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BOLD power spectral density differentiates patients with pathological consciousness

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Introduction

- Functional connectivity has been successfully used to discriminate patients with disorders of consciousness[1,2].
- However, on clinical demand, patients are evaluated under sedation to restrict motion, which considerably limits the classification of patients based on functional connectivity[3].
- Previously it was shown that changes of the frequency properties of spontaneous BOLD signal are of cognitive relevance even in sleeping neonates[4].
- **Therefore, we aimed at exploring the automated discrimination of sedated patients in the clinical entities of minimally consciousness state (MCS) and unresponsive wakefulness syndrome/vegetative state (UWS), based on the frequency profile of the BOLD signal.**

Methods

45 patients in MCS(n=26) and 80 in UWS (n=18), based on the Coma Recovery Scale-Revised (CRS-R), were scanned on a 3T MRI scanner (300 volumes, T1 image)

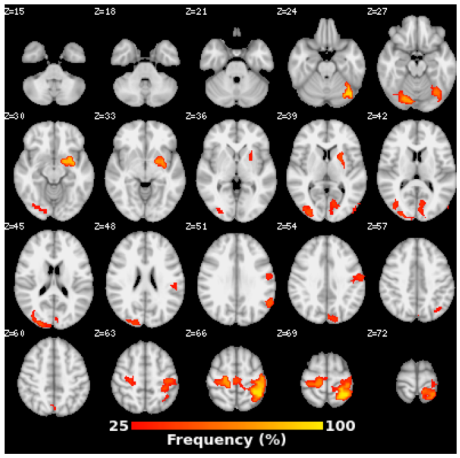
Sedative agents (propofol, sevoflurane, or a combination of both) were administered using the minimum necessary dose.

Preprocessing of functional images included slice-time correction, realignment, segmentation, normalisation, and smoothing (6mm FWHM). Noise reduction included detection and regression of motion outliers (ART toolbox), anatomical component-based correction, and regression of motion parameters, no temporal filtering was applied.

The average power density between 0.01 and 0.1 Hz was estimated and divided by the total power density, for each voxel.

Supervised classification of patients in MCS or UWS was explored with Support Vector Machine classifier using stratified 5-fold cross-validation. The clusters with significant differences between groups ($p<0.005$, uncorrected; cluster size > 10 voxels) in the training sets were selected as features. The 5-fold validation was repeated 20 times to estimate the variability of the classification accuracies and the frequency of each voxel being selected as a relevant feature.

Results



The average classification accuracy was 79%±5 (SD)

The average sensitivity was 76%±10, and specificity 81%±9.

The most frequently selected regions as features included the superior parietal lobule (Frequency: 100%; MNI x, y, z (mm): -26, -50, 64), putamen (97%; -30, -6, -8), occipital fusiform gyrus (92%; -34, -70, -20), occipital pole (65%; 22, -98, 16), angular gyrus (54%; -60, -58, 32).

Conclusions

- The power spectral density of the spontaneous BOLD signal in anesthesia allowed to classify individual patients with MCS and UWS with 79% accuracy.
- The most frequent selected features included association areas in the parietal and occipital lobes and the putamen. Further validation with independent cohorts is needed to generalize the current findings.
- **Taken together, the use of power spectral density may represent an alternative to functional connectivity to classify patients with consciousness disorders under anesthesia, therefore capturing properties of conscious function beyond reportability.**

References

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