

Supplemental Material

Research Articles | Behavioral/Cognitive

Contents of visual predictions oscillate at alpha frequencies

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Supplementary figures

{Supplementary Figure 1}

Figure S1: Localiser temporal generalisation of shape A vs. D and shape B vs. C decoders. **A:** Shape A vs. D decoder, trained and tested (-100 to 600ms) on the two target shapes (Shape A and D) which appeared both in the localiser and the prediction runs. Dashed rectangles indicate clusters used in exploratory early vs. late analysis (90 – 120ms and 160 – 190ms, respectively). **B:** Shape B vs. C decoder tested on Shape A and D trials. No significant clusters were identified. **C:** Shape A vs. D decoder tested on Shape B and C trials. No significant clusters were identified. **D:** Shape B vs. C decoder, trained and tested on Shapes B and C. Solid black lines indicate significant clusters ($p < 0.05$). Solid grey lines at 0ms indicate stimulus onset. **E: Source localisation of shape A vs. D discrimination** during the localiser, training time window of 70 to 200ms post-stimulus, indicating strong occipital activity.

{Supplementary Figure 2}

Figure S2: Pre-stimulus temporal generalisation of predicted shapes. **Top:** Shape A vs. D decoder, trained on shape – only localiser data (50 – 250ms), and tested (-2000 to 500ms) on prediction runs to discriminate between Shape A and D. Black solid line indicating the stimulus onset at 0ms. Dash grey line indicating auditory cue onset is at -1750ms (offset is at -1500ms). Cluster-based permutation test identified two clusters (with cluster threshold $p = 0.05$), first cluster between testing time -1650ms and -1450ms, and training time between 150ms and 250ms with $p = 0.068$, second cluster testing time between -750ms and -450ms, and training time between 150ms and 250ms with $p = 0.0870$. Two clusters did not survive the correction for multiple comparisons ($p = 0.05$). **Bottom:** Decoding time course, averaged over training time of 70 – 200ms. Solid light grey line indicates stimulus onset at 0ms. Dash black line indicates cue onset at -1750ms. No significant decoding of predicted shapes is indicated. Shaded regions represent SEM.

{Supplementary Figure 3}

Figure S3: Prediction templates fluctuate at alpha frequencies – 1/f noise removed. **A (top):** Significant power differences at 10Hz and 11Hz between Shape A vs. D decoding data and Baseline 1 after the subtraction of 1/f noise ($***p = 0.0013$, corrected for multiple comparisons with a false discovery rate of 0.01). This further demonstrates that the shape-specific alpha signals likely reflect oscillations. The baseline power spectrum (dark blue line) was obtained by bootstrapping ($n = 10000$) the randomly shuffled label decoding data ($n = 25$ per participant). Mean and shaded regions indicate SD. Solid orange line indicates the 95th percentile of the generated baseline distribution. Error bars indicate SEM. **A (bottom):** Pre-stimulus (-1250 to 0ms) MEG data after 1/f removal shows significantly higher 10 – 11Hz power for shape A vs. D decoding than for shape B vs. C decoding ($*p = 0.028$, $t(31) = 1.985$). Dark purple line indicates the power spectrum of B vs. C decoder (tested on the identical pre-stimulus main experiment prediction data (as shape A and D). Mean and shaded regions indicate SEM. Error bars indicate SEM. **B: Prediction templates fluctuate at alpha frequencies – alpha band-pass filtered pre-stimulus MEG signals (-1250 to 0ms).** **B (top):** Significant power differences at 10Hz and 11Hz between Shape A vs. D decoding data and Baseline 1 after alpha band-pass filtering pre-stimulus MEG signal ($***p < 0.0002$). Note that only the testing MEG signal was band-pass filtered to alpha, localiser data (which the decoder was trained on) not. The baseline power spectrum (dark blue line) was obtained by bootstrapping ($n = 10,000$) the randomly shuffled label decoding data ($n = 25$ per participant). Mean and shaded regions indicate SD. Solid orange line indicates the 95th percentile of the generated baseline distribution. Error bars indicate SEM. **B**

