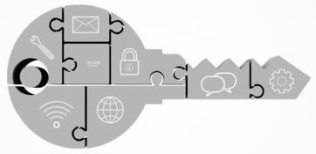
# The Homunculus and the Hand

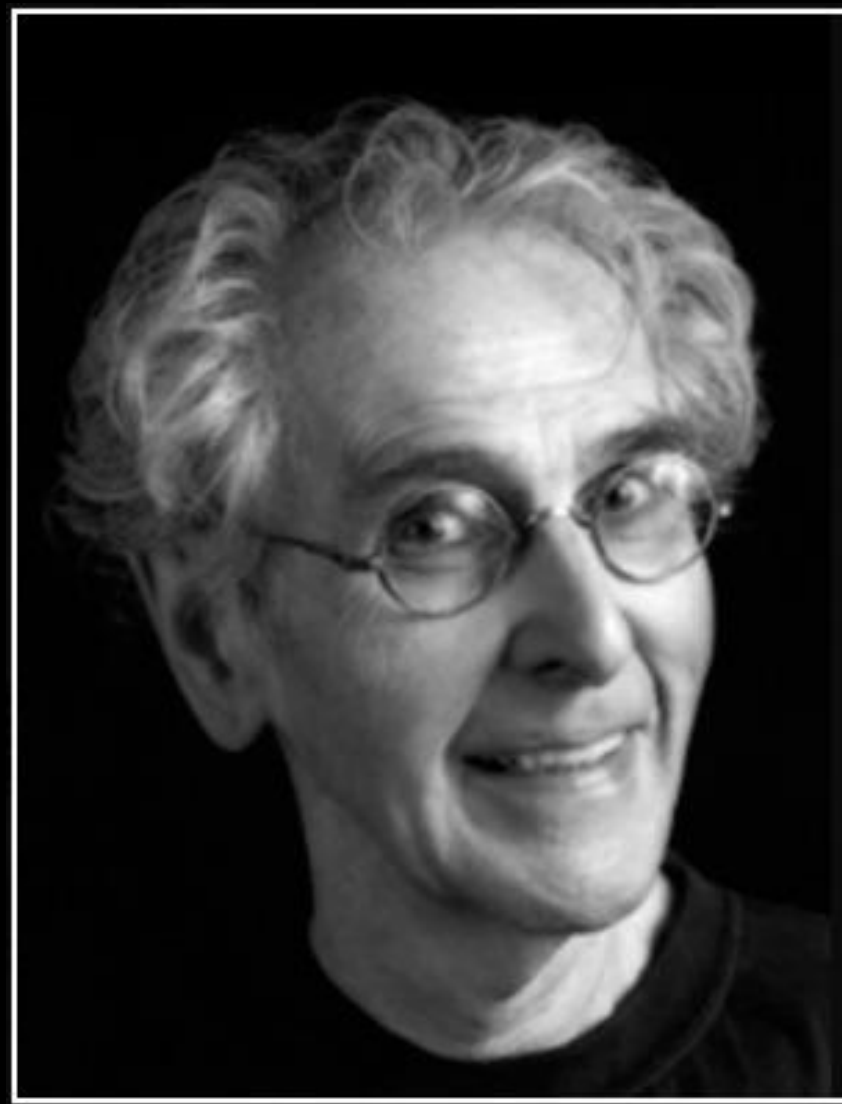
Presented by:
Mike Cricchio, MBA, OT/L, CHT



# The Homunculus and the Hand

(Key Talking Points)

| | |
|---|---|
| The concept of sensory deprivation and neighboring cortical recruitment. |  |
| The association between complex, precise body structures, high density tactile sensitivity regions, and extensive neural representation. |  |
| The link between the amount of cortical real estate and motor movement complexity and capacity. |  |
| The connection between trauma and behavioral changes. |   |



The camera basically is a license to explore.

— Jerry Uelsmann —

AZ QUOTES

# The Homunculus and the Hand

## Outline

7 video segments

7 discussion questions related to each video segment

# The Homunculus and the Hand

# The Homunculus and the Hand

What is the intent and purpose of this presentation?

# The Homunculus and the Hand

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# The Homunculus and the Hand

Why study the homunculus and the hand?

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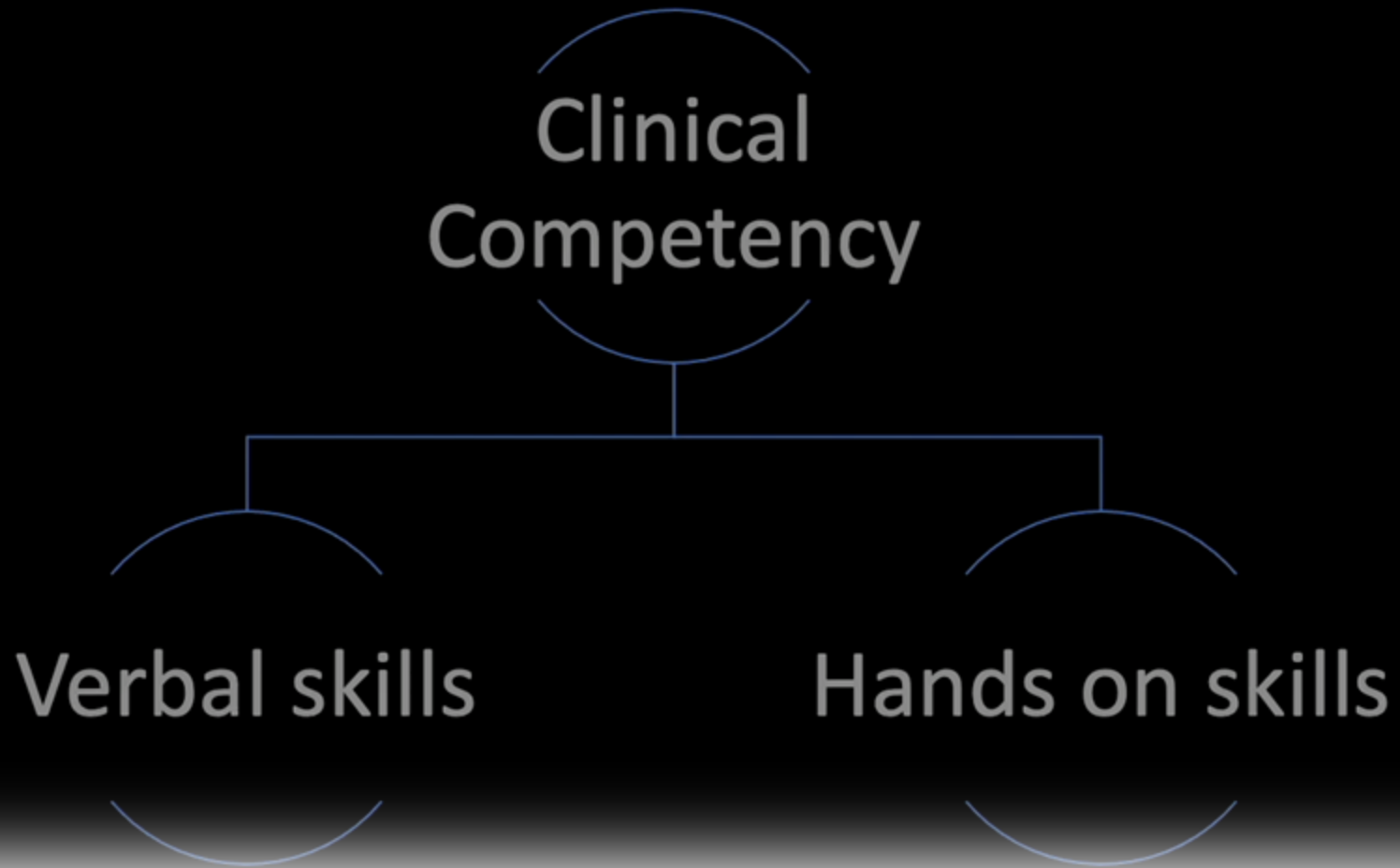
# The Homunculus and the Hand

Why is the relationship between the mechanoreceptors of the hand the central nervous system important?

# The Homunculus and the Hand

(Owner Edition)



# The Homunculus and the Hand

Why is the number and density of nerve fibers to the volar aspect of the hand of clinical importance?

# Mechanorecptors feed the Central Nervous System (CNS)

(Information regarding)

Touch

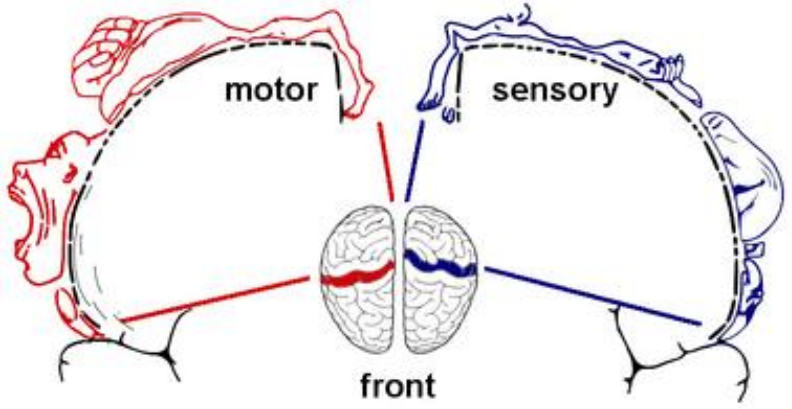
Pressure

Vibration

Cutaneous tension

# The Homunculus and the Hand

Why is it important to understand that peripheral mechanoreceptors are relayed and interpreted in an orderly somatosensory cortex?



# The Homunculus and the Hand

(Owner Edition)

Low Threshold (High Sensitivity)

Meissner corpuscles

Pacinian corpuscles

Merkel disks

Ruffini corpuscles

# The Homunculus and the Hand

Why is it important to understand that the low threshold (high sensitivity) mechanoreceptors are innervated by large myelinated axons?

# The Homunculus and the Hand

(Owner Edition)

**4 Types**

- Meissner corpuscles
- Pacinian corpuscles
- Merkel disks
- Ruffini corpuscles

# The Homunculus and the Hand

How do Semmes Weinstein monofilaments link the boundary of the mechanoreceptors to the somatosensory cortex?

# Weak stimulus **CREATES** action potential

# The Homunculus and the Hand

(Outline)

## Outline:

- **1st section:** General Cortical Anatomy
- **2nd section:** Why Study the Homunculus and the Hand
- **3rd section:** History of the Homunculus Concept
- **4th section:** Somatosensory Cortex
- **5th section:** Primary Motor Cortex
- **6th section:** Concluding Comments

# The Homunculus and the Hand

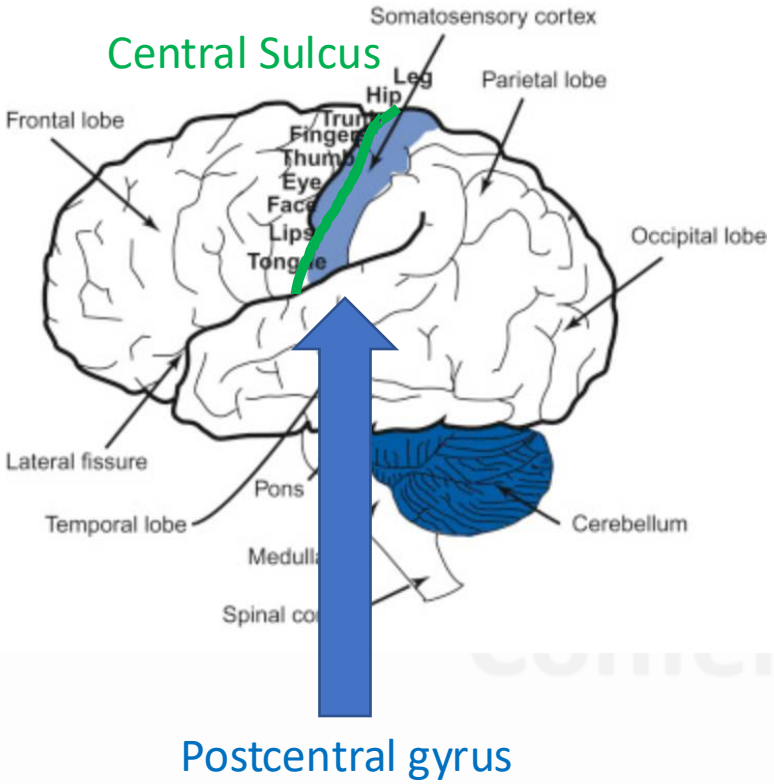
(1st Section)

