

NEUROTECHNOLOGY IN REHABILITATION



Novel approaches in neurorehabilitation
recoveriX
Eodyne RGS

Lídia Gömöri

Dept. of Anatomy, Histology and Embryology (UD)

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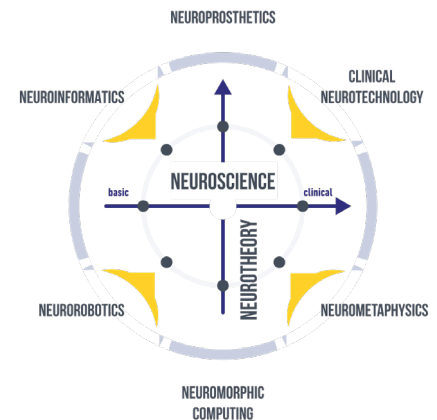
BASIC CONCEPTS

Neurotechnology

Neurotechnology focuses on the realization of a broad set of methods, concepts, artificial systems and technologies that aim to understand, interact with, repair, enhance, and directly influence the brain and behaviour. In other words: technology *from* the brain, *for* the brain and *with* the brain.

Neurorehabilitation

Neurorehabilitation is a complex and highly specialised clinical process that is used to restore, minimise and/or compensate for functional alterations in individuals affected by disability caused by an injury to the nervous system.





NEUROLOGICAL REHABILITATION



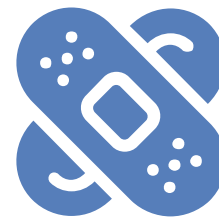
NEUROLOGICAL IMPAIRMENT

Intellectual or emotional impairments
Sensory or MOTOR impairments



DISABILITY AND HANDICAP

Loss of functions,
partial recovery
Social burden



NEUROLOGICAL RECOVERY

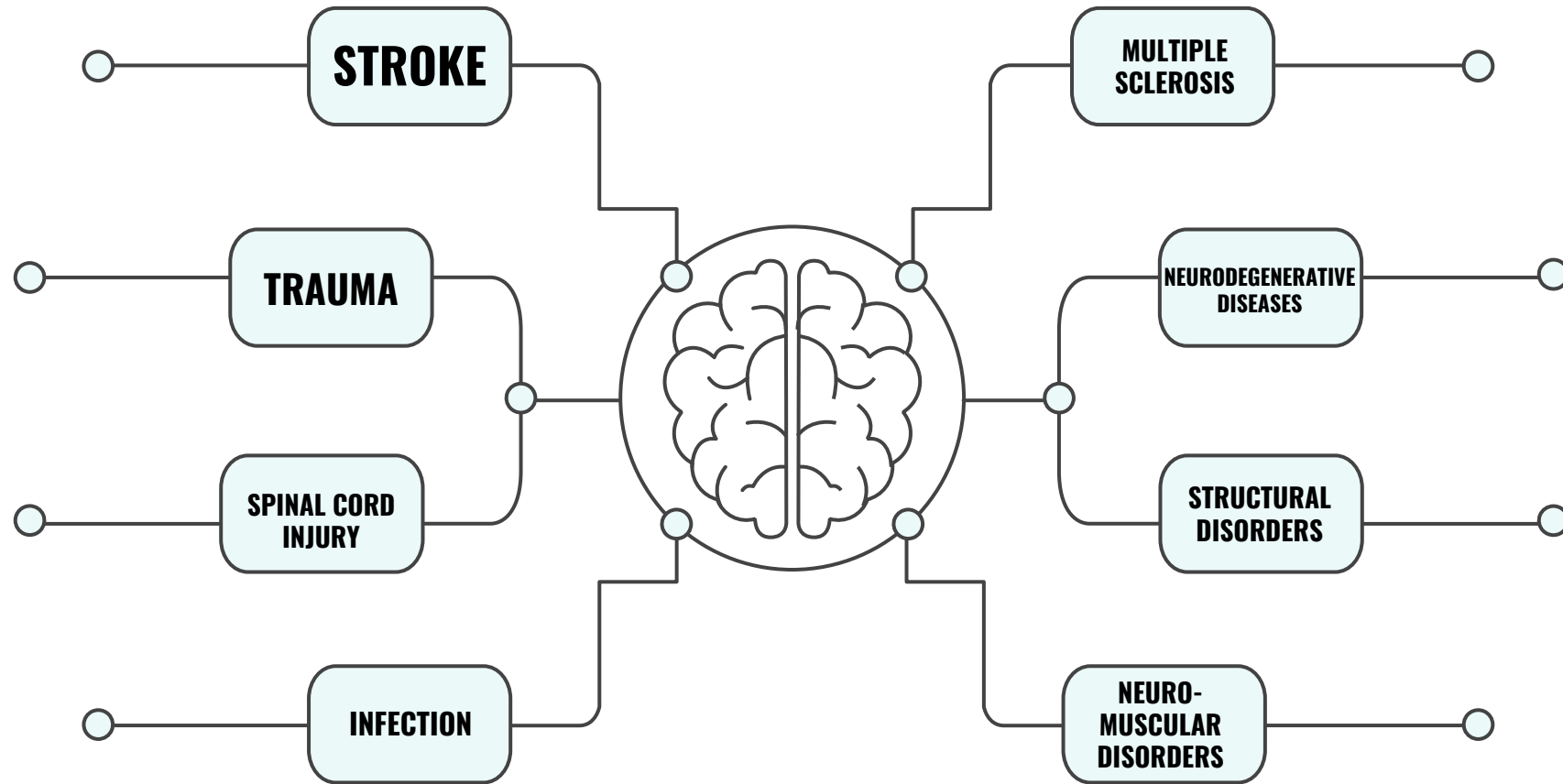
Central nervous system
Vs
Peripheral nervous system



AIMS OF REHABILITATION

- To prevent complications.
 - To promote intrinsic recovery.
 - To teach adaptive strategies.
 - To facilitate function in the patient's normal environment.
-

WHAT CONDITIONS CAN BENEFIT FROM NEUROLOGICAL REHAB?



