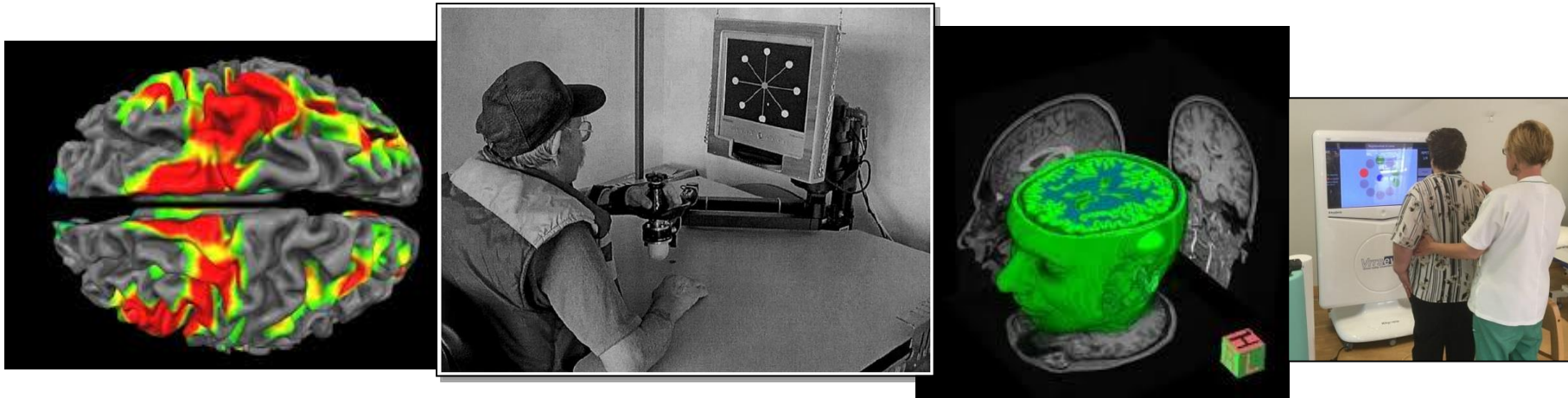


# Le nuove frontiere della Neuroriabilitazione



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## Stroke – Global burden

Stroke is the second leading cause of death and a major cause of disability worldwide.

Although stroke incidence, prevalence, mortality, and disability-adjusted life-years rates tend to decline from 1990 to 2013, the overall stroke burden in terms of absolute number of people affected by, or **who remained disabled from**, stroke has increased across the globe in both men and women of all ages.



*(Feigin VL. et al, «Global Burden of Stroke», Circ Res., 2017)*

# Stroke – Disability

Stroke is one of the **leading causes of long-term disability** in the United States, especially in the elderly population in which stroke incidence is highest.

From the 795,000 new sufferers of stroke, 26% remain **disabled in basic activities of daily living** (Framingham cohort) and 50% have reduced mobility due to **hemiparesis**.

**Aphasia** and **depression** are other frequent causes of disability.

According to an international survey of 11 sites in seven low- and middle-income countries, stroke is the fourth-largest contributor to disability among people older than age 65 years (*Sousa R.M. et al., Lancet, 2009*). Yet the impact of stroke on disability could be underestimated.



# Stroke – Disability

So, while mortality due to stroke is expected to decline in developed countries, **the burden of disability is expected to increase...**

Stroke recovery is heterogeneous in terms of outcome, and it is estimated that 25% to 74% of the 50 million stroke survivors worldwide require some assistance or are fully dependent on caregivers for activities of daily living after stroke.

...this indicates a increasing need for quality **stroke neurorehabilitation.**



*(Veerbeek JM et al., Stroke, 2011)*

# Multiple disabilities related to Stroke

## AHA Statistical Update

### Heart Disease and Stroke Statistics—2014 Update

A Report From the American Heart Association

- In the NHLBI's FHS, among ischemic stroke survivors who were  $\geq 65$  years of age,
- the following disabilities were observed at 6 months after stroke:
  - **50% had some hemiparesis**
  - 30% were unable to walk without some assistance
  - **46% had cognitive deficits**
  - 35% had depressive symptoms
  - **19% had aphasia**
  - 26% were dependent in activities of daily living
  - **26% were institutionalized in a nursing home**



## ~~Severe acquired brain injuries (ABI)~~

~~Severe acquired brain injury results from damage to the brain caused by traumatic or non-traumatic brain injury. It is usually defined as a condition in which the patient has been in coma for at least 24 hours (GCS  $\leq$  8).~~

