Πανεπιστήμιο Θεσσαλίας
Σχολή Επιστημών Υγείας
Τμήμα Ιατρικής

Neuroplasticity

Ευτυχία Καψαλάκη
Καθ. Ακτινοδιαγνωστικής Π.Θ.

https://youtu.be/ELpfYCZa87g

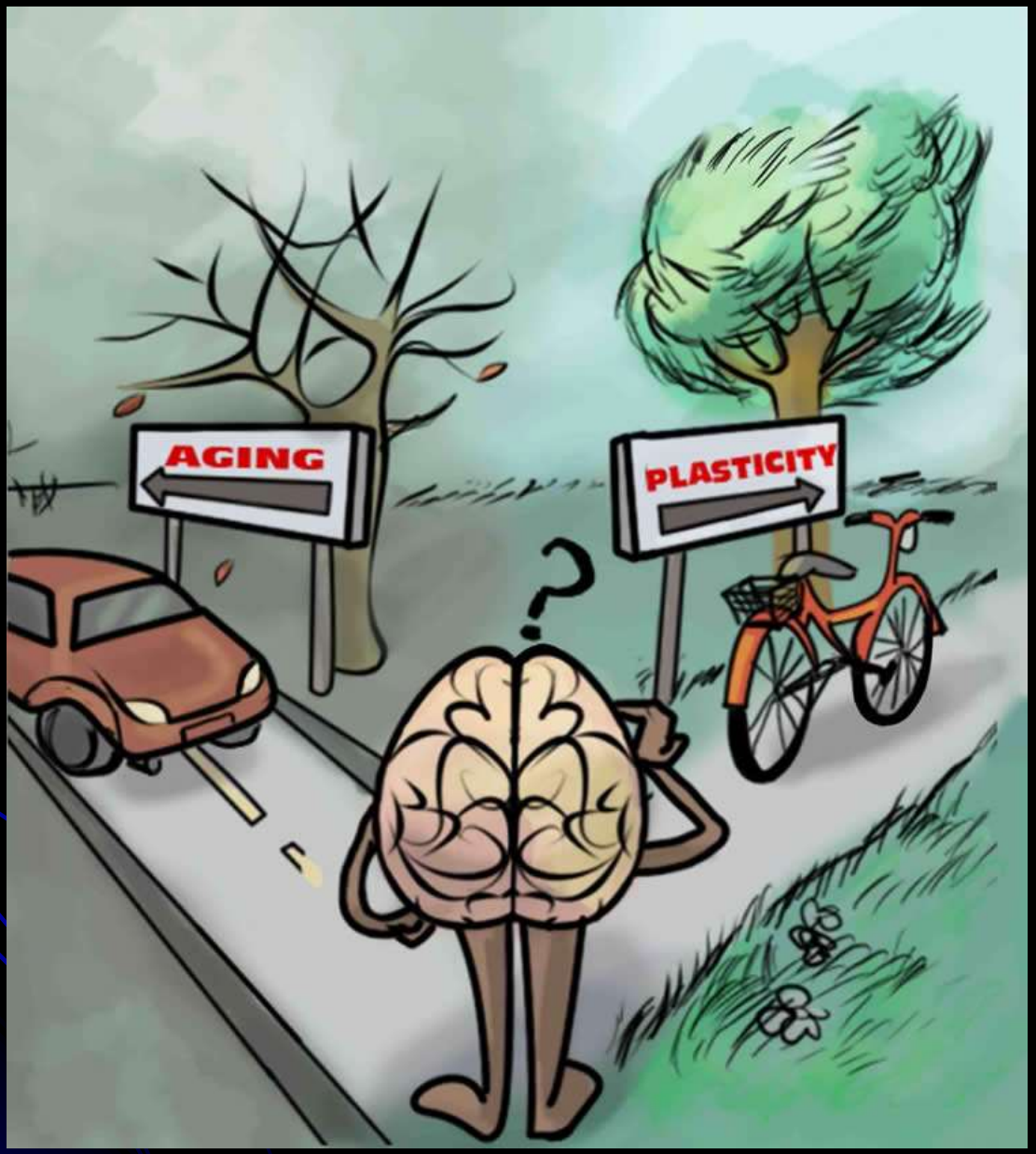
https://youtu.be/cgLYkV689s4

Plasticity

- Brain changes in the presence of new information and stimuli
- Brain may change regardless the age
  - Older age – more delayed plasticity
  - Children better ability to learn languages
  - Children better capacity to recover from brain damage

Plasticity

- Brain capacity to be changed by experience
- Brain capacity to learn and remember
- Brain ability to reorganize after injury


AGING
PLASTICITY
?

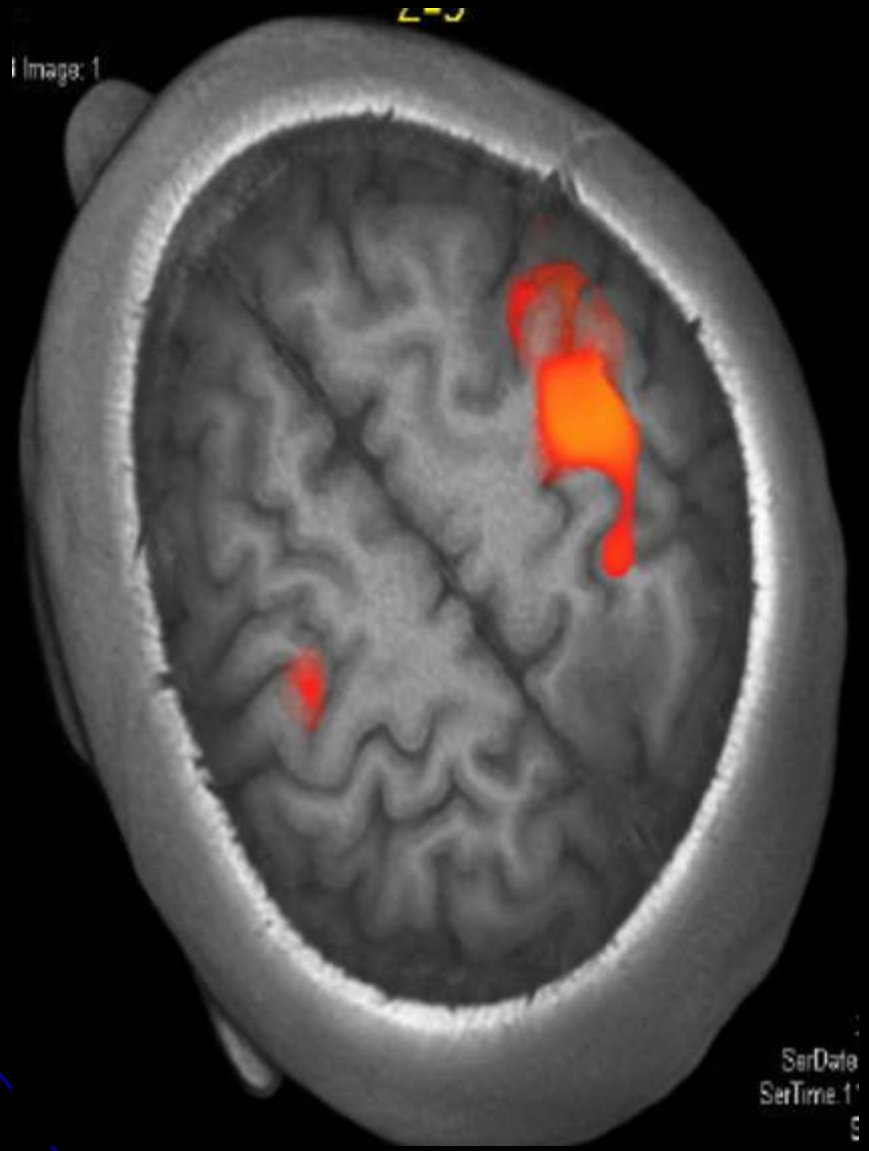


Image: 1
SerDate
SerTime

Memory

- Muscle
- Exercise improves memory
- Releases chemicals (endorphins and serotonin)

- If you don't use it you loose it

- Depression shrinks your brain

- Causes
  - Chemical imbalance
  - Neuron constriction
  - Broken connections

Learning

- Learning changes the size of our brain
- Synapses not used – degenerate

Plasticity

- Neurogenesis – new neurons to new areas
- Synaptogenesis – new connections

- Occurs during normal brain development
- To compensate damage

- Practice plays a key role to plasticity

Can u live with ½ your brain?

- http://www.youtube.com/watch?v=2MKNsI5CWoU

Neuroplasticity – Brain Remodeling

Steps to remodel the brain based upon experiences:

- 1. Repetition
- 2. Correct fundamentals
- 3. Authentic environment

Functional Reorganization

As the brain develops, certain areas of the brain become specialized for specific tasks.

If your experience changes dramatically or parts of the brain are damaged, areas previously specialized for a certain function can take on the work of other areas.

