

The DecNef toolbox: An enhanced toolkit for fMRI-based decoded neurofeedback

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Introduction

Despite its promises, fMRI decoded neurofeedback (DecNef) (Shibata et al., 2011; Taschereau-Dumouchel et al., 2021) is still used by a relatively small number of research groups. This is mainly due to its complexity and the lack of a comprehensive and publicly available set of curated scripts and test data.

Methods

Here, we present the DecNef toolbox, a MATLAB-based package for advanced fMRI preprocessing, machine-learning decoder training, and real-time decoded neurofeedback experiments, accompanied by a demo dataset to help researchers learn how to use the toolbox hands-on. It includes a preprocessing pipeline for selecting, denoising and normalising fMRI data to build a variety of classification models (Yamashita et al., 2008). The core component of the toolbox is the experiment runner, which allows researchers to set up and run decoded neurofeedback from a user-friendly launcher and a simple parameters file. For versatility, we packaged native space and MNI space decoding (Berman et al., 2024) pipelines with real-time parallel computations using central or graphics processing units (CPU or GPU). Moreover, the toolbox includes behavioural and machine-learning analysis tools, allowing subsequent evaluation of DecNef session data (e.g., from simple feedback scores to correlation with a sleepiness indicator and information-leakage analysis (Cortese et al., 2024) using region-of-interest or searchlight methods).

Results

The toolbox is ready to use and has been tested on existing published datasets (Cortese et al., 2021) and in a new experiment conducted as part of an ongoing study aimed at better understanding the impact of confidence and metacognition on the arbitration of abstract maps in a dynamic environment.

Conclusions

This new toolbox aims to enhance researchers' ability to conduct advanced closed-loop neuroimaging experiments and expedite their analysis of associated data. We also hope this

toolbox will help the neurofeedback community grow and thrive through new forms of collaboration and improvement.

References (optional, maximum 6)

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