

Supplemental Material

Research Articles | Behavioral/Cognitive

Dissociating Contributions of Theta and Alpha Oscillations from Aperiodic Neural Activity in Human Visual Working Memory

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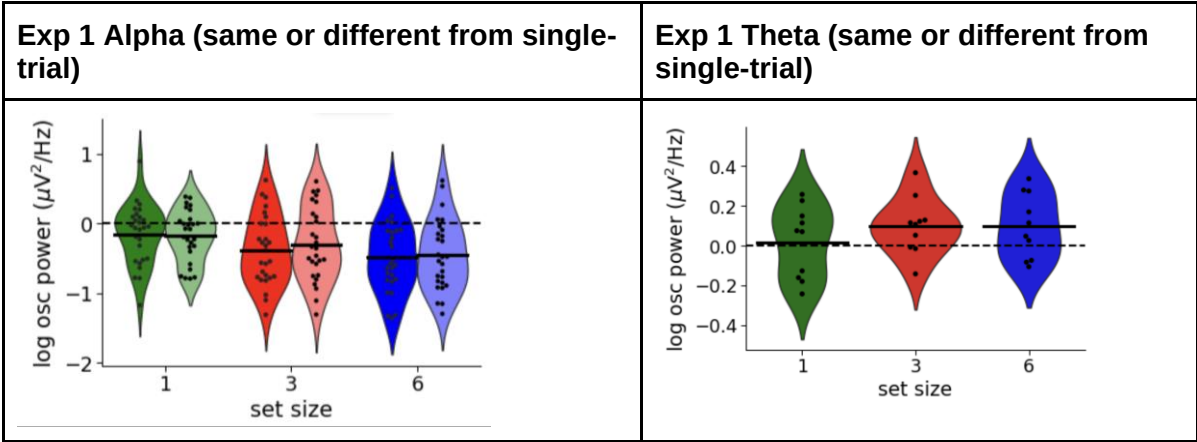
Trial-averaged version versus single-trial fits

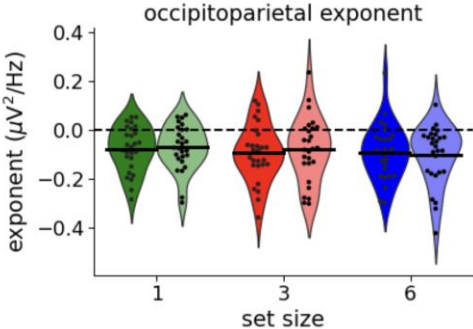
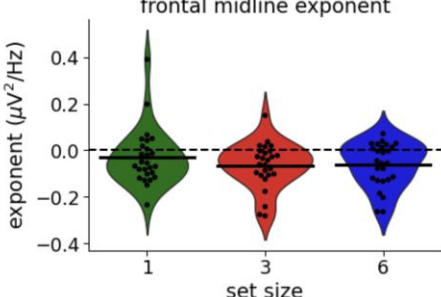
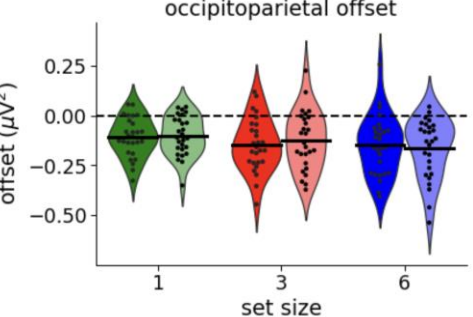
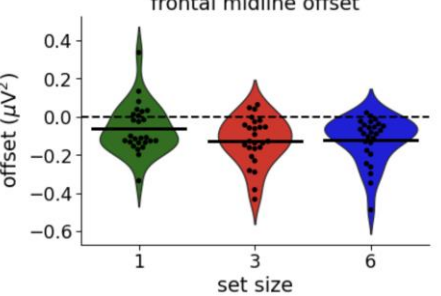
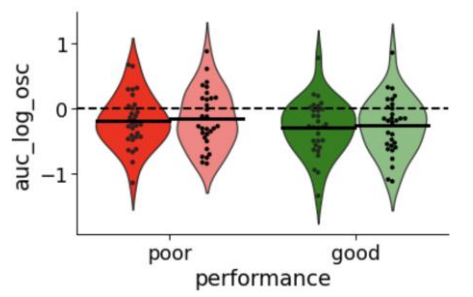
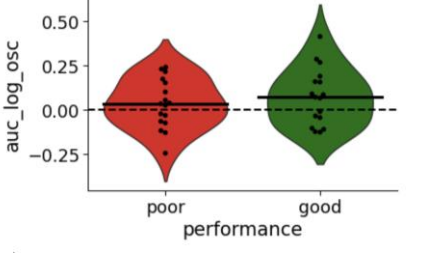
In our main manuscript we chose to fit the specparam model on single-trial data rather than averaged within a condition. The benefit this gives us is that we can perform trial-based baselining by subtracting the model outputs during the cue period (our baseline) from the delay period to account for trial-by-trial variability in attention, drifts in the signal and unknown noise. However, the benefit of the averaged approach is that the PSDs become smoother, resulting in overall better model fits.

