Neuro-Feedback Systems: An Short Overview

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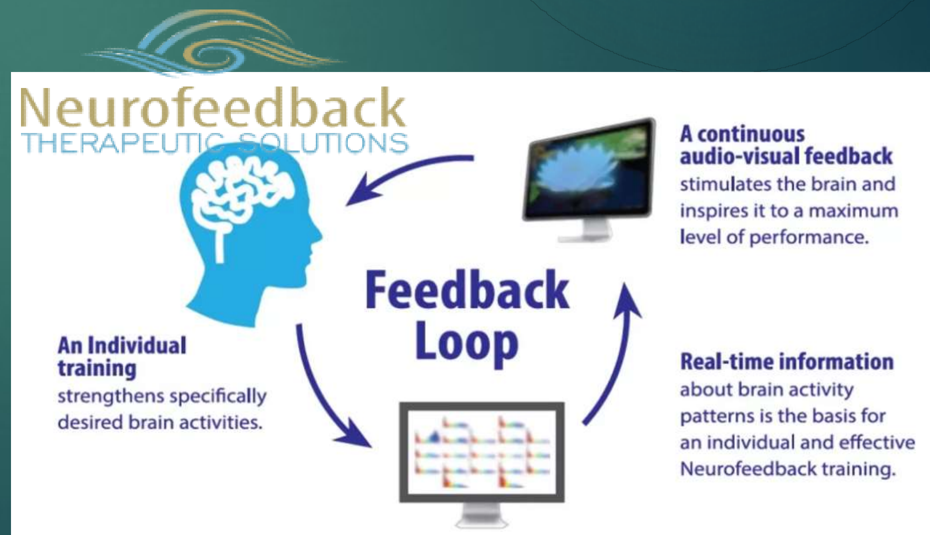
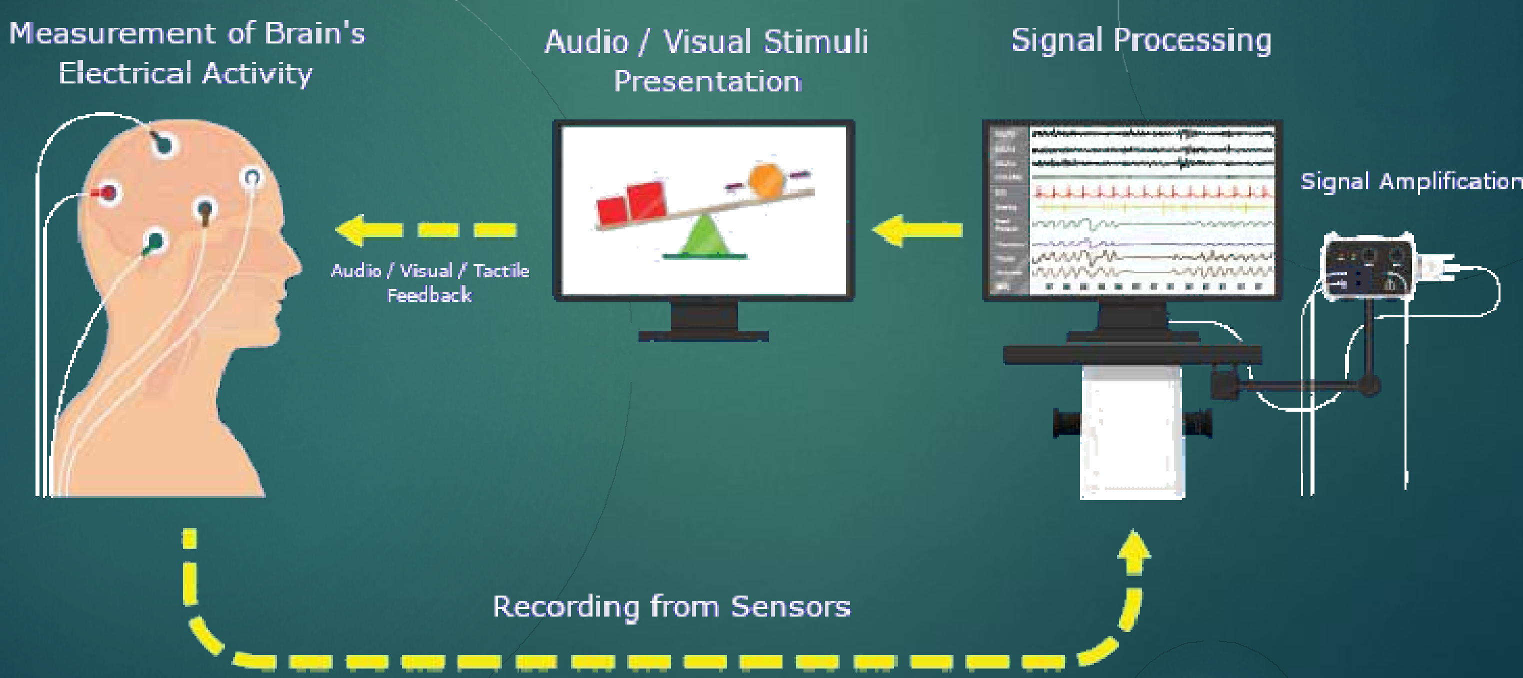
Neuro-feedback