What happens in the brain when a person has a stroke?

Lack of blood supply due to vascular obstruction, bleeding, or hypoperfusion
-> serious brain damage -> motor impairments

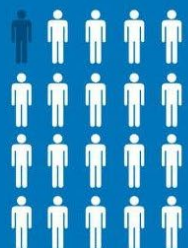
- Usually only affects one hemisphere
- But can also cause complete paralysis
- Spasticity
- Pain, difficulty moving, unintended movements, and other problems

Difficulty with movement can lead to many challenges. Stroke survivors might not be able to work or enjoy their favorite sports or hobbies. They might need help from friends and family, and they may have financial trouble from lost work and the costs of treatment and care. Some stroke survivors are uncomfortable being in public because they think people will tease them about their disabilities.

STROKE

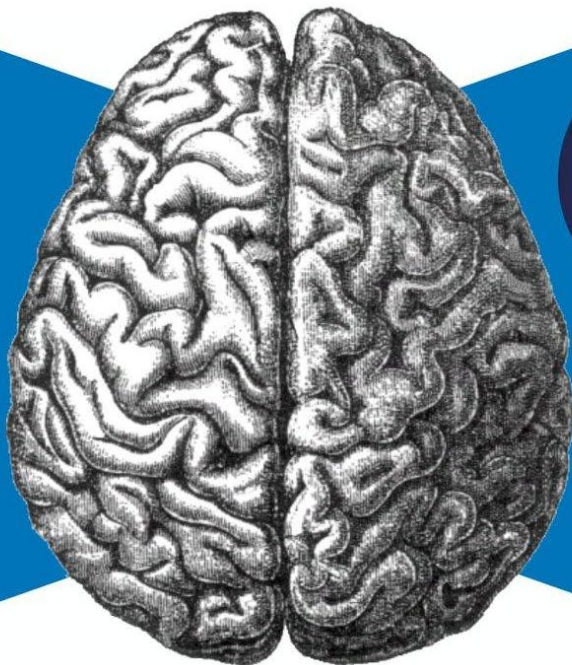
Stroke occurs when a blood vessel bringing blood and oxygen to the brain gets blocked or ruptures. When this happens, brain cells do not get the blood that they need. Deprived of oxygen, nerve cells stop working and die within minutes. Then, the part of the body they control can't function either. The effects of stroke may be permanent depending on how many cells are lost, where they are in the brain, and other factors.

STROKE KILLS
ABOUT 13,000 AMERICANS
EACH YEAR



1
out of
20
deaths

FIFTH
LEADING CAUSE
OF DEATH
IN THE U.S.



ON AVERAGE,
AN AMERICAN
DIES FROM A
STROKE EVERY
4 MIN.



IN 2009, 34% OF PEOPLE HOSPITALIZED
FOR STROKE WERE UNDER 65.



STROKE IS
THE LEADING
CAUSE OF
LONG-TERM
DISABILITY

Know the Warning Signs of Stroke

- Sudden weakness or numbness in the face, arm or leg, particularly on one side of the body
- Sudden confusion, understanding or speaking
- Sudden trouble walking, dizziness, loss of coordination or balance
- Sudden severe headache with no known cause

Treatments for stroke may vary depending on the type of stroke.

An ischemic stroke, which accounts for 87% of all stroke cases, is an obstruction (clot) of a blood vessel that supplies blood to the brain. A hemorrhagic stroke occurs when a blood vessel ruptures, causing a bleed.

- Diverse clinical presentation
Location-based symptoms
- Need for personalized therapy
- Successful rehabilitation requires **multidisciplinary approach**

COMPLEX INNOVATIVE APPROACH FOR POST-STROKE MOTOR REHABILITATION



NOVEL TECHNOLOGICAL DIRECTIONS IN NEUROREHABILITATION



- ROBOTICS AND EXOSKELETONS
 - NON-INVASIVE STIMULATION
 - VIRTUAL REALITY
 - NEURAL INTERFACES
-

ROBOTICS

Robotic rehabilitation therapy offers highly controlled, repetitive and intensive training. It reduces the physical burden for the physiotherapist, and provides objective and quantitative assessments of patients' progress throughout the rehabilitation process.



EXOSKELETONS

- Exoskeletons are “wearable” systems that consist of a mechanical structure, electric motors, sensors, a computer and batteries.
 - active participation required by the user
 - synergy with the user
 - possibility of being used as an assistive device at home
-



NON-INVASIVE BRAIN STIMULATION

The brain is a dynamic organ that is sensitive to internal and external environmental changes. In recent years, neuroscience has gained a better understanding of these mechanisms of neural plasticity.

Transcranial magnetic stimulation (TMS) and electrical brain stimulation are non-invasive techniques which allow us to modulate some of these neural changes in a safe and painless way. They can be combined with other techniques to improve their effectiveness.