## General Cortical Anatomy

# The Homunculus and the Hand

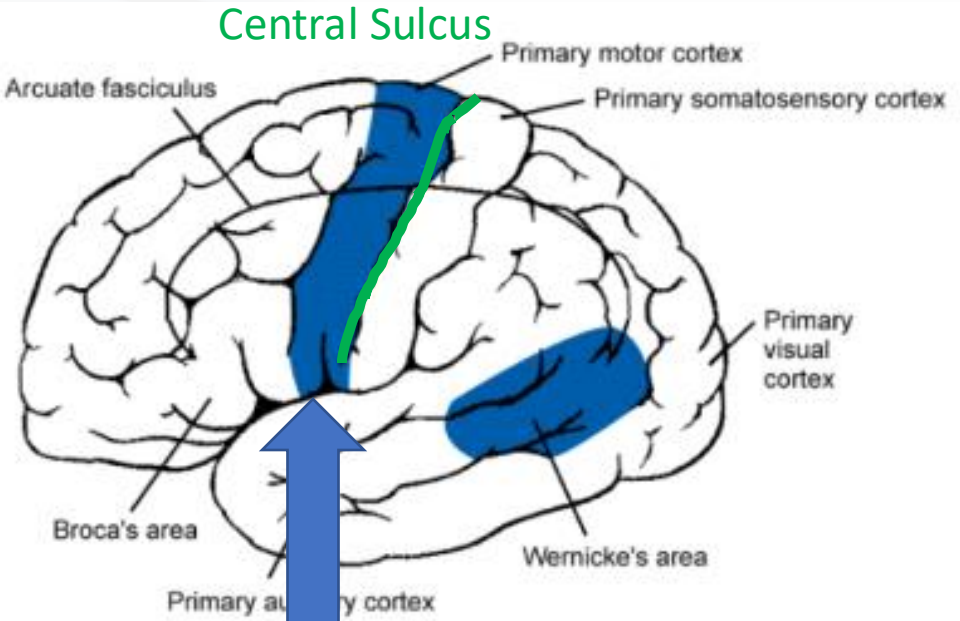
(1st Section: Cortical Anatomy)

## Somatosensory Cortex




Postcentral gyrus

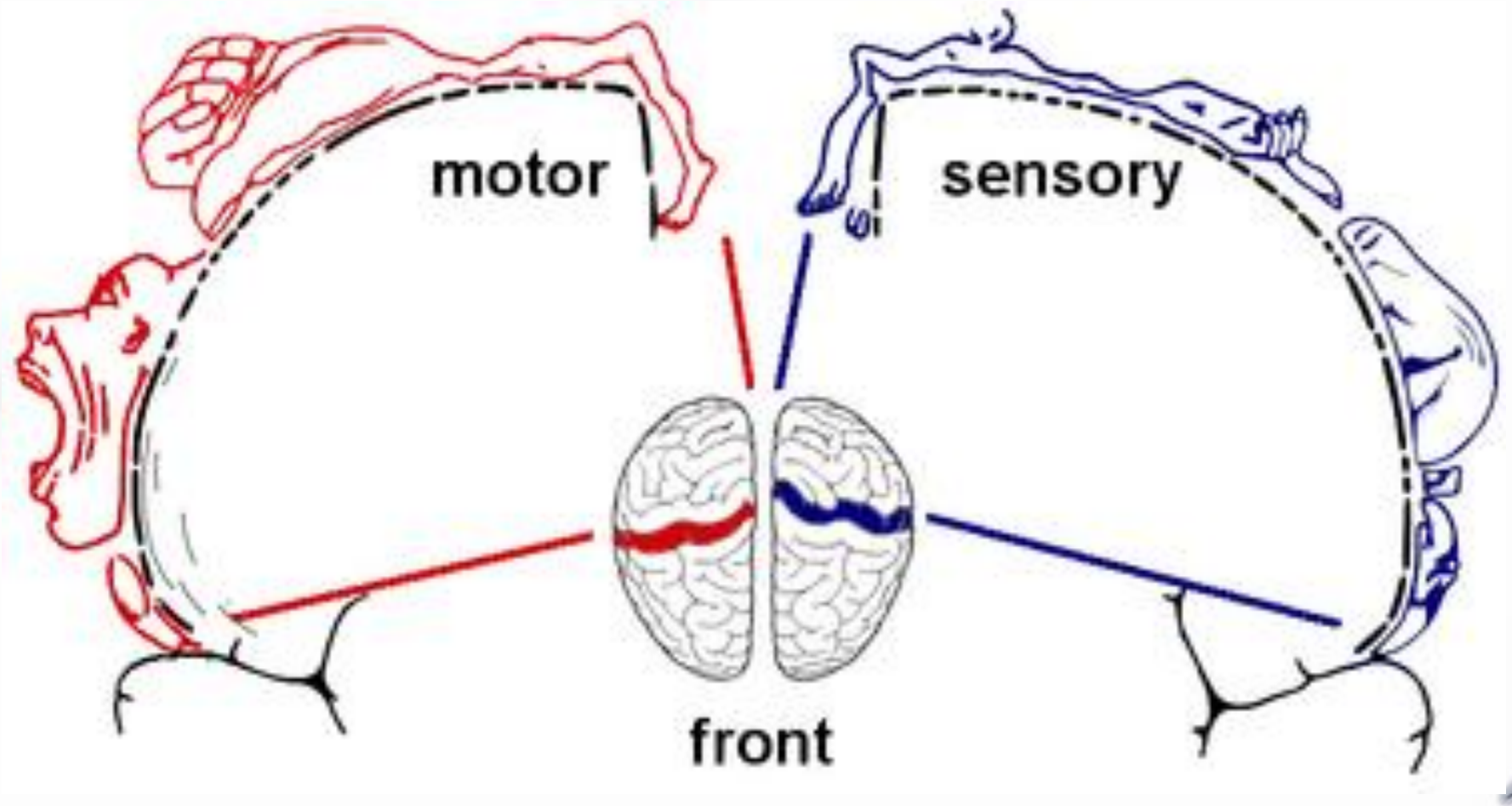
## Primary Motor Cortex




Precentral gyrus

# The Homunculus and the Hand

(1st Section: Cortical Anatomy)



# The Homunculus and the Hand

(2nd Section)

## Why Study the Homunculus and the Hand

# The Homunculus and the Hand

(2nd Section: Why Study the Homunculus)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# The Homunculus and the Hand

# The Homunculus and the Hand

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# The Homunculus and the Hand

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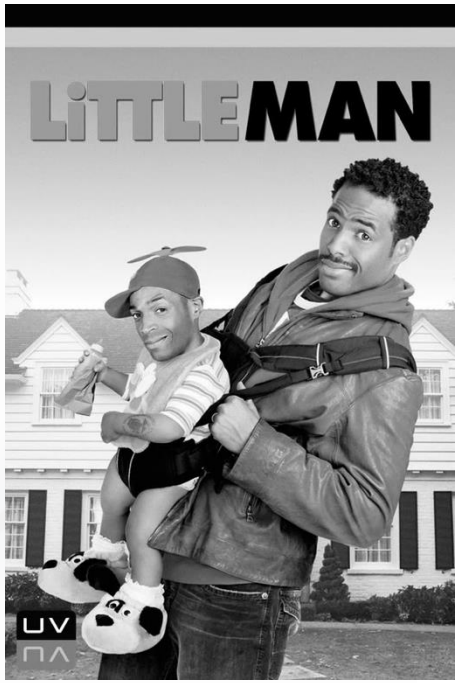
# The Homunculus and the Hand

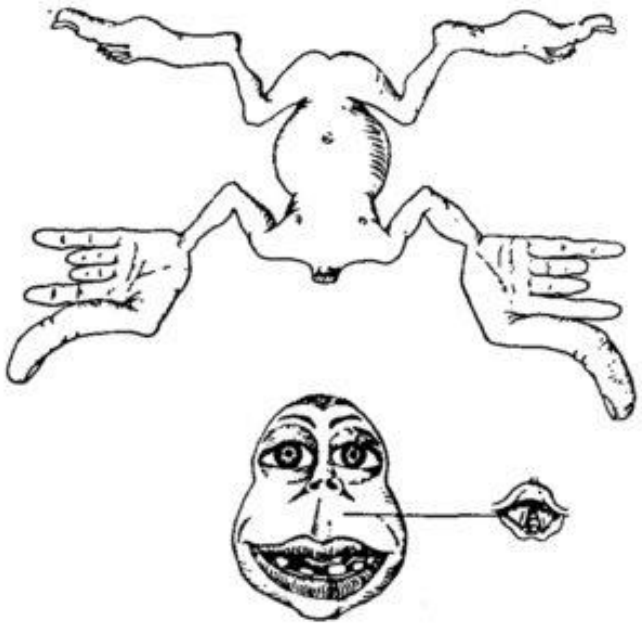
(3rd Section: History of the Homunculus)

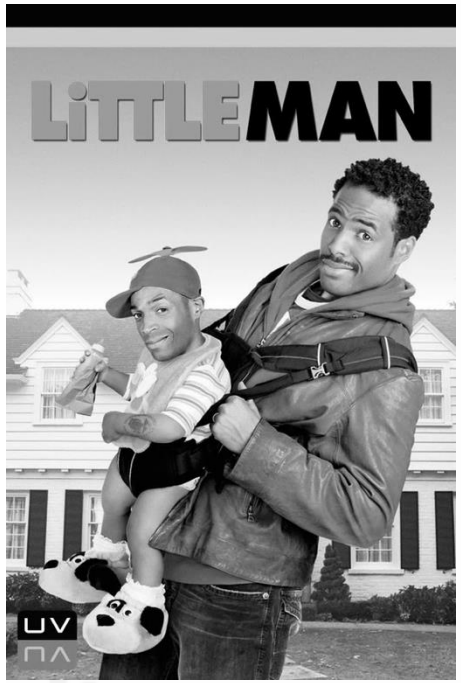
## History of the Homunculus Concept

# The Homunculus and the Hand

(3rd Section: History of the Homunculus)



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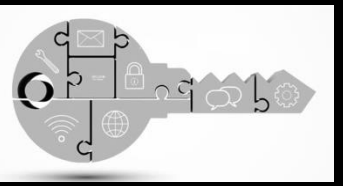
Sensorimotor deprivation

Behavioral changes

Compensatory Motor Skills

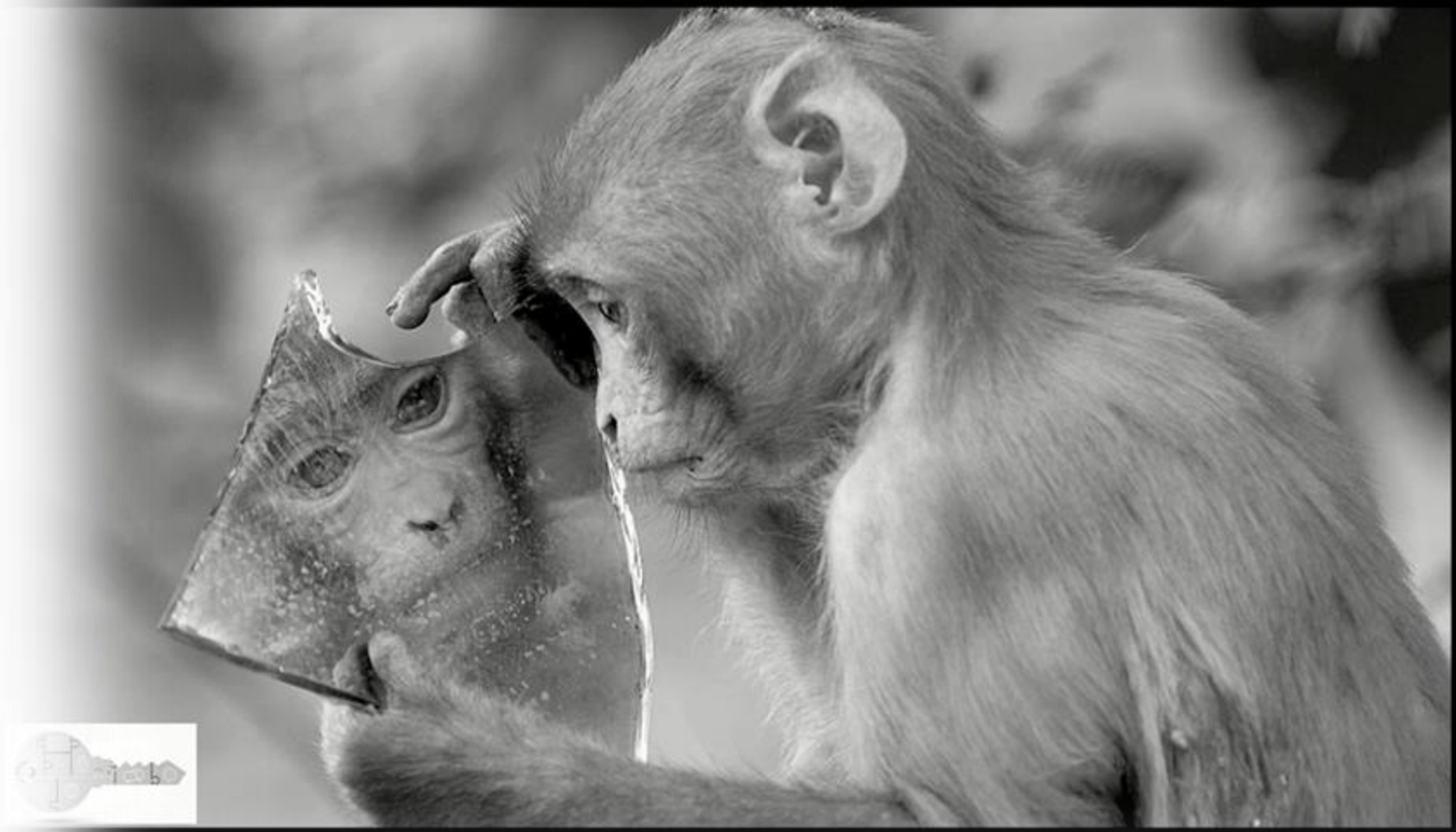
Coping




Kohler & Campbell

# The Homunculus and the Hand

5 video segments and discussion



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# The Homunculus and the Hand

