

# Supplementary Material

## The Role of Associative Cortices and Hippocampus during Movement Perturbations

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#### **1** Supplementary Methods

#### Data Analysis and Filtering Details

For ERP analysis, a second-order IIR notch filter was applied to the raw SEEG data at 60 Hz and its harmonics: bandwidth of 3Hz at -1dB suppression. A high-pass 5<sup>th</sup> order Butterworth filter was also applied to detrend the data with a cutoff of 0.5 Hz, followed by decimating the data to 100 Hz. The 750 ms after each event was extracted, time-locked, and averaged across trials to examine the P300 effect.

On a macro level contacts on the clinical electrodes that were obviously faulty or showed large artifacts were disregarded entirely. Subsequently, all recorded epochs were included in this analysis. No data was rejected on a trial-by-trial basis.

For high frequency activity analysis, the same filtering was applied with the exception of the decimation. Multi-taper spectral estimation<sup>1</sup> was then performed with a time window of 300 ms, a time step of 5 ms, three tapers, and a time-bandwidth product of 2. The high frequency activity (HFA) metric captures high gamma activity and reflects previous work in SEEG<sup>2</sup> and other invasive recordings. It puts equal weight on all frequencies between 50 and 150 Hz and corrects for the 1/f falloff in power. It is calculated by first taking the natural log of the power in each frequency, then

performing a Gaussian normalization based on the power in each frequency over the entire recording session. In order to limit the effect of outliers, only data from the 5<sup>th</sup> to 95<sup>th</sup> percentile were used when calculating the mean and variance for the normalization procedure. HFA includes the average of all normalized log-power frequency bins between 50 and 150 Hz at each time point. Faulty recording contacts, or contacts with interictal activity, were identified by visual inspection and disregarded.

### Calibration Details

A series of five reaching movements towards a target to the right of the center position was completed while the subject was instructed to reach as quickly as possible. The shortest time to target in these trials was used to derive the subject-specific maximum movement speed. The fast and slow movement time instructions provided in the main task were based on 1/3 and 2/3 of the subject specific maximum speed to target, placing a limit on the time the subject can take to reach the desired target and still receive a reward cue. This was done to encourage a range of movement speeds across trials.

#### 2 Supplementary Results

## HFA Responsiveness during perturbed movement

HFA responses after the start of movement show similar albeit not identical results. Posterior Hippocampus (151 - 701 ms, p < .0002), Precuneus (251 - 701 ms, p = 6e-4), and IPS (301 - 701 ms, p = 0.0038) all show an HFA response. The OFC trend is there, but falls with a p-value of 0.011 falls just short of Bonferoni corrected significance. IC (101 - 701 ms, p < 0.0002) shows an HFA response that is not captured in the ERP. See supplementary materials for plots.

#### **3** Supplementary Figures and Tables

Below is a figure representing the high frequency activity after the start of movement.

## 3.1 Supplementary Figures



**Supplementary Figure 1.** HFA analysis of each brain regions aligned to all cues. Rectangular bars represent times of significant difference as identified as non-parametric cluster statistic. X-axis is time from cue. Y-axis is voltage in uV.

#### 3.2 Supplementary Tables

#### Supplementary Table 1: Columns 2-4 represent only completed trails

Patient	Trials with perturbation	Trials without perturbation	Aggregate Success Rate	Completion Rate
Subject 1	27	105	56%	98%
	26	98	53%	100%
Subject 2	30	113	66%	92%

Subject 3	26	128	30%	94%
Subject 4	24	115	50%	97%
Subject 5	31	122	53%	96%
Subject 6	29	123	70%	99%
Subject 7	25	102	29%	93%
Subject 8	30	94	59%	96%
	30	88	64%	98%
Subject 9	N/A	N/A	N/A	N/A
Subject 10	N/A	N/A	N/A	N/A
Subject 11	N/A	N/A	N/A	N/A
Subject 12	N/A	N/A	N/A	N/A

### 4 References

- 1. Mitra, P. & Bokil, H. Observed Brain Dynamics, Oxford University Press, New York (2007)
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