PEPERONI: Portable and Personalized Neurofeedback for Stroke Rehabilitation
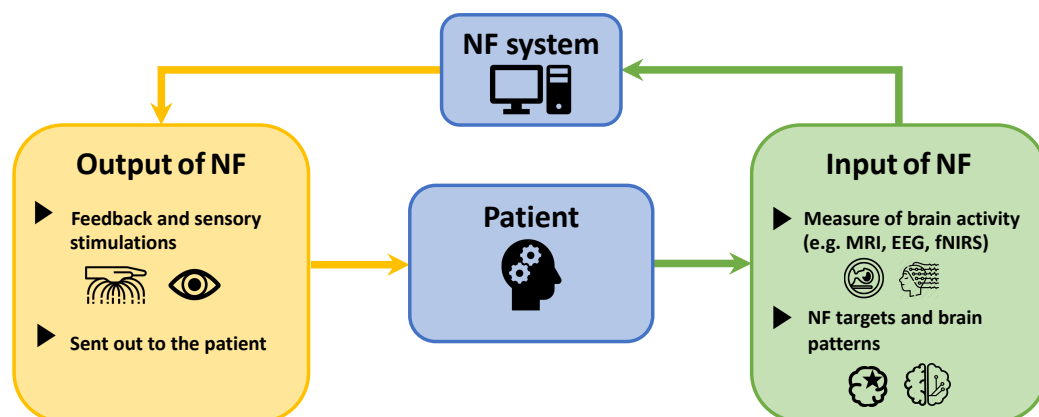
Hybrid

Neurofeedback (NF)

- Consists in presenting a subject with a stimulus directly related to his/her current brain activity
- Can be used to teach subjects to regulate their own brain functions
- Previous studies showed that multimodal (e.g. EEG/fMRI) NF is promising for the treatment of various neuronal pathologies, such as post-stroke rehabilitation
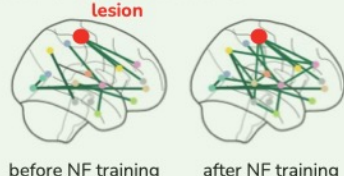

NF system

Output of NF
- ▶ Feedback and sensory stimulations
- ▶ Sent out to the patient

Patient

Input of NF
- ▶ Measure of brain activity (e.g. MRI, EEG, fNIRS)
- ▶ NF targets and brain patterns

PEPERONI project: 2022-2024

- **A. Lamouroux, PhD student,** from Oct. 2022, funded at 75% by CominLabs
- On existing data: assessing changes induced by NF training on brain networks organization
- Identify new connectivity-based biomarkers)
- Design personalized NF target estimation, adapted to each patient, based on its own brain anatomy and function

NF for PRECISION MEDICINE

PERSONALIZED: adapted to patient profile

1. CONNECTIVITY NF INPUT
lesion
before NF training — after NF training
personalize NF marker with connectivity features
- group 1
- group 2
motor outcome / connectivity marker

2. MULTISENSORY NF OUTPUT
adapt the feedback (visual + haptic) to the patient and the task to facilitate neuromodulation
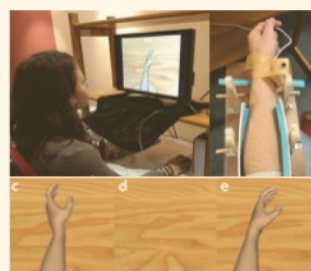
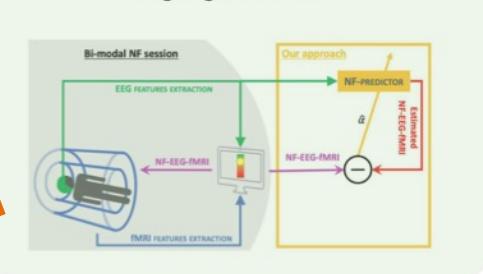**Methodological development**
EEG+fMRI datasets (N=60)

New NF Protocols
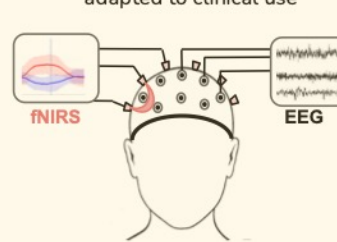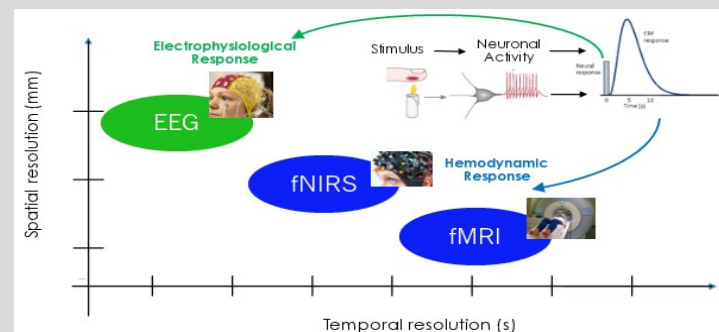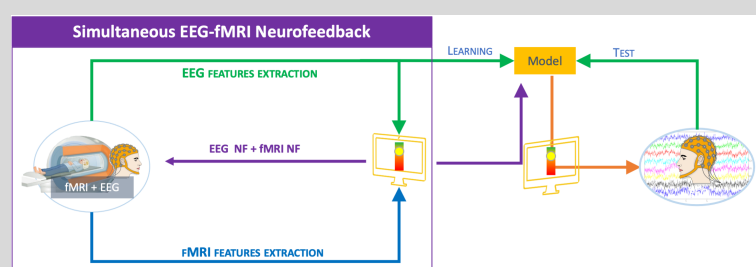*Proof of concept on stroke patients*

1. EEG-only, fMRI "enriched"
Learn a joint EEG-fMRI model to predict fMRI connectivity in EEG-only setting
ongoing PhD Thesis

2. EEG + fNIRS
High spatial (fNIRS) and temporal (EEG) resolution with lighter solutions, more adapted to clinical use
fNIRS   EEG

PORTABLE: adapted to clinical practice

- **F. Le Jeune, postdoc,** from March 2023
- Current systems: mostly visual feedback
- Adapted feedback: reduce the time required to learn to control the system and their brain activity
- Adaptation depending on: personal characteristics of users, evolution of their results
- Start of a new clinical trial: haptic EEG neurofeedback in early stages of stroke (44 patients)

- **C. Muller, postdoc,** from Oct. 2023
- fNIRS and fMRI measure the hemodynamic response
- Study impact of fNIRS for NF
- Propose a new EEG-fNIRS NF acquisition protocol
- Design a proof-of-concept study on stroke patients

- **C. Pinte, PhD student,** from Oct. 2021, not funded by CominLabs
- Preliminary work during former CominLabs project Hemisfer
- Investigating long short-term memory (LSTM) and temporal convolutional neural networks (TCN)

Simultaneous EEG-fMRI Neurofeedback

Consortium

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  - ■ Claire Cury, CR Inria
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