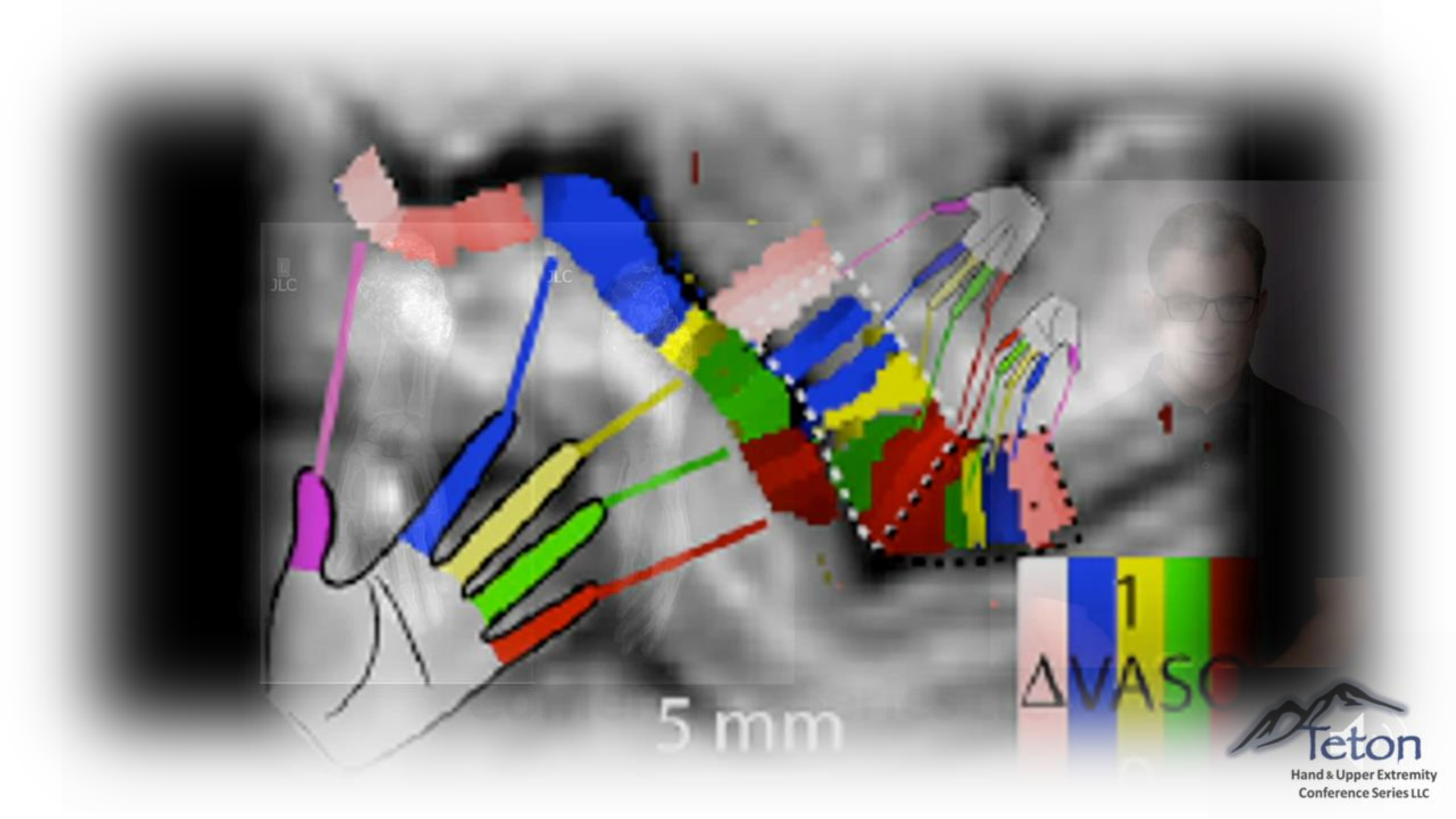
(Owner Edition)

Meissner corpuscles: fine/light touch and position sense

Pacinian corpuscles: vibration and pressure

Merkel disks: pressure, deep static touch, and position sense

Ruffini corpuscles: pressure, slippage of objects on skin and joint angle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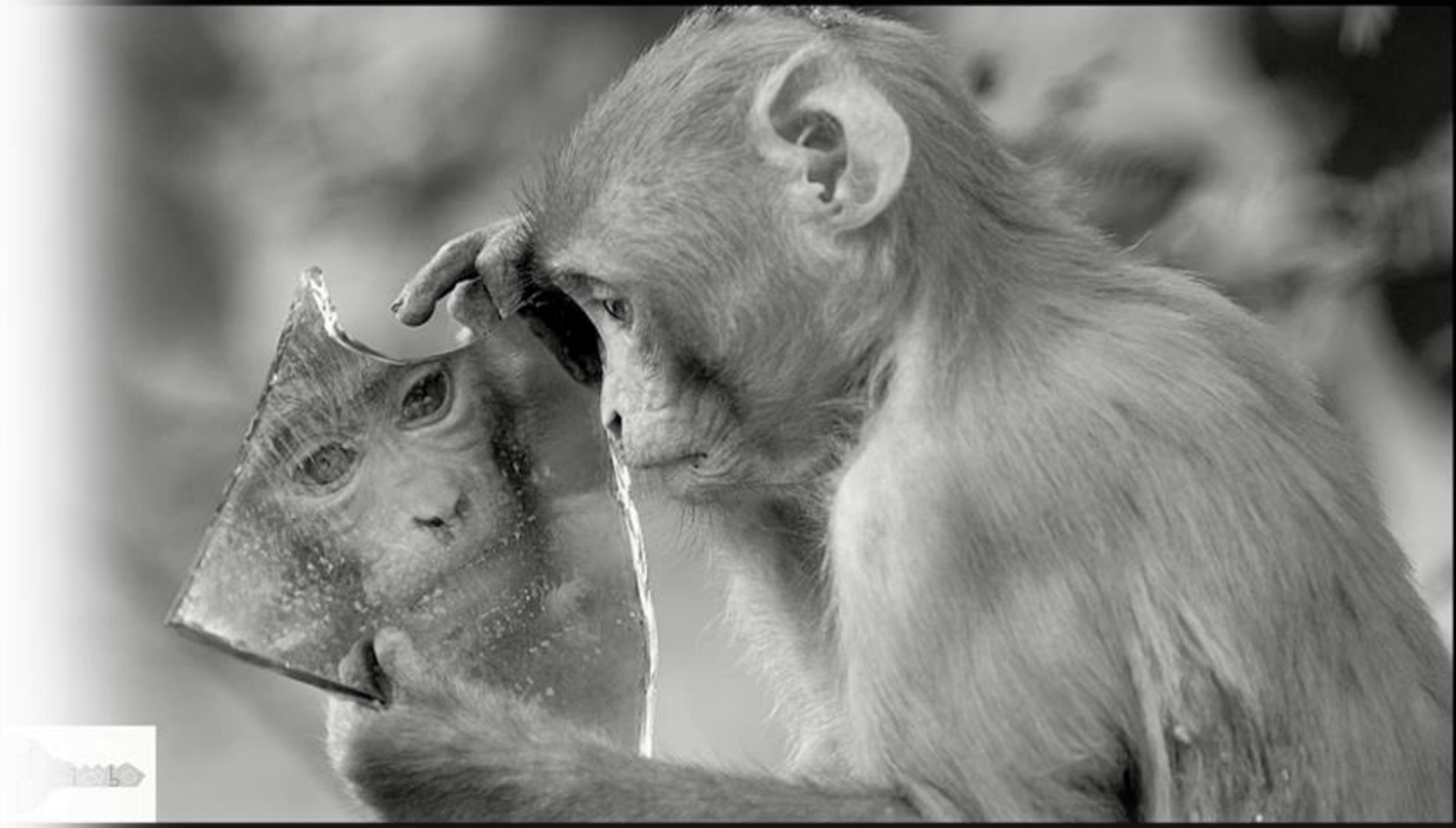

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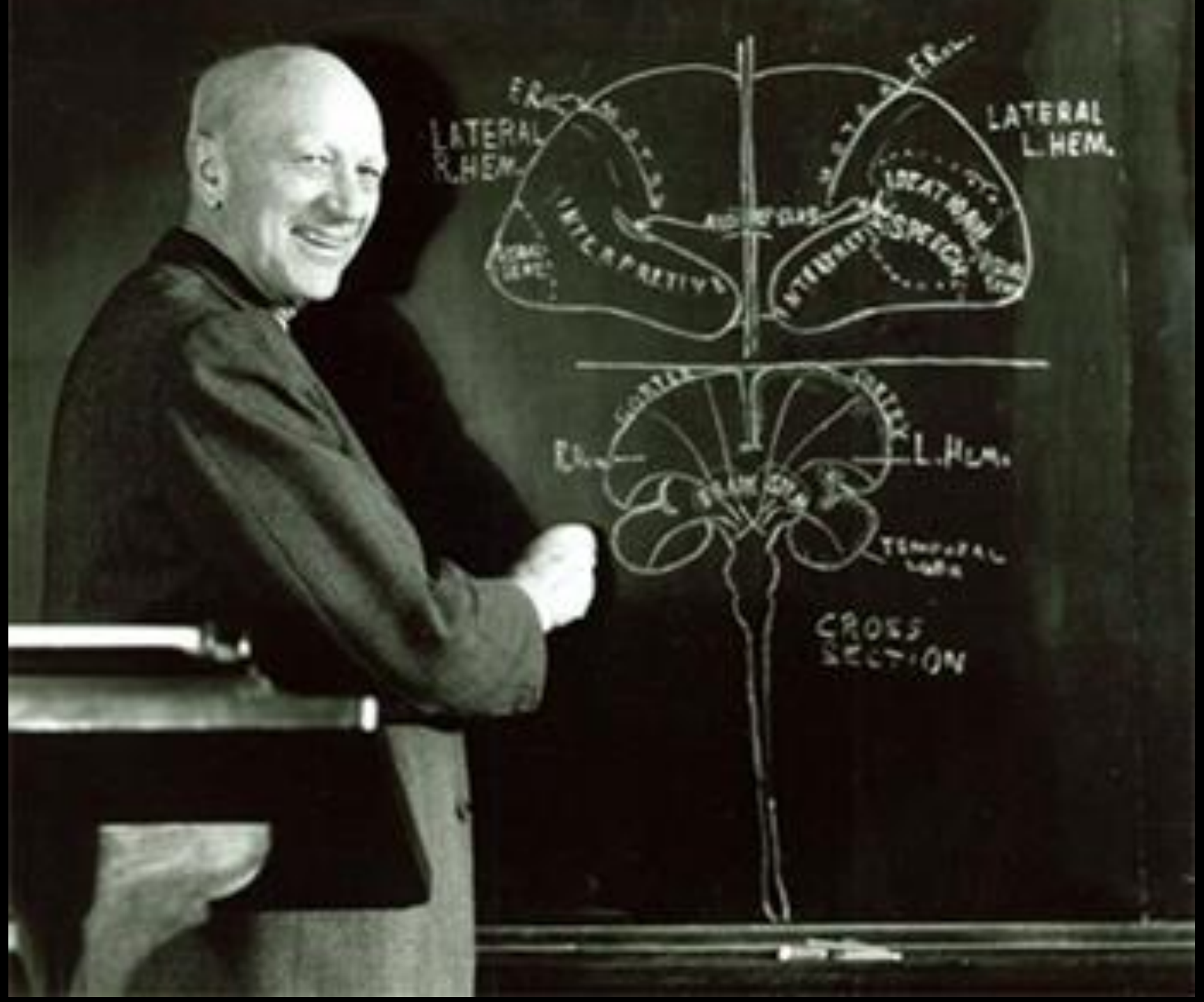
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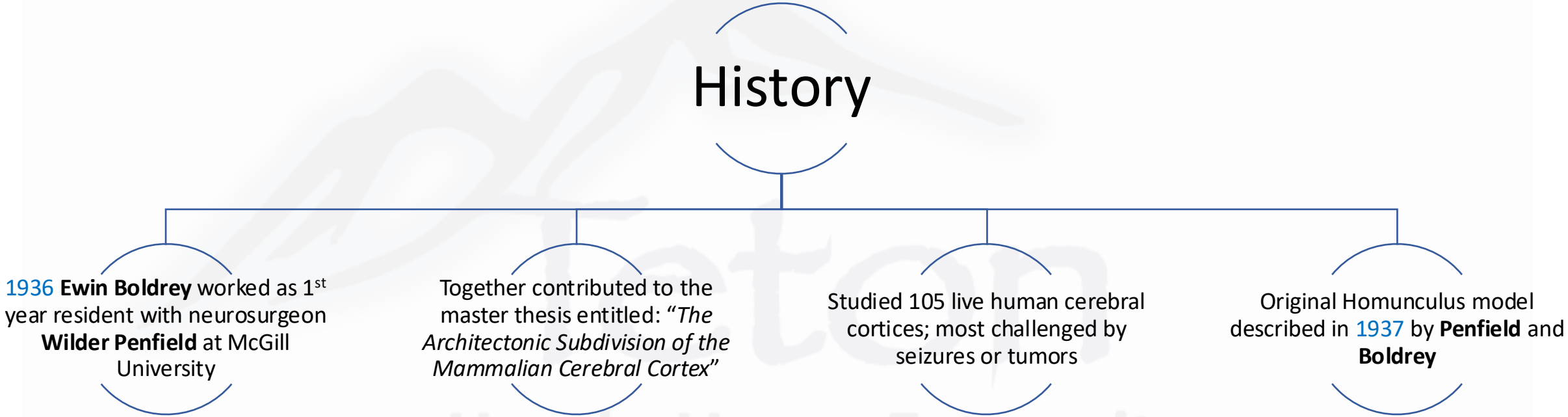
# The Homunculus and the Hand