Levels of Neuroplasticity

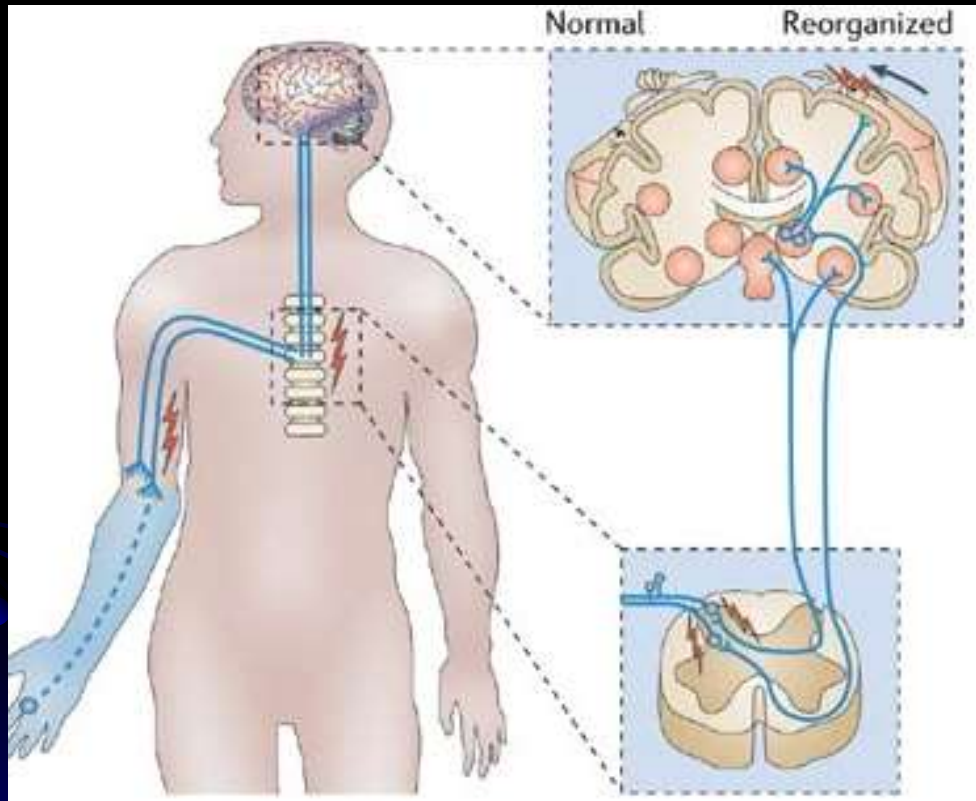
- Cellular changes (result of learning)
- Cortical remapping (response to injury)

Cortical Maps

- Sensory information from certain parts of the body projects to specific regions of the cerebral cortex.
- As a result of this somatotrophic organization of sensory inputs to the cortex, cortical representation of the body resembles a map (or a homonculus).

Brain damage

Phantom Limb Pain

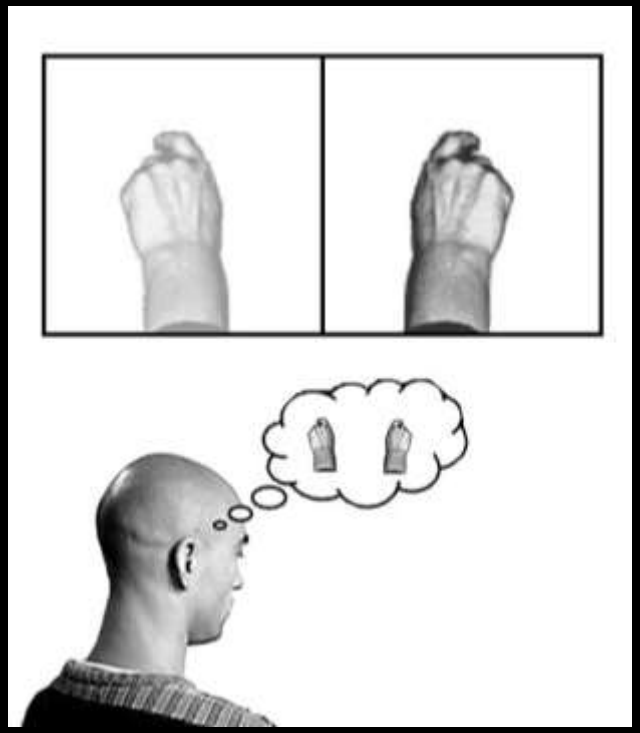


Central changes
- Unmasking
- Sprouting
- General disinhibition
- Map remodelling
- Loss of neurons and neuronal function
- Denervation
- Alterations in neuronal and glial activity
- Sensory–motor and sensory–sensory incongruence

Peripheral changes
- Structural changes in neurons and axons
- Ectopic impulses
- Ephaptic transmission
- Sympathetic–afferent coupling
- Down- and upregulation of transmitters
- Alterations in channels and transduction molecules
- Selective loss of unmyelinated fibres

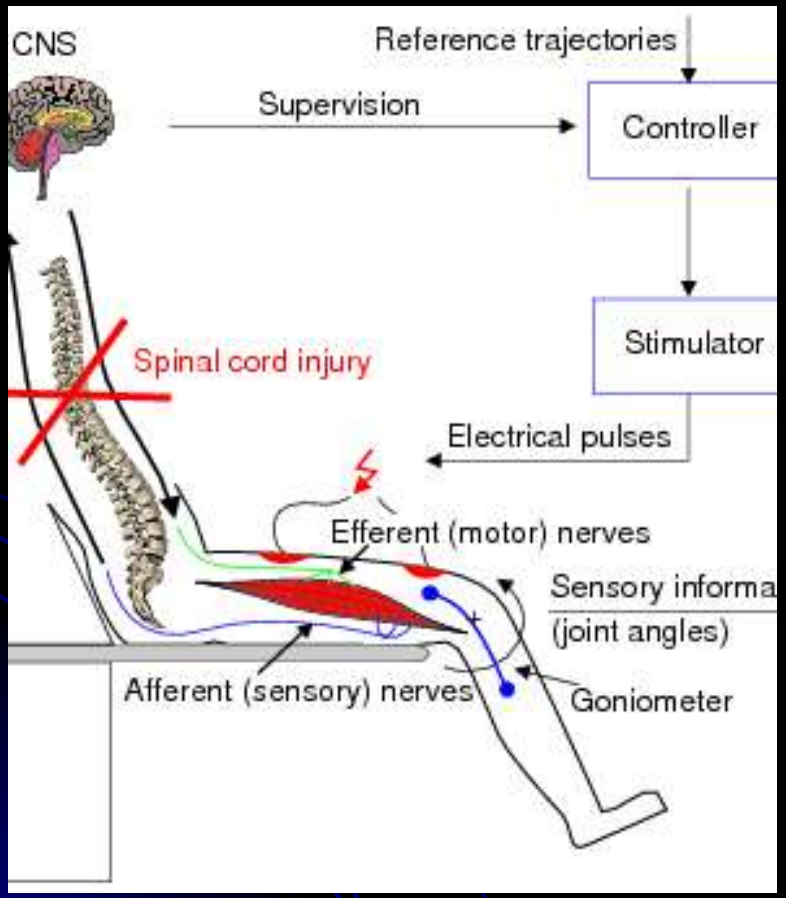
Mirror Box

A diagrammatic explanation of the mirror box. The patient places the good limb into one side of the box (in this case the right hand) and the amputated limb into the other side. Due to the mirror, the patient sees a reflection of the good hand where the missing limb would be (indicated in lower contrast). The patient thus receives artificial visual feedback that the "resurrected" limb is now moving when they move the good hand.



MIRROR THERAPY

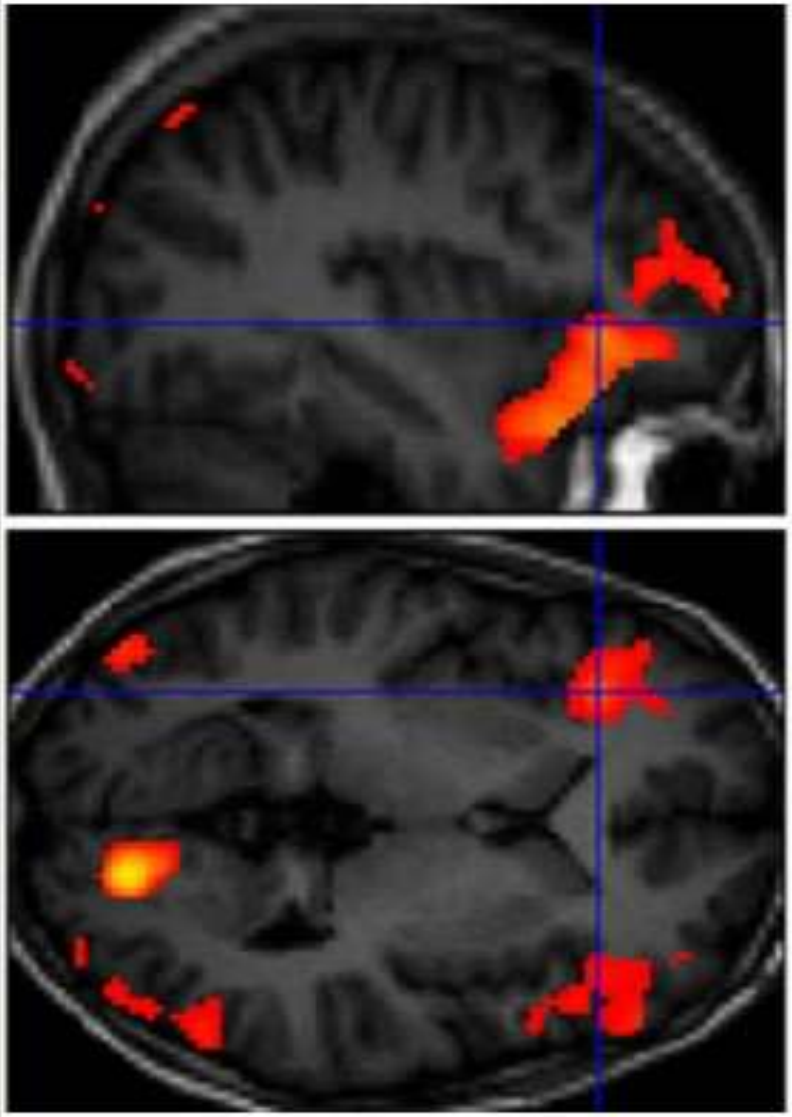
Functional Electrical Stimulation



fMRI/DTI Imaging

- better definition of the patients' functional state,
- better individual prognosis,
- improvement of treatment strategies, and
- progress in understanding how the nervous system acts in response to disease