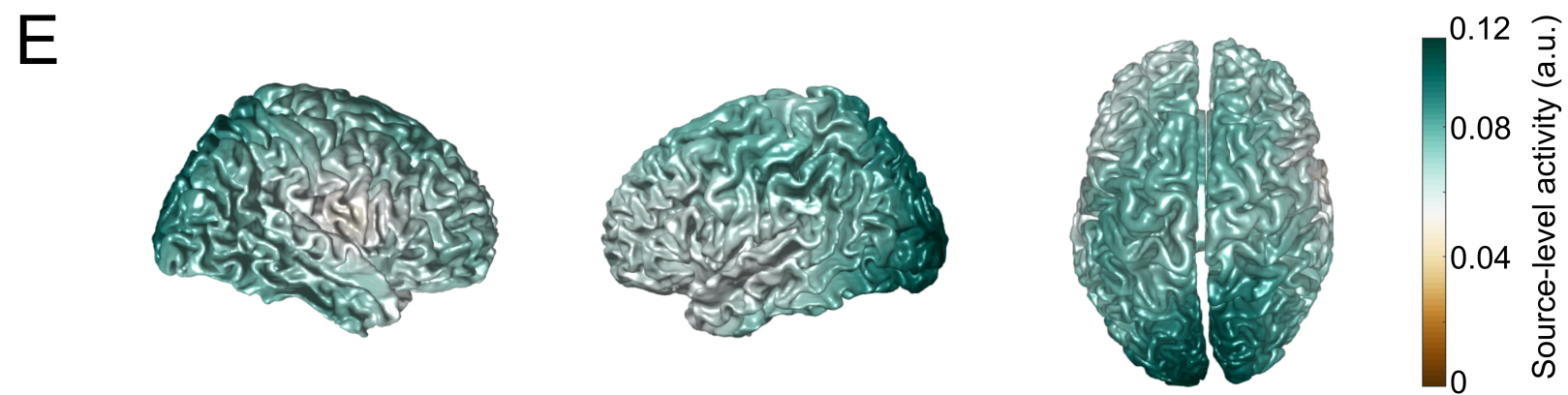
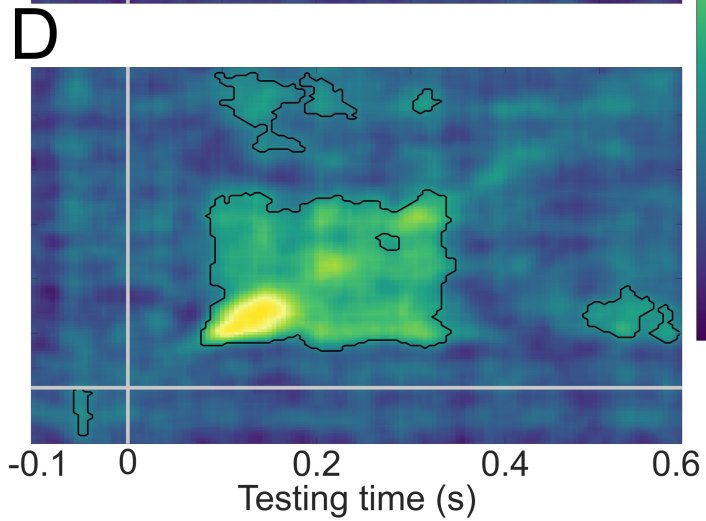
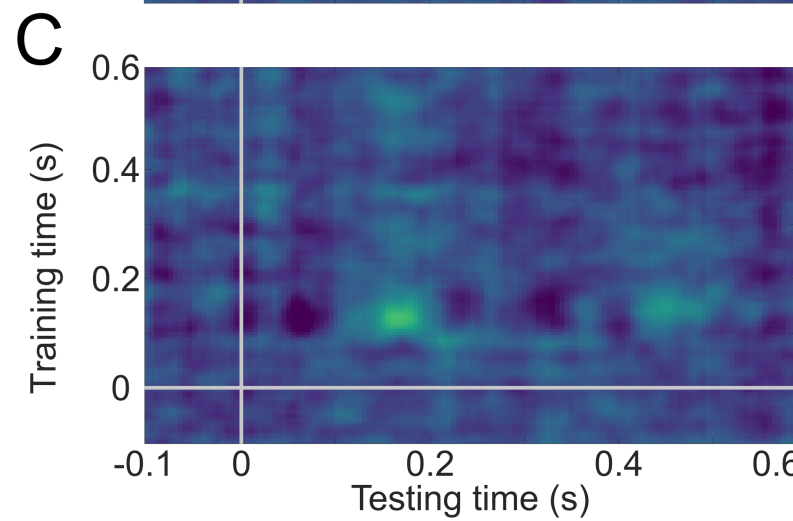
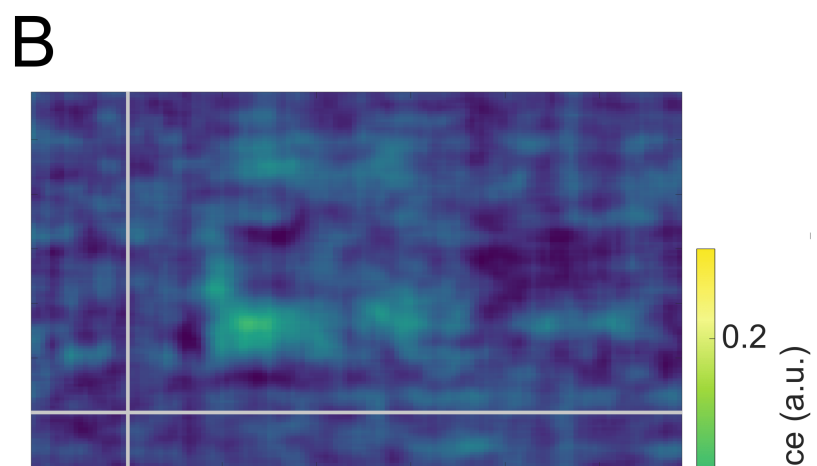
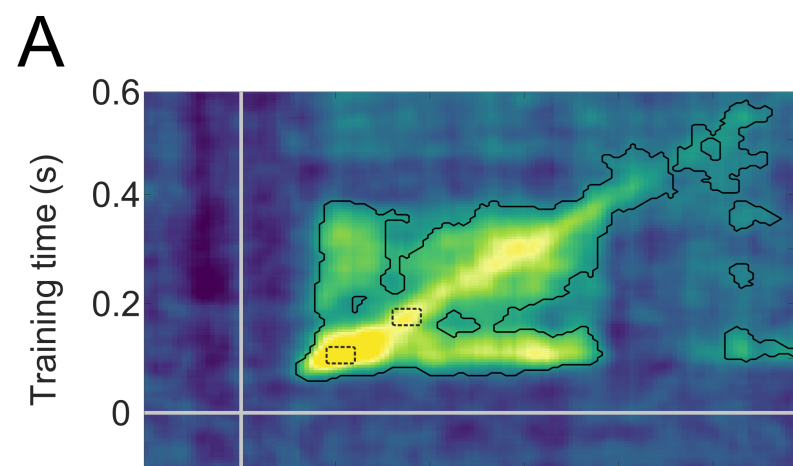
(bottom): Pre-stimulus (-1250 to 0ms) MEG data after band-pass filtering the MEG pre-stimulus signal to alpha, shows significantly higher 10 – 11Hz power for shape A vs. D decoding than for shape B vs. C decoding (*p = 0.028, t(31) = 1.986). Dark purple line indicates the power spectrum of B vs. C decoder (tested on the identical pre-stimulus main experiment prediction data (as shape A and D). Mean and shaded regions indicate SEM. Error bars indicate SEM. **C:** Time frequency representations of shape A vs. D decoding minus **(top)** the 95th percentile of an empirical null distribution (Baseline 1) and **(bottom)** minus shape B vs C decoding between auditory cue onset (-1750ms) and stimulus onset.