(3rd Section: History of the Homunculus)






Penfield W, Boldrey E. Somatic Motor And Sensory Representation In The Cerebral Cortex Of Man As Studied By Electrical Stimulation. *Brain*. 1937;60(4):389-443. doi:10.1093/brain/60.4.389.

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(3rd Section: History of the Homunculus)



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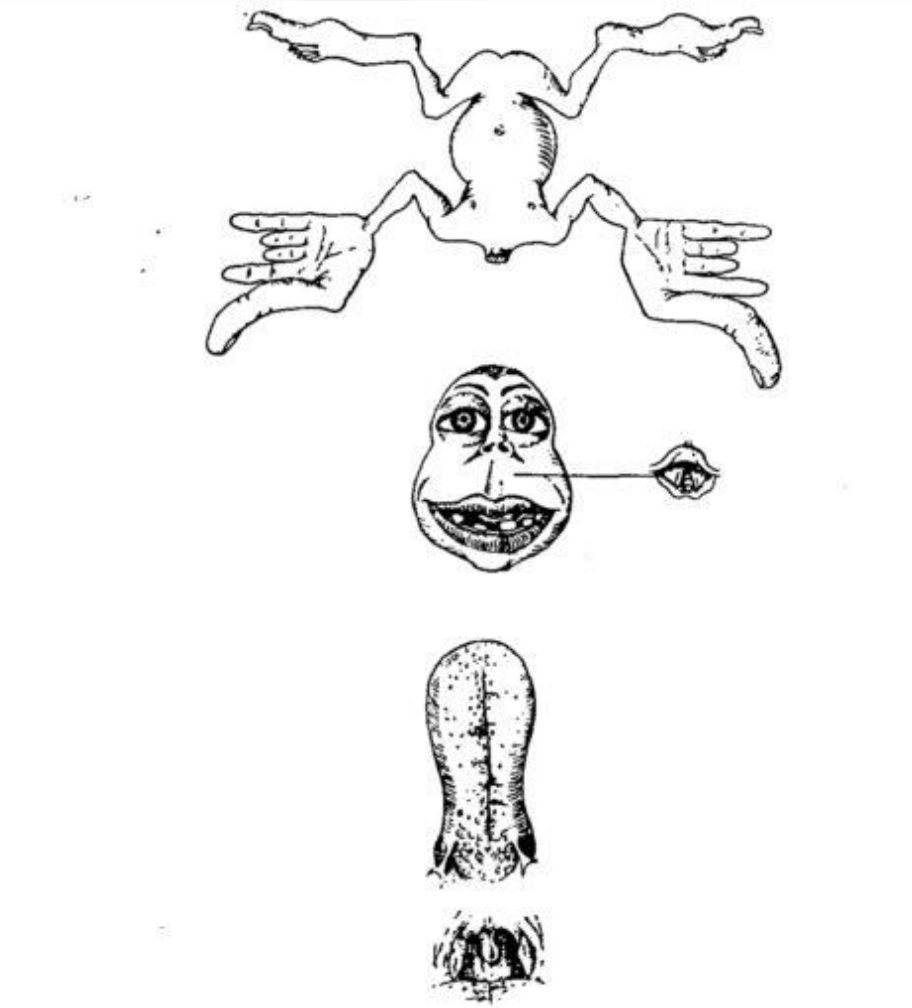

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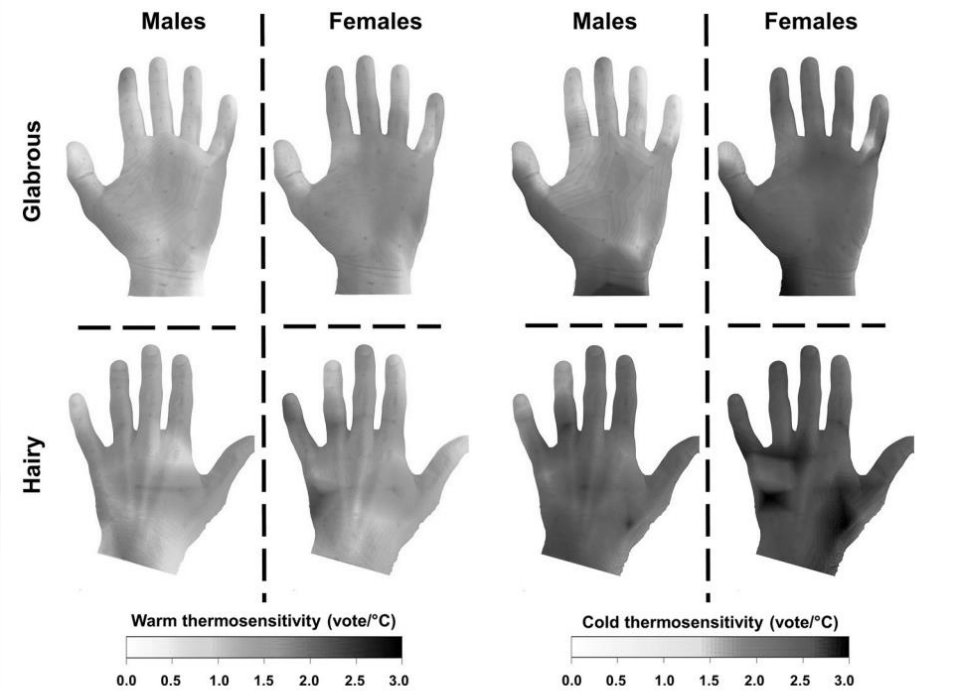
(3rd Section: History of the Homunculus)




Linkenauger, S., Wong, H., Geuss, M., Stefanucci, J., McCulloch, K., Bülthoff, H., Mohler, B. and Proffitt, D., 2015. The perceptual homunculus: The perception of the relative proportions of the human body. *Journal of Experimental Psychology: General*, 144(1), pp.103-113.

# The Homunculus and the Hand

(4th Section)

## Somatosensory Cortex

# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)



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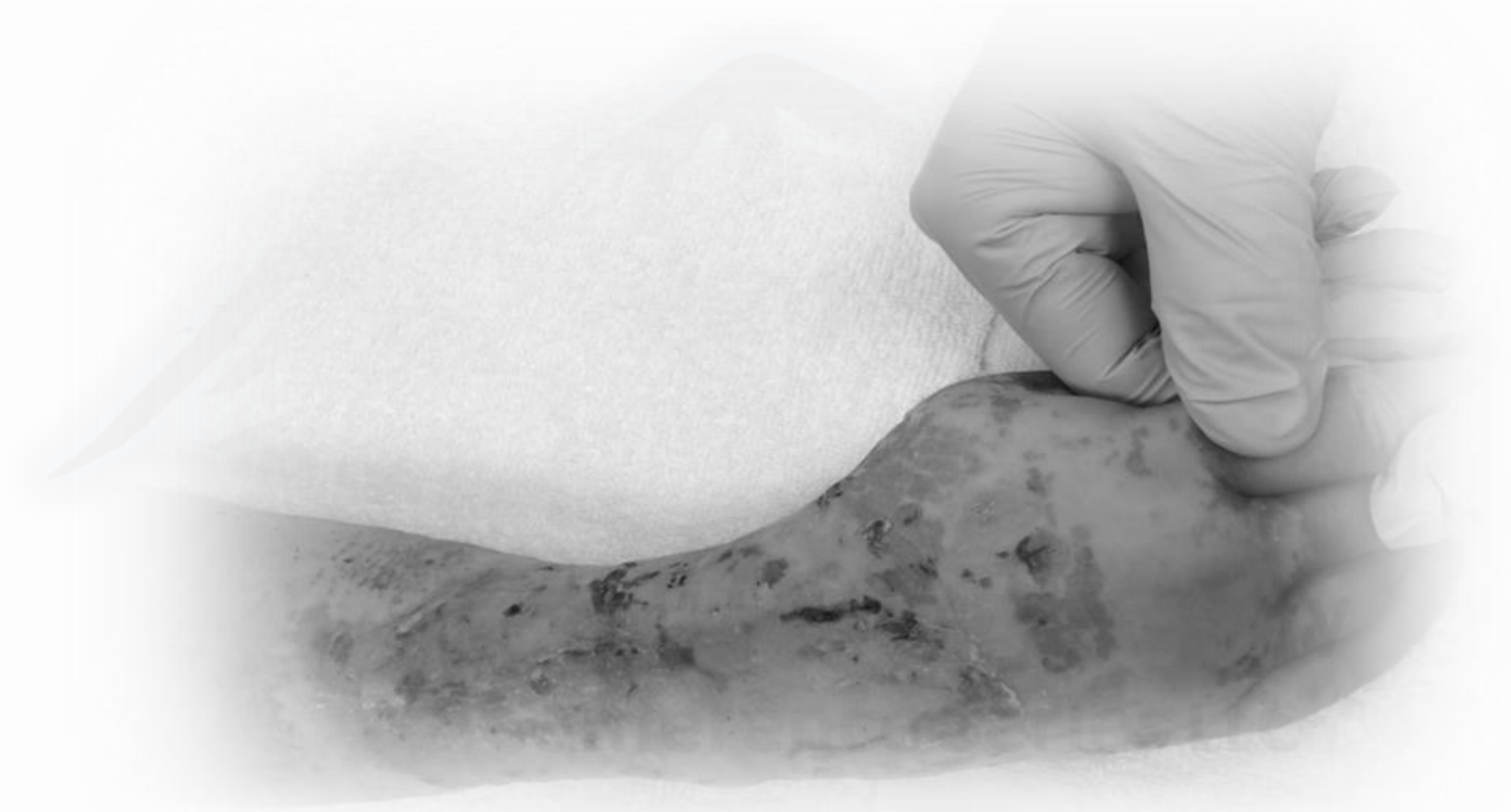
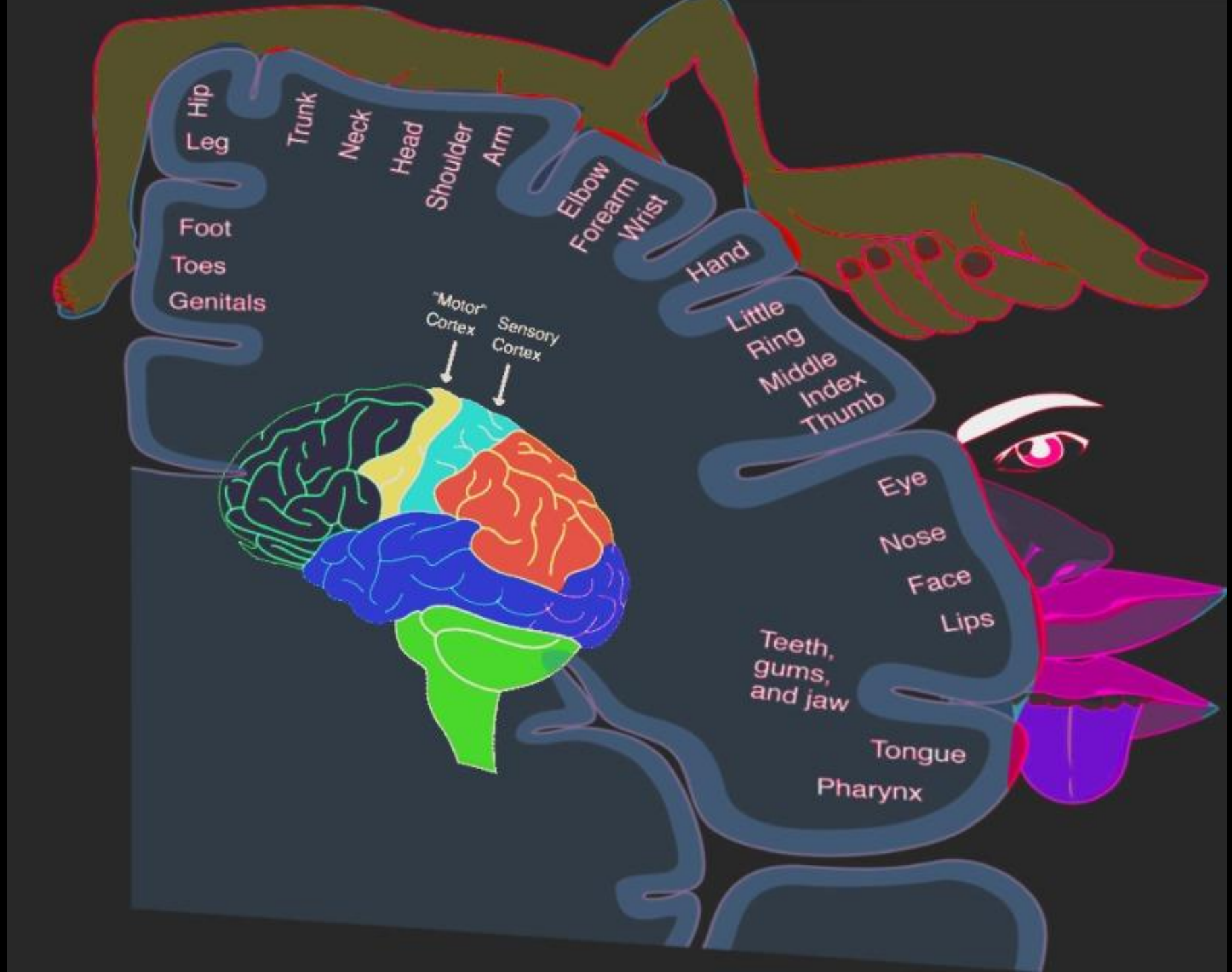
# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)

