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## Supplemental information

# Multi-level decoding of task sets in neurophysiological data during cognitive flexibility

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**Supplemental Information**

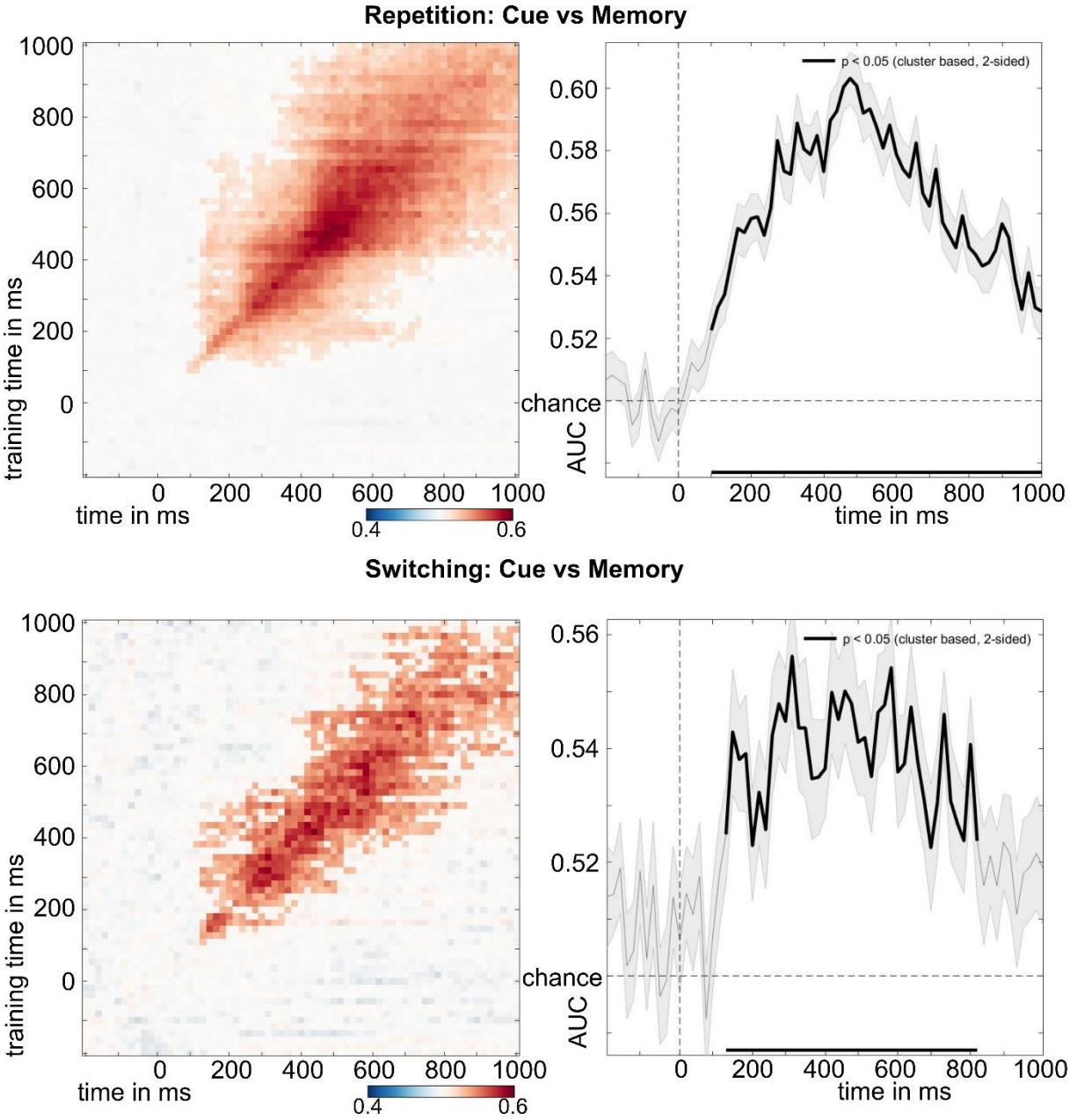


**Figure S1. MVPA results for repetition and switching conditions for the undecomposed EEG as described in *STAR Method*.** Classification of cue versus memory block are shown. Left: Temporal generalization plot. The plots show the degree to which the classifier when trained on a given time point (y-axis) generalizes to time points in the trial (x-axis). The colours indicate the classifier performance. The diagonal (bottom left to top right) shows classification performance when the classifier is trained and tested simultaneously—right: Area under the curve (AUC) decoding accuracy across time. Thicker lines indicate significant time windows ($p < 0.05$; two-sided cluster-based permutation). MVPA was performed on the undecomposed EEG data, following the steps described in *STAR Method*. Similarly to the main text, we introduce first the decoding accuracy results of the classification performance. Then, we describe the temporal generalization matrices: Task repetition and task switching (Cued task repetition vs. Memory-based task repetition and Cued task switching vs. Memory-based task switching). Successful classification was obtained with $N = 81$ participants. In the repetition

condition, the classification was significantly above chance from 100 ms after the stimulus presentation to the end of the trial (1000 ms). Considering the temporal generalization matrix, the above-chance decoding had a diagonal shape with a ramping pattern towards the end of the trial. In the switching condition, the classification was significantly above chance in the time window of 120 ms to 820 ms after the stimulus presentation. This above-chance decoding was characterized by a diagonal shape with jittered edges.

