Pilot Study: eye-tracking and skin conductance to monitor task engagement during bimodal neurofeedback

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INTRODUCTION

NF consists in providing real-time neural activation feedback to self-regulate brain activity [1]. It is a promising brain rehabilitation technique as it can trigger brain plasticity. EEG based NF is widely used, but while it has excellent temporal resolution, it has limited spatial resolution. On the other hand, NF based on fMRI, offers a better spatial resolution, but has slow dynamics. Current studies are showing the high potential of combining EEG and fMRI in bimodal NF. However, a significant percentage of people undergoing NF training, fails [2]. Motivational and attentional factors have been identified as predictors of NF learning, as poor performances can lead to disengagement with the task and a label of "non-responder"[3].

We propose to use eye-tracking (ET) and skin conductance (SC) tools to identify attention and arousal features, with the aim of monitoring real-time changes in task engagement during bimodal EEG-fMRI NF in our forthcoming work. In this pilot study we aim at:

1) synchronizing all devices (ET, SC, EEG, fMRI)

2) identifying ET and SC features to detect changes in task engagement.

METHOD AND MATERIALS

We synchronized all devices an tested the set up in 6 participants. We acquired structural and functional data in a 3T scanner, while simultaneously recording EEG activity using a 64-channel MR-compatible cap. A MR-compatible ET camera system was used to register ocular movements from the dominant eye at 60Hz. View Point was used to compute the number of saccades and fixation durations (saccades velocity threshold [normalized gaze position change/ms]=0.20). A MR-compatible Brain Vision Galvanic Skin Response set was used to acquire electrodermal activity from the index and middle fingers. Quantity of SC responses (SCR) and their amplitude were obtained through a Continuous Decomposition Analysis using Ledalab [4].

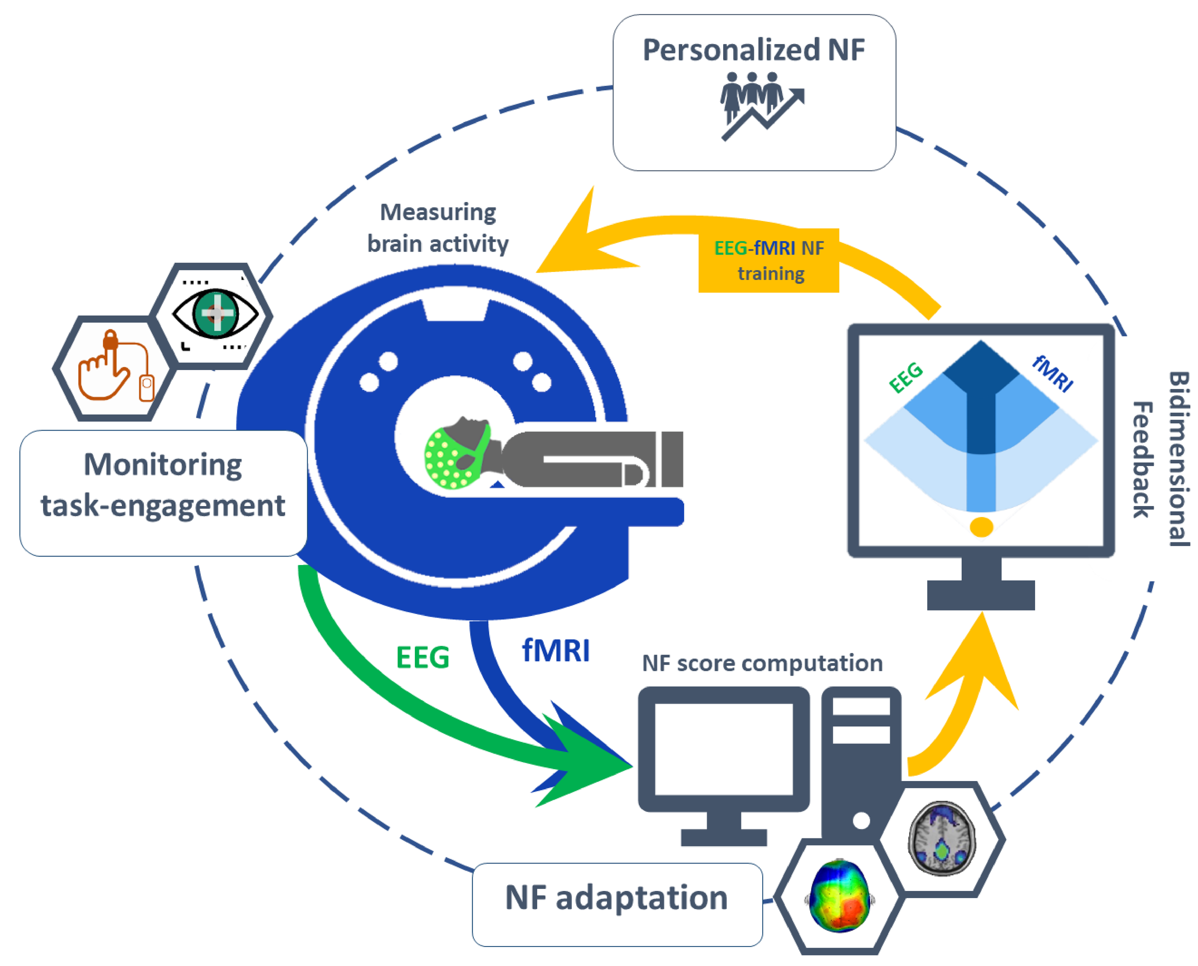
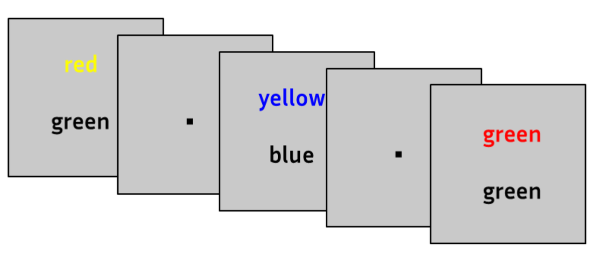
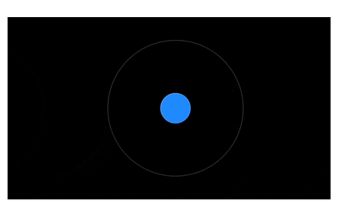