- Neuro-feedback is a type of biofeedback that uses **real-time** displays of **brain activity**—most commonly electroencephalography (EEG), to teach **self-regulation** of brain function.
- Neuro-feedback could support clinicians and therapists in the **rehabilitation** process of people affected by a wide range of neurological disorders and pathologies such as **ADHD**, **epilepsy**, **schizophrenia** and **stroke**.



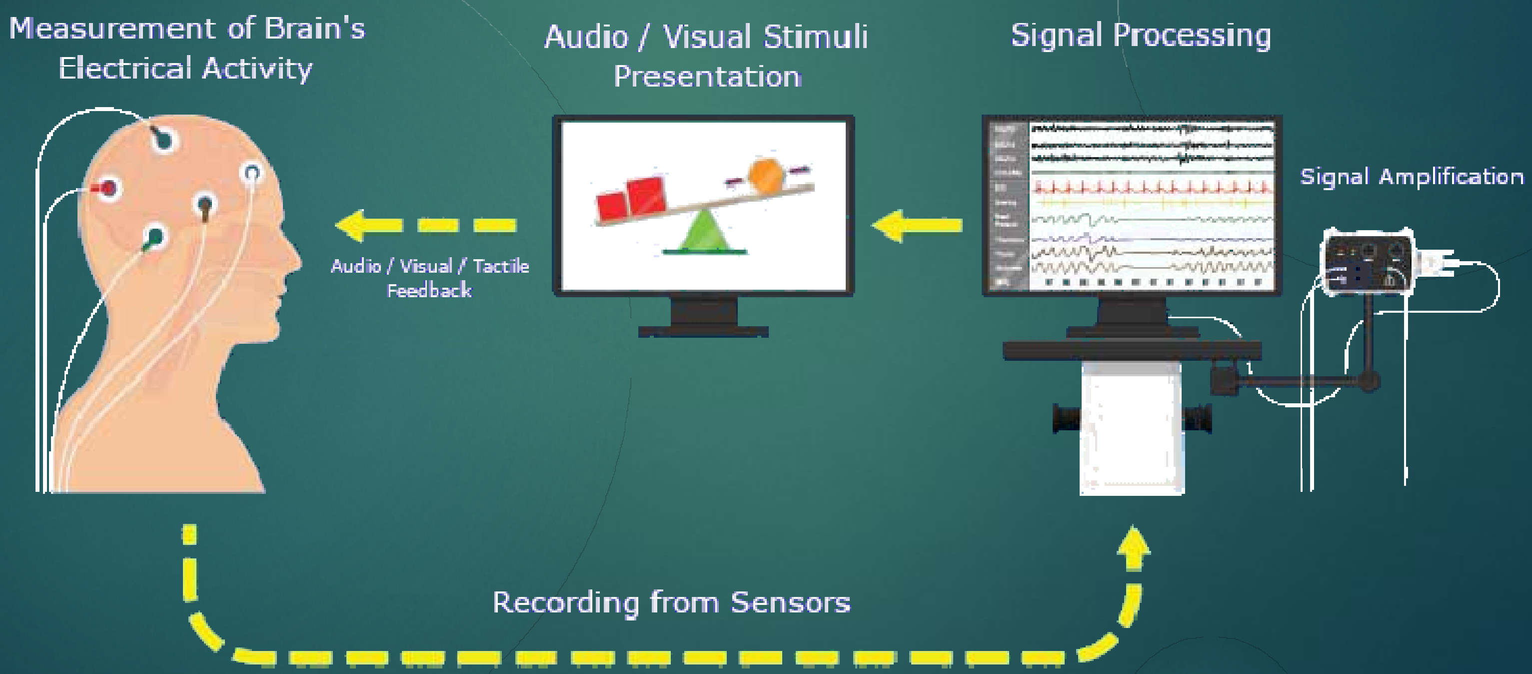
Neuro-feedback

- Real-time feedback from brain activity
- Reinforce brain function



Typical elements

- EEG device to acquire brain signals
- Feedback presented using video or audio



Neurofeedback Applications

- Therapy
  - ADHD
  - Depressive and anxiety disorders
  - Stroke
  - Traumatic brain injury
  - Epilepsy
  - PTSD
  - ….
- Performance enhancement