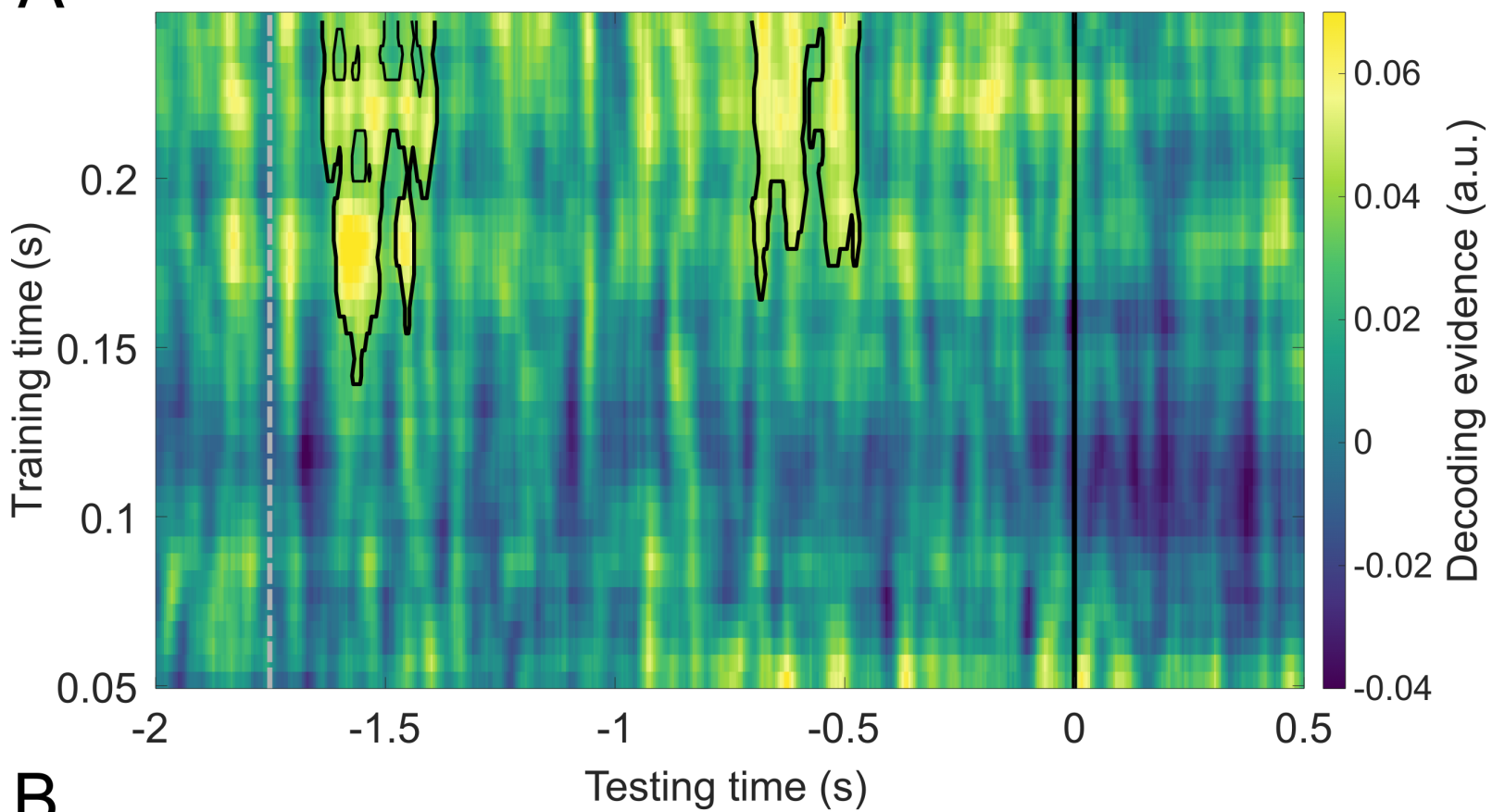
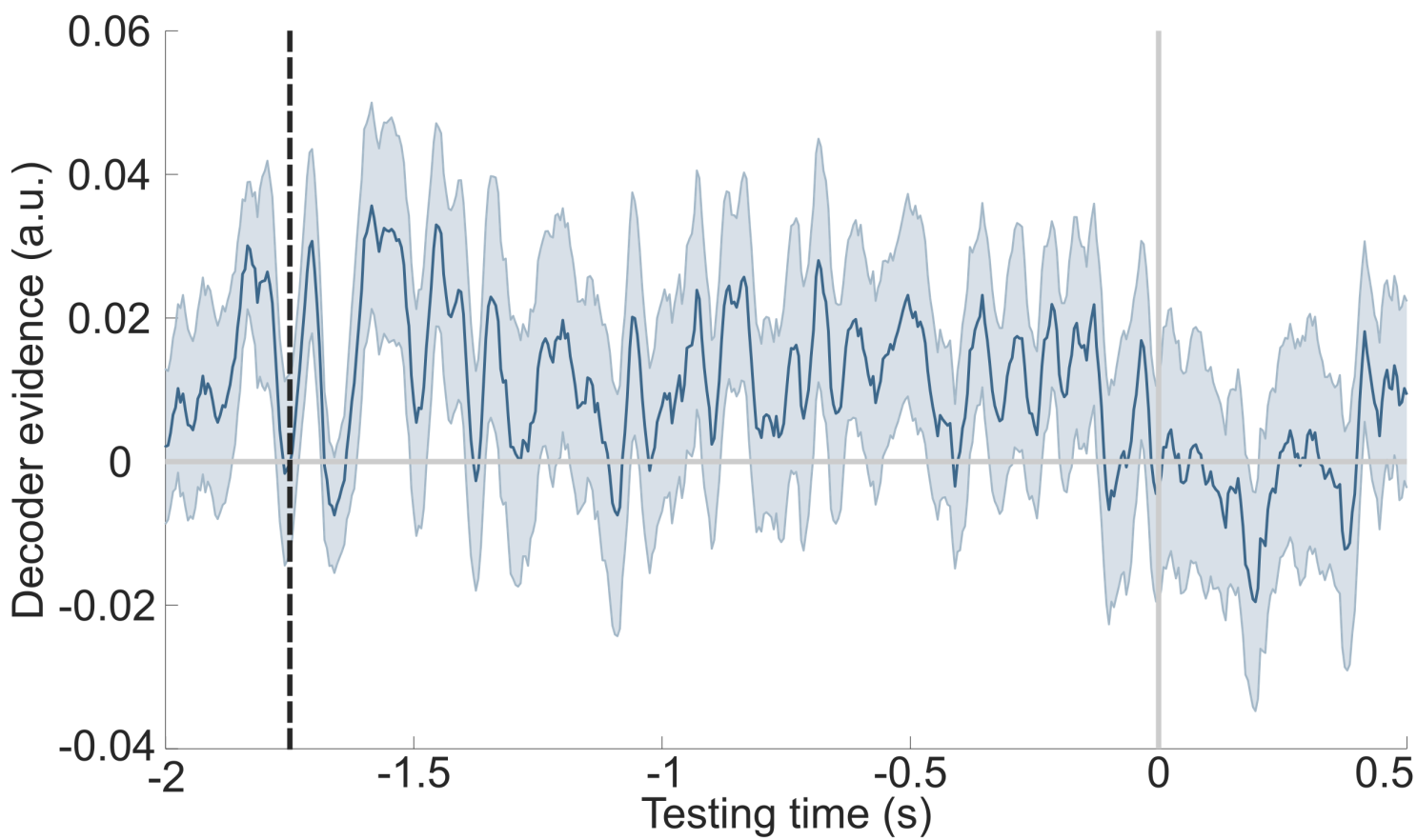
{Supplementary Figure 4}

