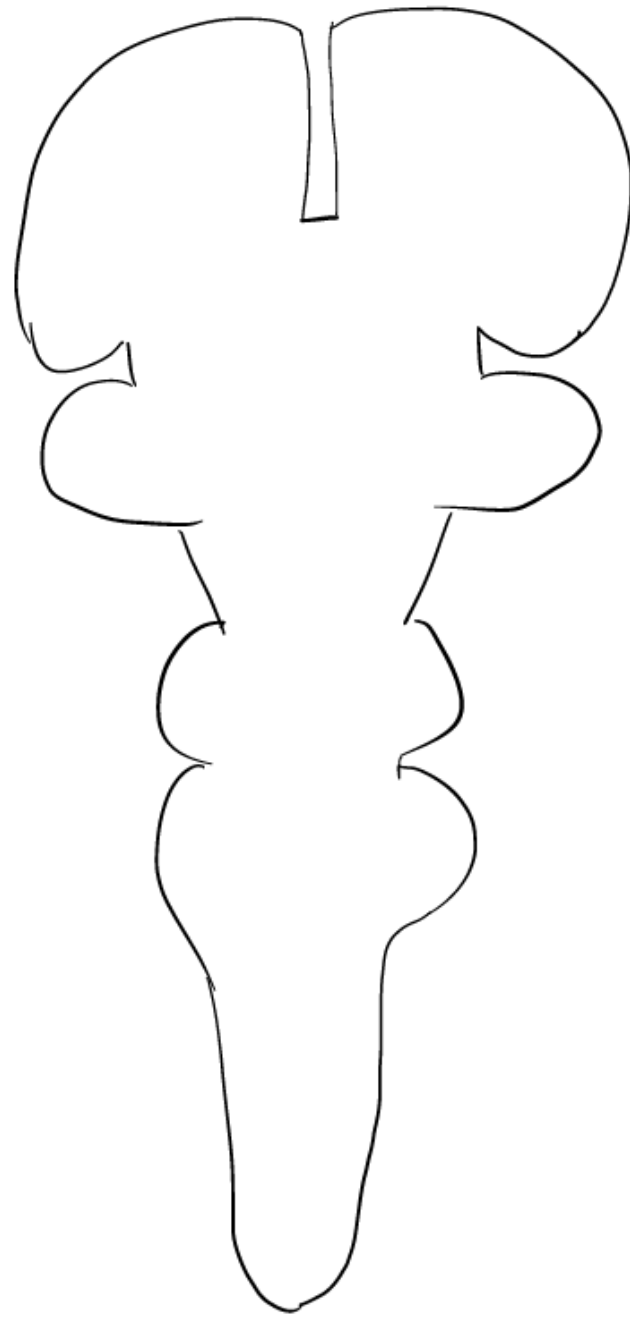
Cerebellum sends corrective signals via the thalamus to cortex to keep movements on course

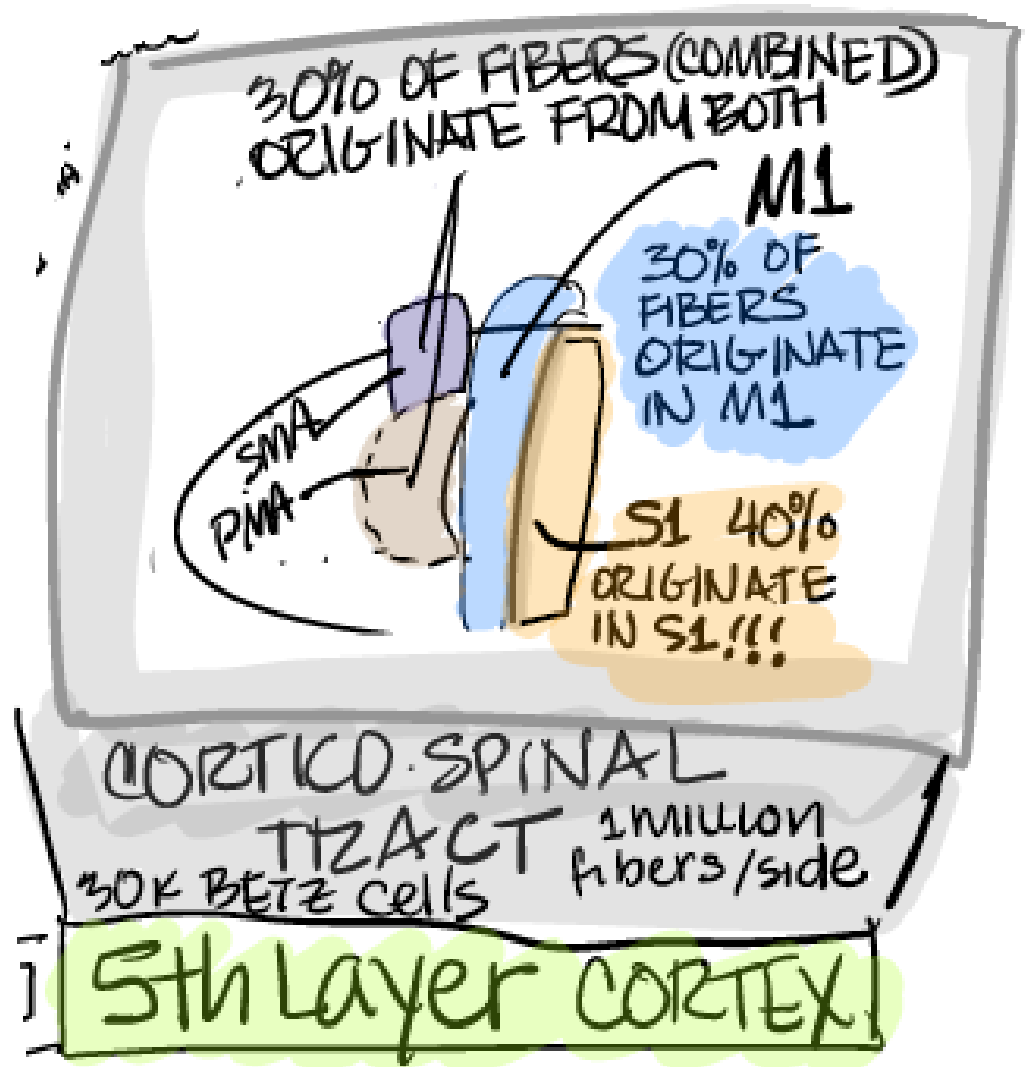
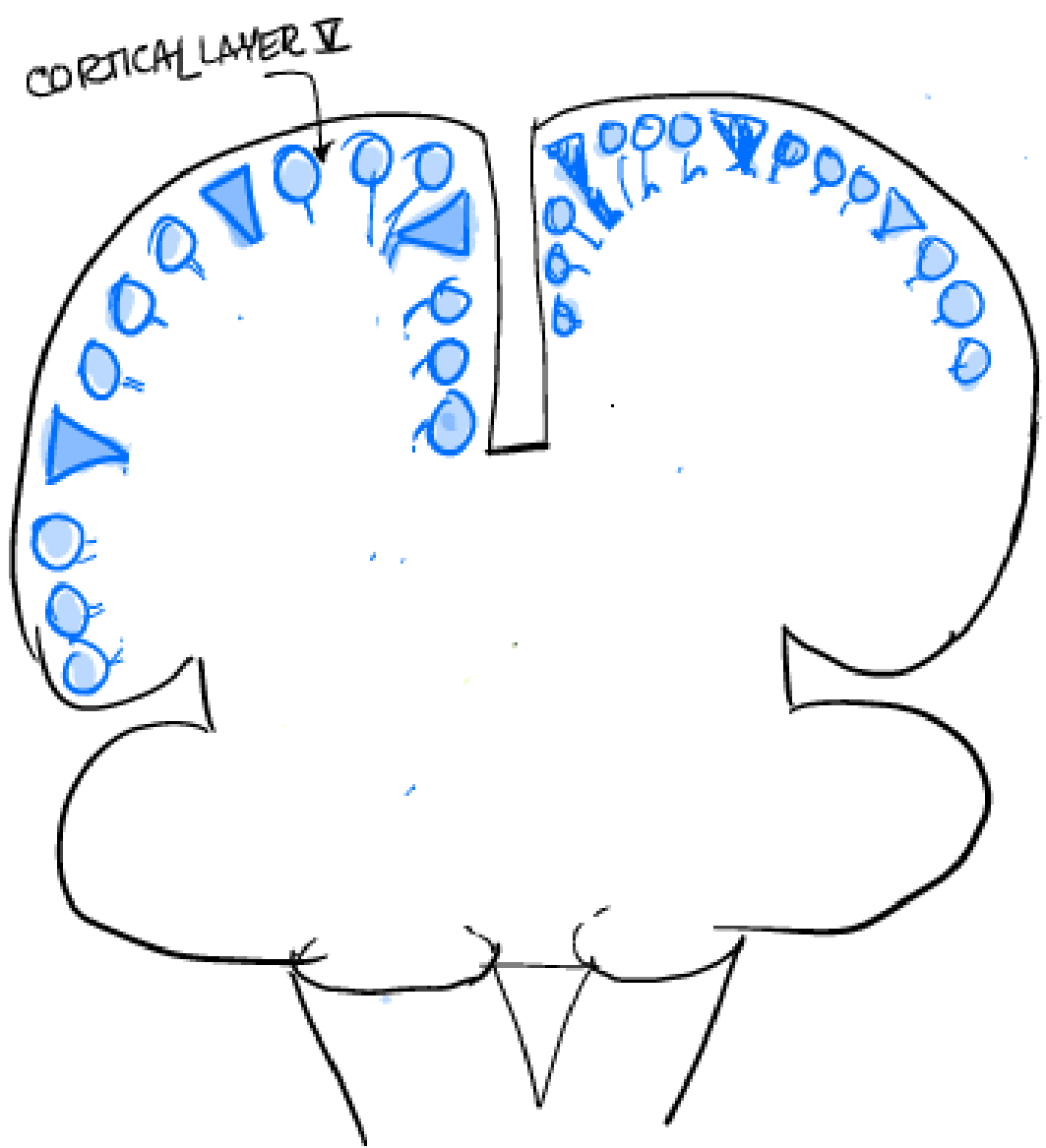
Cerebellum also sends signal via the spinal cord to muscle to correct the muscle directly



