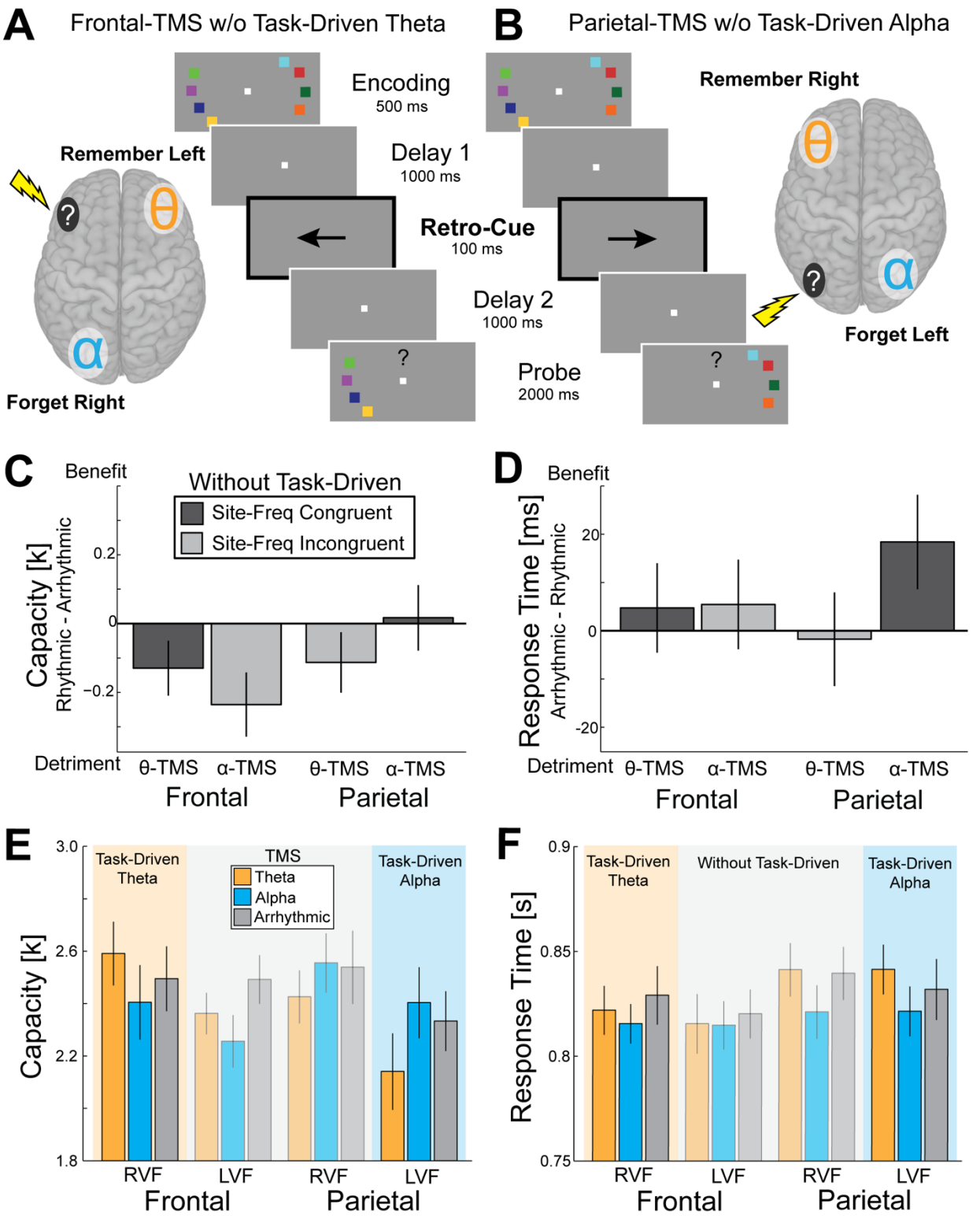

Figure S1. Behavioral analysis of rhythmic TMS on WM performance for conditions without task-driven oscillations. Related to Figure 1 and Figure 2.

A retro-cue to the left visual field was not expected to drive theta oscillations in the left frontal cortex (A); and a retro-cue to the right visual field was not expected to drive alpha oscillations in the left parietal cortex (B). Due to the lack of a strong hypothesis for the neural activity on these conditions (depicted as a question mark in the region targeted by TMS), we did not predict an effect of rhythmic TMS. We calculated difference scores relative to arrhythmic-TMS and performed a two by two (TMS site by TMS frequency) repeated-measures ANOVA for the capacity (C) and response time (D) difference scores. There was no interaction for either capacity ($F(1,19) = 1.91$, $p = 0.18$, $\eta^2_p = 0.091$) or response time ($F(1,19) = 1.09$, $p = 0.31$, $\eta^2_p = 0.054$). Site-frequency congruency is defined as the conditions that would produce a behavioral benefit if the task-driven activity were also present, and site-frequency incongruency refers to the conditions that would have produced a behavioral detriment. The bottom row shows the capacity € and response time (F) for each individual condition that were used to calculate difference scores. The task conditions are defined as a retro-cue to the right visual field (RVF) or to the left visual field (LVF) and are arranged by TMS session: TMS applied to left frontal cortex or left parietal cortex. Retro-cues to the contralateral visual field (RVF) have been previously shown to drive theta oscillations in Frontal cortex (highlighted in light orange); and retro-cues to the ipsilateral visual field (LVF) drive alpha oscillations in Parietal (highlighted in light blue). The control conditions, when the retro-cue was not expected to drive theta or alpha oscillations, are highlighted in light grey. TMS was applied in either theta frequency (orange), alpha frequency (blue), or in an arrhythmic control condition (dark grey). Error bars are within-subject SEM.