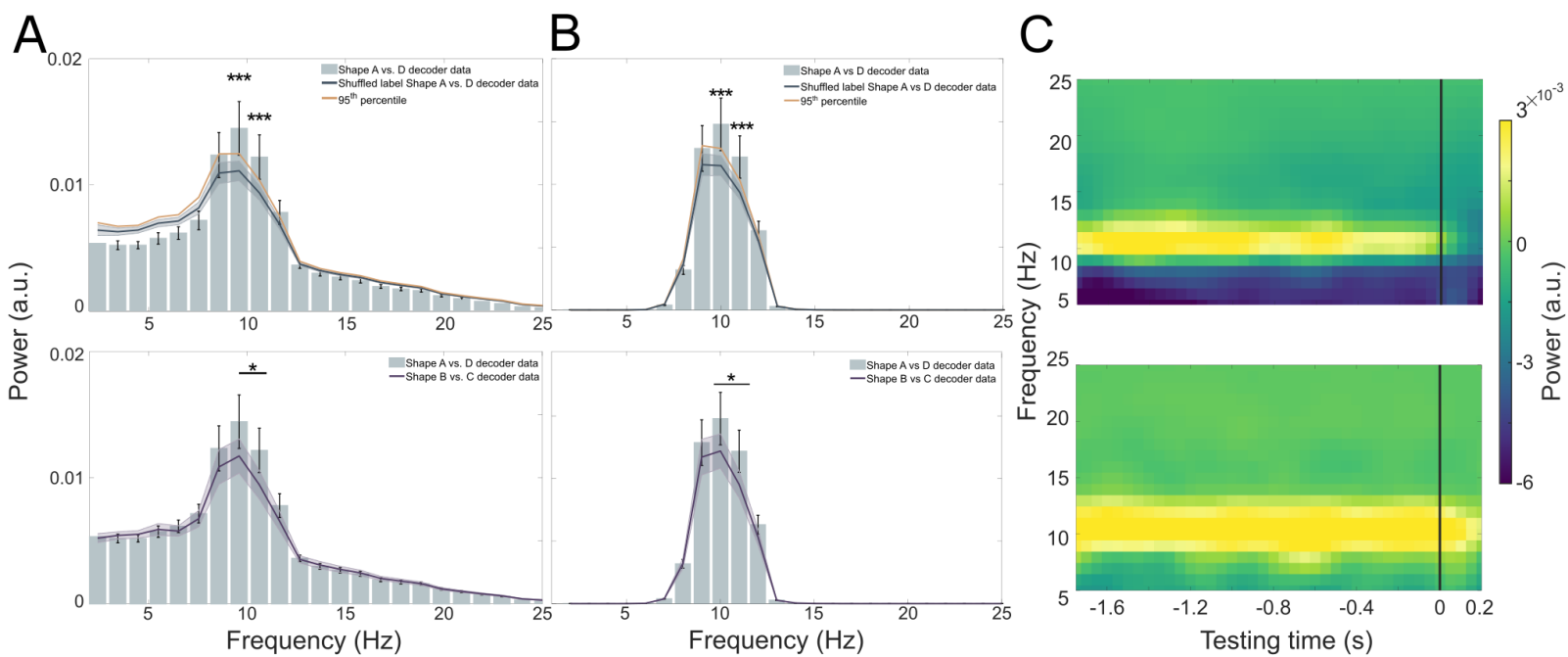
Figure S4: Coherence between raw alpha oscillations and shuffled label decoder traces. An empirical null distribution was created by calculating alpha coherence between shuffled label decoding signals and raw MEG signals (n = 1000 permutations). **A:** Topography of sensor-level alpha (10Hz with 2Hz spectral smoothing) coherence between raw MEG signals (-1250 to 0ms) and **(left)** shuffled-label decoder traces (-1250 to 0ms), topography represents the 95th percentile of the empirical null distribution. The 95th percentile of this null distribution was subtracted **(right)** from the sensor-level coherence obtained using non-shuffled label decoders (cf. **Fig. 3B-top**). **B:** Mean source-localised alpha coherence between raw MEG signals (-1250 to 0ms) and **(left)** shuffled-label decoder traces (-1250 to 0ms), source-map represents the 95th percentile of the empirical null distribution. The 95th percentile of this null distribution was subtracted **(right)** from the source-localised coherence obtained using non-shuffled label decoders (cf. **Fig. 3C-top**).