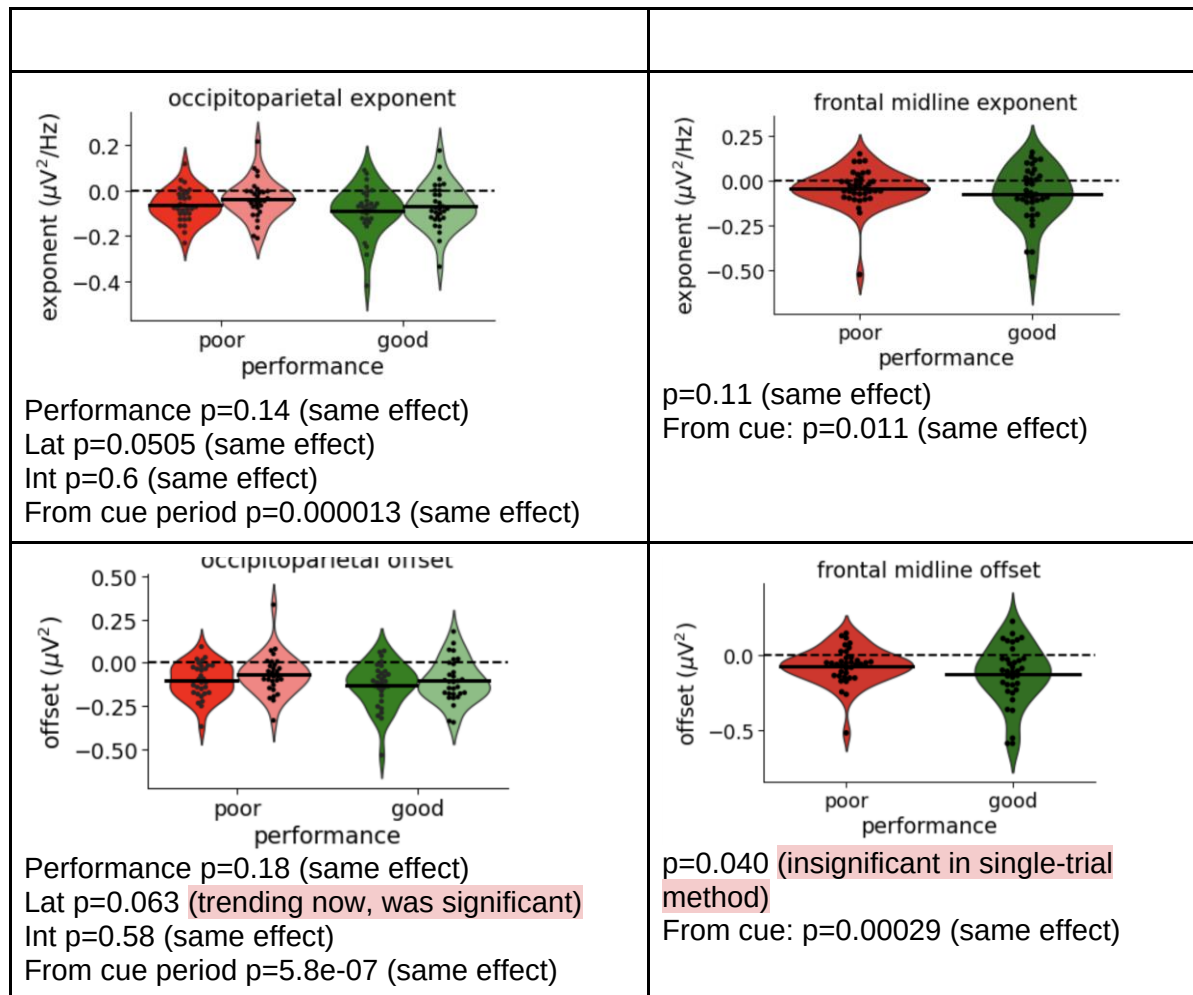
Here, we included the averaged approach and compared it to our single-trial fits. The majority of our results remain the same, with only one change for fm-theta in Experiment 2. The averaged method finds significantly lower aperiodic offset during the good performance than the poor performance condition, which was not significantly different in the single-trial approach. We find a few differences for the occipitoparietal regions. In Experiment 1, the exponent is no longer showing a significant decrease with an increase in set size, neither is the offset (although the results are still considered trending). Whereas in Experiment 2, we find significantly lower aperiodic-adjusted alpha power in the good condition, compared to the poor condition, which we didn't find for the single-trial method. All these differences, including the figures are shown in Supplementary Table 1. We included these findings in the supplementary materials, because we see the averaged method being employed in other papers (Frelah et al. 2025; Virtue-Griffiths et al. 2025) and wanted to provide a better understanding of our own data, and to compare it to the current body of literature.