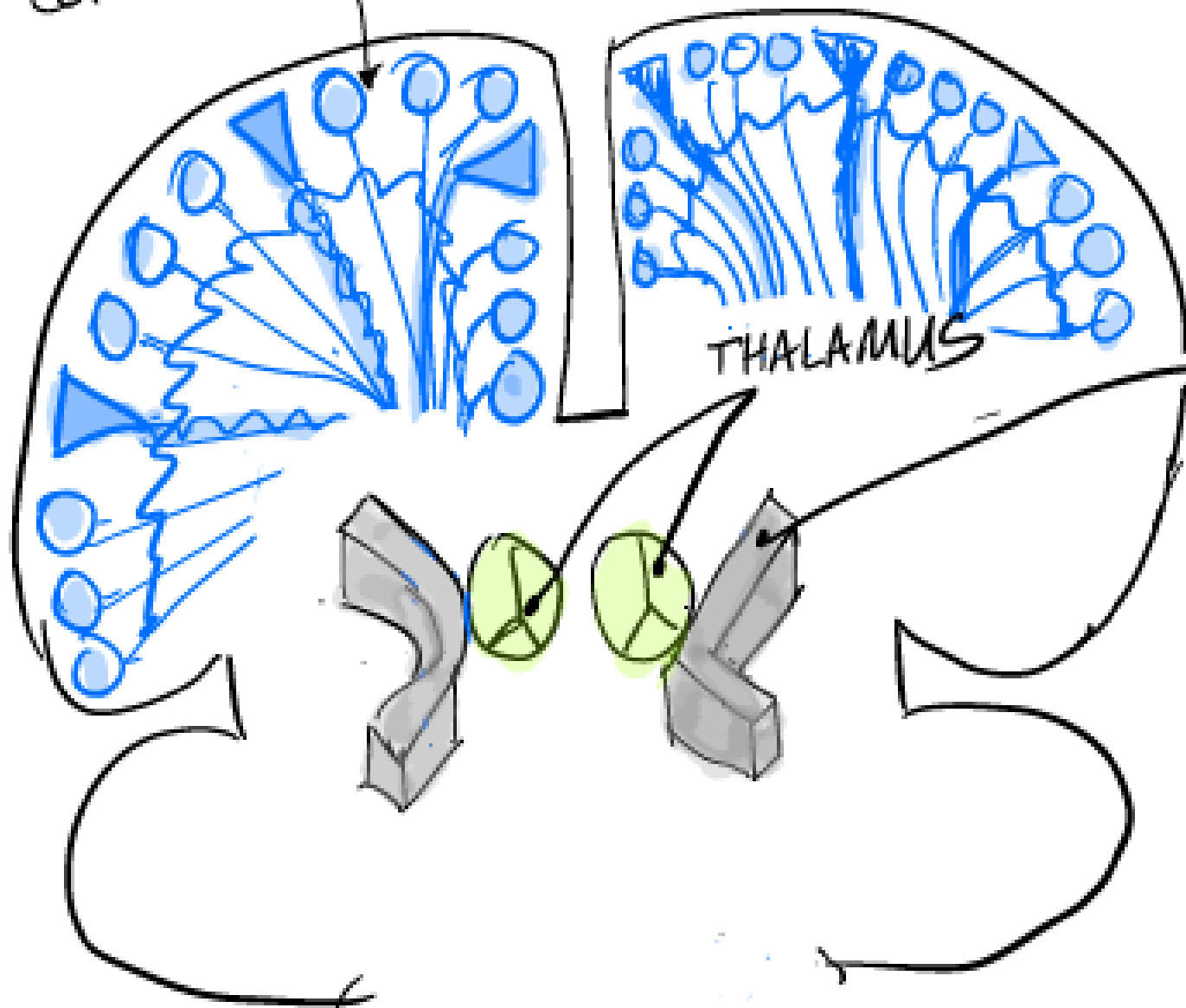


Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience : Exploring the Brain*. China: Wolters Kluwer, 2016. Print.



