time nor error rate was improved after a night's sleep. Behavioral learning was accompanied by the large-scale β-ERS over the associative cortical regions, which appeared only when the rules were learned at the end of day1, and, without fading in strength after a night's sleep, followed the errorless task performance and task repetition throughout day2. In line with the suggested role of the prefrontal β-ERS in retaining the acquired rules, the β-ERS at the prefrontal cortex did not grow in strength during the repetitive training over day2, whereas such progressive increase did characterize β-ERS originating from associative temporal and parietal cortical areas.

Our results support the hypothetical role of the large-scale β-ERS in the strengthening of memory traces for associative rule learning in the human brain. A lack of the significant effect of a night's sleep on behavioral and neural concomitants of the newly trained words suggests that a night's sleep alone is not sufficient for consolidation to occur. It appears that other factors (e.g., the rule practicing over day2) might also influence the transferring of newly learned association patterns from short-term to long-term memory.

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Data-driven unsupervised EEG clustering on tantric meditation data

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Introduction

Self-induced changes in functional activity during meditation can shed light on brain regulation mechanisms and reveal connections between higher-tier cortical centers and limbic structures. However, registration and analysis of meditative states are rather challenging. We present unique EEG data registered in a Tibetan Buddhist monastery established in India. Three experienced meditators were recorded during ongoing tantric meditation. This meditation has a strict protocol, that includes four stages related to bodily functions and four advanced mental stages. Our goal was to find continuous temporal clusters in EEG data that could reflect the stages of meditation.

Methods

Common neurophysiological features were calculated within 1s epochs. 40 EEG channels were aggregated in 15 ROI. We considered PSD and power indices in delta, theta, alpha, beta, and gamma bands within each ROI and coherence and PLV between ROIs. The resulting feature space was z-scored and reduced to the top-20 PCA components. We developed an unsupervised technique that detects optimal change-points in time-series data based on an ensemble of Ward's hierarchical clustering with time connectivity constraint. We made no restrictions on the number of EEG clusters. The algorithm chooses the optimal cluster number and cluster margins maximizing clustering quality metrics: mean distance between clusters, Silhouette coefficient, Calinski–Harabasz and Davies–Bouldin indices.

We performed a post-hoc analysis of the EEG clusters obtained. Information value metric was used to reveal the most informative features for each cluster. Afterward, the statistics for selected features were calculated; baseline (recording average) and cluster-wise comparisons were performed.

Results

We obtained from 4 to 9 continuous temporal clusters with high clustering quality for each subject. The features in each cluster were significantly different compared to both the baseline and the neighboring clusters; the statistics survived Bonferroni correction. We observed high variability between subjects with respect to EEG clusters number, length, and feature behavior; that demonstrates the data-driven nature of the proposed algorithm.

Additionally, we checked our method sensitivity. Our technique is stable with respect to epoch length (0.5–3s) and states order organization in a record. Also, we randomly shuffled the epochs within subjects and ran the clustering algorithm on this unstructured data. Obtained clusters showed poor clustering quality metrics and no statistical significance between clusters.

To conclude, we proposed a general data-driven approach for detection of brain functional states associated with profound mental transformations.

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GABAergic and glutamatergic control of perceptual versus value-based decisions

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Introduction

Decision making usually relies on the integration of evidence in favour of or against certain options. This holds for perceptual, but also value-based decisions.

Despite domain-specific neural representations, biophysical models of decision circuits suggest that both perceptual and value-based choices rely on the balance between excitatory and inhibitory neuronal pools in recurrent cortical networks. In support of this, theoretical and empirical work has linked decision variables to the excitation/inhibition balance of cortical networks and individual differences in neurotransmitter availability. Yet, causal evidence is still scarce.

Methods

In this study, we pharmacologically manipulated activity at either GABA receptors, glutamatergic NMDA receptors or no receptors by orally administering lorazepam (1 mg), d-cycloserine (250 mg) or placebo, respectively, to 60 healthy participants in a within-subject design. Participants then performed a perceptual and a value-based decision-making task in the MEG scanner on three testing days. Perceptual decisions were based on perceived motion of a random dot kinematogram, whereas value-based decisions were made between two options that varied in reward magnitudes and reward probabilities, and,