NFB: An example Mu-rhythm

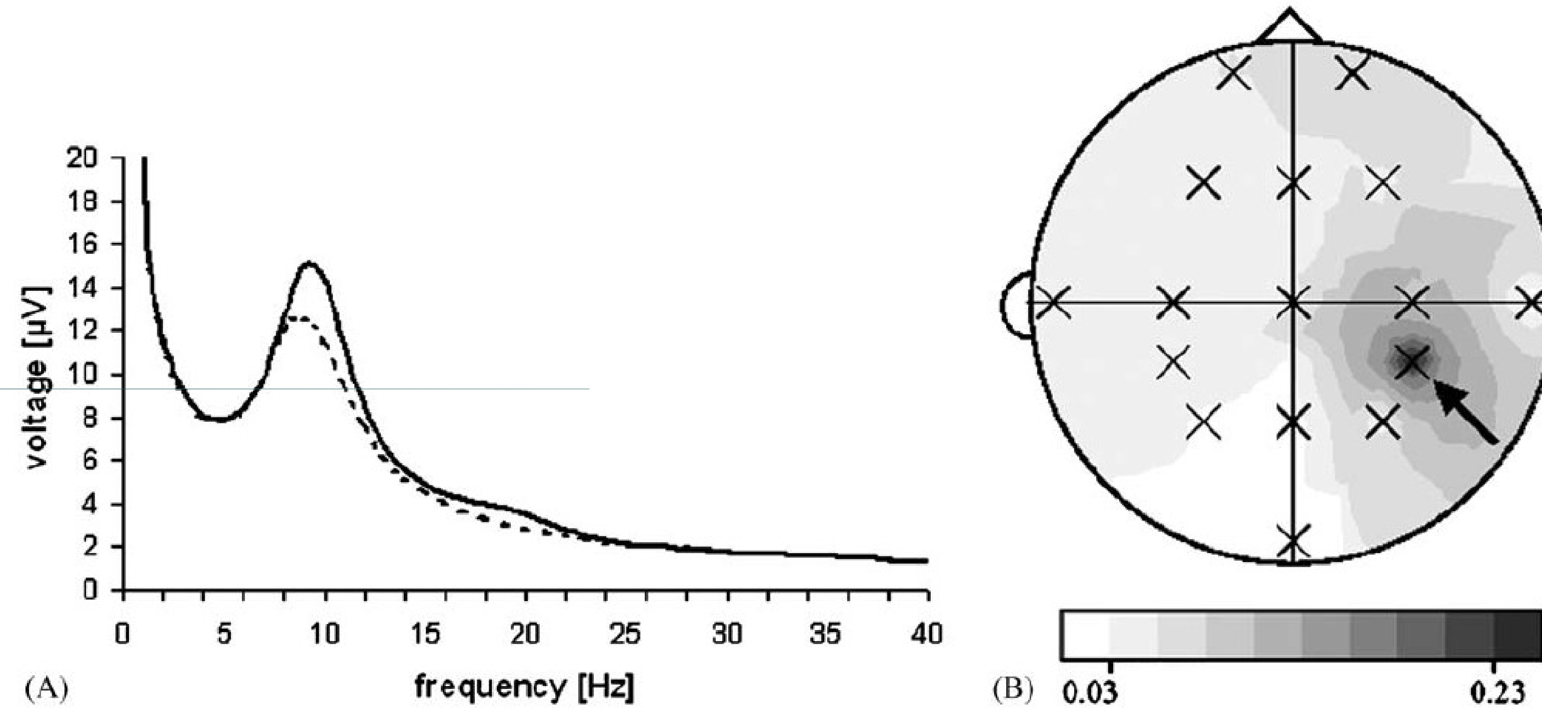


Fig. 2. Data from a patient trained to self-regulate sensorimotor rhythm. He received feedback from CP4 (arrow in B) in the frequency range of 9–12 Hz. (A) Power spectrum. The voltage is plotted as a function of frequency. The solid line shows the power spectrum during relaxation and related upward cursor movement; the dashed line during imagined left-hand movement and related downward cursor movement. A voltage difference can be clearly seen in the 9–12 Hz frequency band (mu-rhythm) and also — albeit smaller — in the beta band around 18–22 Hz. (B) The topography of the determination coefficient (r^2), is the proportion of the total variance of the sensorimotor-rhythm amplitude that is accounted for by target position. The r^2 is highest (dark grey) under the feedback electrode.