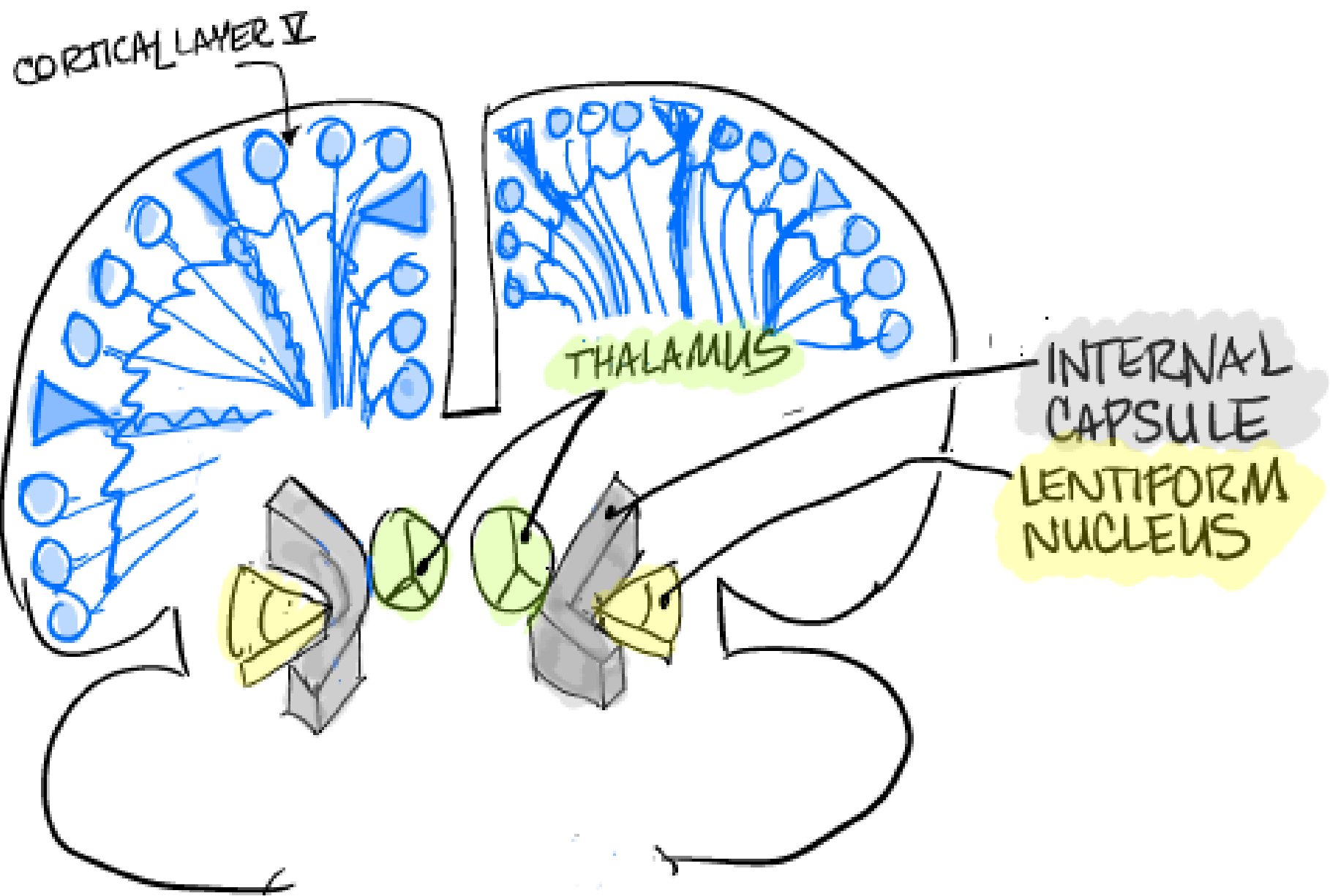


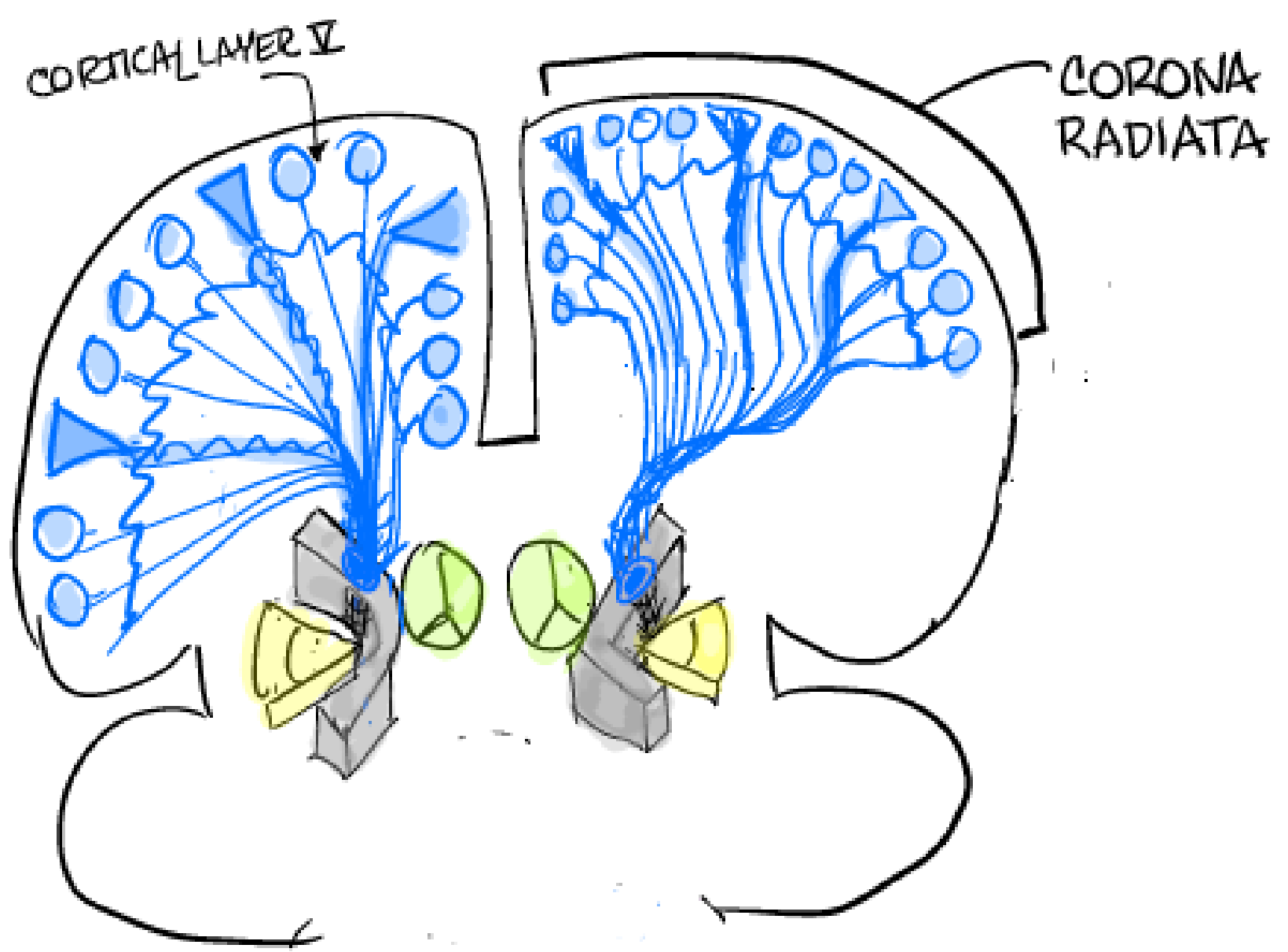
CORTICAL LAYER V

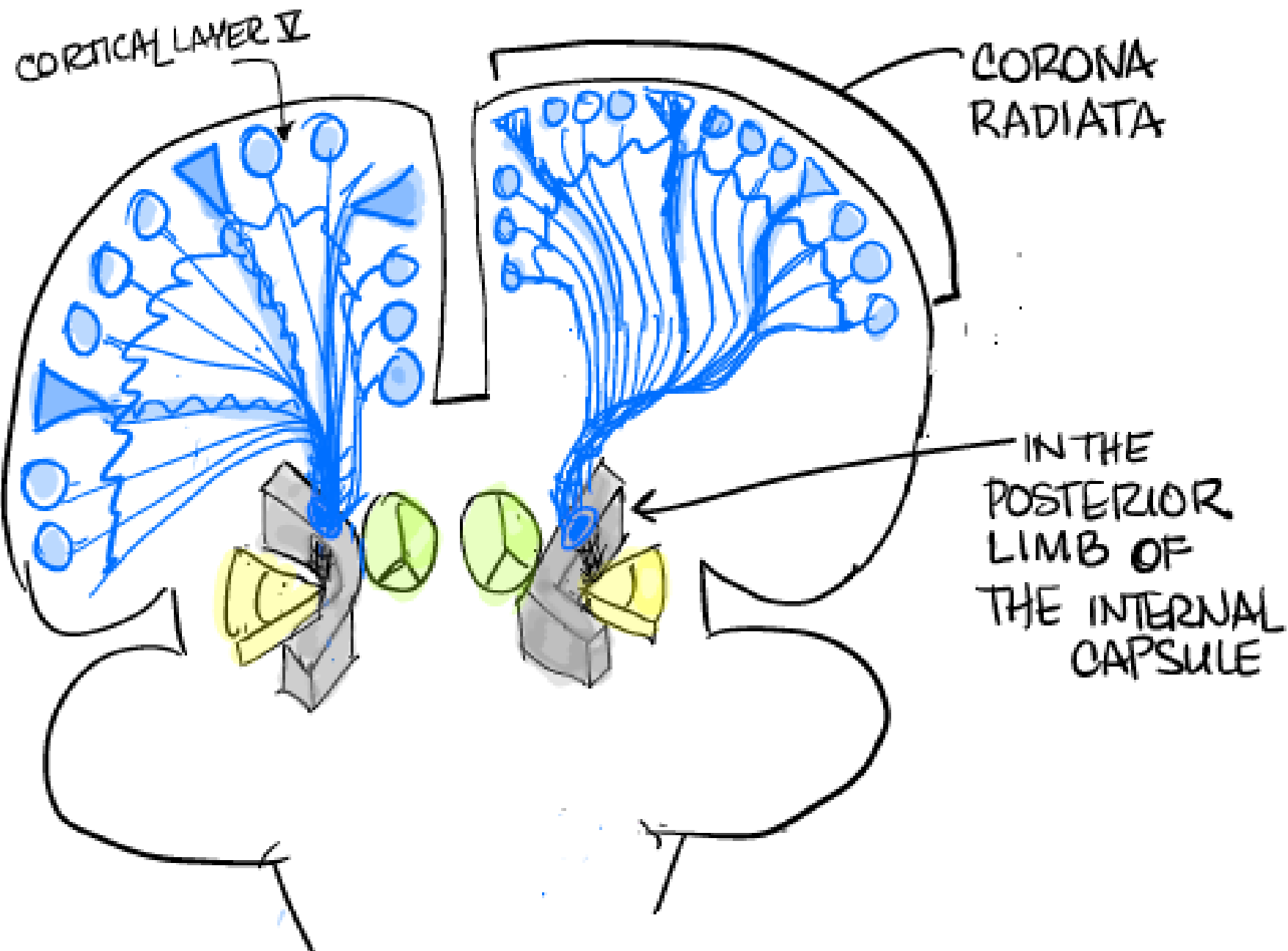


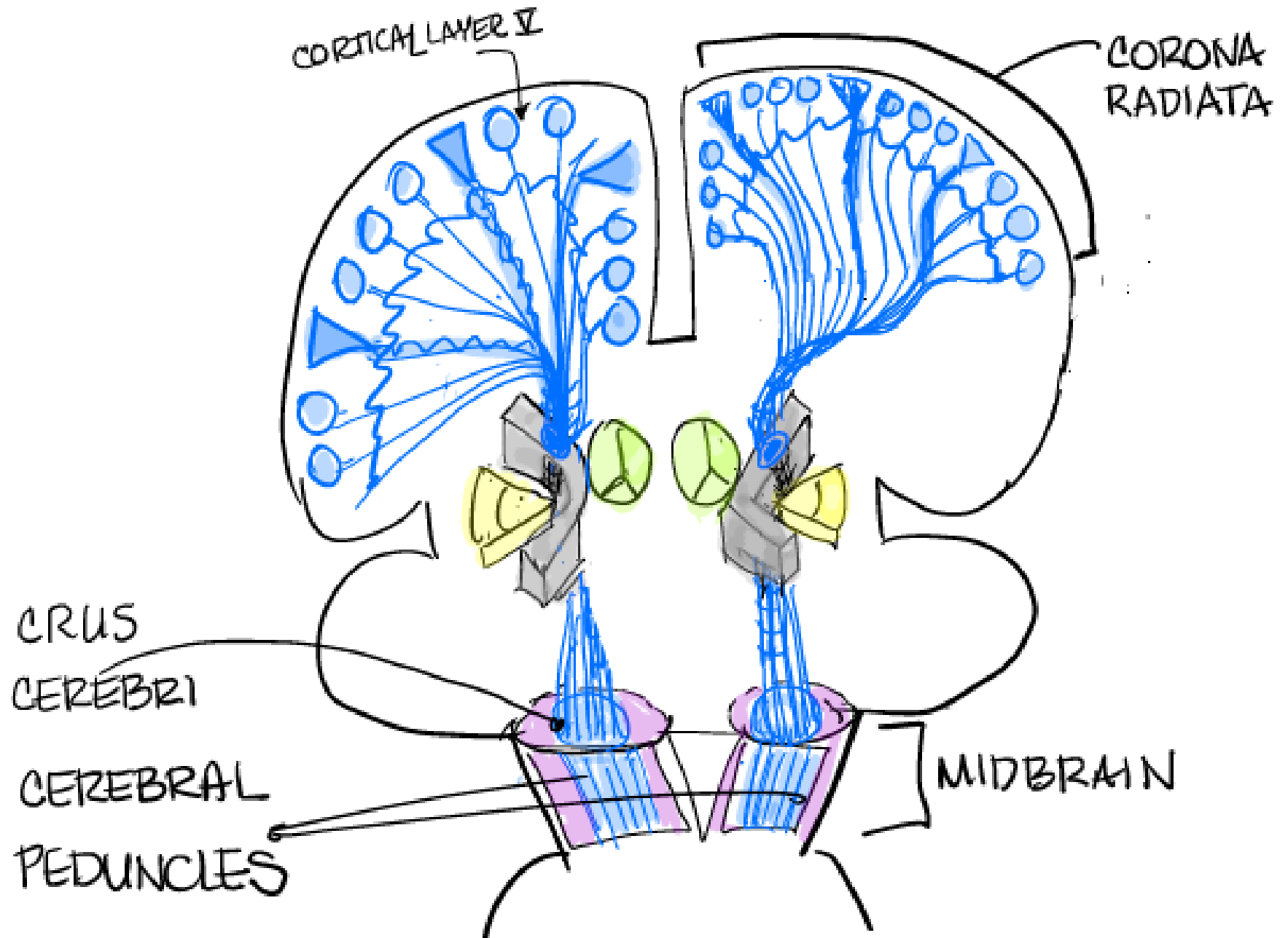