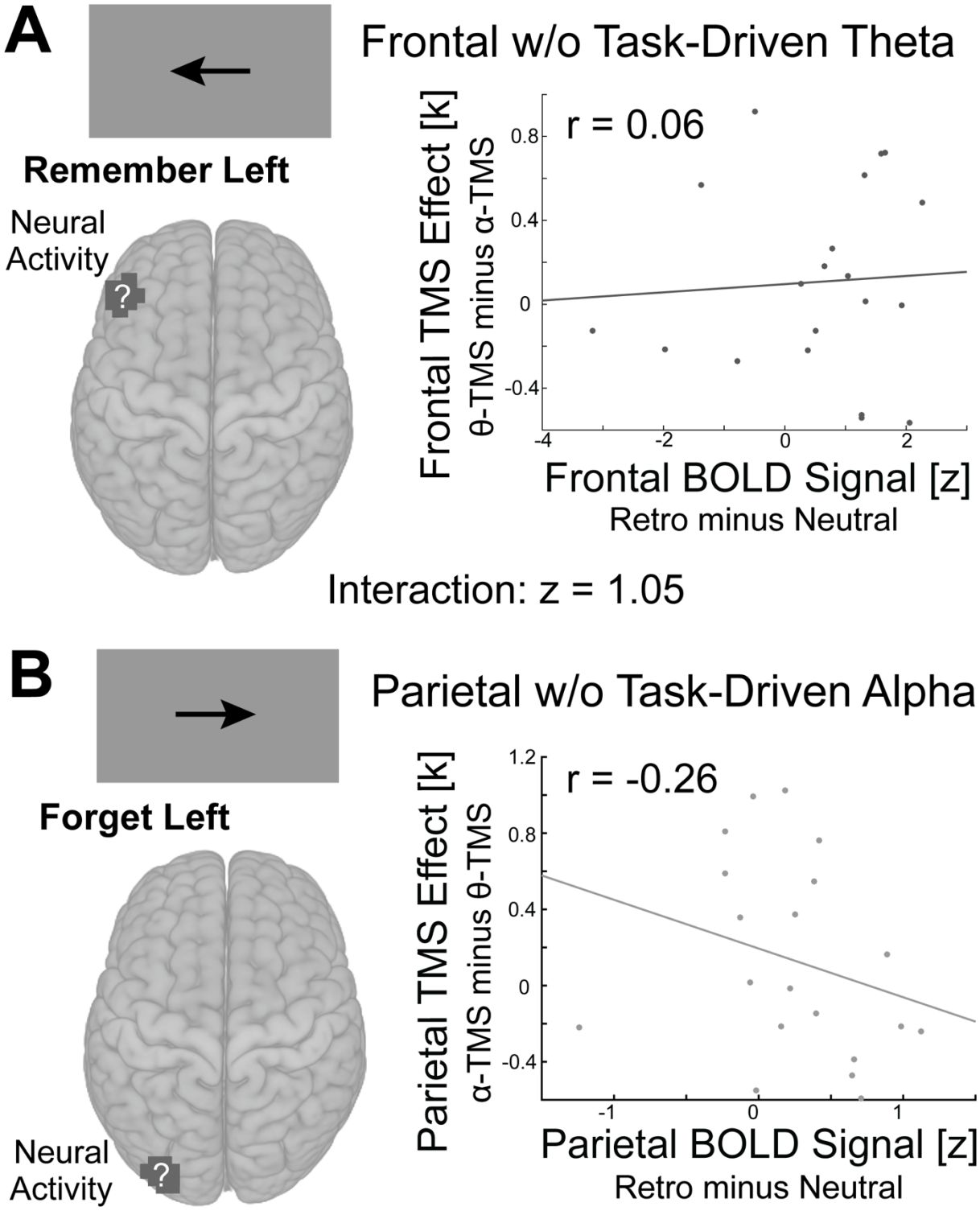

Figure S2. **Brain Behavior Correlation Exploratory Analysis. Related to Figure 3.**

A retro-cue to the left visual field was not expected to drive theta oscillations in the left frontal cortex (A); and a retro-cue to the right visual field was not expected to drive alpha

oscillations in the left parietal cortex (B). When the retro-cue did not drive neural oscillations in the regions targeted by TMS, we do not expect a systematic change in the targeted region for retro-cue relative to neutral-cue (depicted by a question mark). Therefore, we did not expect to find a correlation between neural activity as measured by blood-oxygenation dependent (BOLD) signal and the behavioral effect of TMS on capacity in the control conditions. As hypothesized, we did not find a correlation between BOLD signal and TMS effect in frontal cortex ($r(18) = 0.06$, $p = 0.794$; A) or parietal cortex ($r(18) = -0.26$, $p = 0.263$; B). There was no significant difference between the correlations for frontal and parietal TMS ($z(18) = 1.05$, $p = 0.29$).