VIRTUAL REALITY

and Augmented Reality

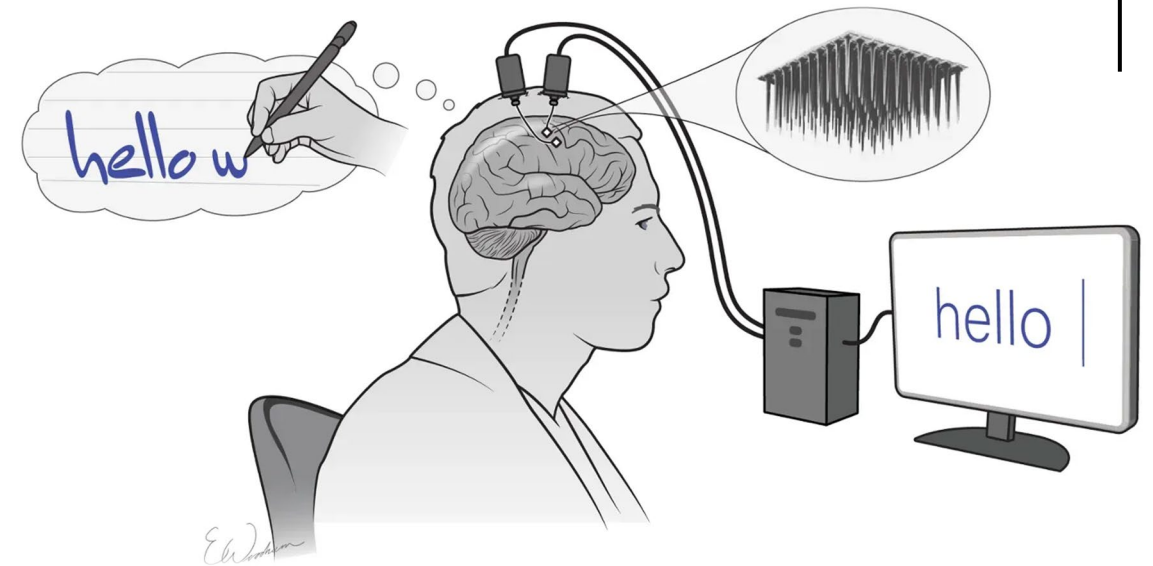
Virtual reality is a useful cutting-edge tool that can assess virtual scenarios that can be used for motor rehabilitation and intervene in them. Thanks to accelerometers and inertial trackers, virtual reality devices can detect the user's orientation with a high level of precision.

Virtual reality is, therefore, a field of innovation and translational research applied to clinical practice, which, when correctly used, configured and supervised by professionals, contributes to the patient's recovery.



NEURAL INTERFACES

The ultimate goal of neural interface research is to create links between the nervous system and the outside world either by stimulating or by recording from neural tissue to treat or assist people with sensory, motor, or other disabilities of neural function.



NEURAL INTERFACES

BCI/BMI

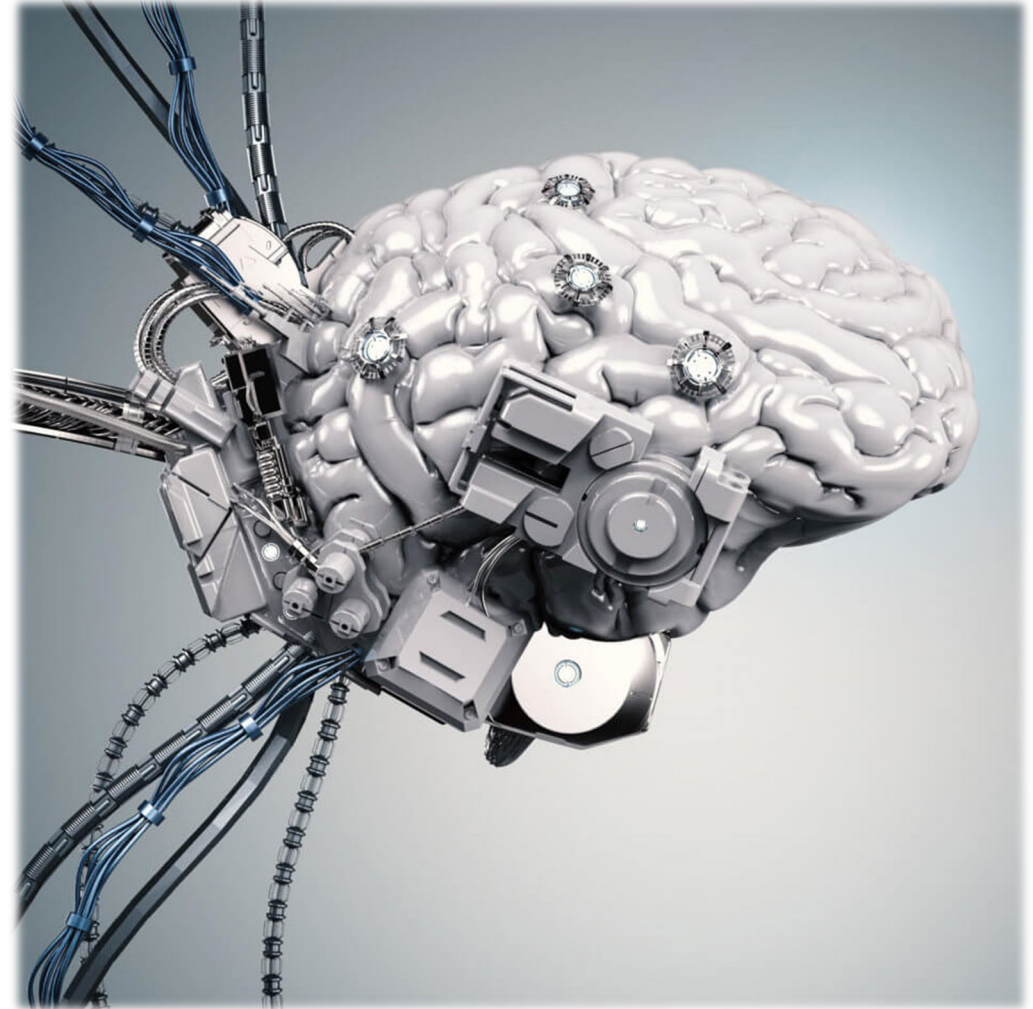
Brain-Computer Interface/
Brain-Machine Interface
(+ closed-loop versions)