THALAMUS

INTERNAL CAPSULE

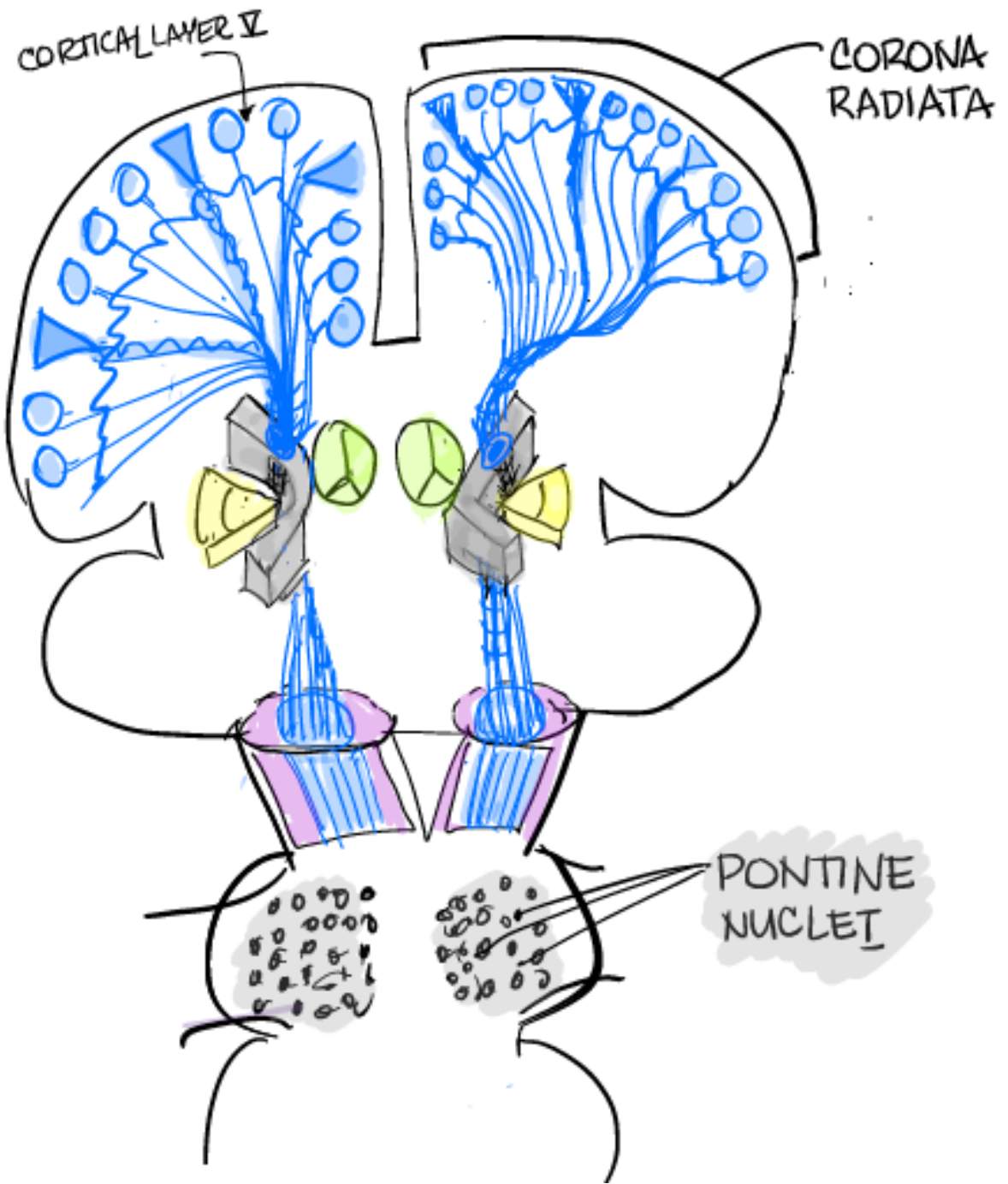


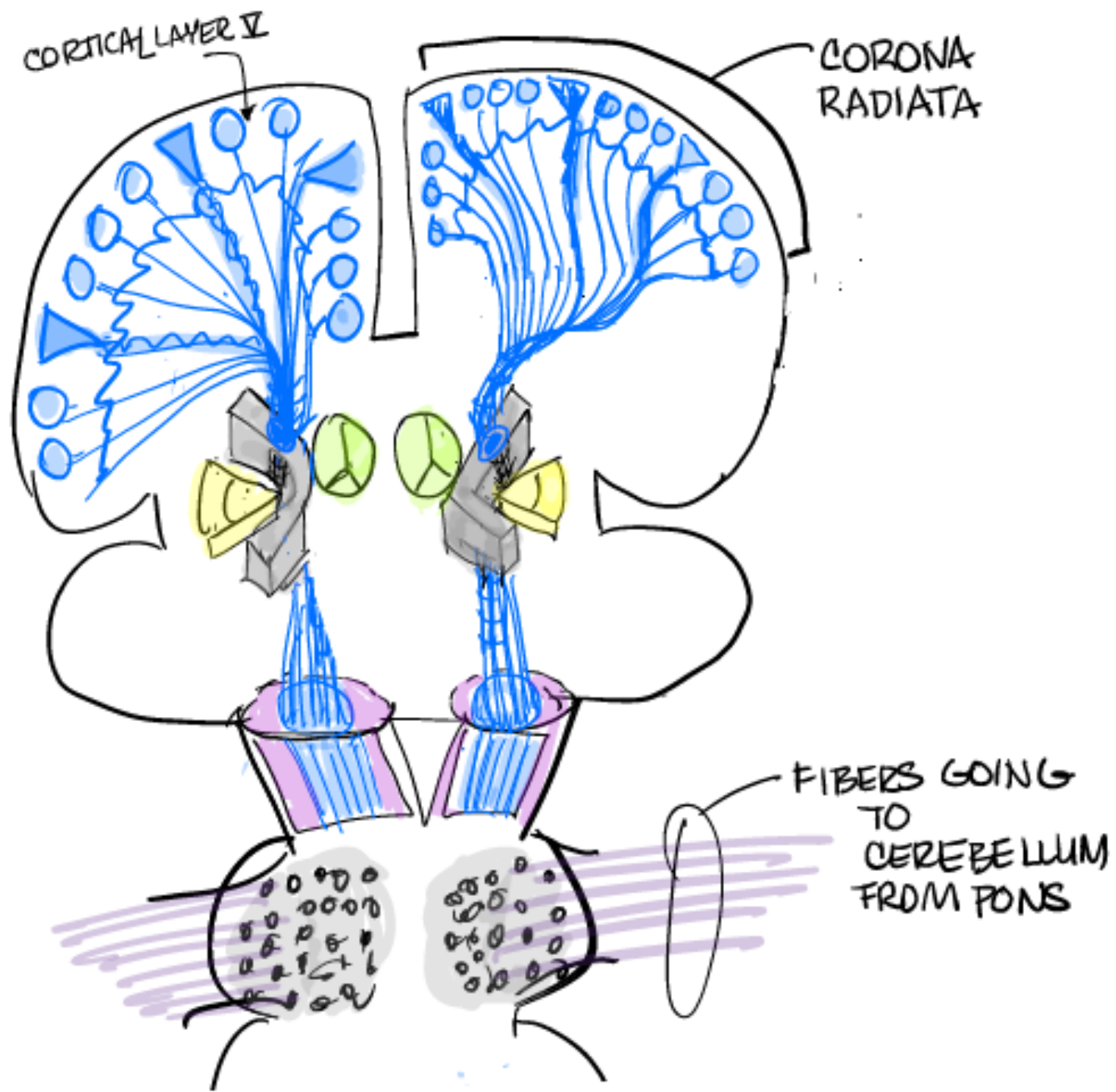


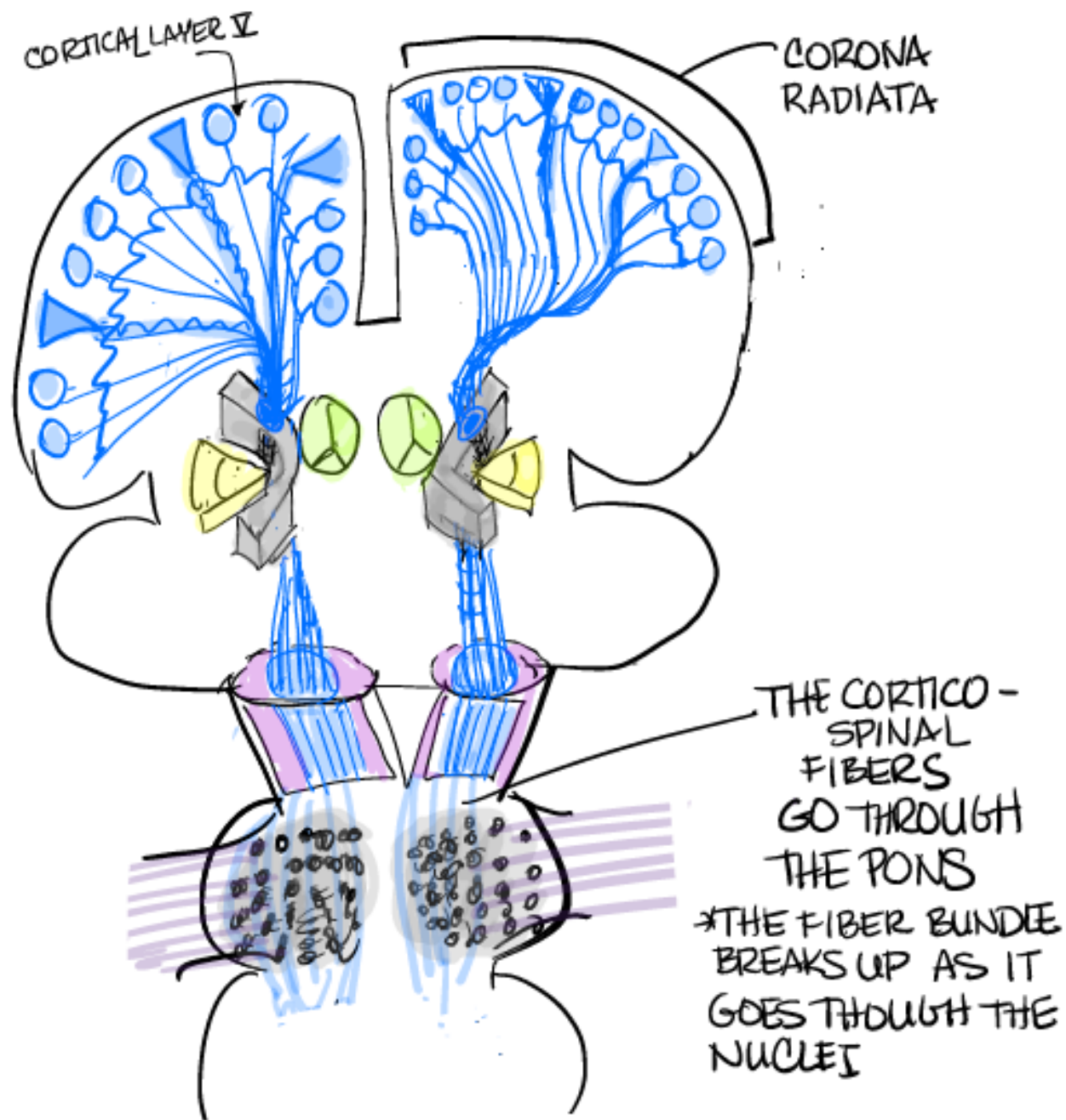