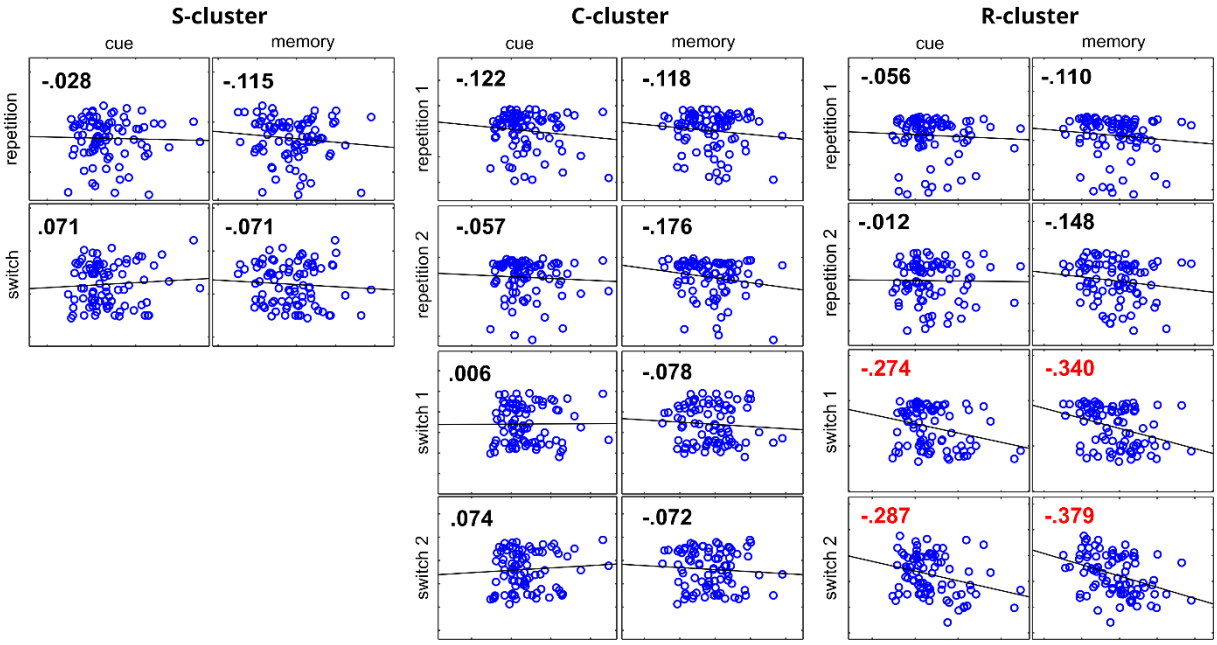


**Figure S2. Scatter plots and correlations of AUC values (y-axis) and behavioural switch cost measures (x-axis), as described in the *Statistics section of STAR Methods*.** Correlation coefficients are given, significant correlations are indicated by a red font colour. To analyse the exact relationship between task dynamics and MVPA results, correlations were run between AUC values and behavioural switch cost measures. Confidence intervals after a bootstrapping of 5000 are given. The left panel shows the *S-cluster*. Switch cost in the cued block did not correlate with decoding performance of task repetition rule ($r$ = -.028, $p$ = .798, *CI* [-.234; .172]). Switch cost in the memory block did not correlate with decoding performance of task repetition rule ($r$ = -.115, $p$ = .293, *CI* [-.354; .129]). Similarly, switch cost in the cued block did not correlate with decoding performance of task switching rule ($r$ = .071, $p$ = .514, *CI* [-.177; .306]). Finally, switch cost in the memory block did not correlate with decoding performance of task switching rule ($r$ = -.071, $p$ = .519, *CI* [-.282; .149]). The central panel shows the *C-cluster*. Switch cost in the cued block did not correlate with decoding performance in the first ($r$ = -.122, $p$ = .261, *CI* [-.378; .144]) and second ($r$ = -.057, $p$ = .599, *CI* [-.265; .159]) above-chance decoding of task repetition rule. Switch cost in the memory block did not correlate with decoding performance in the first ($r$ = -.118, $p$ = .278, *CI* [-.328; .105]) and second ($r$ = -.176, $p$ = .105, *CI* [.121; -.409]) above-chance decoding of task repetition rule. Similarly, switch cost in the cued block did not correlate with decoding performance in the first ($r$ = .006, $p$ = .955, *CI* [-.231; .239]) and second ($r$ = .074, $p$ = .496, *CI* [-.153; .288]) above-chance decoding of task switching rule. Finally, switch cost in the memory block did not correlate with decoding performance in the first ($r$ = -.078, $p$ = .476, *CI* [-.284; .129]) and second ($r$ = -.072, $p$ = .508, *CI* [-.284; .145]) above-chance decoding of task repetition rule. The right panel shows the *R-cluster*. Switch cost in the cued block did not correlate with decoding performance in the first ($r$ = --.056, $p$ = .609, *CI* [-.261; .136]) and second ($r$ = -.012, $p$ = .909, *CI* [-.210; .188])

above-chance decoding of task repetition rule. Switch cost in the memory block did not correlate with decoding performance in the first ($r$ = -.110, $p$ = .312, *CI* [-.318; .093]) and second ($r$ = -.148, $p$ = .175, *CI* [-.351; .063]) above-chance decoding of task repetition rule. Correlations with decoding performance of the task switching rule are reported in the main text.