Figure 1. Bimodal EEG-fMRI NF set-up, in which we aim at integrating and synchronizing ET and SC devices to monitor task engagement during NF sessions.

Cognitive tasks

Cognitive workload was stimulated using a color-word interference Stroop task (~5min) followed by a two-minute rest in which a video encouraging heart coherence was presented.





Changes in attentional focus were monitored by stimulating:

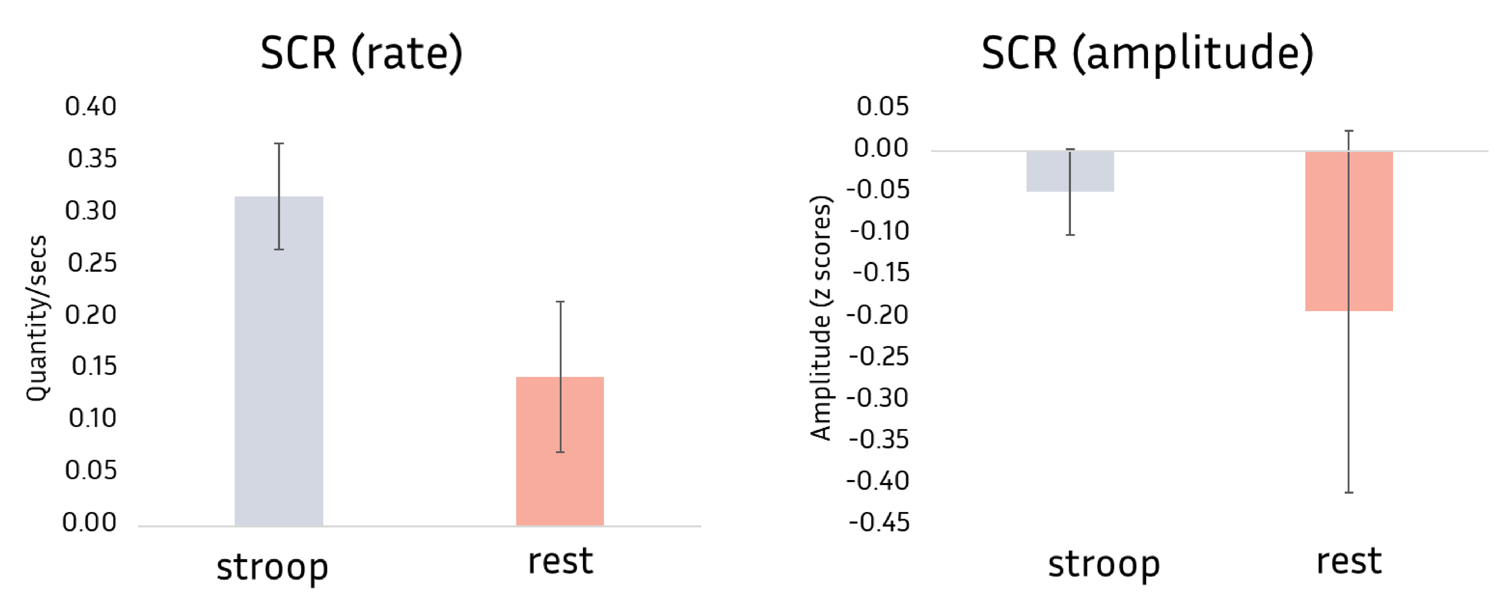
1) External focus (i.e. monitoring color changes in a moving ball),
2) internal focus (i.e. verbal fluency task),
3) mind wandering,

while using the same visual stimulus based on the NF feedback display.