BSI

Brain-Spine Interface

PNI

Peripheral Nerve Interface



BMIs

Types on spatial location basis

Types on Application basis

Non-invasive BMIs

Hybrid BMIs

Invasive BMIs

Motor BMIs

Sensory BMIs

Sensorimotor BMIs

Electroencephalography (EEG)

Endogenous EEG

Exogenous EEG

Magnetoencephalography (MEG)

Near Infrared Spectroscopy (NIRS)

Magnetic Resonance Imaging (fMRI)

Electrocorticography (ECoG)

Local Field Potential

Single Unit Recording

Patch Clamp

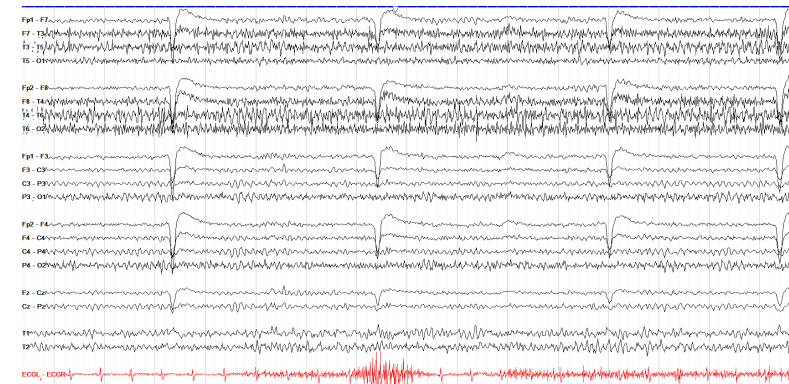
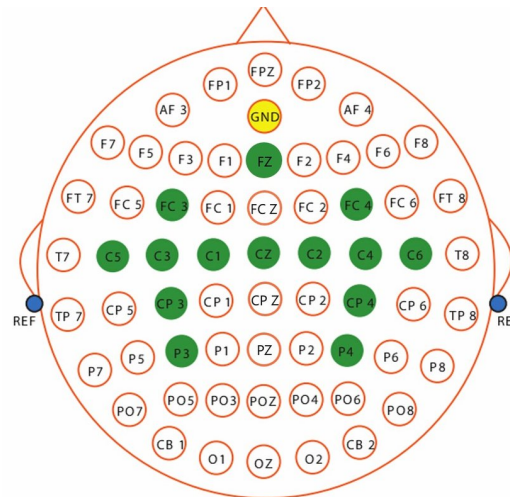
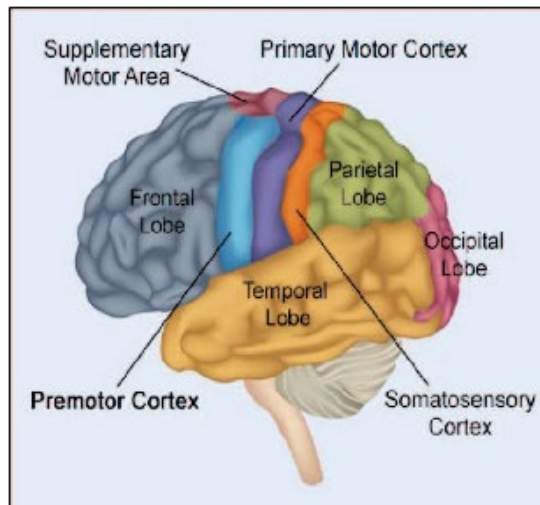
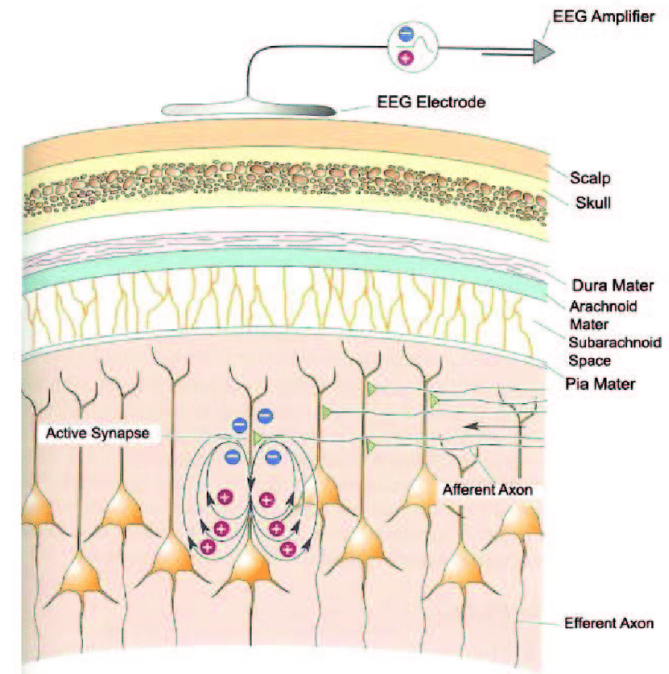
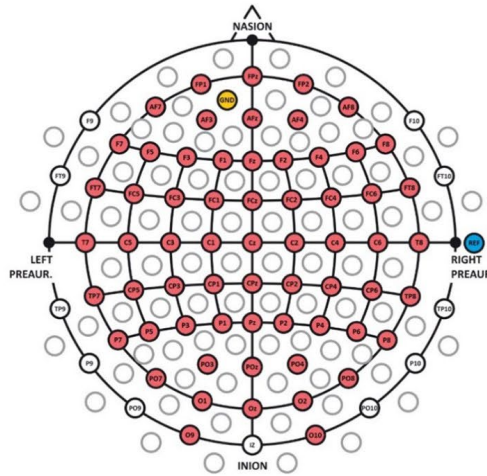
How can we **train the brain** to help **stroke** patients?