## Severe acquired cerebral lesions

- not necessarily coma
- complex and severe disability
- need of specific and intensive multidisciplinary rehabilitation



# Not only motor disabilities...

## Cognitive rehabilitation

Cognitive rehabilitation therapy (CRT) is the multisensory goal-oriented programme of relearning or compensating for cognitive skills and abilities that have been altered or lost after brain damage. In particular, CRT is focused on improving cognitive functions (memory, attention and concentration) and daily living skills (i.e. using the telephone, managing medication and handling money). Cognitive impairments can indeed strongly interfere with safety, productivity, independence and personal relationships and, more generally, with the human global functioning.

A cognitive rehabilitation program should begin with a competent assessment.



Coordinated and multidisciplinary rehabilitation team  
(Neurologist, Neuropsychologist, Speech/language therapist...)



Not only motor disabilities...

## **Post-stroke neurobehavioural disability (NBD)**

Neurobehavioural disability is common within a subacute stroke inpatient population, particularly interpersonal and cognitive difficulties and preliminary analyses indicate associations with reduced functional ability, cognition and mood.



*(Stolwyk R.J. et al, Top Stroke Rehabil, 2018)*



# NeuroRehab Team

**Neurologist**

**Physiotherapist**

**PATIENT**

**Occupational  
Therapist**

**Speech  
Therapist**

**Neuropsychologist**

**Orthotician**



# Stroke neurorehabilitation

**Table 1. Limitations of Conventional Rehabilitation<sup>9,11</sup>**

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Time-consuming

Labor- and resource-intensive

Dependent on patient compliance

Limited availability depending on geography

Modest and delayed effects in some patients

Requires transportation to special facilities

Initially underappreciated benefits by stroke survivors

Requires costs/insurance coverage after the initial phase of treatment

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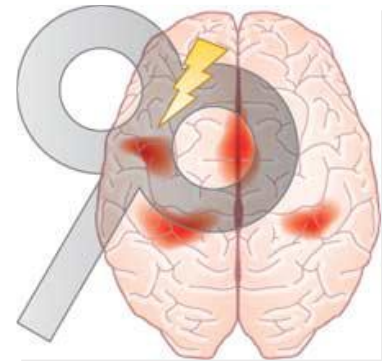


# Transcranial Magnetic Stimulation (TMS)

TMS is a non-invasive technique that consists of a magnetic field emanating from a wire coil held outside the head. The magnetic field induces an electrical current in nearby regions of the brain. TMS was originally developed as a diagnostic tool for mapping brain function. It appears promising as a treatment for some neurological and psychiatric conditions. TMS can also measure neuronal output and interactions between different neuronal assemblies to evaluate progress during rehabilitation.

## Repetitive transcranial magnetic stimulation: a tool for human cerebellar plasticity

2010 Giacomo Koch, MD, PhD



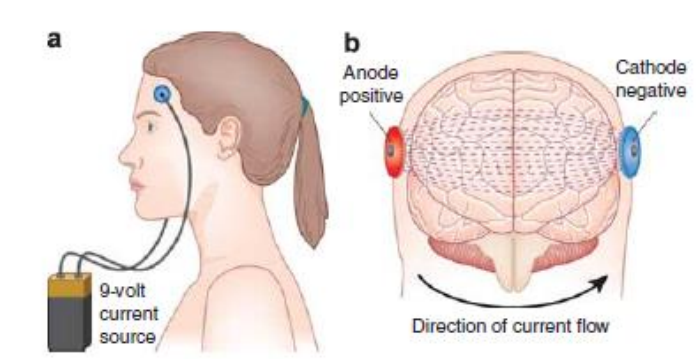
“...Recent studies have shown that rTMS of cerebellar structures is capable of inducing long-lasting changes in the excitability of cerebello-thalamo-cortical pathways. Thus, this novel approach may be important for investigating the functions of cerebellar plasticity. Indeed, cerebellar rTMS has been shown to modulate motor control, cognitive functions, emotion and mood. Moreover, recent studies seem to indicate that long-lasting modifications of cerebellar pathways could be usefully exploited in the treatment of several pathological conditions characterized by altered cortical excitability, such as Parkinson's disease, stroke, depression and schizophrenia”

# Transcranial direct current stimulation (tDCS)

tDCS is a portable, non-invasive neuromodulatory technique that elicits constant weak electric currents directly to the scalp via two surface electrodes (anode and cathode); it does not cause depolarization as TMS does, but modifies electrical properties of the extracellular medium.