Mirror Therapy

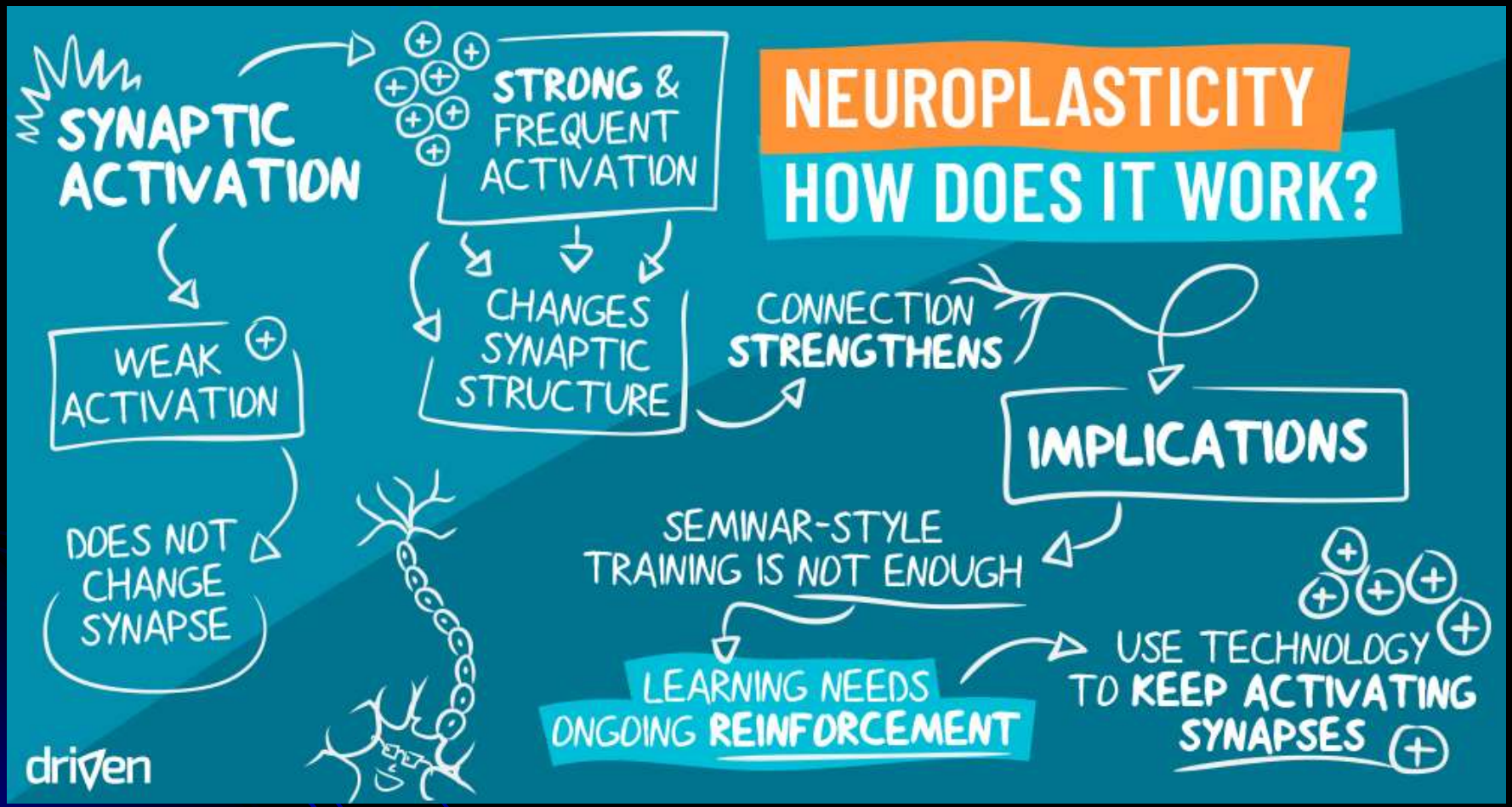


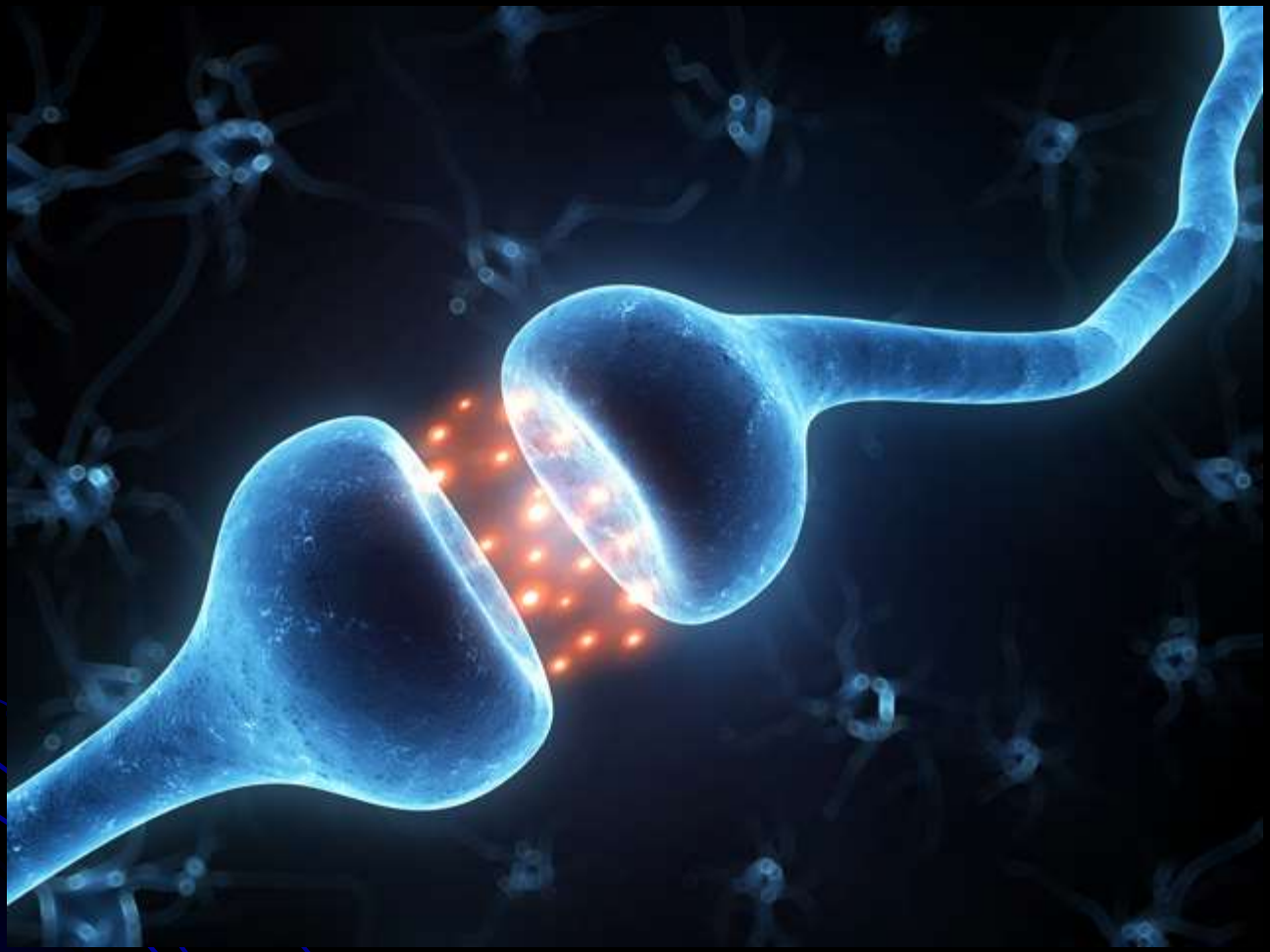
TRAIN THE BRAIN

- In a pilot study , fMRI demonstrates that brain areas, that are involved in sensory-motor learning (mirror neurons), are activated by the visual illusion from mirror therapy.

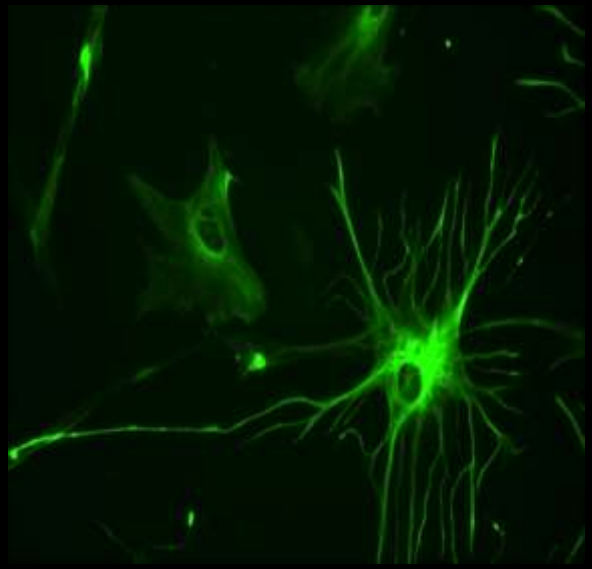
Mechanisms of Neuroplasticity

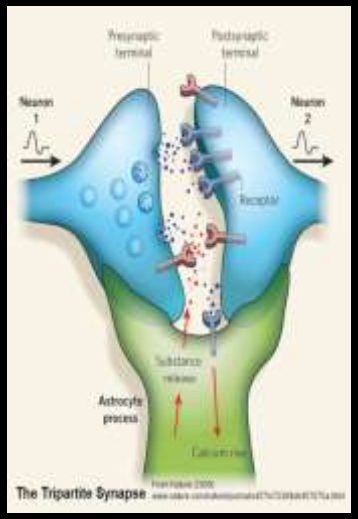
1. Diaschisis – neuronal structures that are anatomically connected to a lesion or region damaged by stroke undergo reduced blood supply and metabolism.
2. Behavioral compensation – occupational therapy directs the individual's interaction with the environment to utilize viable neurons surrounding the area of the lesion in order to reorganize their capacity to compensate for damaged neurons.
3. Adaptive plasticity – dendritic growth and angiogenesis occurs near the damaged areas. Dendritic growth is an adaptive response to substitute for the lost function.
   - This is a critical time of OT intervention.
   - Positive plasticity happens through use or doing.
   - Negative plasticity happens through disuse or doing little.