Many people who have had a stroke have trouble moving, even after therapy with the best experts and methods. New ways to make stroke therapy more effective could help people recover more effectively.

- A BCI that detects brain activity
- Controls a muscle stimulator
- And monitors response
- Rewarding feedback for correctly imagined movements

recoveriX®
MOTOR-RECOVERY NEUROTECHNOLOGY

EEG BASED SIGNAL AQUISITION



3 in 1 NEUROFEEDBACK

**MOTOR
IMAGERY**

**VIRTUAL
REALITY**

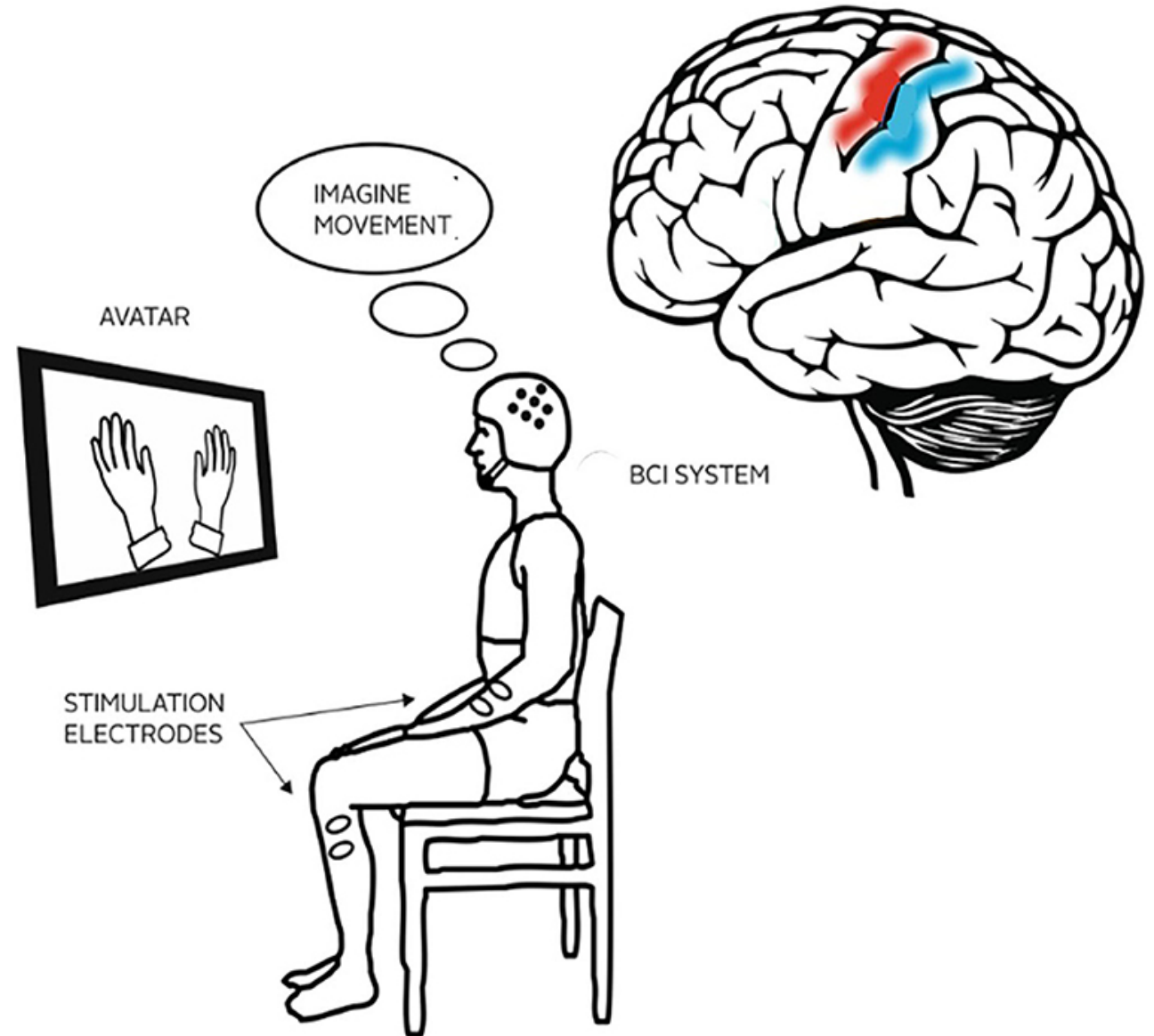
**FUNCTIONAL
ELECTRICAL
STIMULATION**





Using BCIs in post-stroke therapy can lead to increased [brain plasticity](#), meaning that the brain can create new connections that help it learn to perform certain functions again, such as moving the hand without spasms or other difficulties.

[The brain's remarkable ability to change itself to adapt to new information and situations, such as therapy. This ability helps people recover from stroke and other injuries.](#)





**SYNAPTIC
ACTIVATION**



**STRONG &
FREQUENT
ACTIVATION**

NEUROPLASTICITY

HOW DOES IT WORK?

