Neurofeedback-based adaptive audiovisual tutorial for enhancing multi-modal learning

ABSTRACT:

Background
Our project aims to facilitate the development of an adaptive brain-computer tutorial. Using fMRI, we pursue neural patterns that reliably predict the learning of association between visual patterns and a numerical identifier. Growing empirical evidence suggests that specific elements of learnt content may correspond with unique neural patterns, which are similarly manifested across individuals.

Aims
Investigating the formation of canonical neural representations throughout two encoding sessions. It examines intersubject correlation between brain signal obtained during the encoding phase in a brain anatomy tutorial. We further examine whether across-subject similarity of BOLD signal during item-encoding correlates with success in short and long-term learning.

Method
The participants learnt and completed a final examination of all 24 learned items outside of the scanner. An identical examination design was administered after 7 days. Data were collected from 22 participants during the learning phase using a 7T MRI scanner located at the Maastricht University.
Employing a searchlight method, we conducted a whole-brain comparison of intersubject correlation between correctly and incorrectly-encoded items. We examined both item-specific and item-general correlations and tested its link to accuracy in both short-term and long-term learning tasks.

Results
We found robust correlations across the parietal, frontal, parahippocampal, and early visual cortices. We obtained evidence that the encoding of items that were correctly remembered one week after the learning sessions involved increased item-specific intersubject correlation in parietal regions and enhanced item-general intersubject correlation in prefrontal areas relative to incorrect items.

Conclusions
These findings point to an intriguing functional dissociation within the frontoparietal network in the formation of canonical memory traces. These neural markers can be integrated in a BCI tutorial to optimize learning.

Keywords

Brain-computer interface, Learning, Machine learning, Neural decoding

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