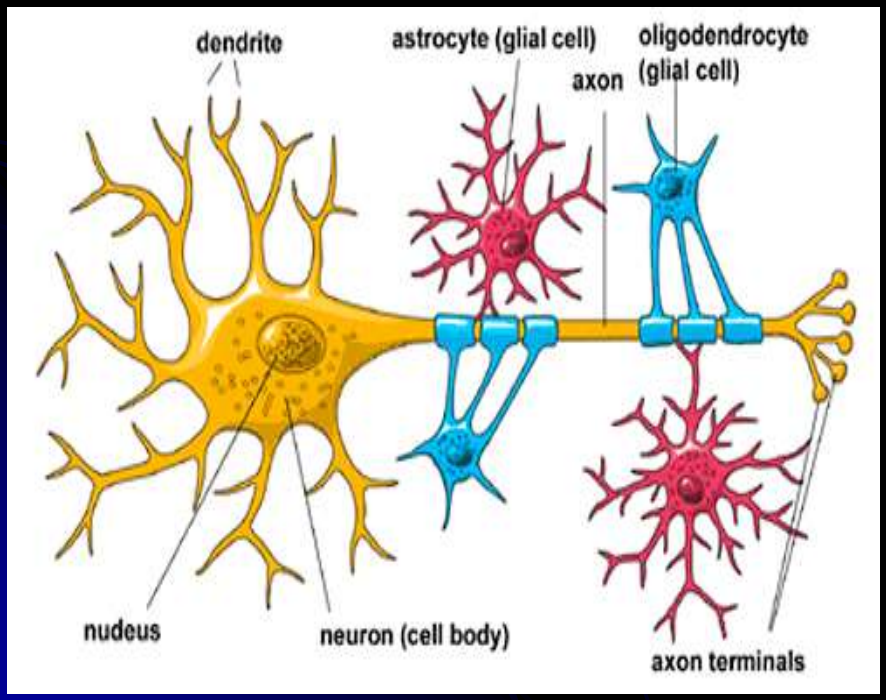

SYNAPTIC ACTIVATION
STRONG & FREQUENT ACTIVATION
NEUROPLASTICITY
HOW DOES IT WORK?
WEAK ACTIVATION
CHANGES SYNAPTIC STRUCTURE
CONNECTION STRENGTHENS
IMPLICATIONS
DOES NOT CHANGE SYNAPSE
SEMINAR-STYLE TRAINING IS NOT ENOUGH
LEARNING NEEDS ONGOING REINFORCEMENT
USE TECHNOLOGY TO KEEP ACTIVATING SYNAPSES
driven