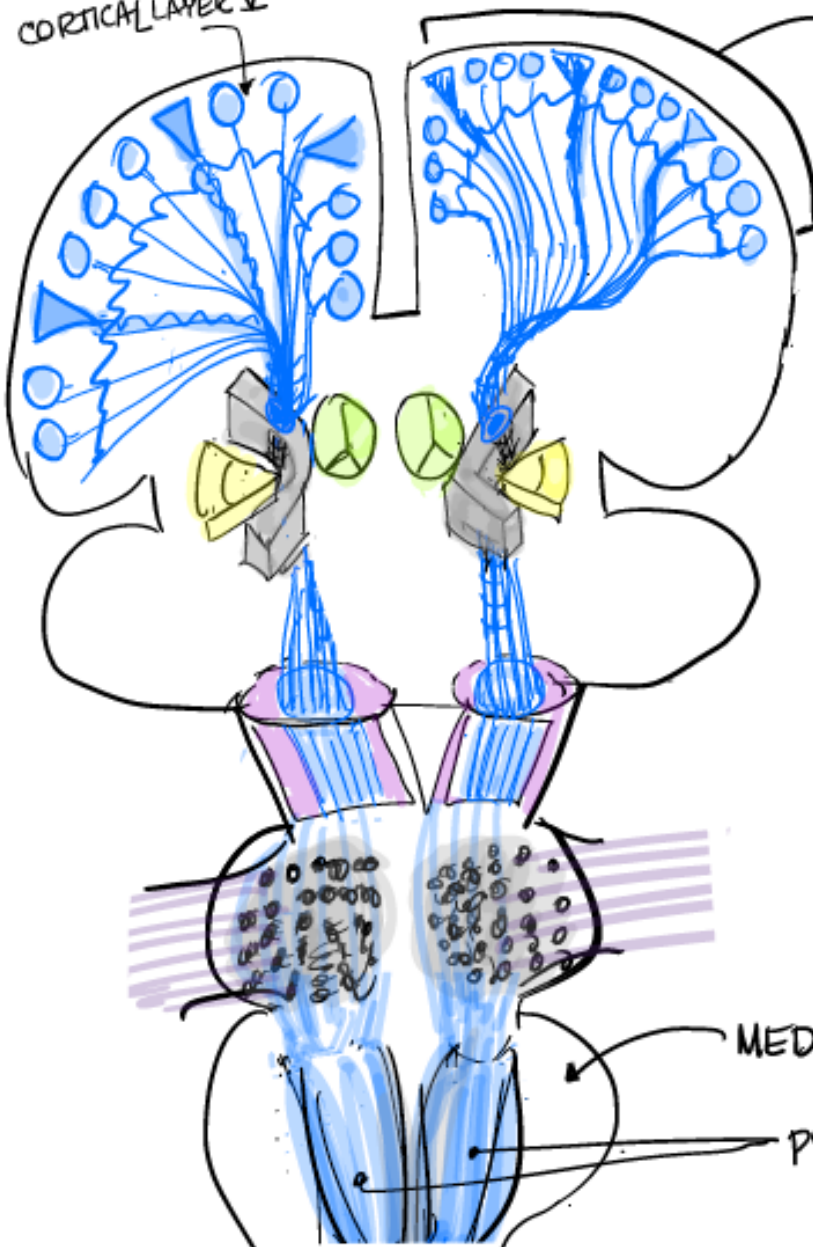






CORTICAL LAYER V

CORONA  
RADIATA

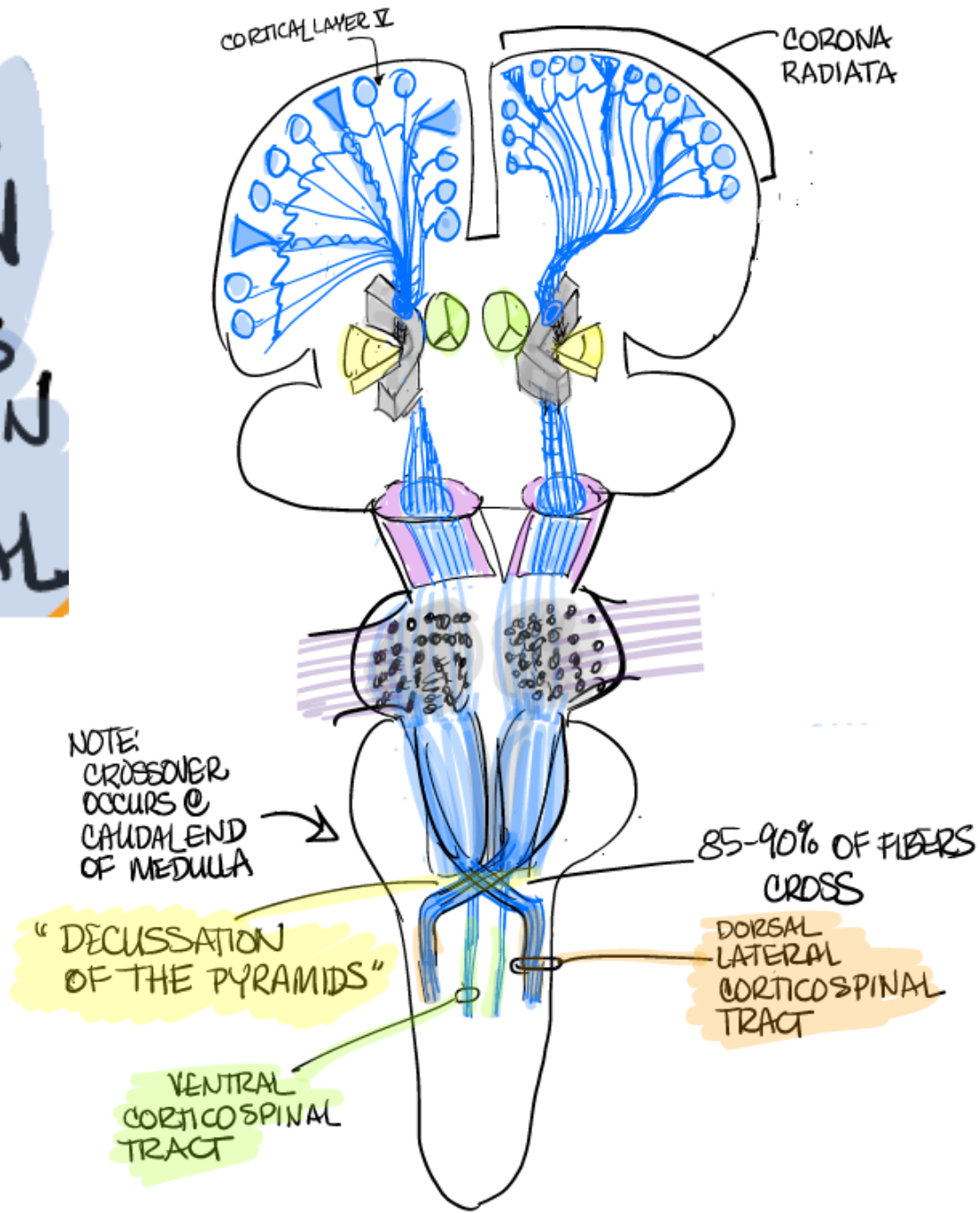


MEDULLA

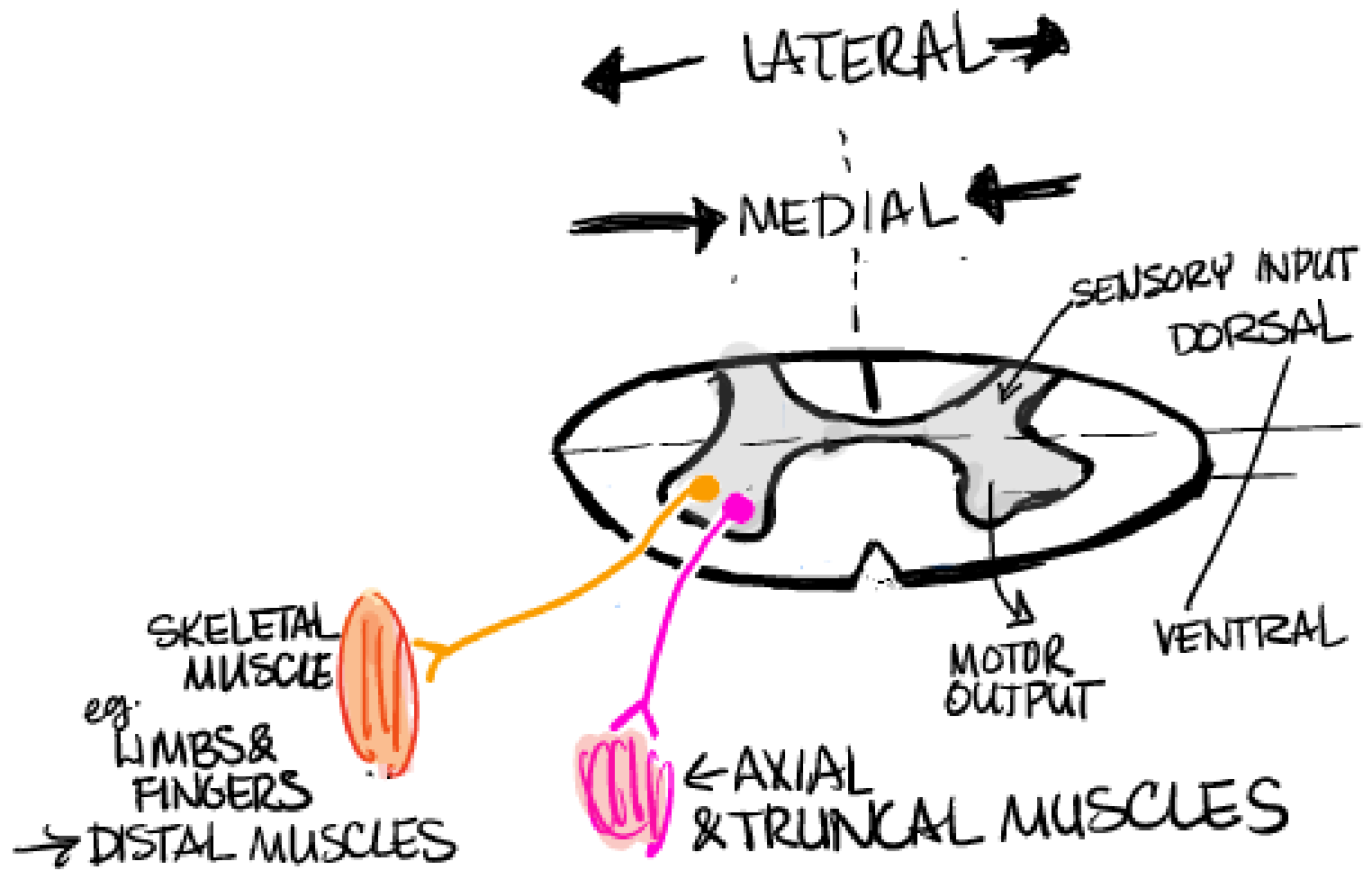