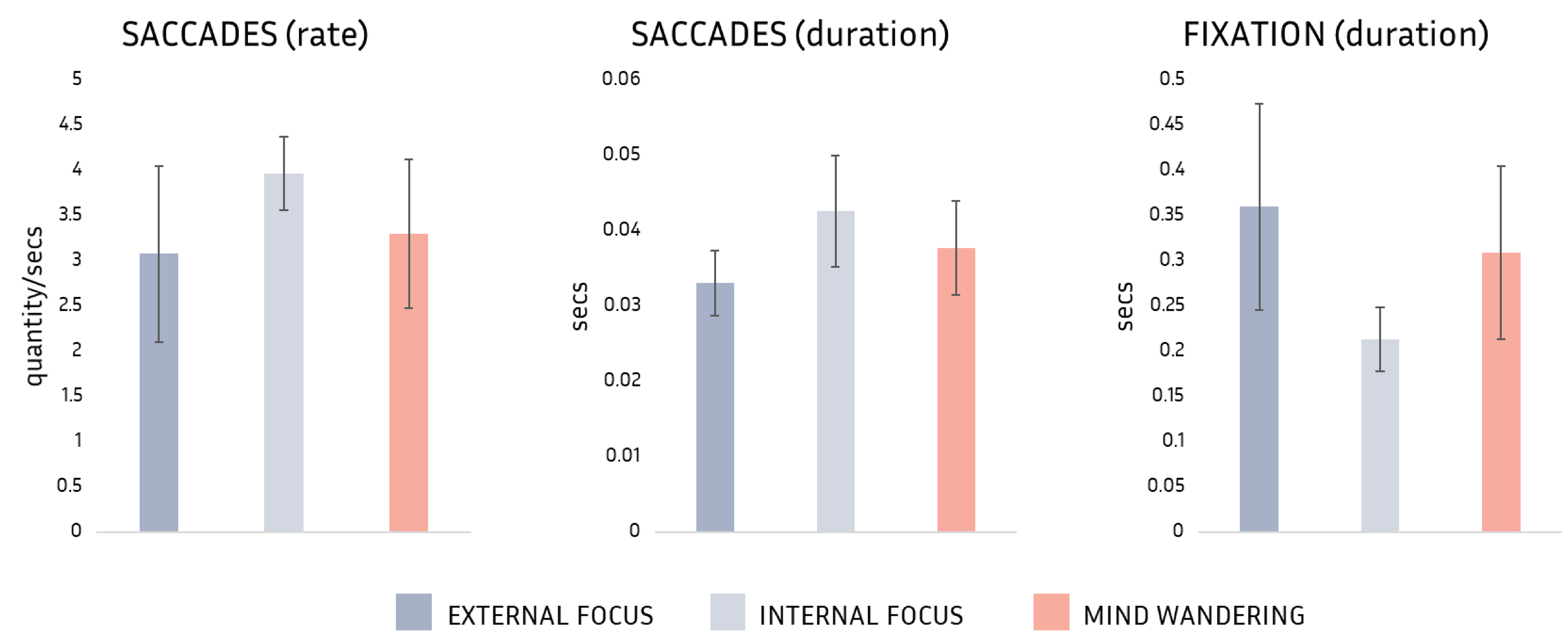
We simultaneously recorded and time-stamped fMRI, EEG, ET and SC signals, while the participant was completing the cognitive task.

PRELIMINARY RESULTS

Workload



Attentional focus



EEG and fMRI signals were simultaneously recorded as proof of the set-up feasibility for subsequent analysis during NF sessions.

NEXT CHALLENGES

- Complete data acquisition of the pilot study (N=20).
- Develop a task-engagement classifier using SC and ET features.
- Analyze all these data in real time to adapt NF target online during NF sessions.

By using ET and SC features to monitor task engagement during a NF session, NF targets may be adapted online to keep the participant focused during the training. Thus, NF procedures may be personalized with the aim of boosting its potential in rehabilitation.

This poster corresponds to a talk for the special session "Bimodal functional neuroimaging data fusion: methods and applications" on April 19th

References

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The EyeSkin-NF project is funded by Inria Exploratory Action 2021 to C.C. as PI.
Data acquisition was approved by the institutional review board (IRB: NCT05107232) and this study is supported by the University Hospital of Rennes and the University of Rennes.

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