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Leg
Trunk
Neck
Head
Shoulder
Arm
Elbow
Forearm
Wrist
Hand
Little
Ring
Middle
Index
Thumb
Foot
Toes
Genitals
"Motor" Cortex
Sensory Cortex
Eye
Nose
Face
Lips
Teeth, gums, and jaw
Tongue
Pharynx


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# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)

# The Homunculus and the Hand

(4th Section: Somatosensory Cortex )

## 'Humanize' the Hand

"Sensory experiences connect us to the people around us, to the rest of the world, and to our own bodies. Pleasant or unpleasant, they're part of being human."



Løseth, G. E., Ellingson, D., & Leknes, S. (2020). Touch and pain. In R. Biswas-Diener & E. Diener (Eds), *Noba textbook series: Psychology.* Champaign, IL: DEF publishers. Retrieved from http://noba.to/mkw27f6a

# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)

## Our Job

- Develop treatment plan that reflects the amount of cortical real estate occupied on both the sensory and motor cortices by the hand.

## Our Job

- to create an environment that encourages disclosure and focuses on physical and psychosocial impairment.

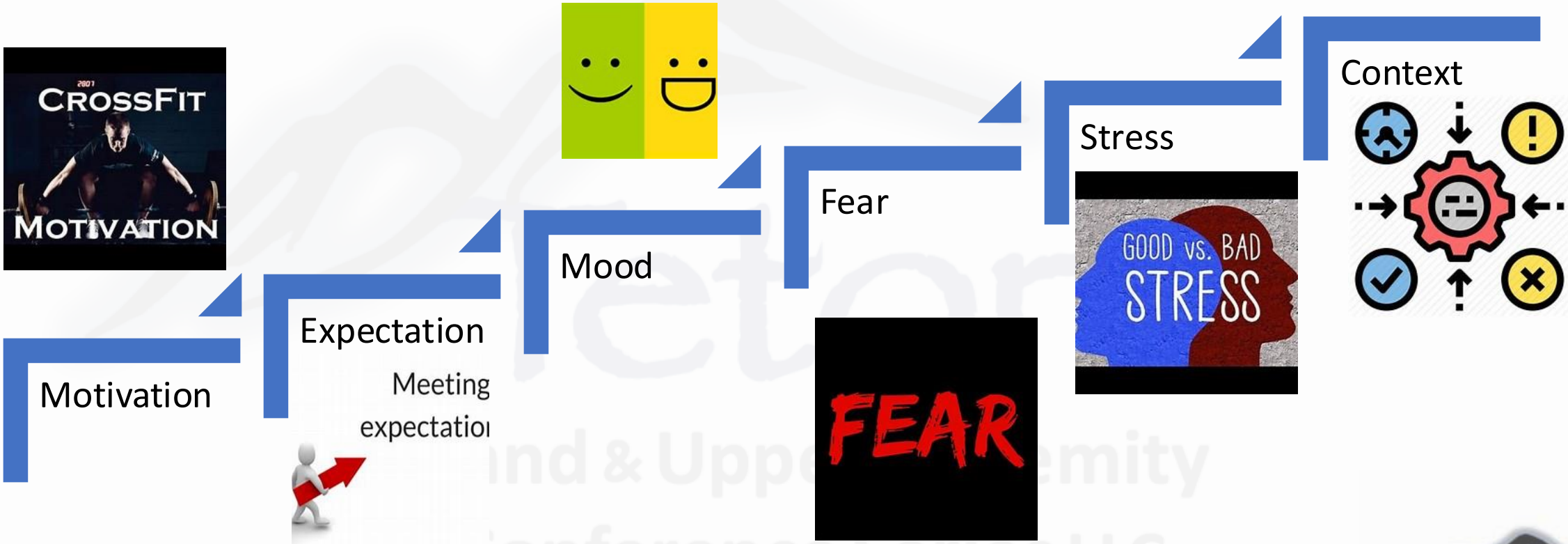
## Our Job

- to educate the patient to the impact that anatomical and/or cortical trauma can have to the hand, perception and psychological state.

Linkenauger S., Wong, H., Geuss, M., Stefanucci, J., McCulloch, K., Bülthoff, H., Mohler, B. and Proffitt, D., 2015. The perceptual homunculus: The perception of the relative proportions of the human body. *Journal of Experimental Psychology: General*, 144(1), pp.103-113.

# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)



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# The Homunculus and the Hand

(4th Section: Somatosensory Cortex)

Visual Perception

Tactile Perception

Løseth, G. E., Ellingson, D., & Leknes, S. (2020). Touch and pain. In R. Biswas-Diener & E. Diener (Eds), *Noba textbook series: Psychology.* Champaign, IL: DEF publishers. Retrieved from http://noba.to/mkw27f6a

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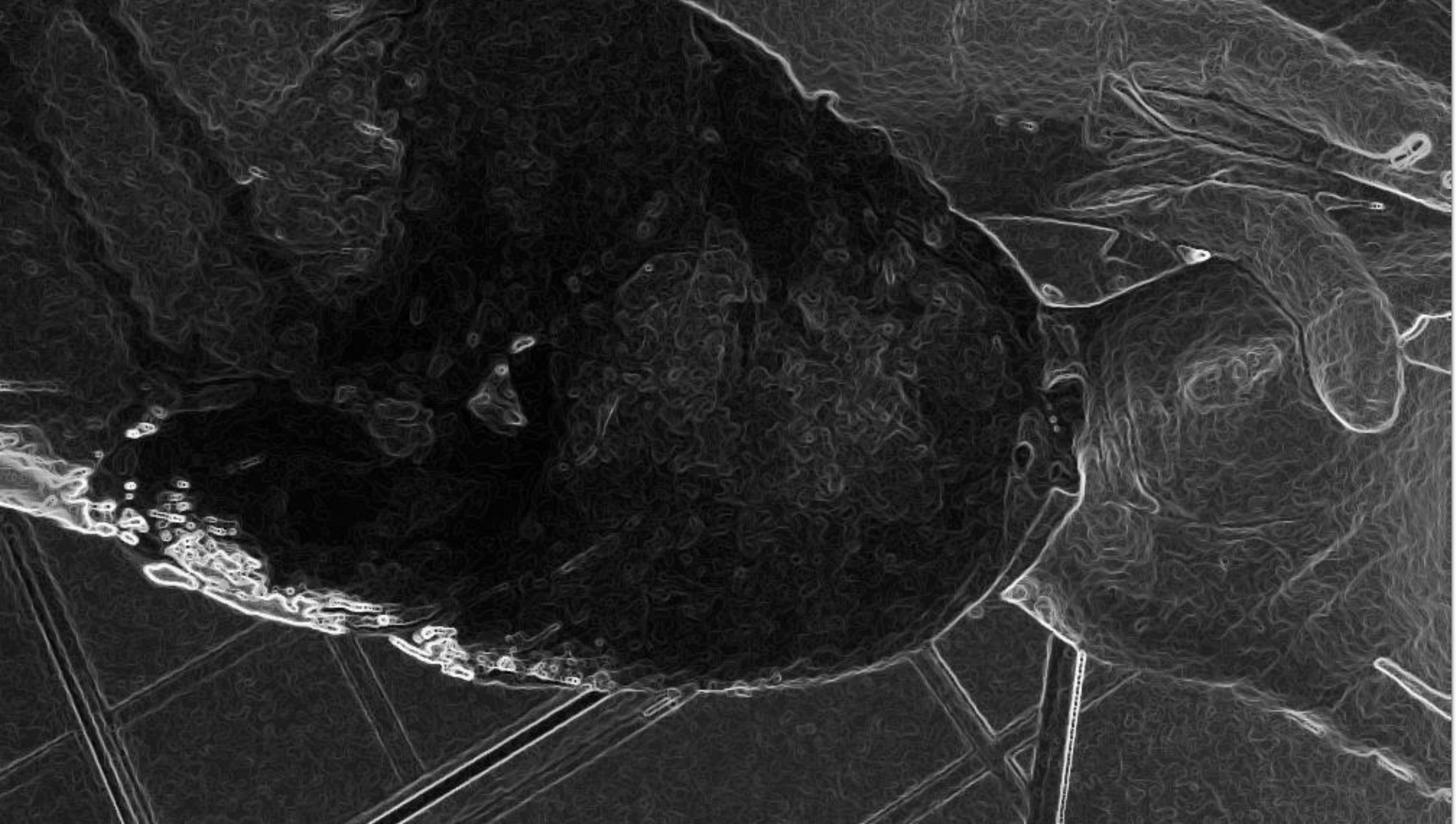

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# The Homunculus and the Hand

(4th Section)

It is my experience, that if we can establish **ONE MONTH** of regular and routine therapy, incorporating the physical and psychosocial, these patients will appreciate the needed gains to establish…


a **BASE** of progress. This base is necessary to take the patient beyond the destructive period of depression that often accompanies the 1st 4 weeks of dealing with pain, limited ROM/function, physical dissonance and estrangement of the extremity.

# The Homunculus and the Hand

(5th Section)

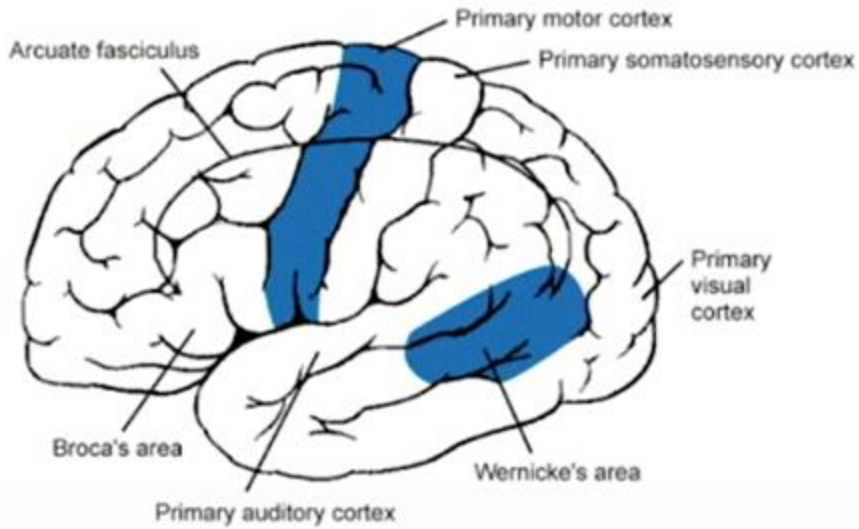
## Primary Motor Cortex

# The Homunculus and the Hand

2 video segments and discussion

# The Homunculus and the Hand

(5th Section: Motor Cortex)

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# The Homunculus and the Hand

(5th Section: Motor Cortex)

"Our results suggest that the intrinsic connectivity of the motor cortex is shaped by the probability distribution of its **ACTIVATION** states."