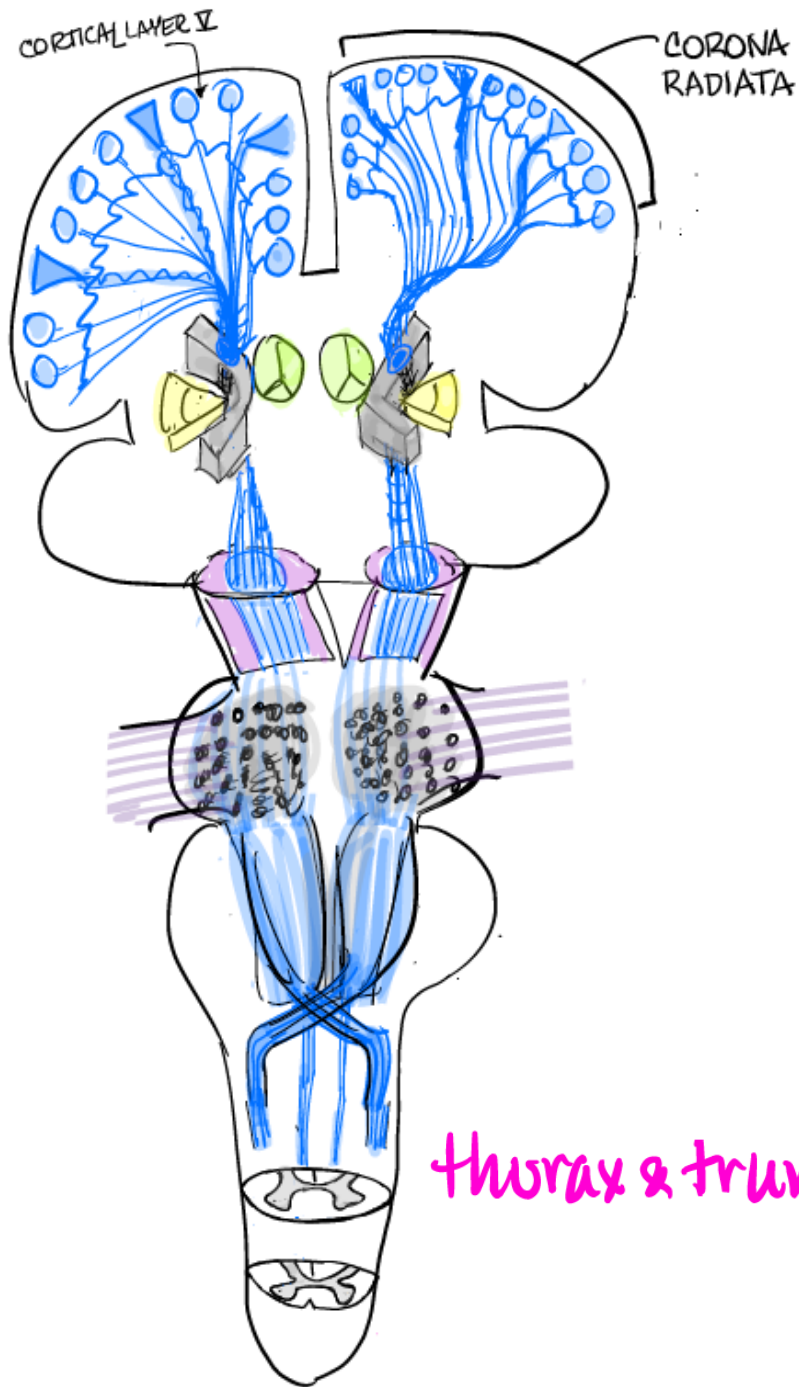
PYRAMIDS

# PYRAMIDAL DECUSSATION

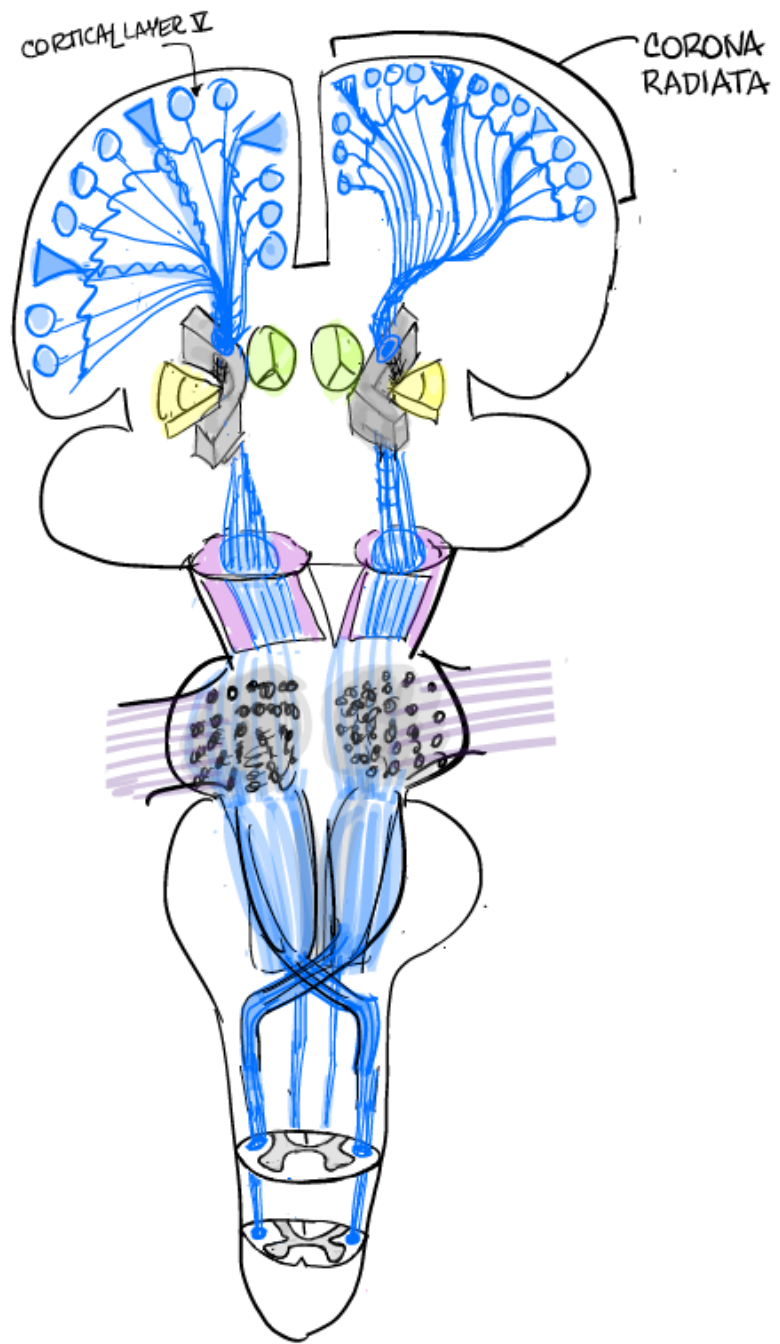
NOTE: ALL LESIONS ABOVE DECUSS'N WILL BE CONTRALATERAL

