Supplementary Methods

Subjects. We tested three subjects who had been surgically implanted with bilateral depth electrode arrays into prefrontal cortex. Intracranial recordings can be ethically obtained in cases of medically intractable epilepsy, where they are used to precisely localize regions of seizure onset. The clinical team determined the placement of these electrode arrays so as to best localize epileptogenic regions. All subjects had normal range personality and intelligence and were able to perform the task well. Our research protocol was approved by the institutional review board at Huntington Memorial Hospital, Pasadena, CA, and informed consent was obtained from each the subjects.

Each subject had a single electrode array implanted into vPF in each hemisphere, orthogonally placed on a lateral to medial trajectory through inferior frontal gyrus. All three subjects had similar placements (Supplementary Figure 1).

Intracranial recordings. We utilized the two most lateral electrode contacts on each array for a total of four electrodes per subject (two per hemisphere) and 12 electrodes across all three subjects. iEEG signal was recorded using standard clinical depth electrode arrays with 1 mm platinum contacts and an inter-electrode spacing of 8 mm (Spencer electrodes; Ad-Tech Medical, Racine, WI). The signal was amplified, sampled at 200 Hz, and band-pass filtered between 0.3–70 Hz (Grass-Telefactor apparatus, West Warwick, RI). Recordings were acquired using a sub-galeal reference and then re-referenced to a common average reference (CAR). Choice of reference did not affect the results.

Although intracranial depth recordings mainly reflect local processing, it is possible that distant sources may also contribute to the observed activity. To address this we computed the bipolar derivation of the two most lateral electrode contacts on each array, thus eliminating distant sources of activity. Analysis of the bipolar recordings exhibited the same pattern of effects as that of the CAR recordings, providing conclusive evidence that our results are based upon activity localized to vPF.

Task design. Experimental stimuli were controlled using LabView software (v6.0; National Instruments, Austin, Texas) and were presented on a black background using a touchscreen interface. At the

beginning of every trial a red fixation stimulus (1.7 cm in diameter) was presented at the center of the screen and the subject initiated the trial by touching the stimulus with his or her right hand. After a brief delay (1–1.3 s) a blue target stimulus was presented (1–1.3 s in duration) at one of six locations on the screen (see Supplementary Figure 1). Target location was selected randomly on each trial and targets were located 13 cm from the center of the screen. After the target was extinguished, there was a brief memory period (1–1.3 s) and then the fixation stimulus was extinguished, signalling the subject to make a reach to the location formerly indicated by the target. Subjects had to reach the former target location within two seconds and hold this location for 400 ms. Correct responses were followed by a high frequency tone while incorrect responses were followed by a low frequency tone. Subjects exhibited high accuracy [94%±2% ms, mean ± s.d.] and acquired the target in approximately one second [946±58 ms].

Analysis of spatial selectivity. The 1 s post-stimulus activity from individual trials was binned into 50 ms bins and trials from different directions were compared via an ANOVA using DIRECTION and BIN as the main effects. A given electrode was said to exhibit spatial selectivity if the interaction between the two main effects exceeded a threshold ($P<0.01$; corrected for the number of electrodes in a given subject).

We additionally quantified the selectivity of each electrode exceeding this threshold by calculating the Selectivity Index (SI),