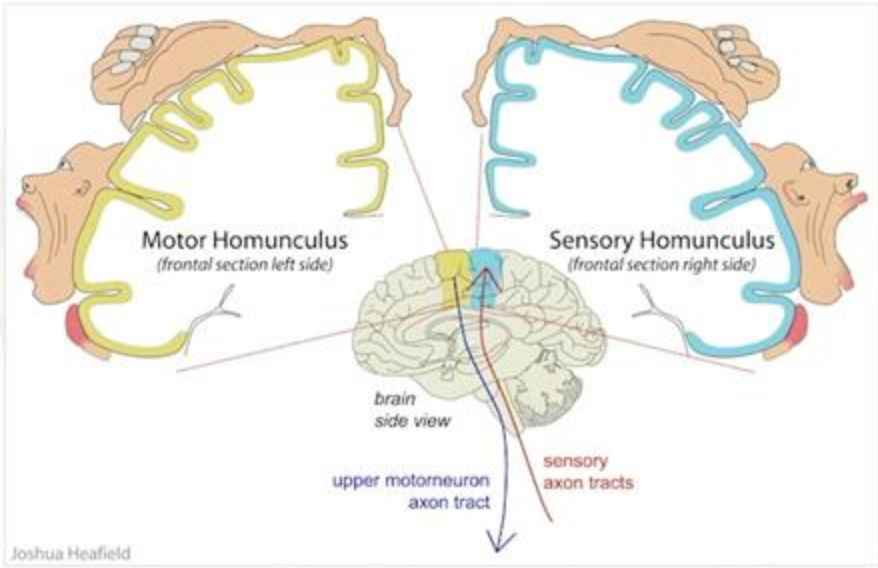
Ejaz, N., Hamada, M., & Diedrichsen, J. (2015). Hand use predicts the structure of representations in sensorimotor cortex. *Nature Neuroscience*, *18*(7), 1034–1040. doi: 10.1038/nn.4038

# The Homunculus and the Hand

4 video segments and discussion

# The Homunculus and the Hand

(5th Section Motor Cortex)






Gandhoke GS, Belykh E, Zhao X, Leblanc R, Preul MC. Edwin Boldrey and Wilder Penfields Homunculus: A Life Given by Mrs. Cantlie (In and Out of Realism). *World Neurosurgery*. 2019;132:377-388. doi:10.1016/j.wneu.2019.08.116.



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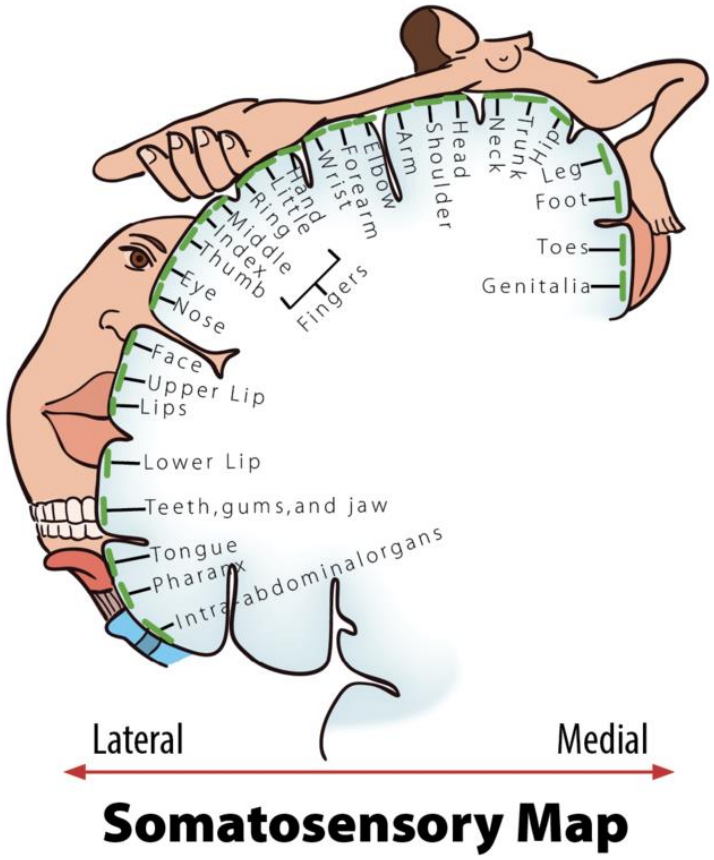
# The Homunculus and the Hand

(5th Section: Motor Cortex)

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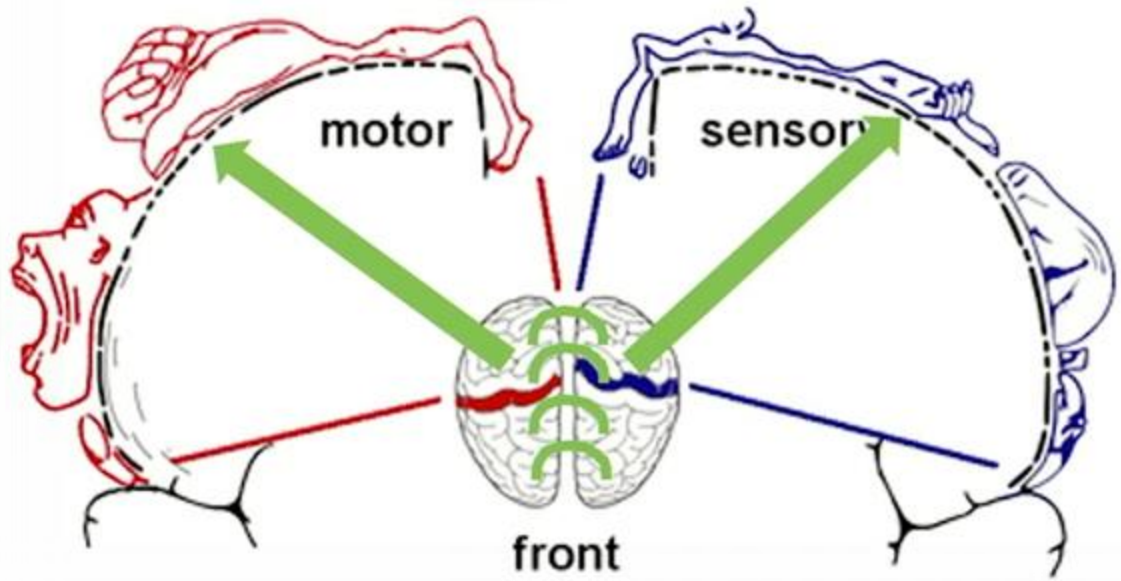
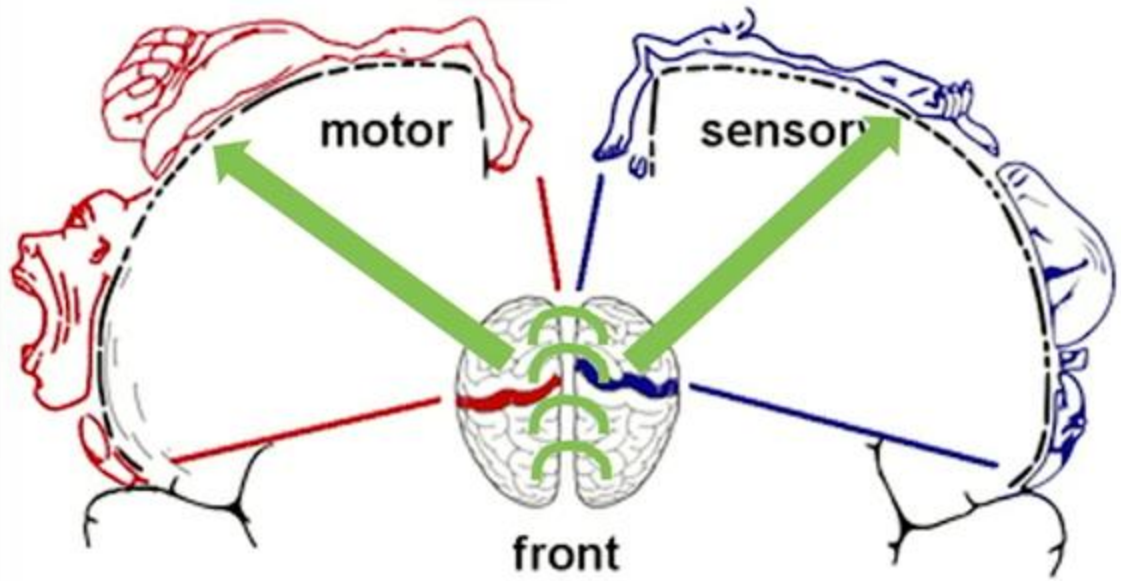
# The Homunculus and the Hand

(5th Section: Motor Cortex)




# The Homunculus and the Hand

(5th Section: Motor Cortex)

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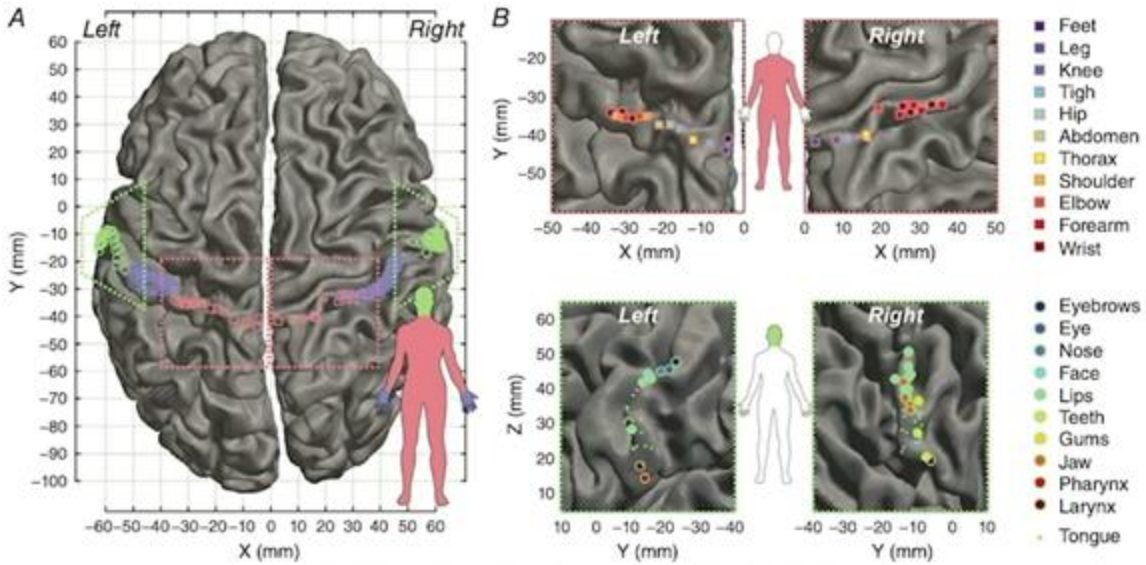
# The Homunculus and the Hand