{Supplementary Figure 5}

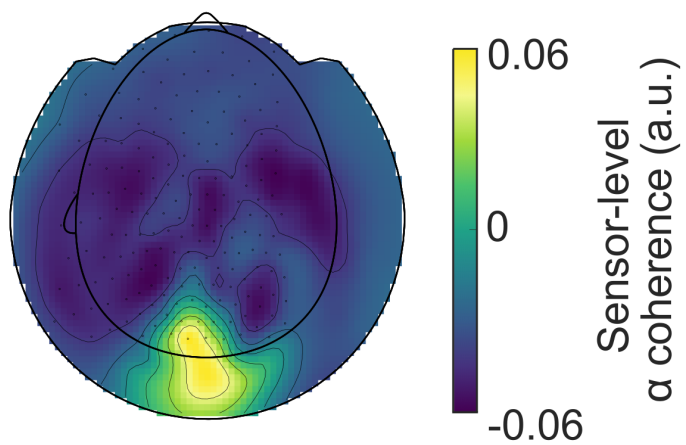
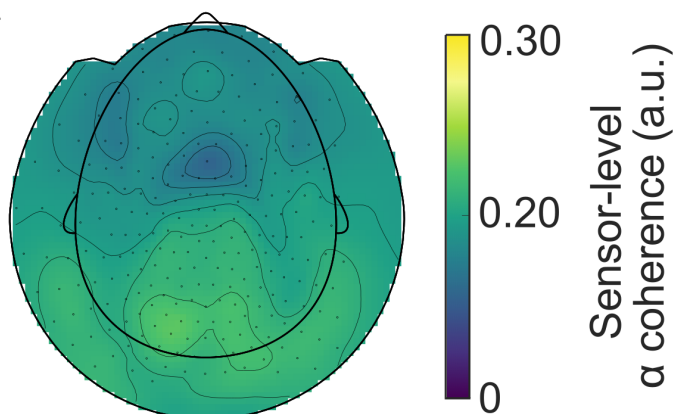
Figure S5 Individual subjects scatter plots of shape-specific alpha power as a function of valid vs incorrect prediction trials. We expected to observe an opposite trend between valid and invalid prediction trials, meaning for correct responses higher overall shape-specific alpha power for valid trials vs. incorrect valid trials, whereas higher power was expected for incorrect invalid trials vs. correct invalid trials (noticeable trend in subjects S07, S09, S20).



A**B**



A



B