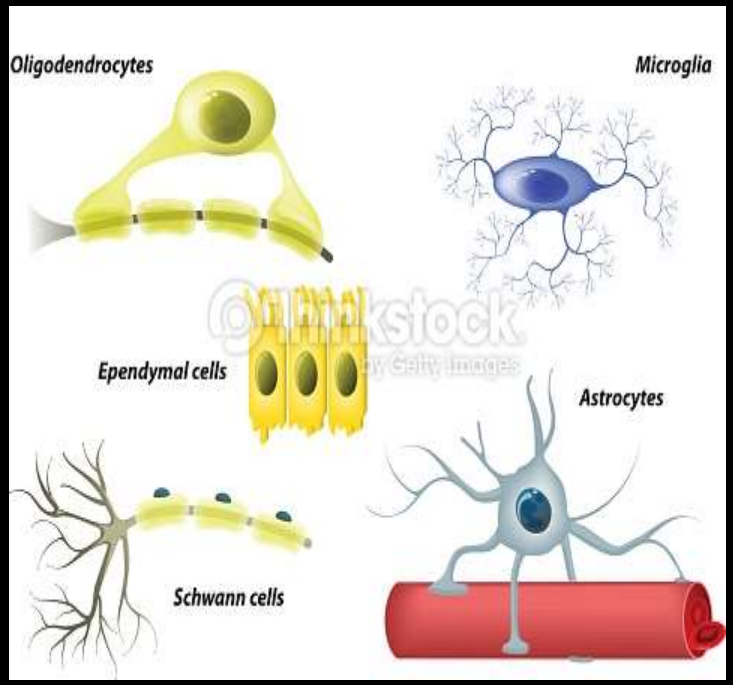


Neurons
Glial cells

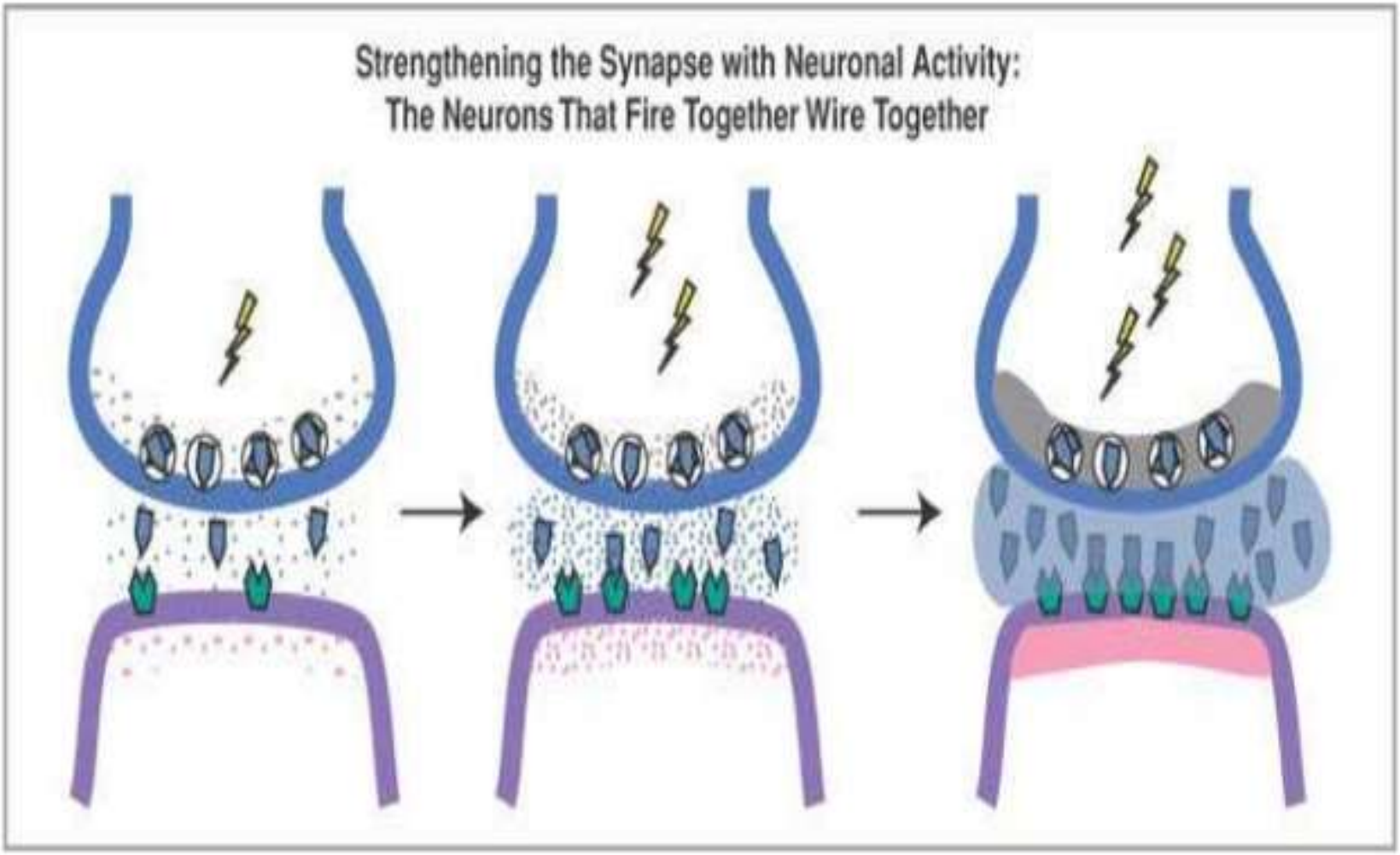


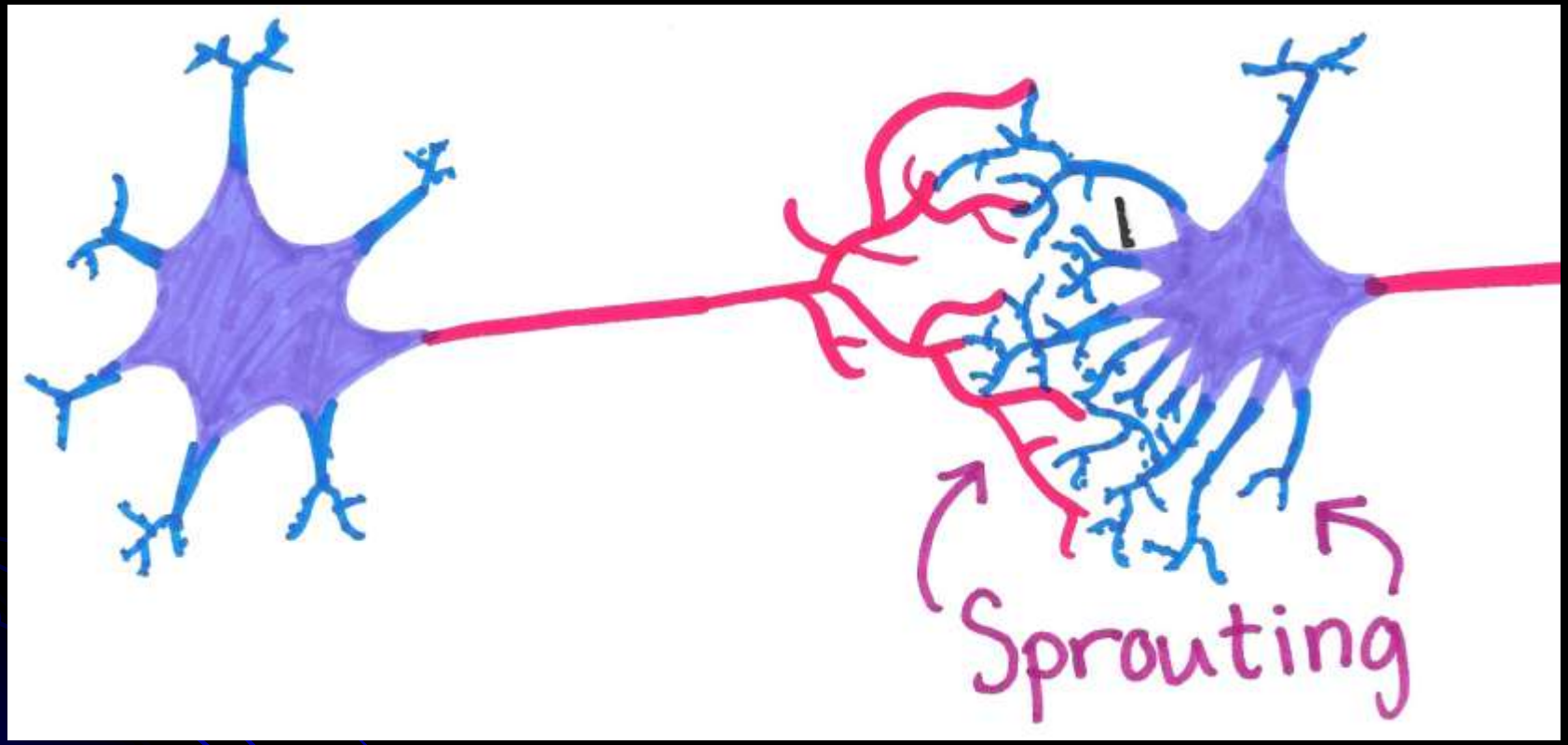




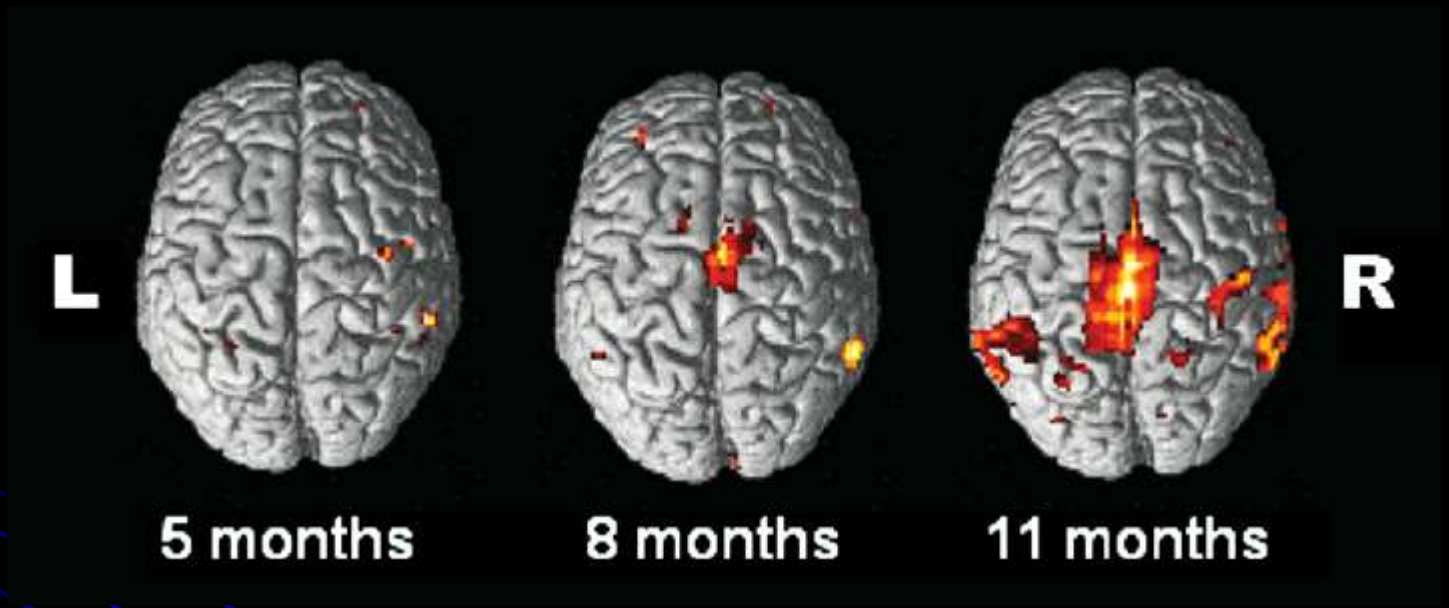


Released neurotransmitters strengthen the synapse

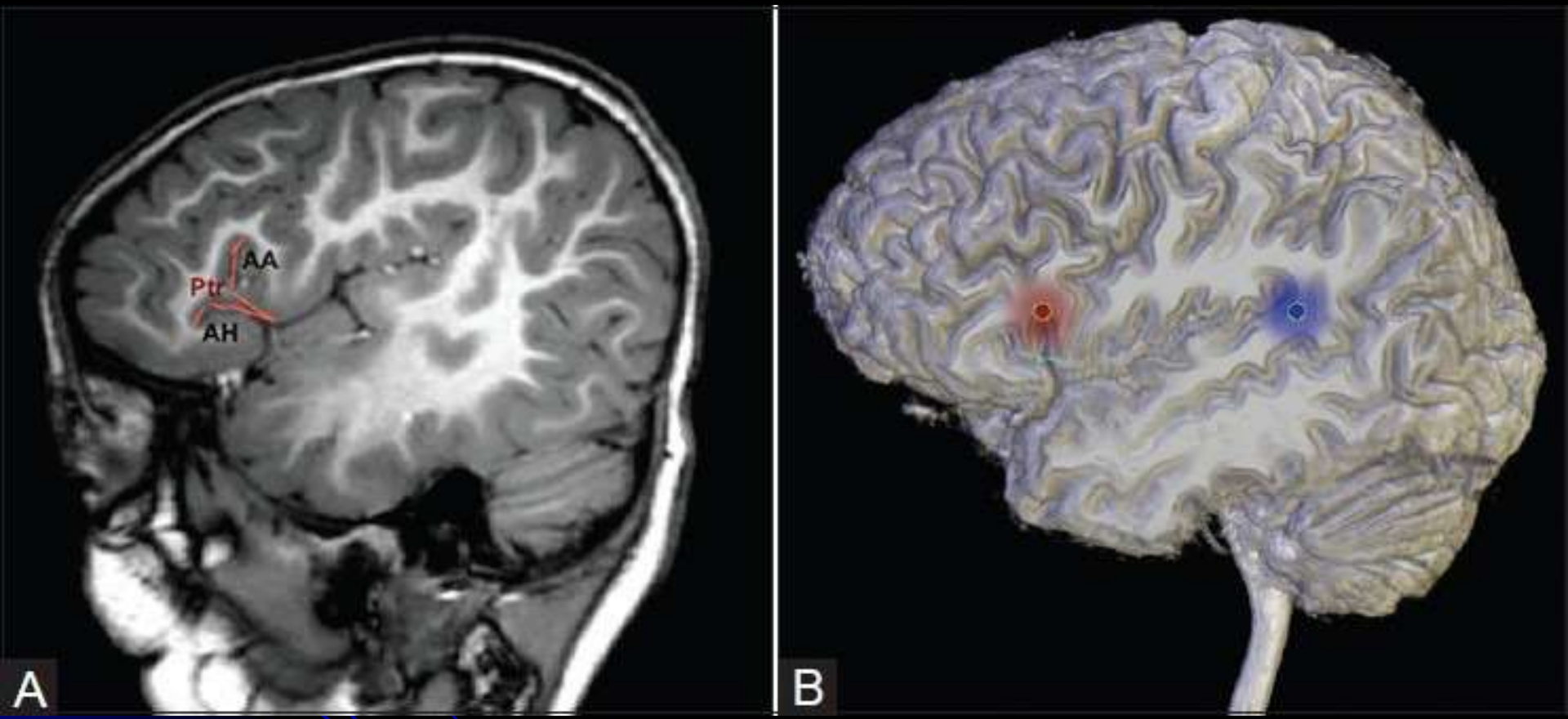



Sprouting