Conversion of EEG Activity Into Cursor Movement

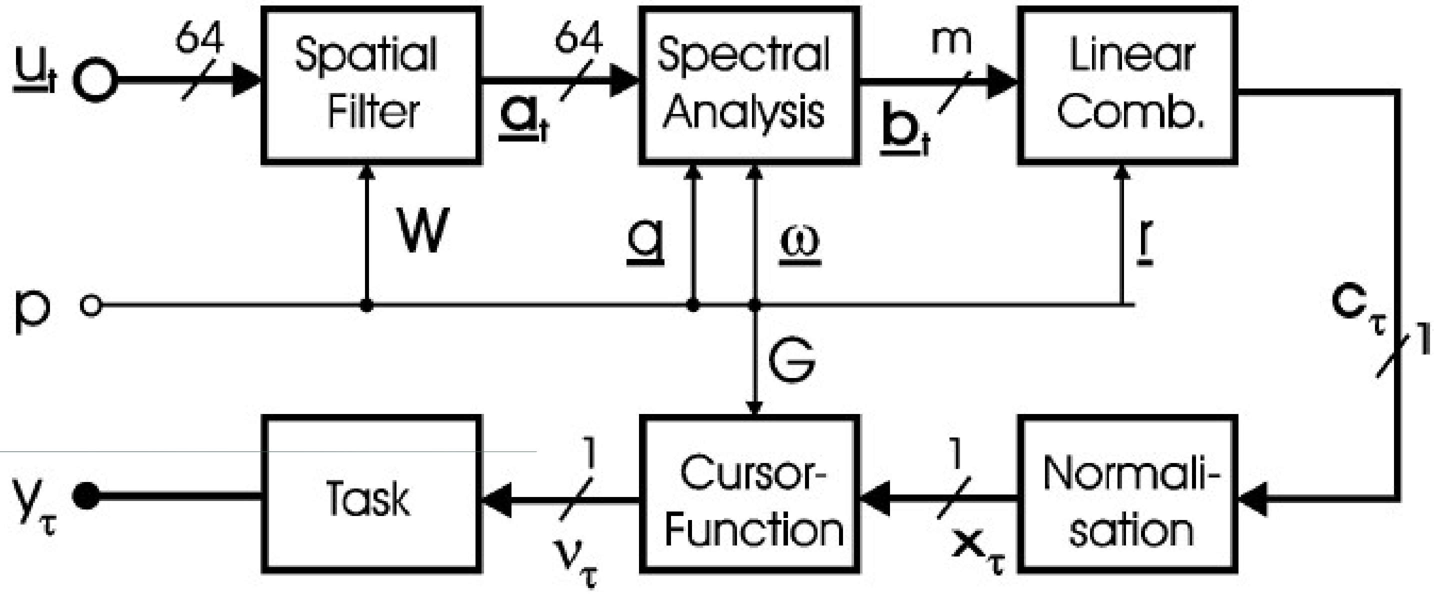
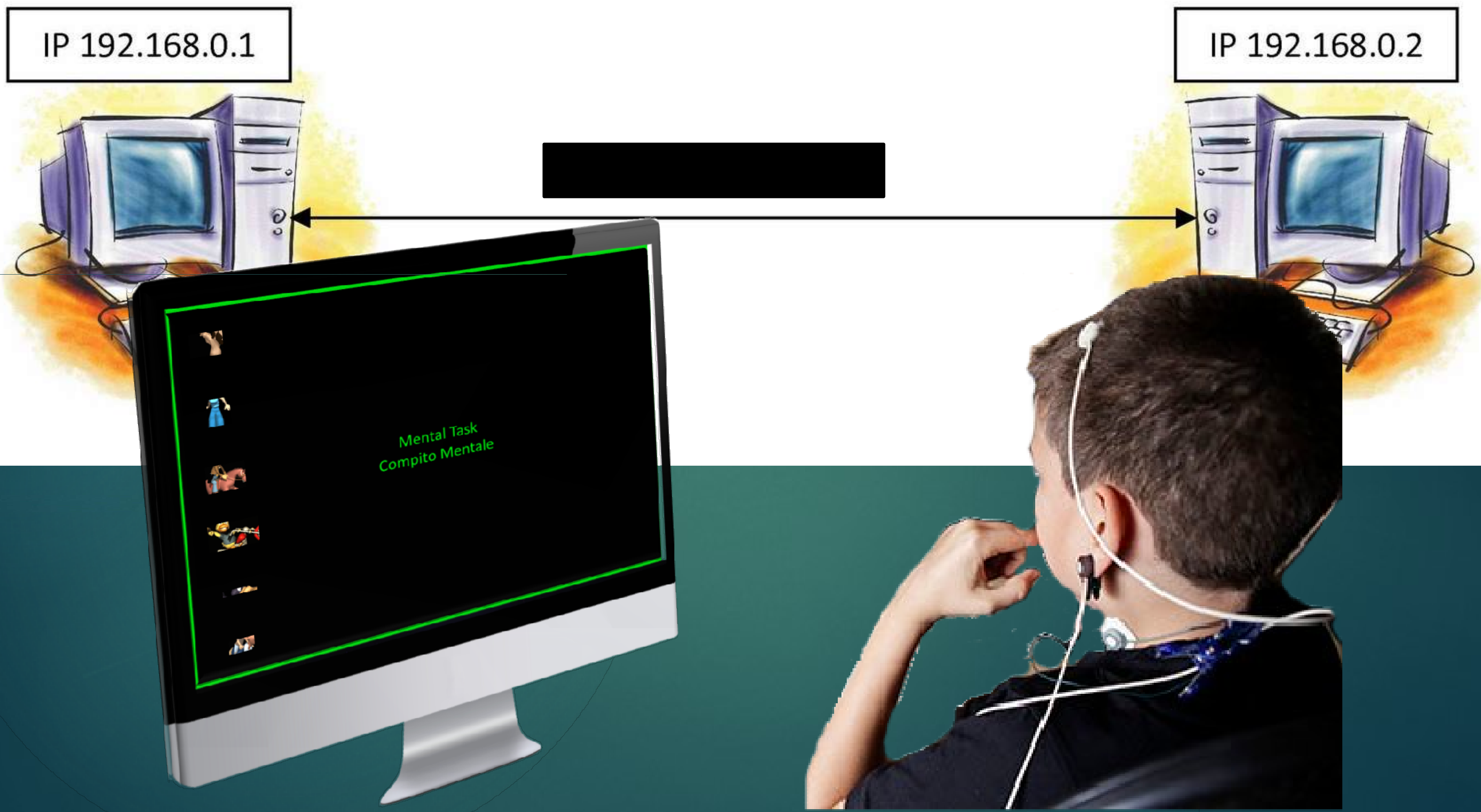