**WEAK ⁺
ACTIVATION**

**DOES NOT
CHANGE
SYNAPSE**

**CHANGES
SYNAPTIC
STRUCTURE**

**CONNECTION
STRENGTHENS**

IMPLICATIONS

**SEMINAR-STYLE
TRAINING IS NOT ENOUGH**

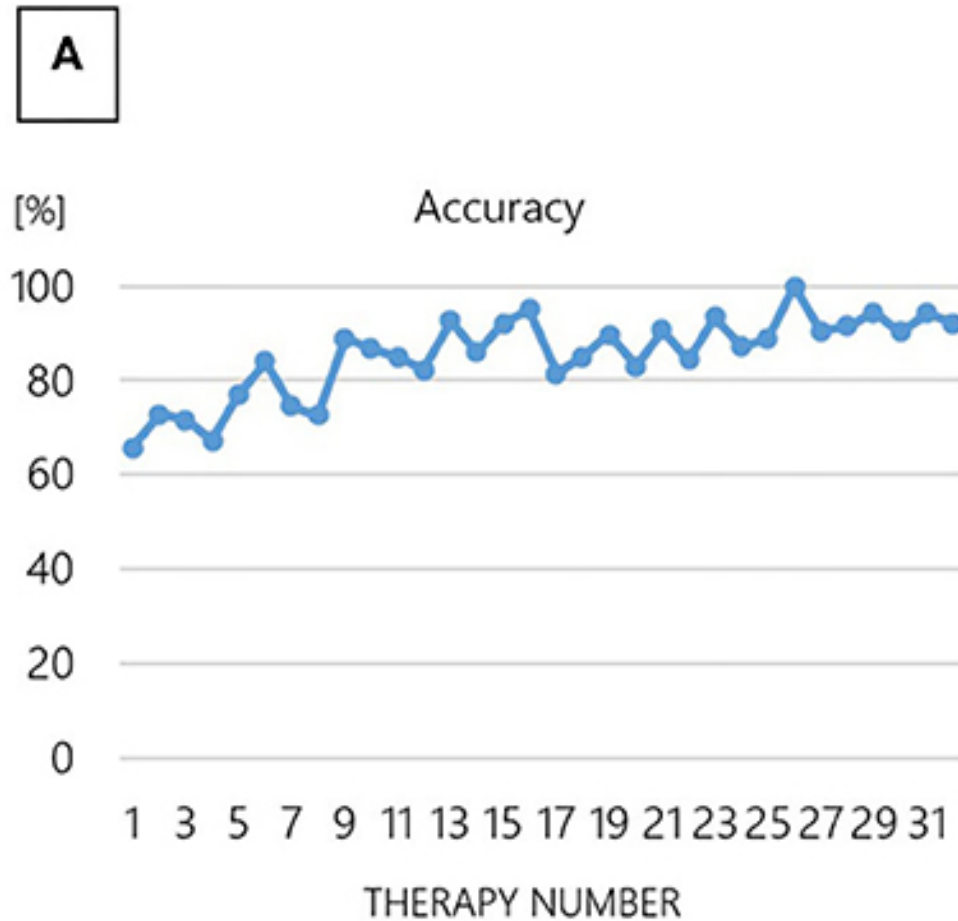
**LEARNING NEEDS
ONGOING REINFORCEMENT**

**USE TECHNOLOGY
TO KEEP ACTIVATING
SYNAPSES ⁺**

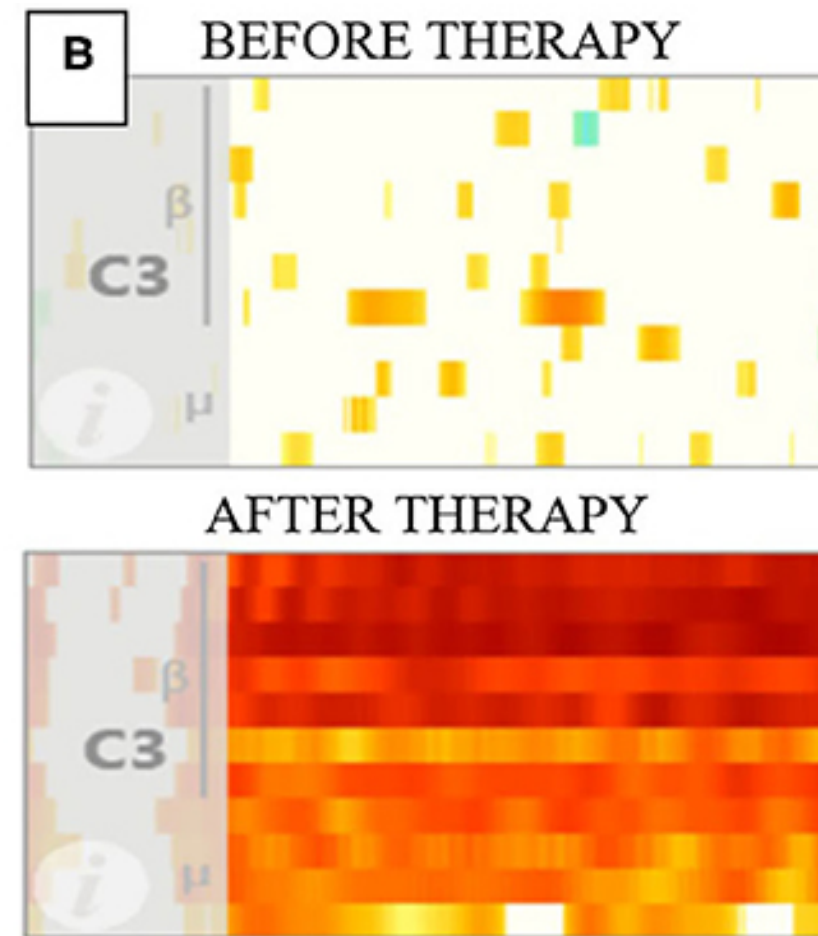


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RESULTS OF RECOVERIX THERAPY