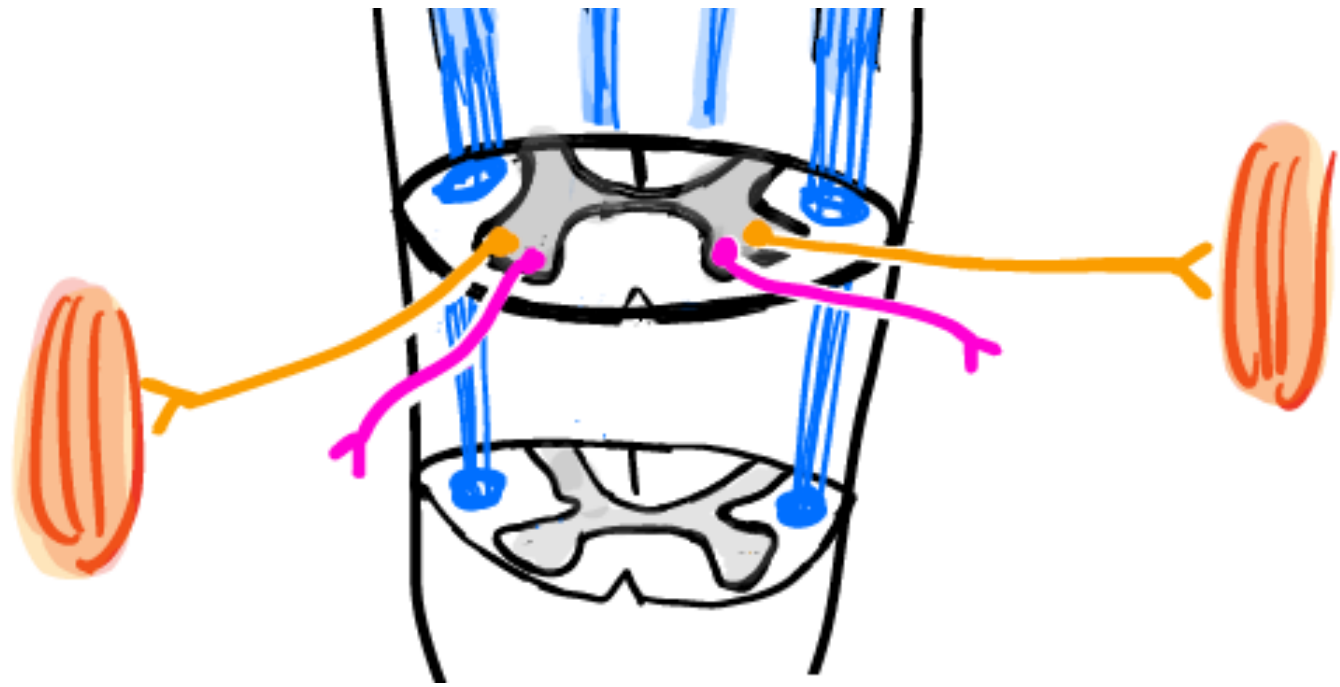
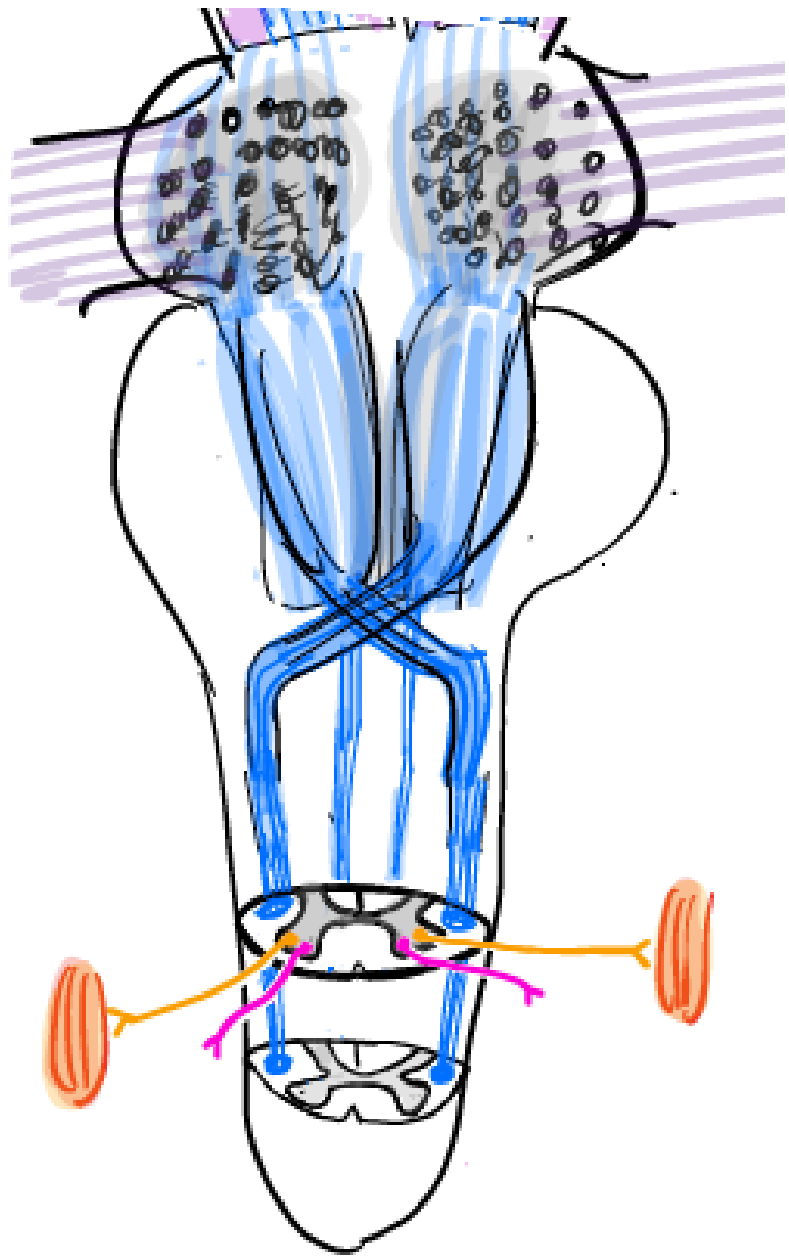




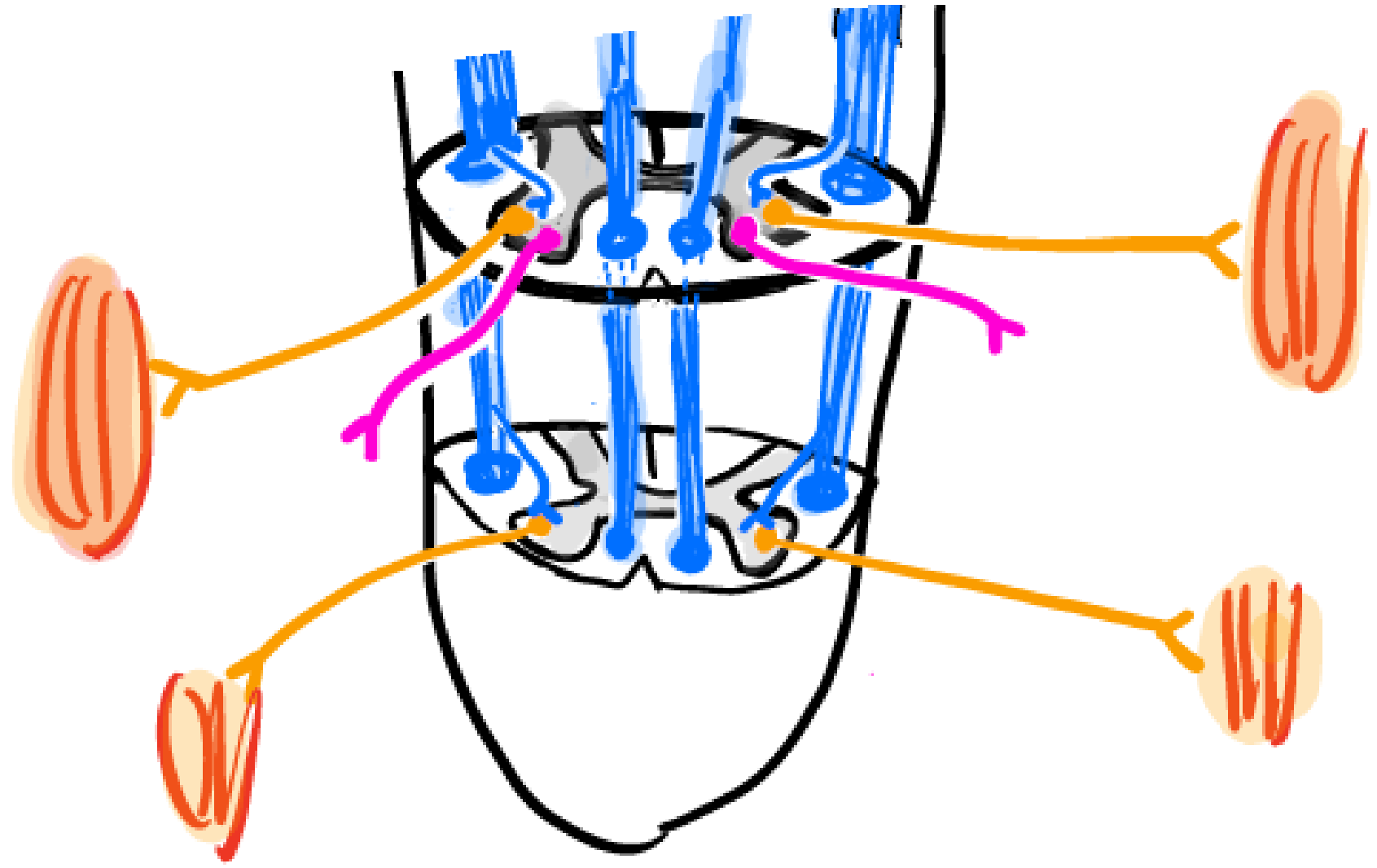
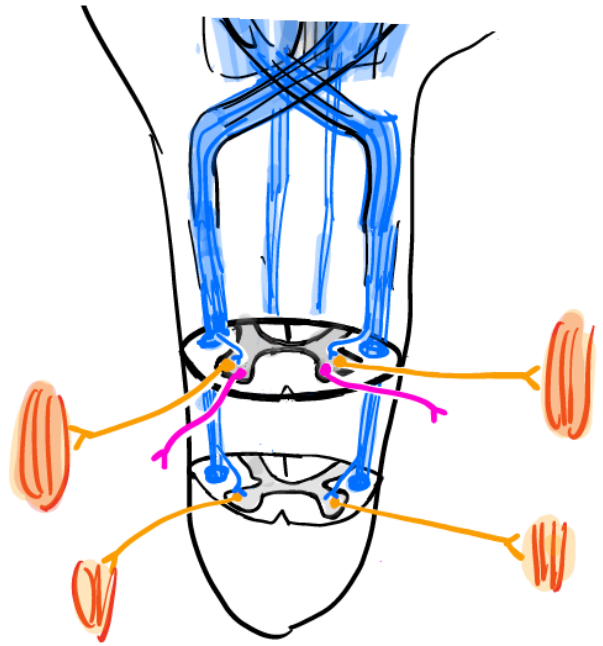


