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OPM-MEG versus SQUIDS MEG for object decoding via multivariate patter analysis

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Multivariate pattern analysis (MVPA) is a well-established method in functional neuroimaging, commonly applied to fMRI, MEG, and EEG data to classify spatial patterns of brain activity associated with different objects or experimental conditions. Optically pumped magnetometer (OPM)-based MEG systems have the potential to enhance MVPA performance, as they are theoretically shown to offer improved spatial specificity compared to conventional SQUID-based MEG systems [1]. However, this theoretical advantage has yet to be confirmed experimentally.

In this study, we directly compared object decoding performance between an OPM-MEG system and a traditional SQUID-MEG system using an MVPA approach. Nine participants completed an object recognition task while brain activity was recorded in two modalities: picture stimuli and their corresponding written words [2]. Each participant took part in two recording sessions—one using a 76-sensor OPM-MEG system (FieldLine Inc) and one using a conventional SQUID system (Elekta Neuromag system).

We applied MVPA to pairwise classify responses to objects on the screen using data from 68 magnetometers for both MEG systems. Our results show that, for pictured and word-based stimuli, classification accuracy was consistently higher with OPM-MEG compared to SQUID-MEG. This provides experimental evidence supporting the expected spatial advantages of OPMs for decoding patterns of brain activity.

[1] Nugent, Allison C., et al. "On-scalp magnetocorticography with optically pumped magnetometers: Simulated performance in resolving simultaneous sources." *Neuroimage: Reports* 2.2 (2022): 100093.

[2] Bezsudnova, Yulia, et al. "Spatiotemporal properties of common semantic categories for words and pictures." *Journal of Cognitive Neuroscience* 36.8 (2024): 1760-1769.

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