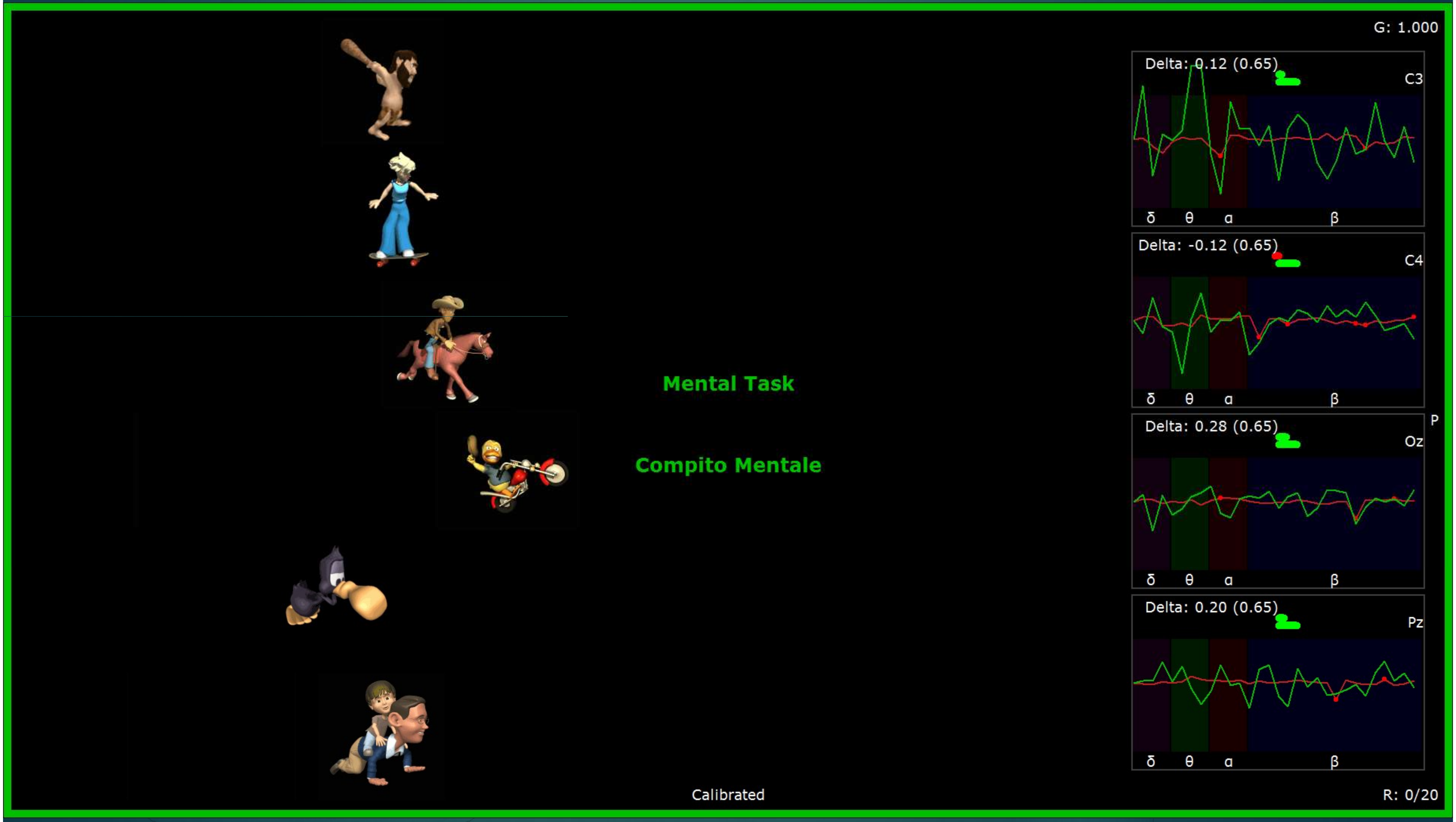
Fig. 2. Spatial filter improves signal-to noise ratio of the signal $\underline{u}_t$ of the 64 electrodes using a weight matrix W as parameter. Spectral analysis is performed on a selection $\underline{q}$ of the spatially filtered signals $\underline{a}_t$. Thereby, $\underline{w}$ selects the frequency bands. With the weights $\underline{r}$ these m spectrally analyzed signals $\underline{b}_\tau$ are linearly combined. The resulting scalar c_τ is normalized (x_τ) and then mapped to a cursor position ν_τ using the scalar G as an input. Finally, this cursor position is represented in the context of a task (e.g., three boxes, highlighted target) on the screen (y_τ).