## Transcranial Direct Current Stimulation Improves Word Retrieval in Healthy and Nonfluent Aphasic Subjects

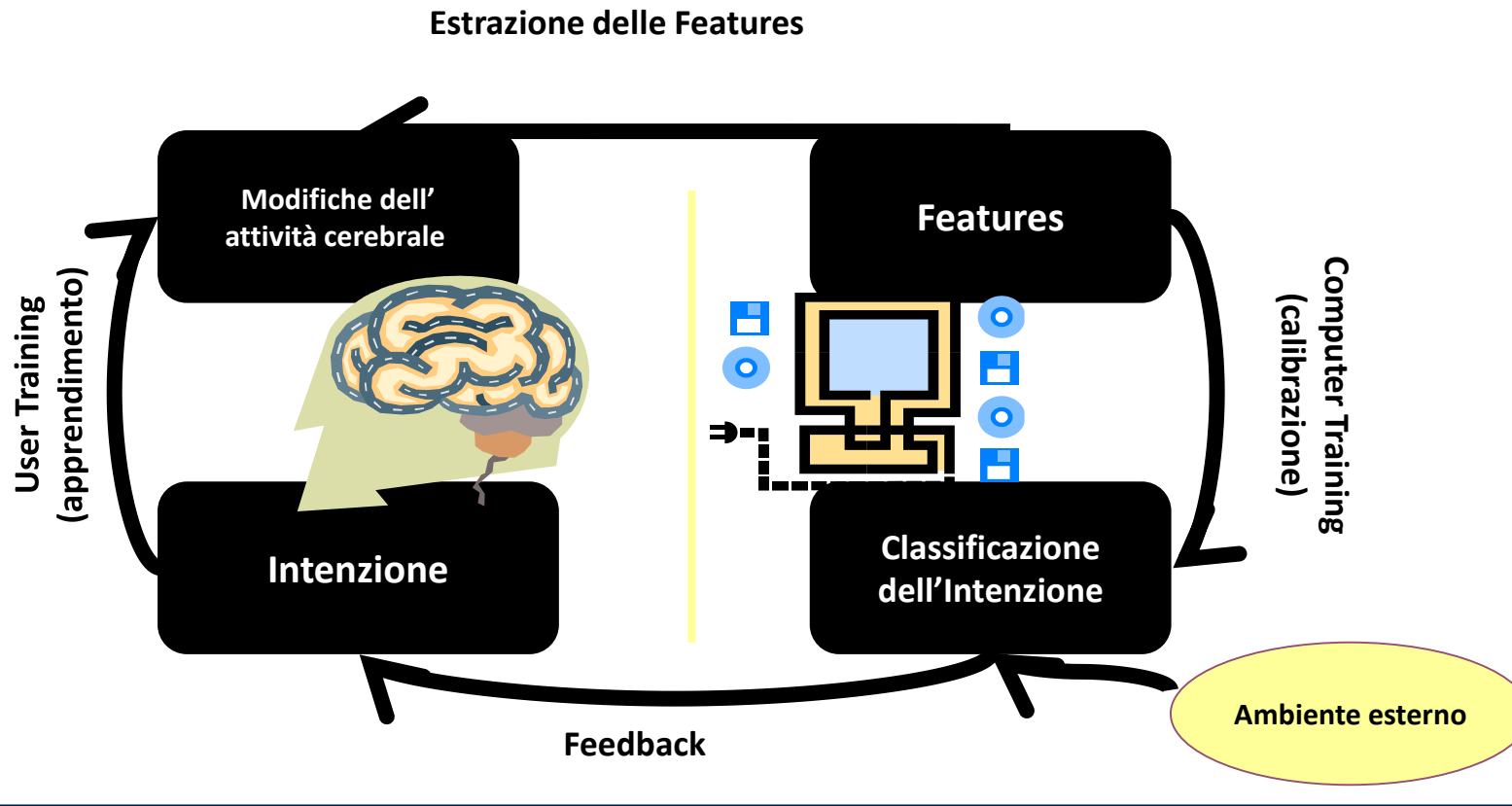
Fiori V. et al, J Cogn Neurosci, 2011



Objective: to investigate the potential of tDCS to enhance associative verbal learning in 10 healthy individuals and to improve word retrieval deficits in three patients with stroke-induced aphasia. “Anodic tDCS had significantly improved their accuracy on the picture-naming task. Both normal subjects and aphasic patients also had shorter naming latencies during anodic tDCS than during sham condition. At two follow-ups, performed only in two aphasic subjects, response accuracy and reaction times were still significantly better in the anodic than in the sham condition, suggesting a long-term effect on recovery of their anomic disturbances”.