In comparison, whereas Virtue-Griffiths et al., (2025) found steepening effects on frontal electrodes without WM load conditional differences, we found a flattening effect without concomitant WM load induced differences. The occipitoparietal regions were similar in the sense that we both found flattening exponents. However, when we use the single-trial method, we do find a significant decrease in exponent due to WM load, whereas we do not in the averaged method and neither does Virtue-Griffiths et al., (2025).

Supplementary Table 1. Comparison between fitting spectral parameterization on single-trials versus within condition averaged PSDs.



Set-size $p=0.0002$ (same effect) Lat = ns (same effect) Int = ns (same effect/trending in single-trial)	$p=0.15$ (same effect) From cue period $p=0.12$ (same effect)
occipitoparietal exponent  Set-size = ns (was significant in single-trial method) Lat = ns (same effect) Int = ns (same effect) From cue period: $p=0.00002$ (same effect)	frontal midline exponent  Ns (same effect) From cue period: $p=0.002$ (same effect)
occipitoparietal offset  Set-size $p=0.076$ (was significant in single-trial method) Lat = ns (same effect) Int = ns (same effect) From cue period: $p=4.14e-07$ (same effect)	frontal midline offset  $p=0.95$ (same effect) From cue period: $p=0.000019$ (same effect)
Exp 2 alpha  Performance $p=0.019$ (was n.s. in single-trial) Lat = ns (same effect) Int = ns (same effect)	Exp 2 theta  $p=0.29$ (same effect) From cue: $p=0.1$ (same effect)