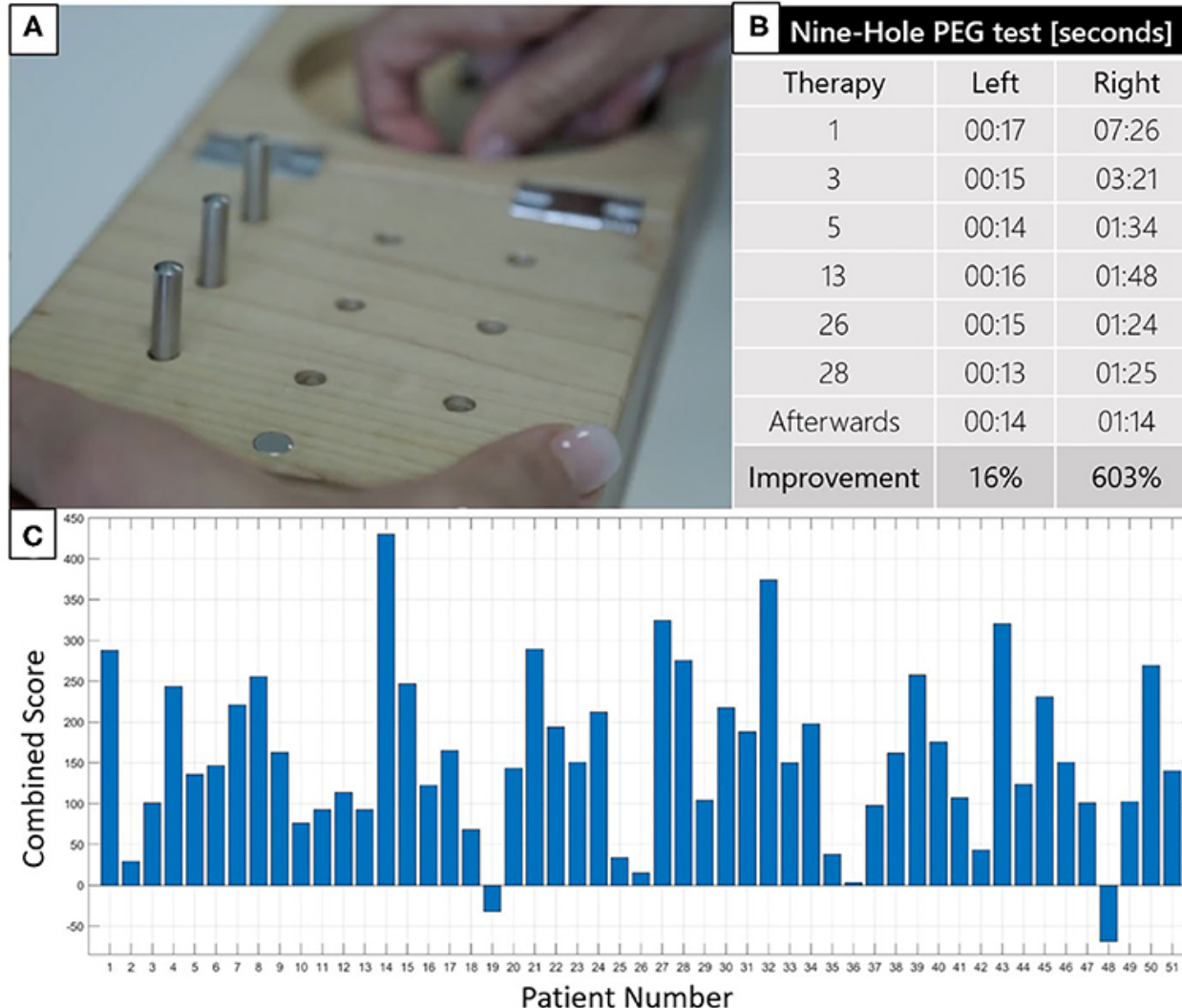


BCI accuracy



Brain activity

RESULTS OF RECOVERIX THERAPY



Movement

- results showed that the BCI therapy helped most patients regain movement and/or reduce spasticity in their hands and arms.
- the therapy works better for patients who achieve more than 80% accuracy.
- BCI therapy even worked many years after the patient's stroke. One patient participated 31 years after the stroke and still improved!
- BCI therapy helped the patients' brains to learn how to better control their movements.

recoveriX
NEUROTECHNOLOGY



**Practice makes perfect,
the key is repetition.**

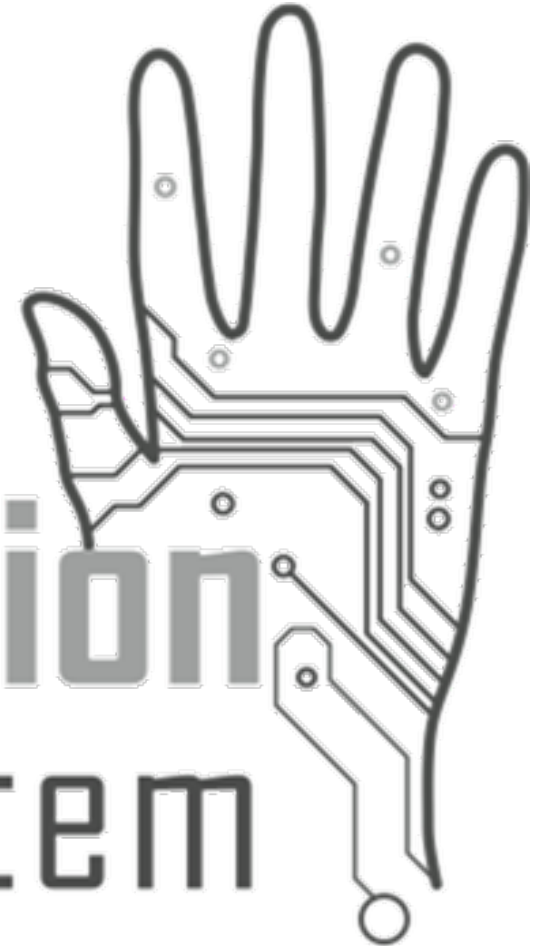
**But how do we increase
patient adherence?**