Brain recovery after stroke

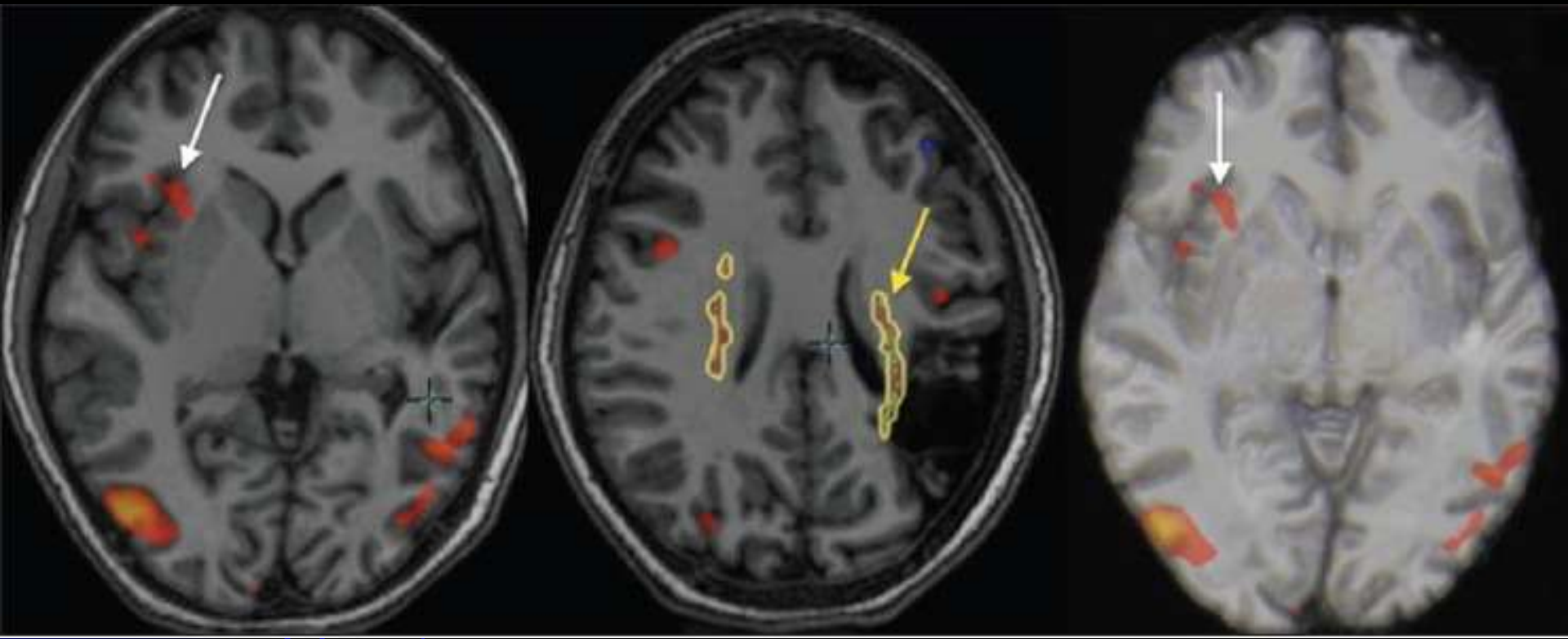


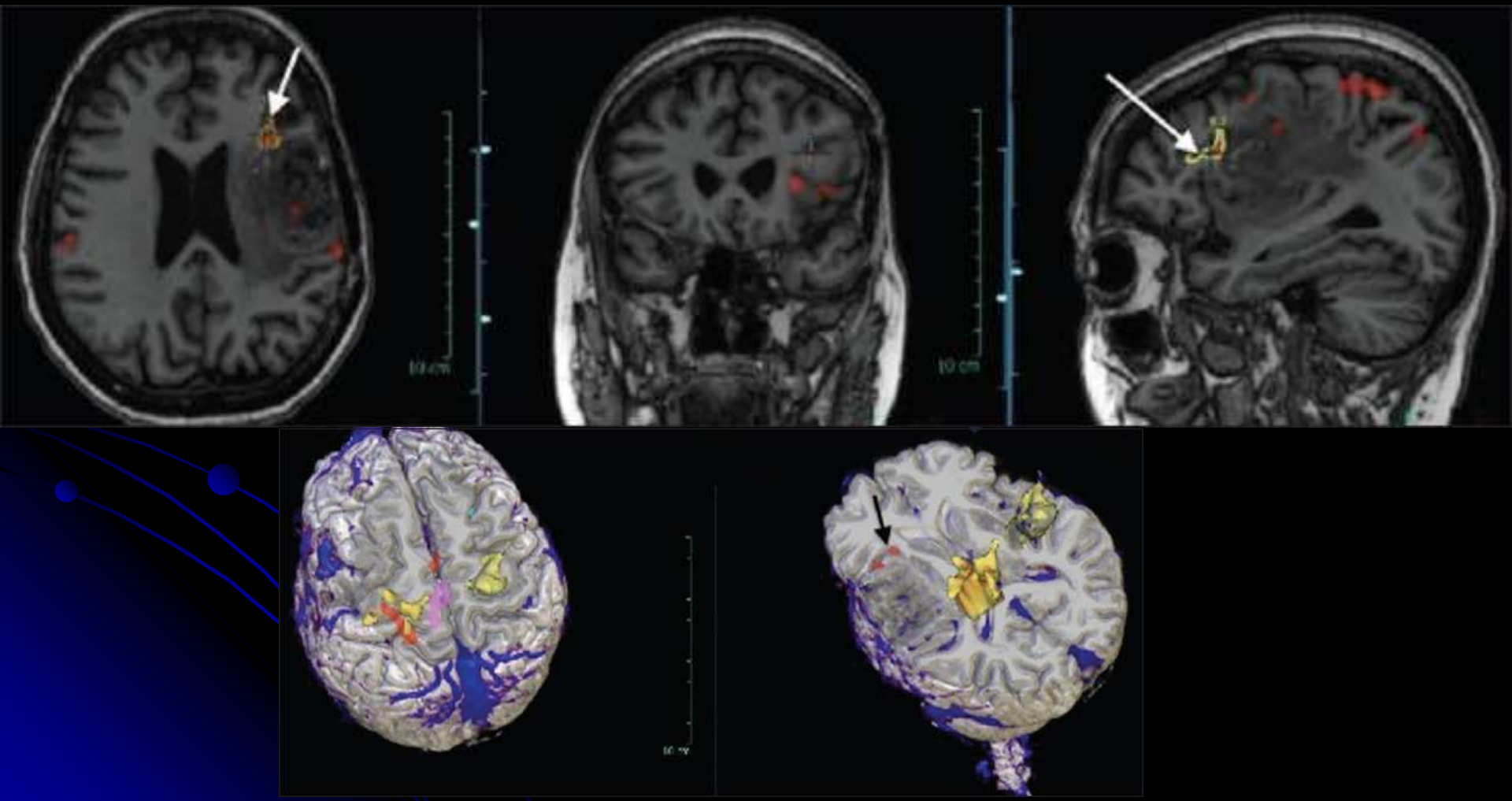
Language networks



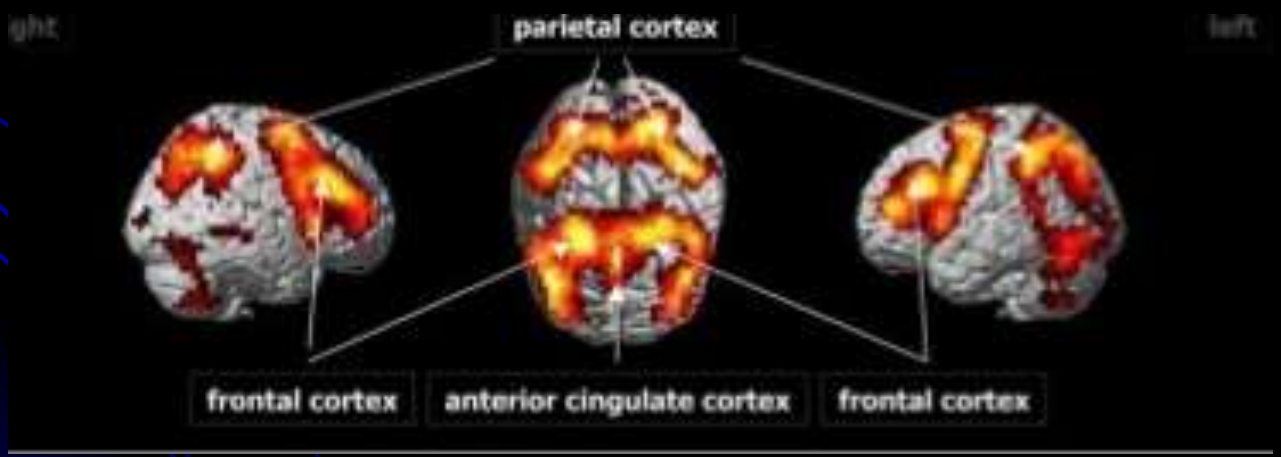
Verb generation

Passive listening

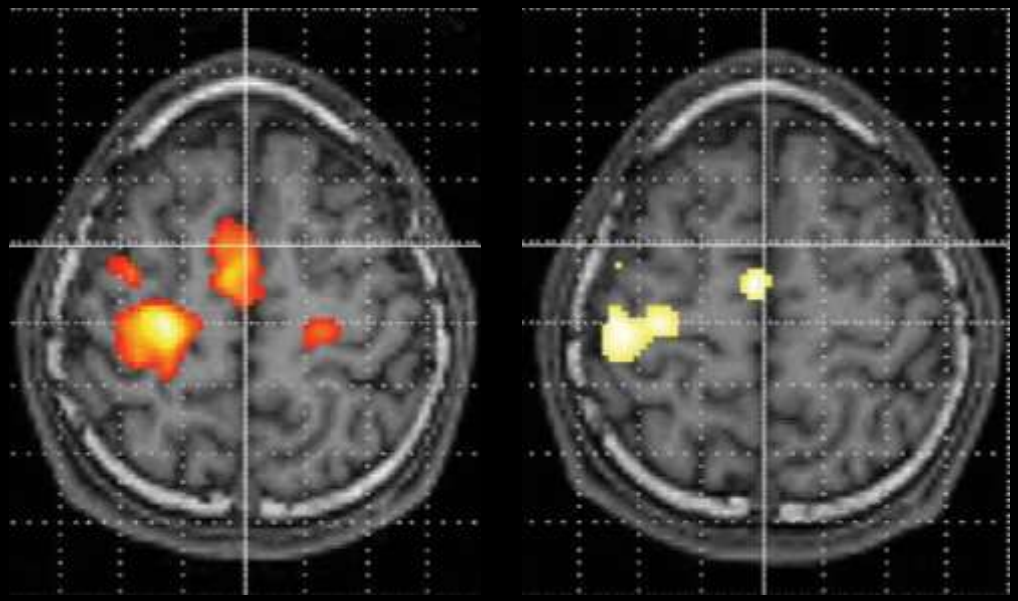




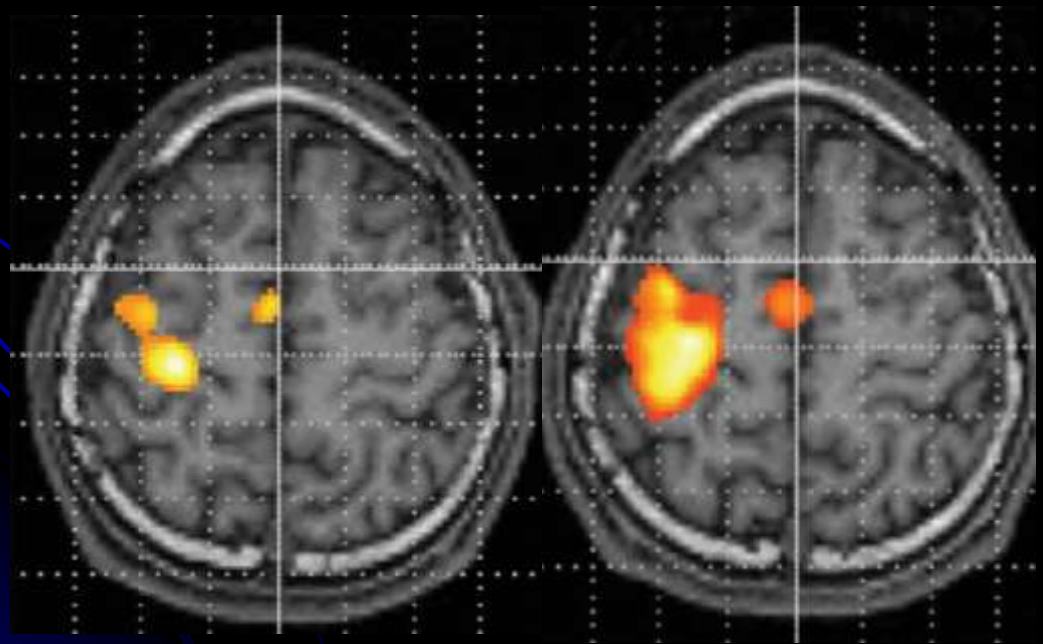
- The prefrontal cortex enables us to regulate emotions, and more specifically, helps us inhibit inappropriate or incapacitating emotions.
- If our left prefrontal cortex is less active, then negative emotions (such as depressed mood) may be expressed more frequently and more intensely.
- An active Left PC indicates a happy mood.