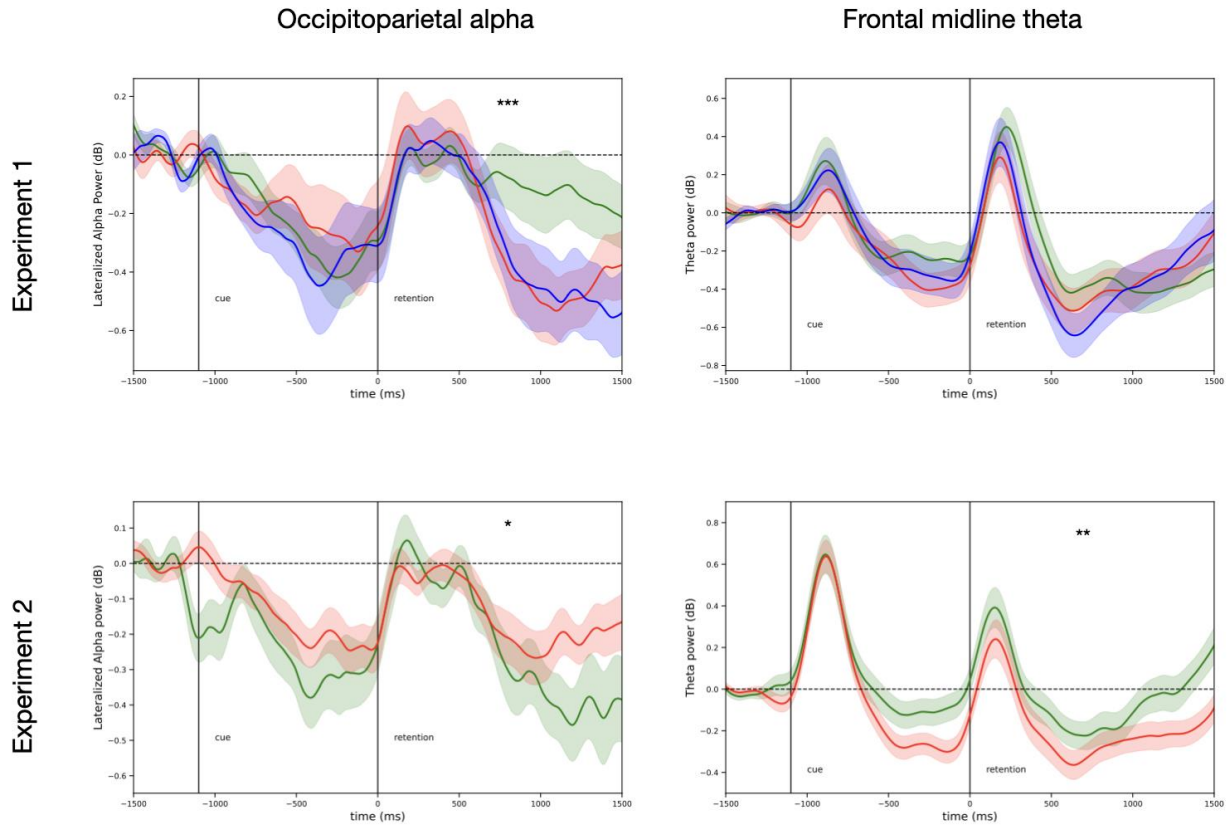
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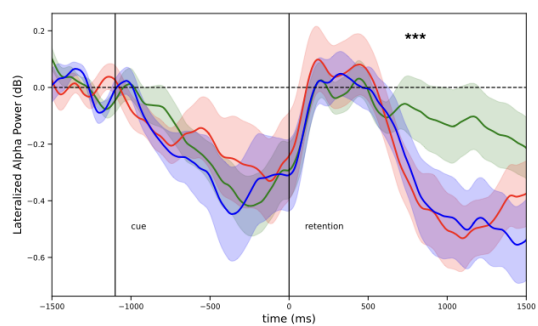
Replication of original results



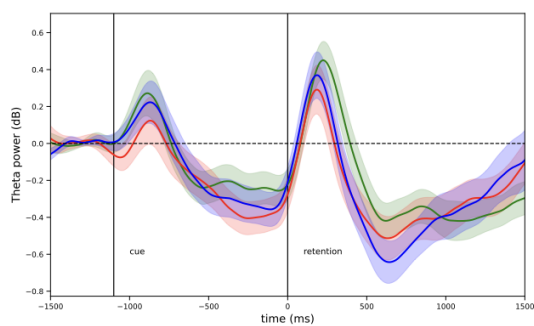
Supplementary Figure 1. Replication of original paper (Adam et al., 2018), using the same method, the Hilbert transform. Here we show the results of the two experiments and alpha and theta frequencies. For Experiment 1, we found a significant effect of set size on occipitoparietal alpha power during the delay period ($F(2,52) = 8.23$, $p = 7.8 \times 10^{-4}$, $\eta_p^2 = 0.24$), and of lateralization ($F(1,26) = 2.71$, $p = 1.3 \times 10^{-3}$, $\eta_p^2 = 0.33$), but not for the interaction effect ($F < 1.0$). In Experiment 2 we found similar results for performance ($F(1,36) = 4.74$, $p = 0.036$, $\eta_p^2 = 0.12$), and for lateralization ($F(1,36) = 18.57$, $p = 1.2 \times 10^{-4}$, $\eta_p^2 = 0.34$), but not for the interaction effect ($F < 1.0$). For frontal midline theta, we find no significant differences between the set sizes during the delay period ($F < 1.0$), but in Experiment 2, we find a significant increase in power during good compared to poor performance ($t(36) = -3.42$, $p = 1.6 \times 10^{-3}$, Cohen's $d = 0.42$).

Experiment 1

Occipitoparietal alpha



Frontal midline theta



Experiment 2