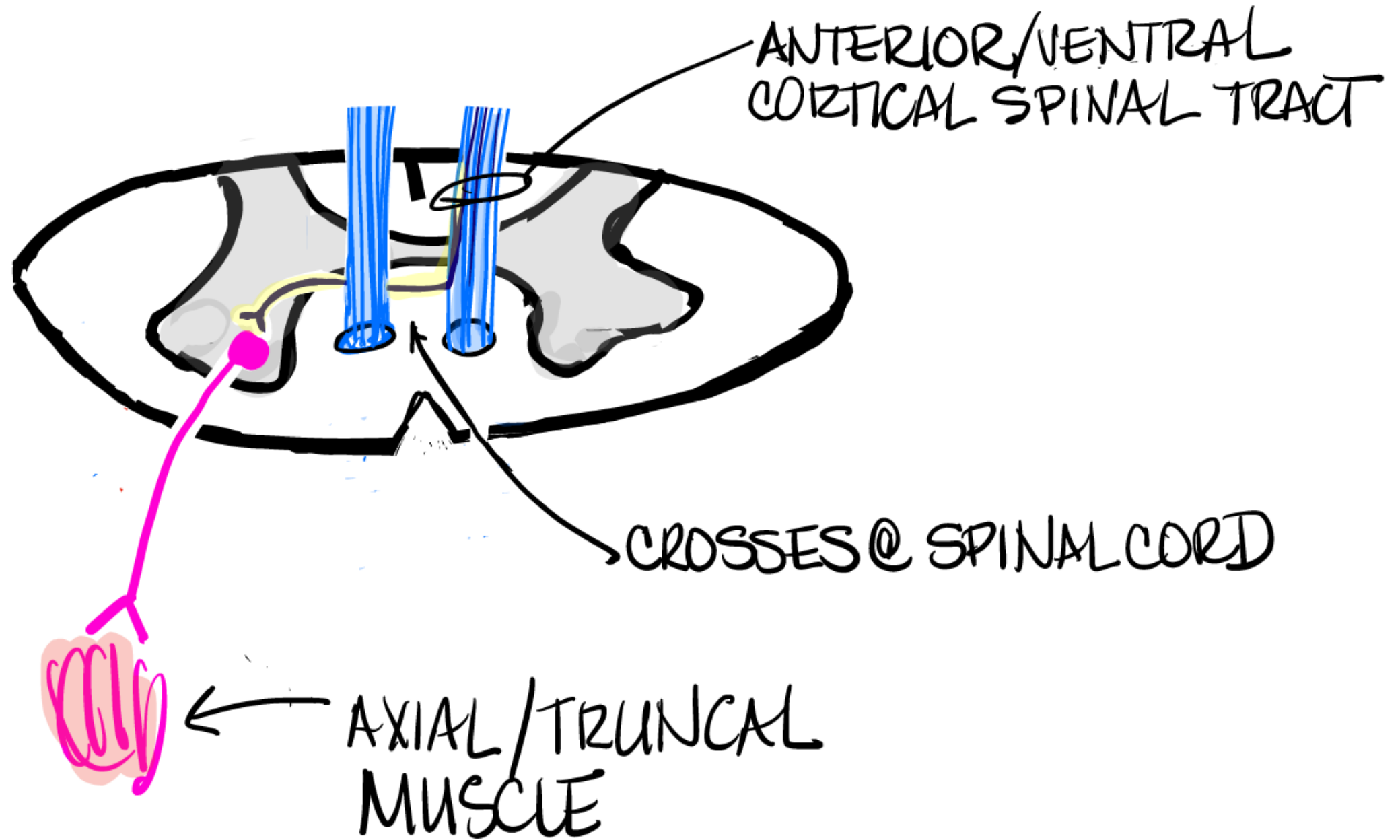
thorax & trunk muscles (mn are in medial ventral horn)

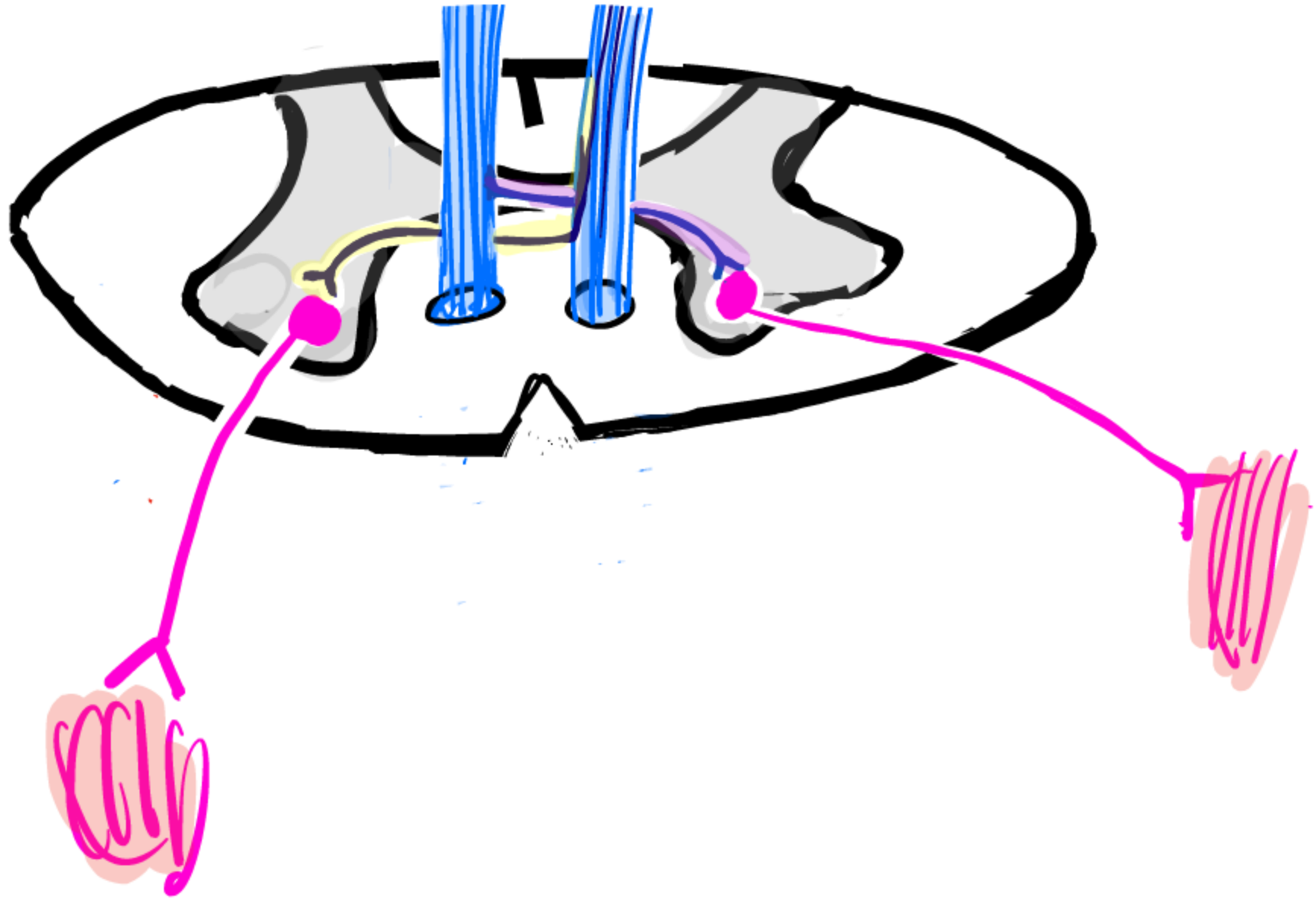


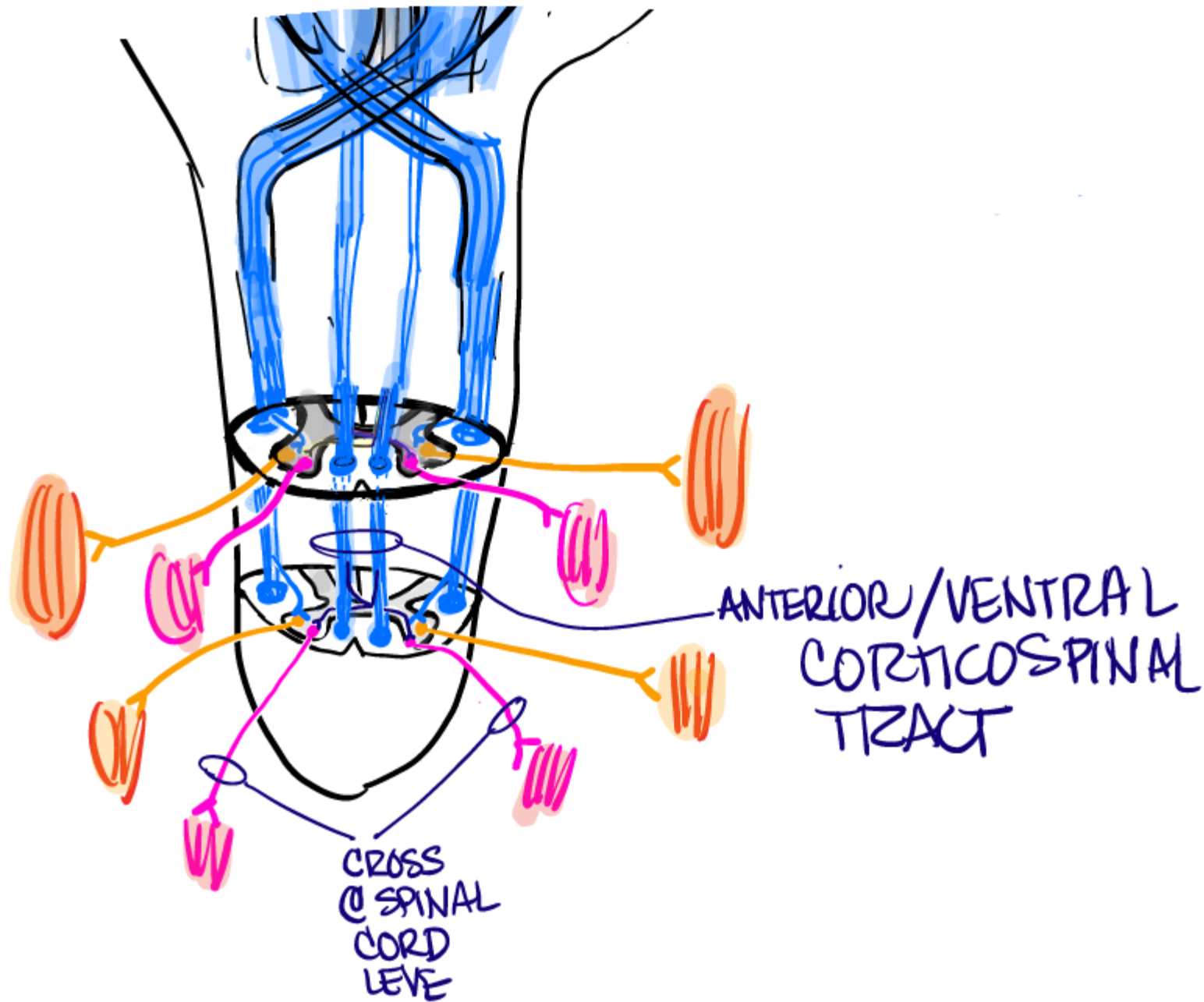














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