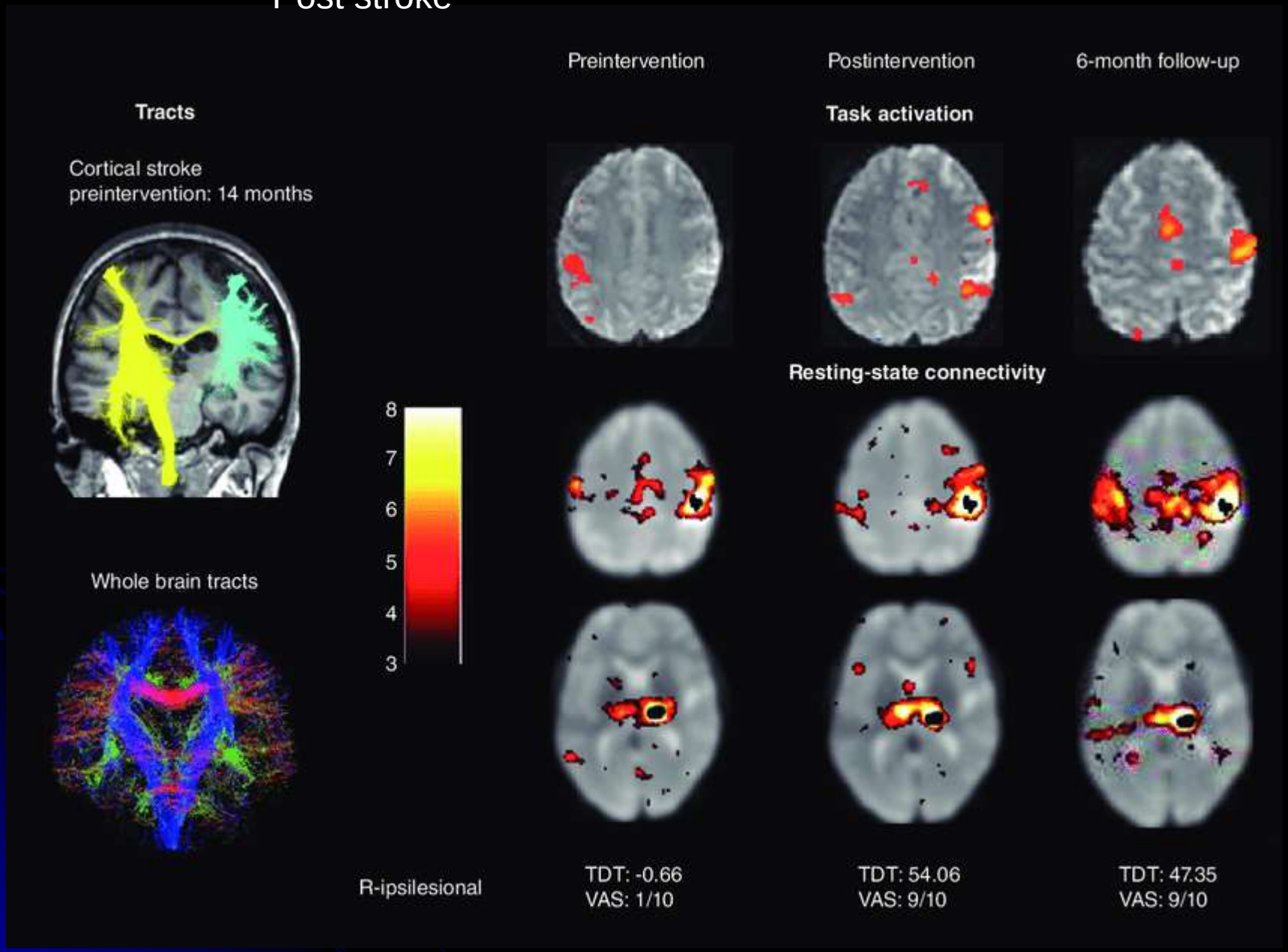
Before Stroke rehab

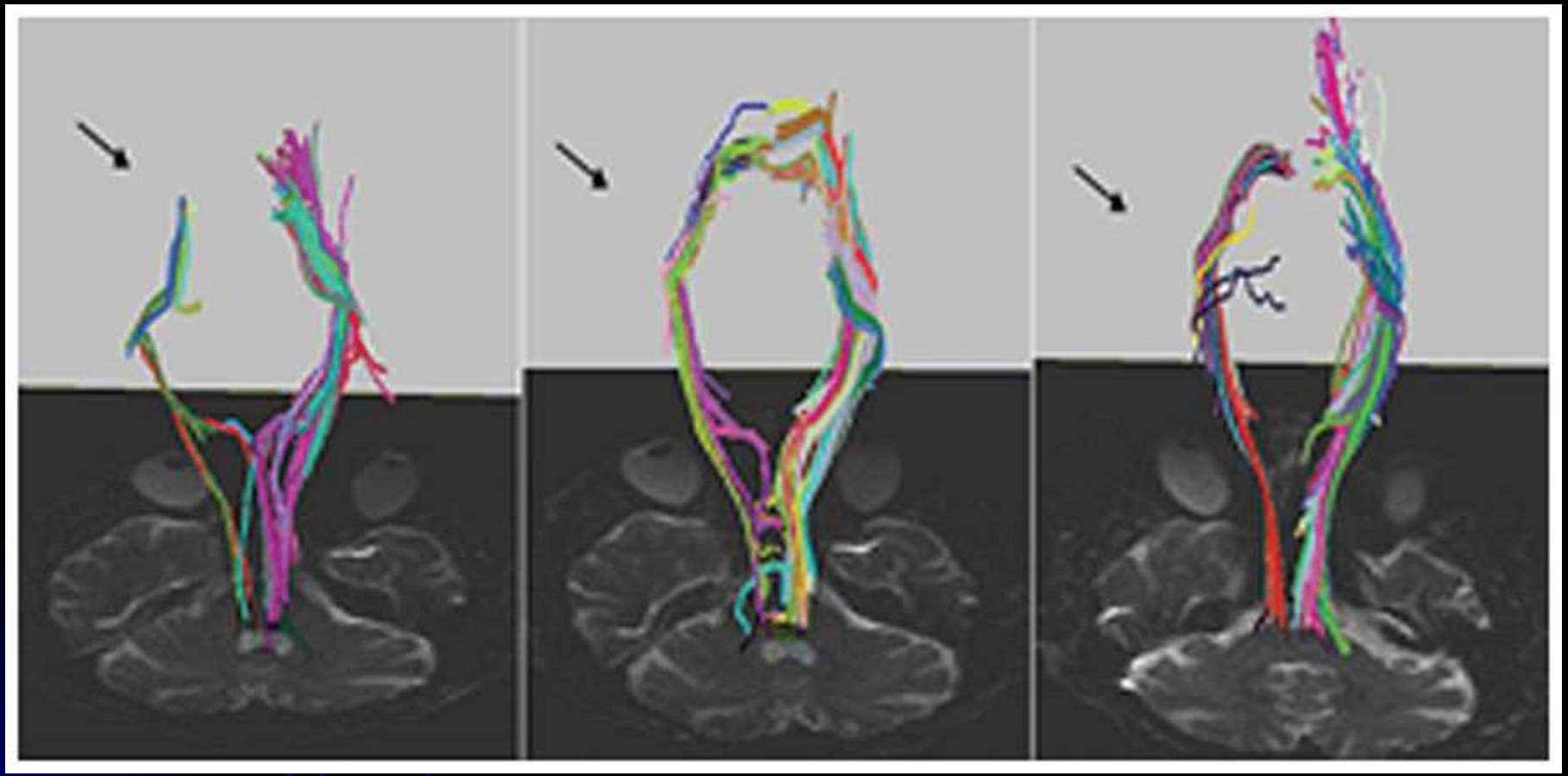


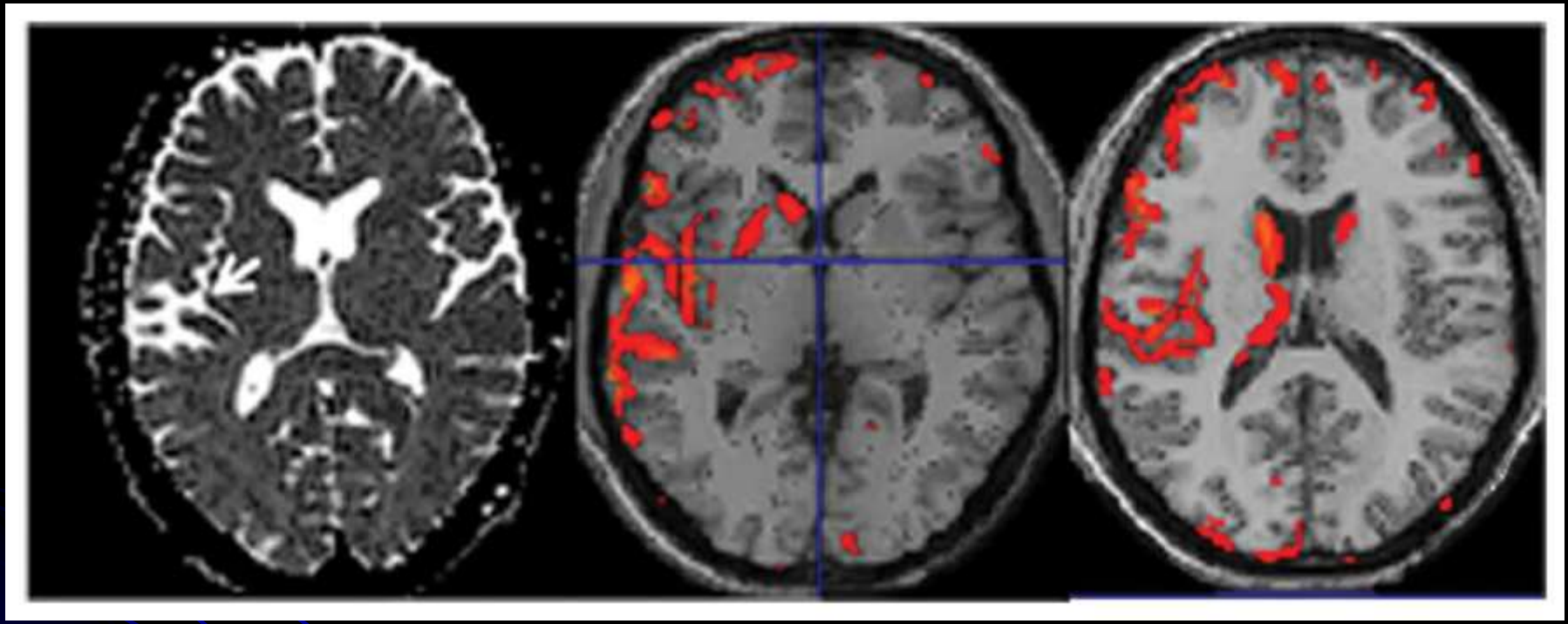
After



Post stroke

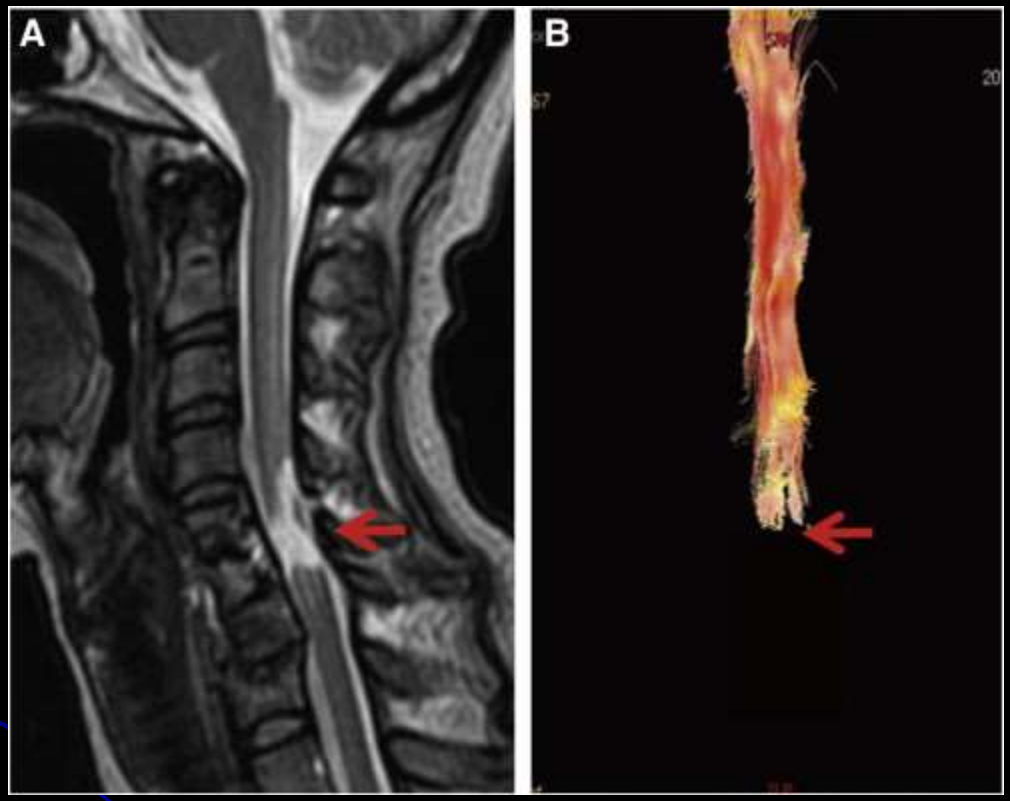

Preintervention
Postintervention
6-month follow-up
Tracts
Task activation
Cortical stroke
preintervention: 14 months
Resting-state connectivity
8
7
6
5
4
3
Whole brain tracts
R-ipsilesional
TDT: -0.66
VAS: 1/10
TDT: 54.06
VAS: 9/10
TDT: 47.35
VAS: 9/10

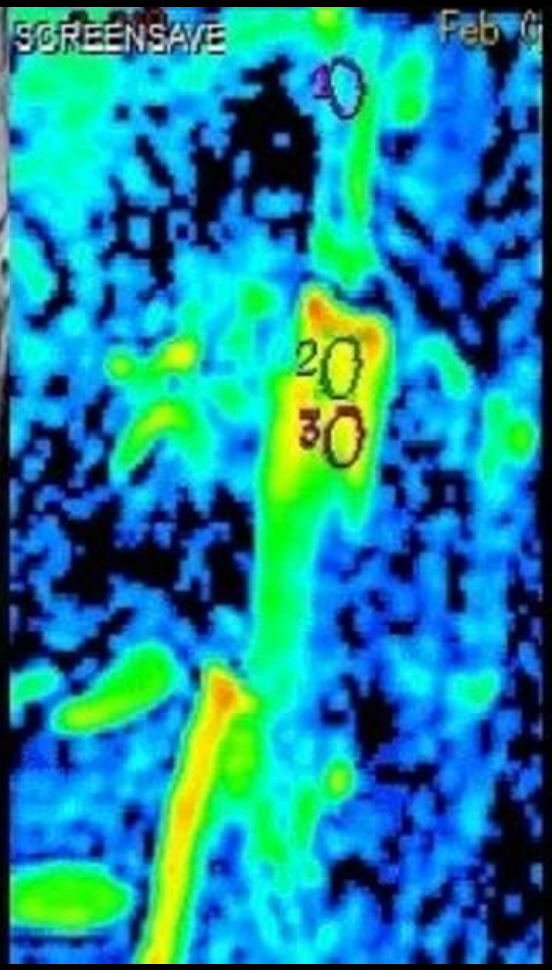




Brain atrophy VBM


A
B
C


A
B



EPOS


nuts
mental fitness
cognition
Neuroplasticity
brain change
sleep
new connections
neurological conditions
zinc
brain fat
word retrieval
EPA
avocado
white matter
brain foods
grey matter
wellbeing
brain plasticity
turmeric
Mild cognitive impairment
gut-brain axis
emotions
brain health
alzheimer's
cerebral volume
exercise
flavonoids
anti-inflammatory
DHA
probiotics
aging brain
omega-3
psychological changes
wild fatty fish
diet
age-related
memory
mental function
brain fog
stroke
healthy brain
micronutrients
oxidative stress
folic acid