Georg E. Fabiani, Dennis J. McFarland, Jonathan R. Wolpaw, and Gert Pfurtscheller, *Member, IEEE*

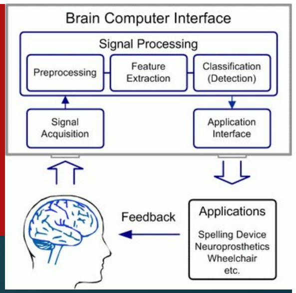
Speedy'O'Brain System



Speedy'O'Brain – Racing Mode

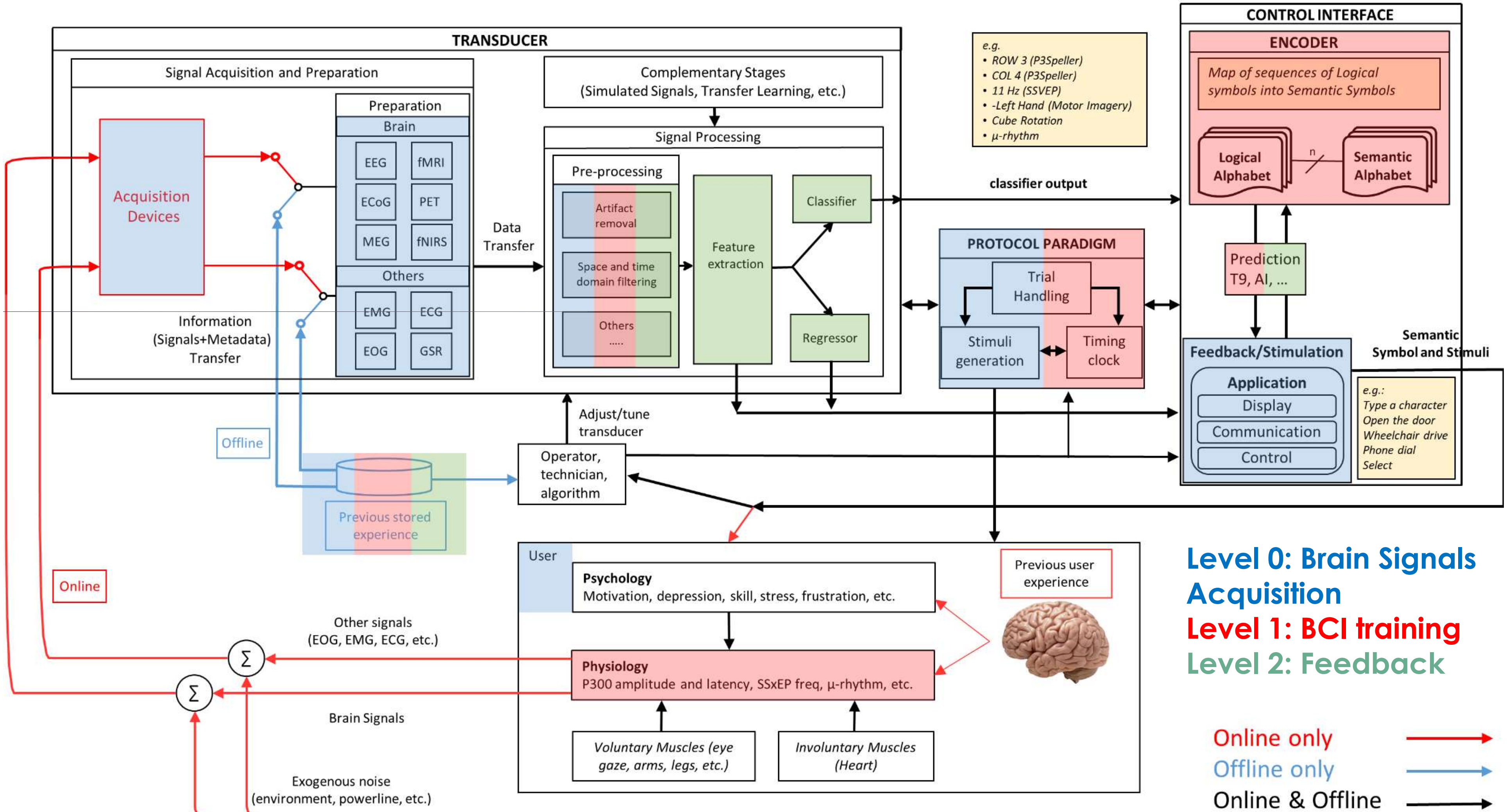


Signal Acquisition



- Scalp (EEG)
- Cortical surface
- Intracortical
- fMRI
- NIRS
- Scalp (MEG)

IEEE P2731 - Data Storage



Level 0: Brain Signals Acquisition
Level 1: BCI training
Level 2: Feedback

Online only
Offline only
Online & Offline