Neodyne

Rehabilitation
Gaming System





Computer

*to show virtual reality environments,
provide automatic adaptation to the user,
and communication to care providers*

Motion Sensor

to track body movements

Data Gloves

*(optional)
to track finger movements*

3D glasses

*(optional)
to see depth
in the virtual
environments*





Rehabilitation Gaming System

 by eodyne





Rehabilitation
Gaming System

Ice Hockey



Rehabilitation
Gaming System

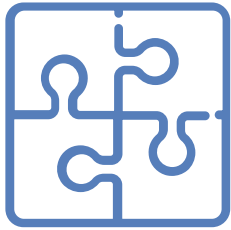
Mirror Virtual Therapy



RGS has treated more than 3000 patients and has been validated by neuroscience experts and clinicians in several hospitals.



WHAT MAKES RGS EFFICIENT?



GAMIFICATION

- Motivation
- Immersive effect
- Positive experience



VR/AR

- Limitless possibilities
- Continuous concentration and feedback



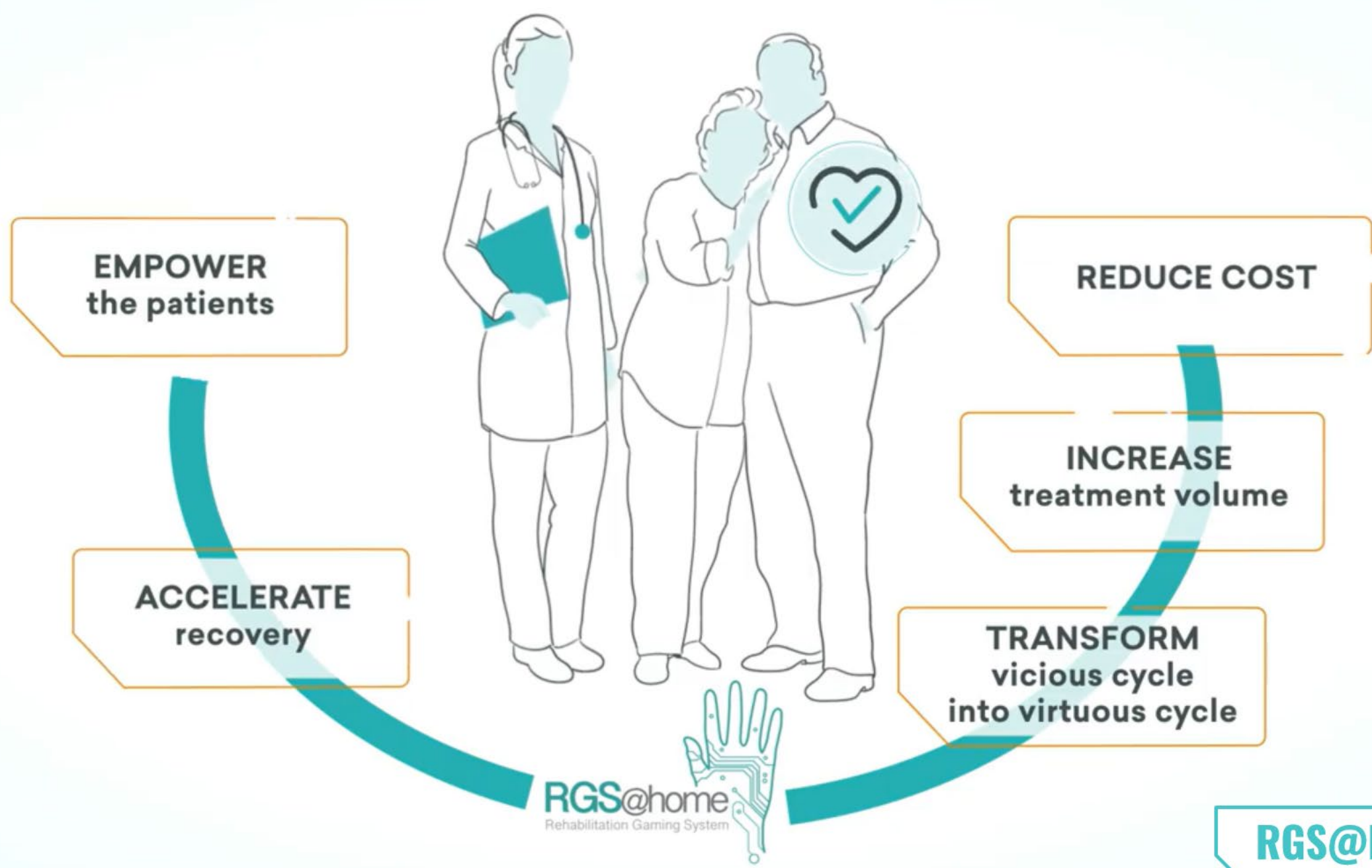
ADAPTIVITY

- Programs adapting to patient's needs



ANALYSIS

- Continuous tracking and evaluation of performance
-



THANKS FOR YOUR ATTENTION!



- theneurotech.eu
- recoverix.com
- eodyne.com