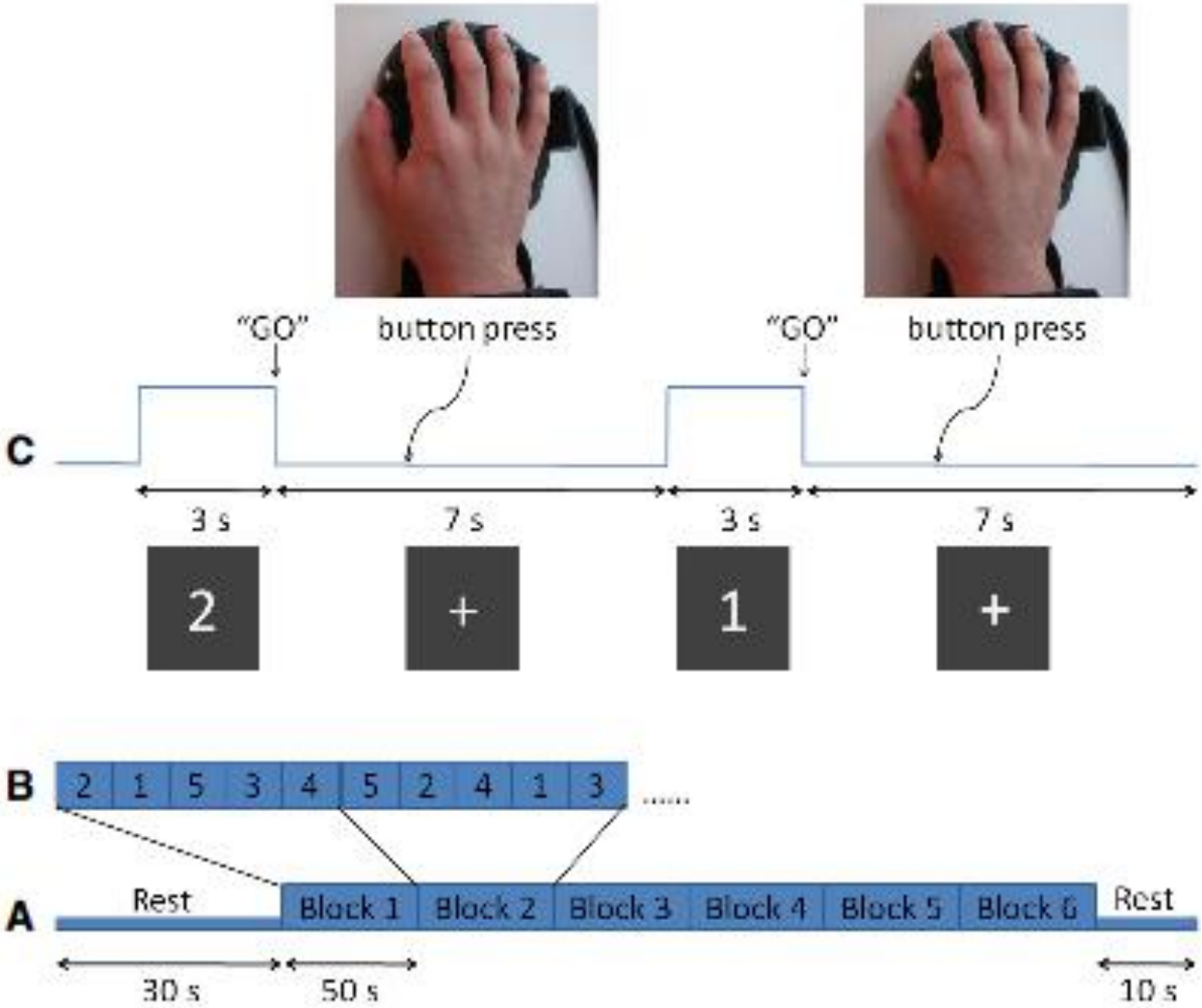
(5th Section: Motor Cortex)

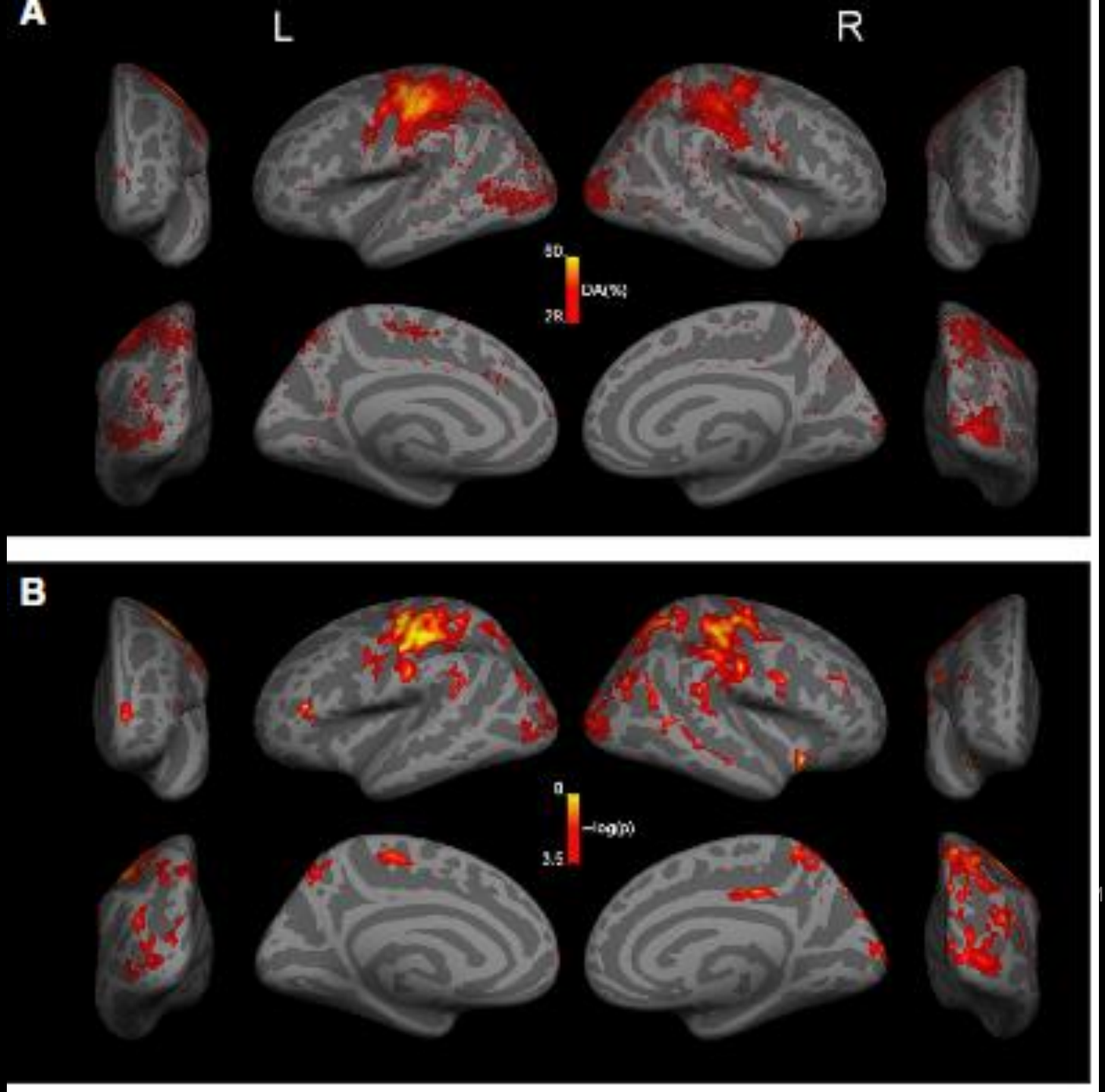





Kuehn, E., Dinse, J., Jakobsen, E., Long, X., Schäfer, A., Bazin, P.-L., … Margulies, D. S. (2017). Body Topography Parcellates Human Sensory and Motor Cortex. *Cerebral Cortex*, *27*(7), 3790–3805. doi: 10.1093/cercor/bhx026