# Brain Computer Interface (BCI)

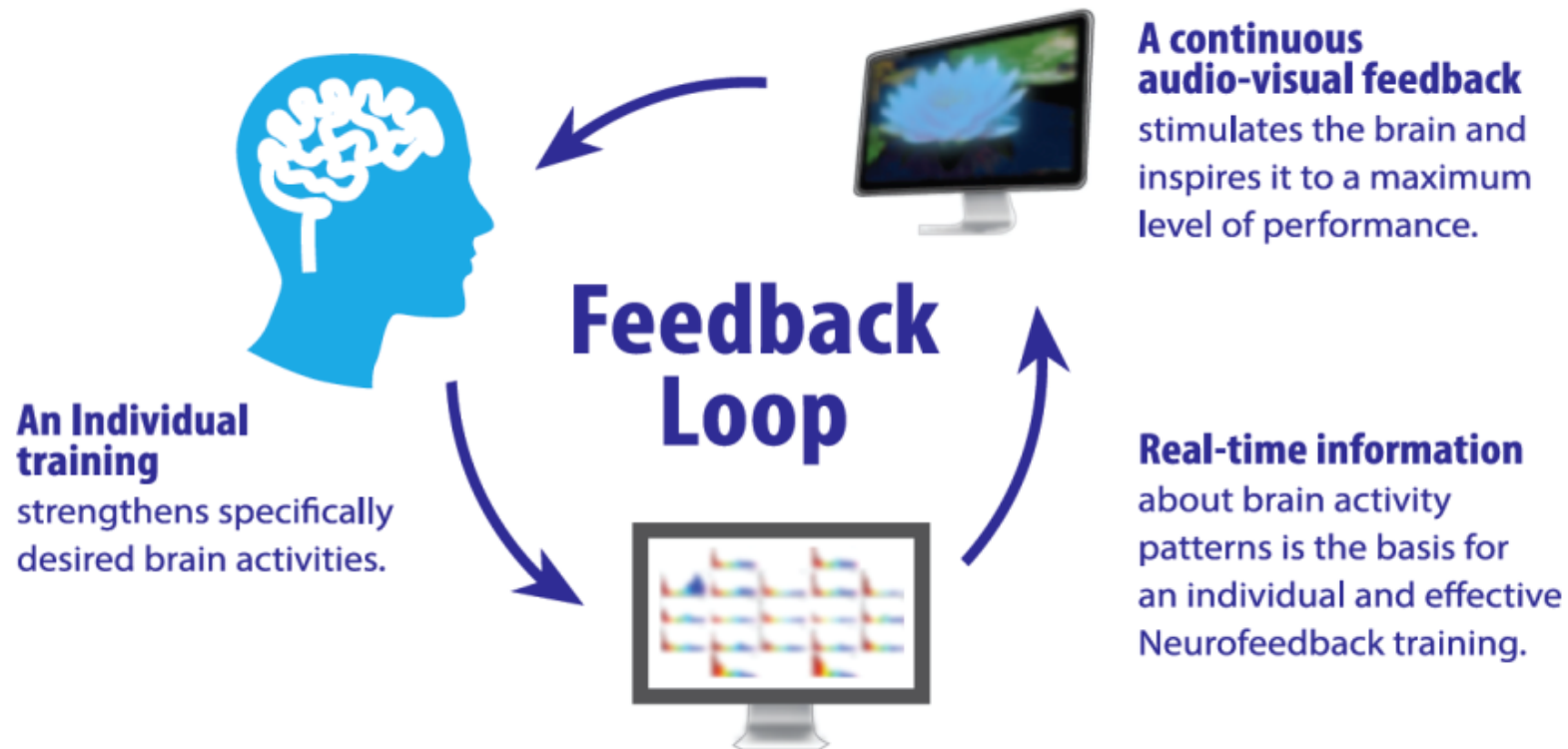
BCI is a collaboration between a brain and a device that enables signals from the brain to direct some external activity, such as control of a cursor or a prosthetic limb. The interface enables a direct communication pathway between the brain and the objective to be controlled.



# Neurotechnology

Areas of application:

- Neural prostheses, brain-machine interface (BMI, BCI) and bio-hybrid interfaces



# Neurotechnology

Areas of application:

- Assistive technology for neuromotor, sensory and cognitive rehabilitation.