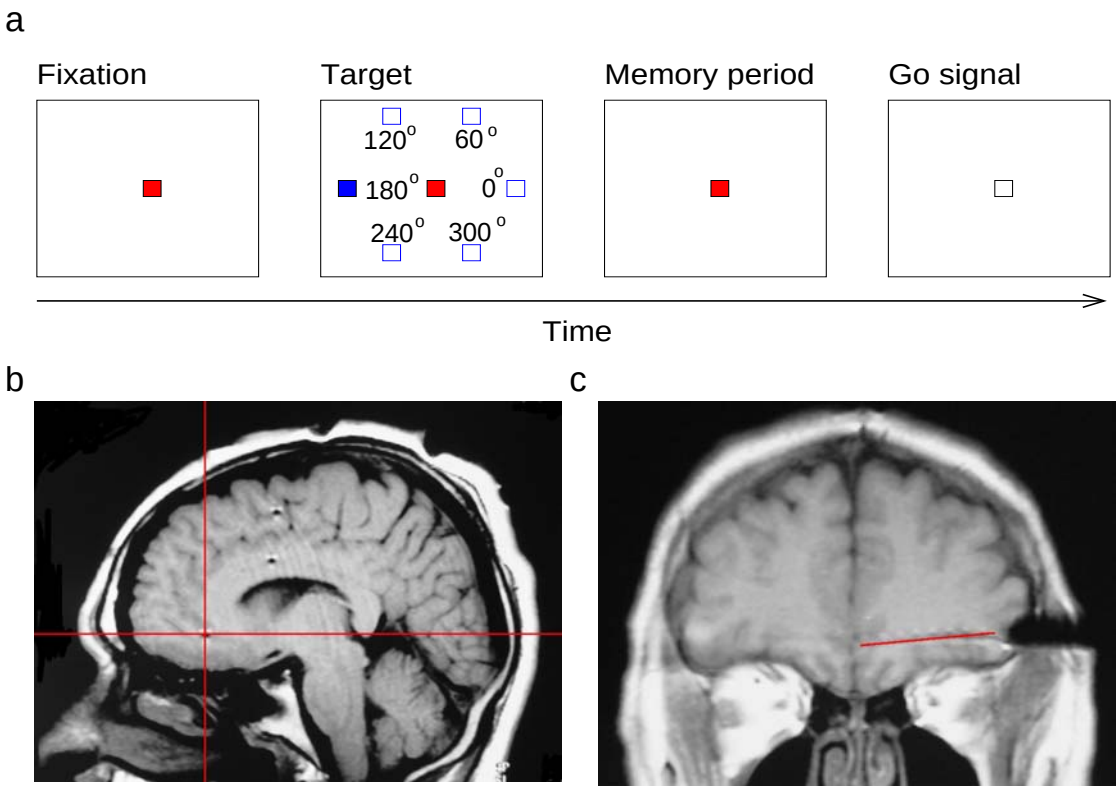
$$SI = \frac{\left|\mu_{left} - \mu_{right}\right|}{\sqrt{\sigma_{left}^2 + \sigma_{right}^2}}$$

where μ represents the mean activity and σ represents the standard deviation calculated during the time bin of greatest difference (as assessed by a post-hoc *t*-test) for trials comprised of targets presented either to the right or to the left of the fixation stimulus.

Target location and movement direction decode. Those electrodes exhibiting spatial selectivity during the target presentation period or the movement period were then examined for their usefulness in decoding either the target location or the movement direction, respectively. No electrodes passed our

criterion for exhibiting spatial selectivity during the memory period, hence, we did not attempt to decode using activity from this period.

Fisher's linear discriminant was used to classify a given trial into either the preferred or anti-preferred direction using a leave-one-out procedure. For time-domain decodes a 300 ms moving window of activity was binned into 50 ms bins and classified on a trial by trial basis. For frequency-domain decodes a 300 ms moving window of activity was transformed using Slepian multi-tapers with a bandwidth of 5 Hz [14]. Log-transformed spectral power at integer frequencies between 5–45 Hz were used in the decode.



Supplementary Figure 1: Experimental design and recording locations. **(a)** Schematic of the trial design. A red fixation stimulus appears on the screen and the subject places his hand on the stimulus to initiate the trial. After a brief delay, a blue target stimulus appears and then disappears during the memory period. When the red central fixation disappears (the "Go" signal) the subject reaches to the location formerly indicated by the blue target stimulus. **(b)** Sagittal MRI image showing the anterior-posterior and inferior-superior electrode placement in Subject 1. Electrodes were orthogonally placed in a lateral to medial trajectory perpendicular to the intersection of the red lines. **(c)** Coronal view of depth electrode placement in the same subject. Red line indicates the electrode trajectory in left vPF. The large MRI artifact at the right of this image is due to the electrode connector that is fixed to the skull. All three subjects had similar electrode placements.