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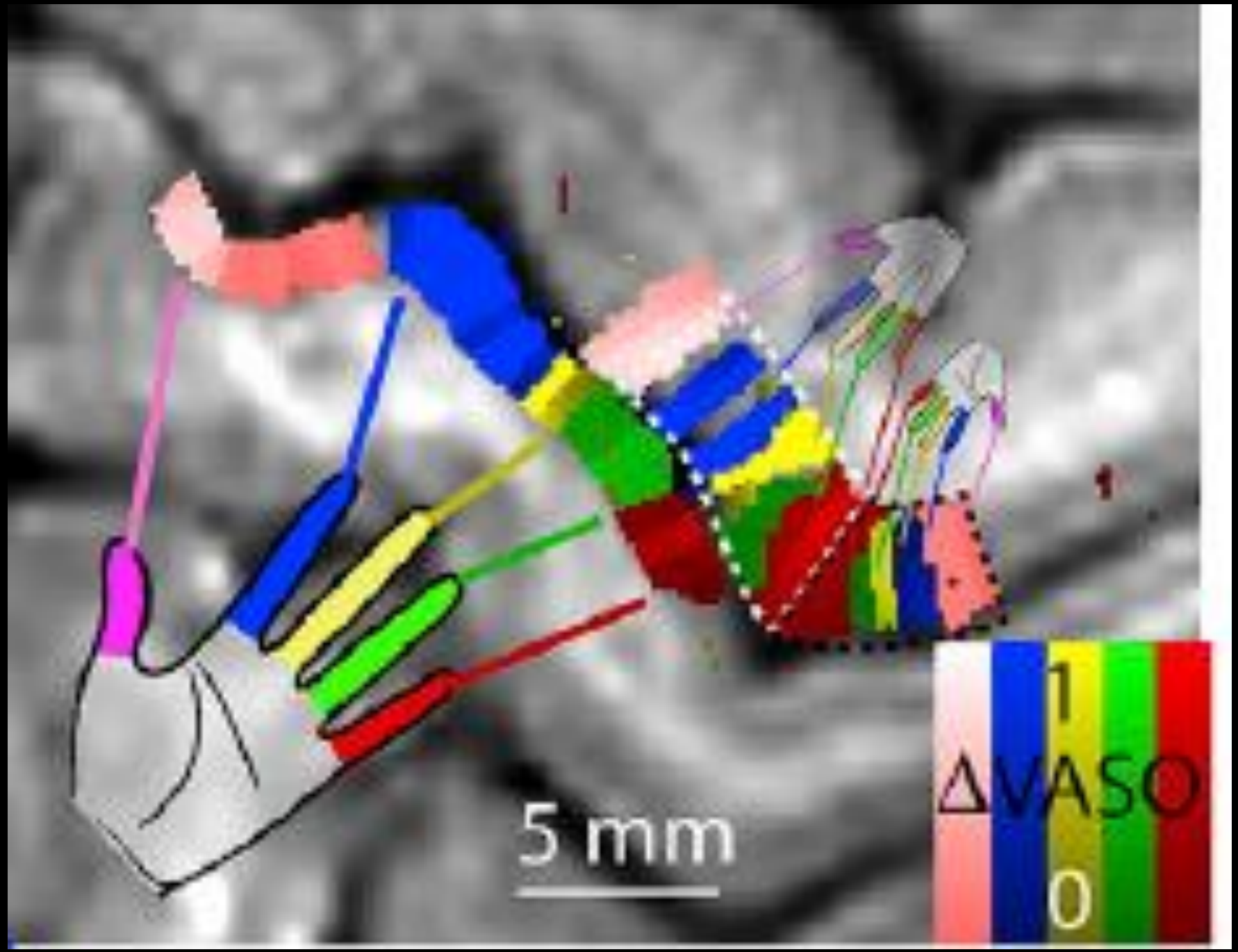
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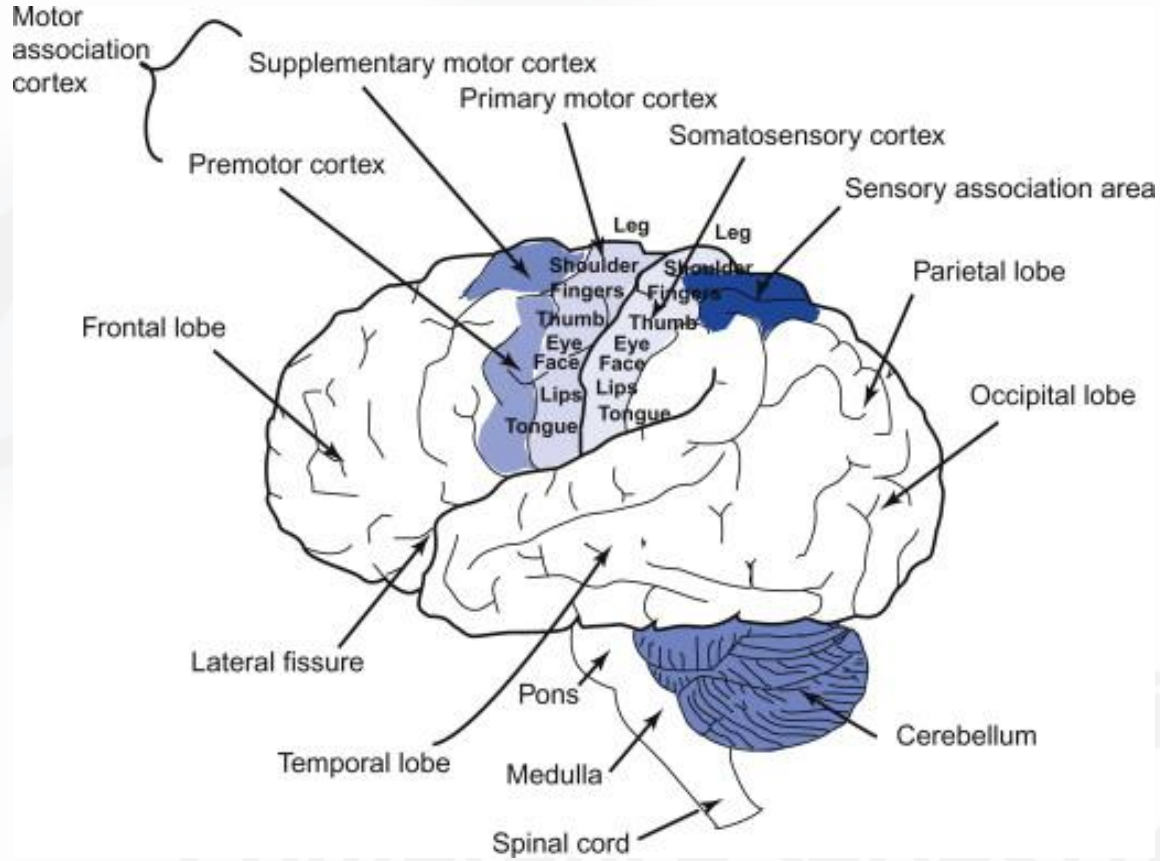
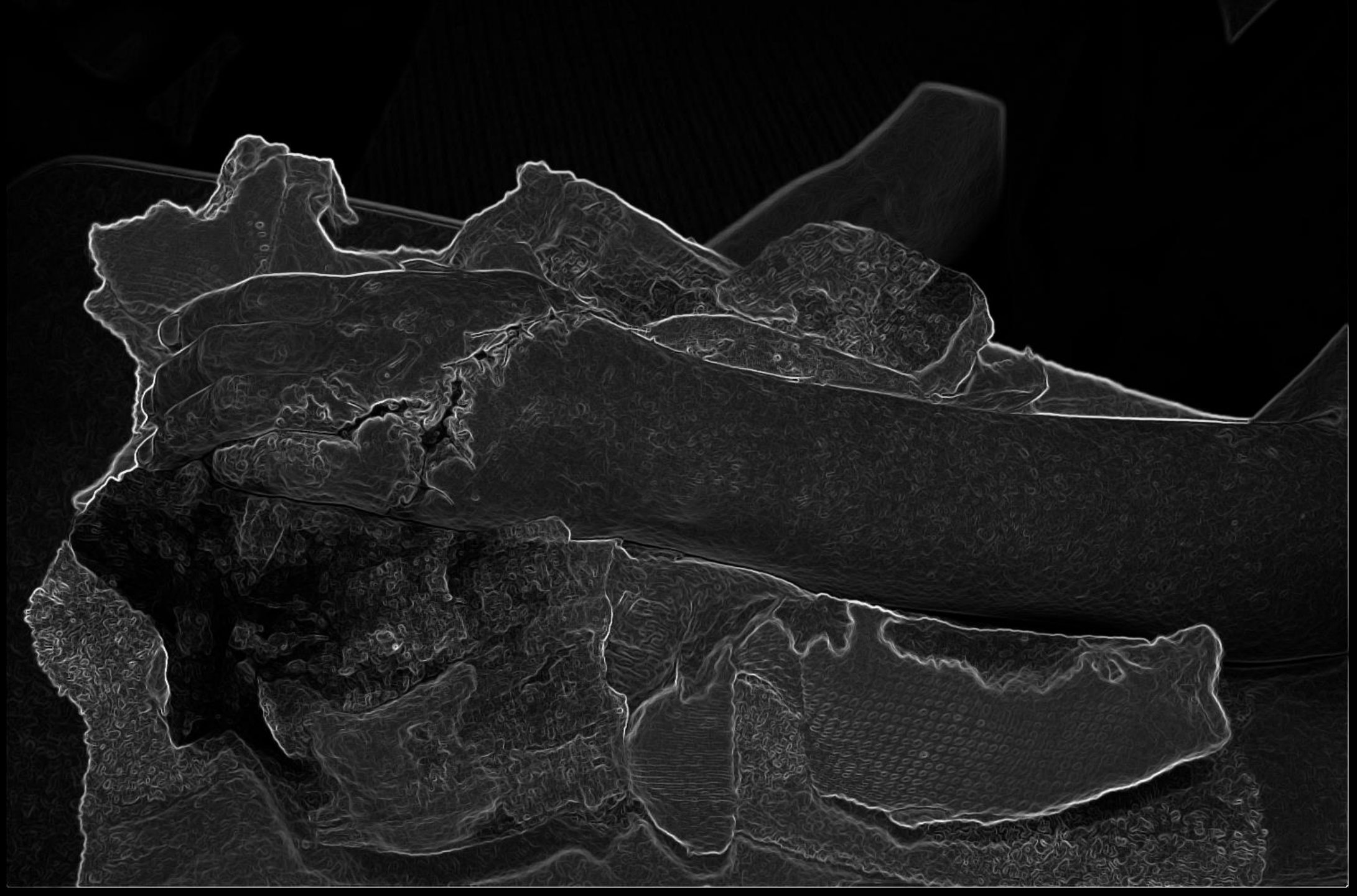
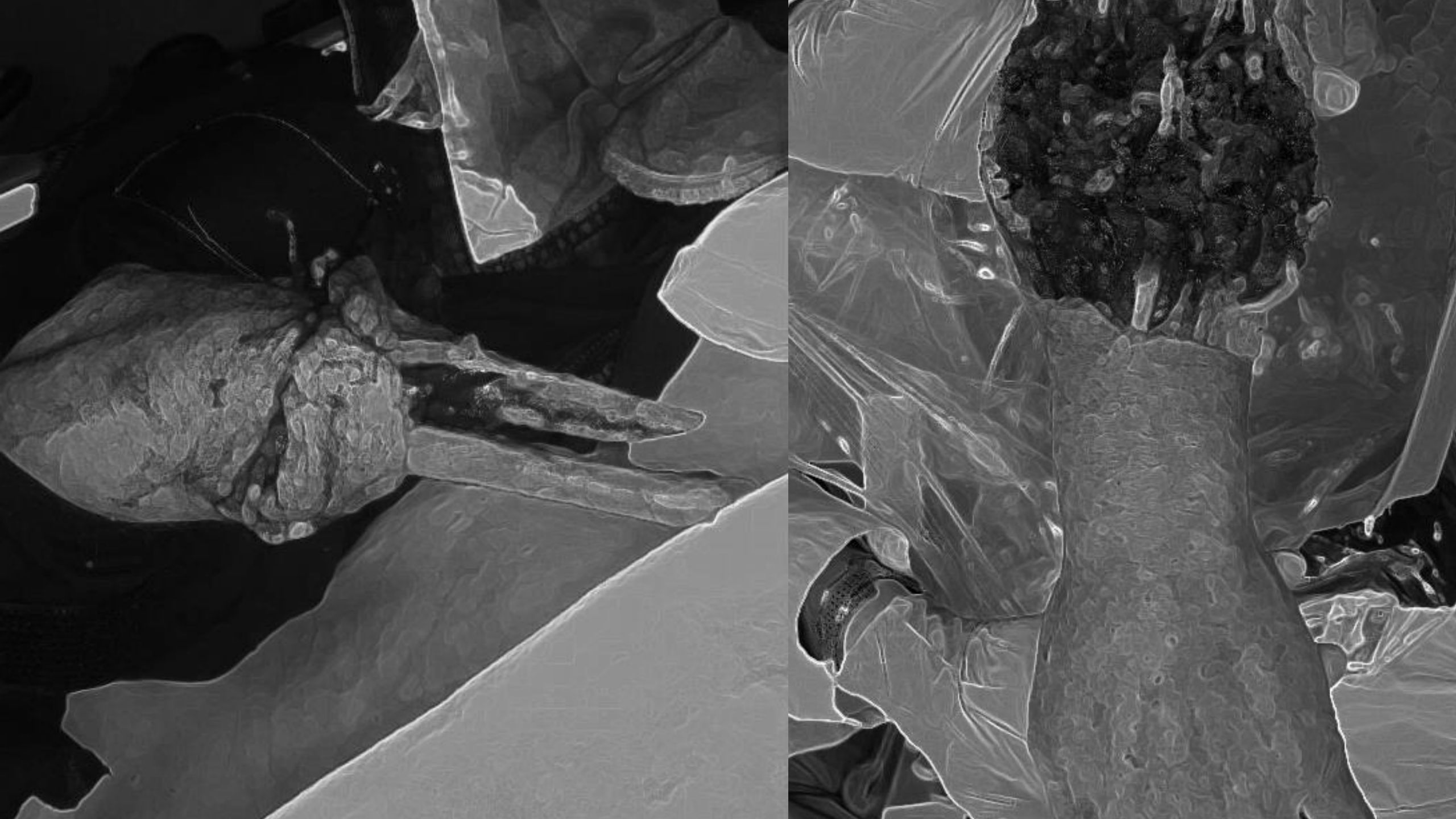
# The Homunculus and the Hand

(5th Section: Motor Cortex)




Huber, L., Finn, E. S., Handwerker, D. A., Bönstrup, M., Glen, D., Kashyap, S., … Bandettini, P. A. (2018). Sub-millimeter fMRI reveals multiple topographical digit representations that form action maps in human motor cortex. doi: 10.1101/457002





# The Homunculus and the Hand

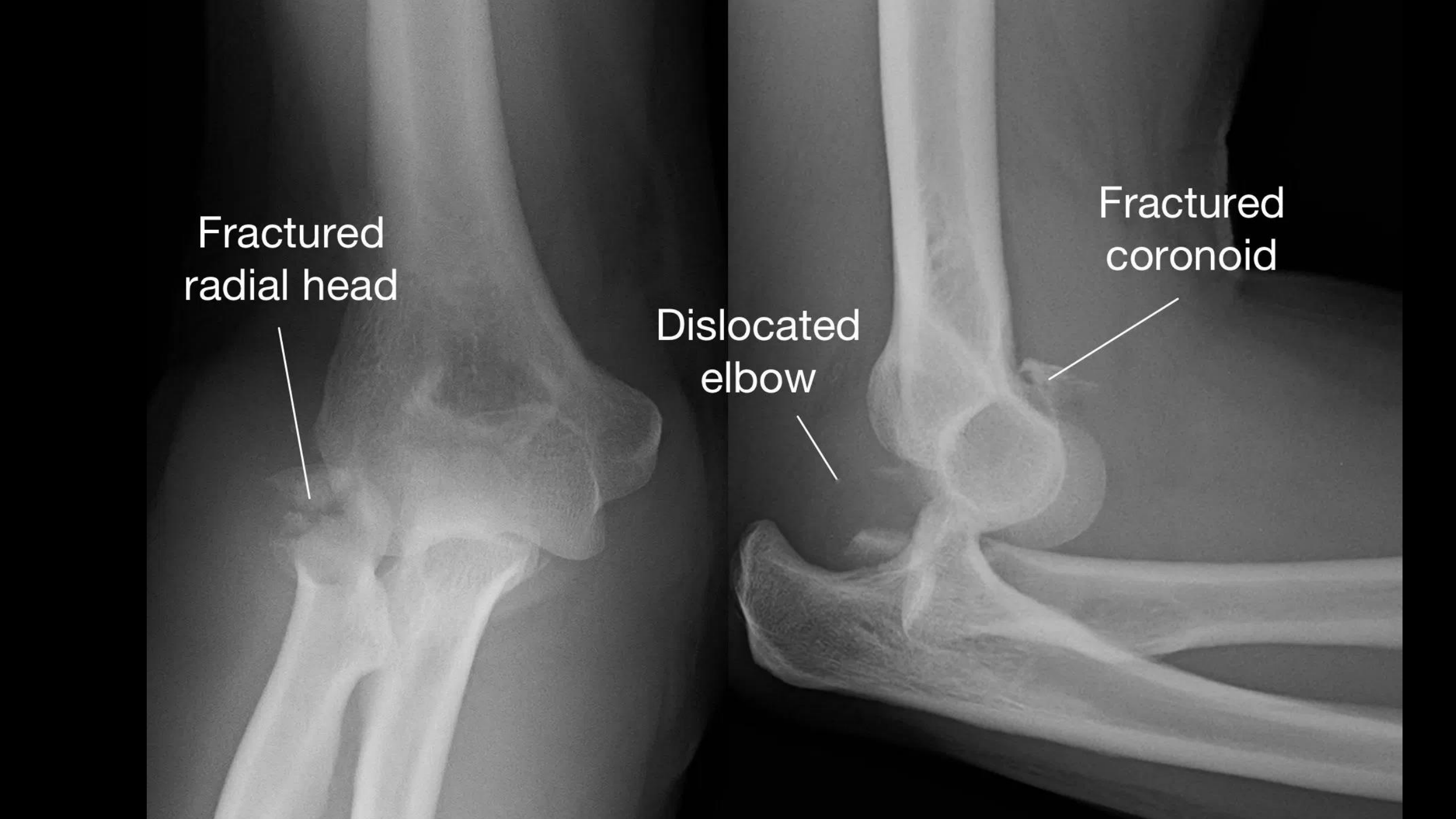
(6th Section)

## Concluding Comments

# The Homunculus and the Hand

(Key Talking Points)

| | |
|---|---|
| The concept of sensory deprivation and neighboring cortical recruitment. |  |
| The association between complex, precise body structures, high density tactile sensitivity regions, and extensive neural representation. |  |
| The link between the amount of cortical real estate and motor movement complexity and capacity. |  |
| The connection between trauma and behavioral changes. |  |


Fractured radial head
Dislocated elbow
Fractured coronoid

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