Supplemental Methods

Cognitive tasks

The N-back is a sequential-letter memory task in which working memory load is varied (1). Letters were presented in succession, appearing one at a time on the screen. Subjects were required to press the "1" button to target stimuli and the "2" button to any non-target stimuli. In the 0-back condition, the target stimulus was a pre-specified letter (e.g., "X"). In the 1-back condition, the target stimuli were letters that matched the immediately preceding letter (e.g., "P" following a "P"). Likewise, in the 2-back condition, target stimuli were letters that matched the letter that was presented two trials back (e.g., "L" following a "T", which followed a "L"). Letters could be upper or lower case, but subjects were instructed to disregard the case and base responses only on the identity of the letter. Each stimulus was presented for 500 ms, followed by a delay of 2,000 ms before the next trial. There were 3 blocks for each of the 0-, 1-, and 2-back conditions with 36 trials in each block, for a total of 324 trials. Because stimulus and response characteristics were constant across the conditions, the only difference was the requirement to maintain and update increasingly greater amounts of information at higher working memory loads. Subjects with schizophrenia exhibit substantially impaired performance and decreased functional activation of the DLPFC relative to matched controls at the 2-back load (2).

In the AX-CPT task, subjects were required to maintain an attentional set across a delay interval in order to overcome a prepotent response tendency. Letter stimuli were presented as cue-probe pairs requiring the use of context information to properly produce target vs. nontarget responses (3). Letters were presented on the screen, one at a time, in succession. Target responses (button press "1") were to the probe letter X, but only when preceded by the cue letter A, and were otherwise non-targets (button press "2"). A preponderance of AX cue-probe pairings (70% of all trials) was implemented to set up a strong tendency to respond "target" to an

X probe since this response would be correct on the majority (87.5%) of trials. This tendency was built up during a practice block. On trials in which X was not preceded by an A cue (referred to as BX trials), subjects had to maintain and use the cue information to overcome the prepotent tendency to produce the target response to X probes. Subjects with schizophrenia perform worse than controls in this condition, especially when the delay between cue and probe is extended to several seconds; in addition, their impaired performance is associated with decreased DLPFC activity (4). In this study, cue and probe stimuli were each presented for 300 ms. During short delay trials, the cue-probe interval was 1,000 ms with a 5,000 ms intertrial interval (ITI); for long delay trials, the cue-probe interval was 5,000 ms with 1000 ms ITI. There were 30 blocks (15 short delay, 15 long delay) of 10 trials each for a total of 300 trials.

The Preparing to Overcome Prepotency (POP) task is a cued stimulus-response reversal paradigm that, similar to the AX-CPT task, requires increases in cognitive control through the maintenance and use of context information to overcome prepotent response tendencies (5). Trials proceeded in the following order: cue (a green or red square; 500 ms); delay period (1000 ms); probe (a white arrow pointing left or right; 1000 ms); and a variable ITI (1000-2000 ms). Cues indicated conditions requiring either low (green cue) or high (red cue) degrees of cognitive control. Over the delay period, subjects were required to maintain the trial-type information and prepare for a response to the upcoming probe. For the low-control condition, subjects were required to respond in the direction of the arrow that followed (e.g., for a right-pointing arrow, press the right button); for the high-control condition, responses were required in the *opposite* direction (e.g., for a right-pointing arrow, press the left button). To reinforce the prepotency of the cue-probe mappings of the low-control trials, thereby increasing the control requirements during the high-control trials, 70% of the trials were low-control and the remaining 30% were

high-control. The cue and probe stimuli each had durations of 500 ms. There were 6 blocks of 100 trials each.

Electrophysiology

During the POP task, EEG data were acquired as previously described (5) using a 129 Ag-AgCl coated carbon fiber electrode Geodesic Sensor Net (EGI, Eugene, OR) with a sampling frequency of 250 Hz. Data were filtered on-line with a 0.1-100 Hz band pass hardware filter. Electrode impedances were kept below 50 kΩ. All channels were referenced to Cz. Data were filtered off-line using an 8-100 Hz bandpass, 60 Hz notch Butterworth Filter (Time constant: 0.0199s, Slope: 12 dB/oct). Epochs were defined as -400 to +1700 ms relative to the cue onset. Error trials and epochs containing artifacts (EEG or EOG exceeding ±100 μV) were excluded. Average segment counts for the high and low control conditions were 317 and 132, respectively. Data were re-referenced to average reference (6).

Time-frequency analyses were carried out using Brain Vision Analyzer (Brain Products GmbH, Munich, Germany). The wavelet transformation was applied using the complex Morlet wavelet which is defined by $mo(x)=c\cdot\exp(-x^2/2)\cdot\exp(i\omega_0 x)$, with c=7, using 40 frequency steps spanning 8-100 Hz. For analysis of gamma band oscillations, we examined 40 Hz induced (i.e., not time locked to stimulus) activity, shown to be reduced in frontal brain areas of schizophrenia compared with healthy subjects performing the POP task (5). Data were referenced to a -200 to -50 ms pre-cue baseline interval.

References

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