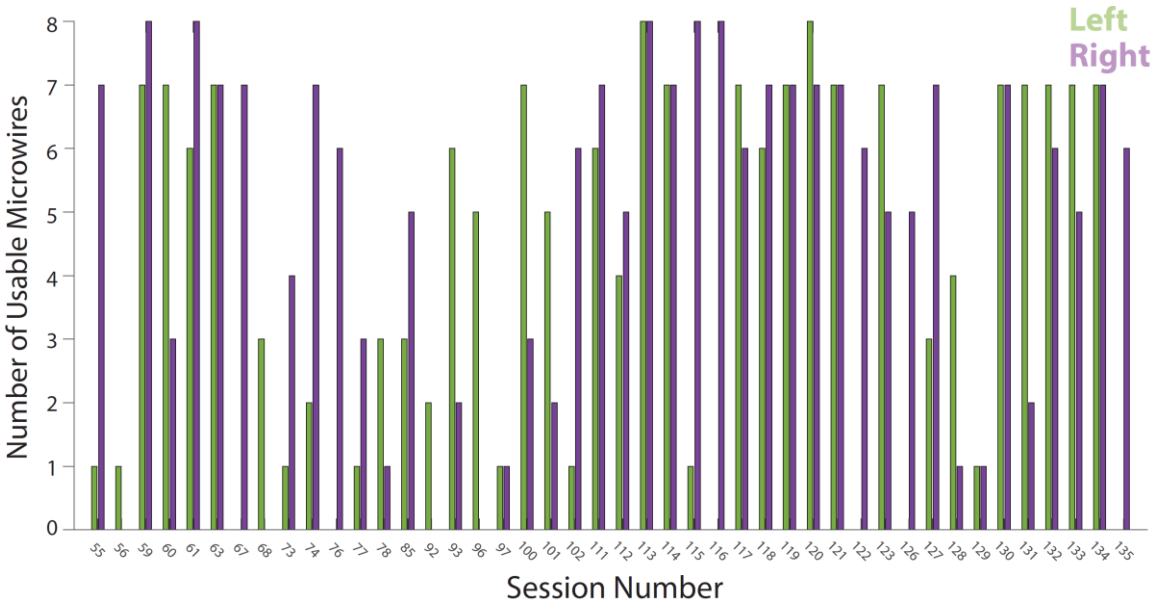
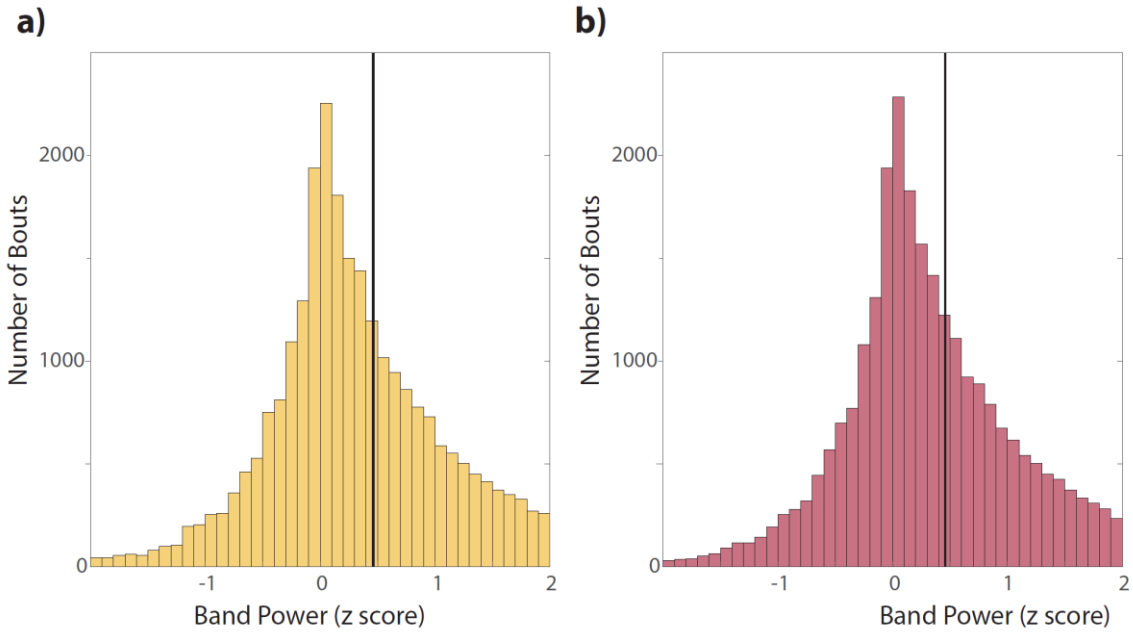
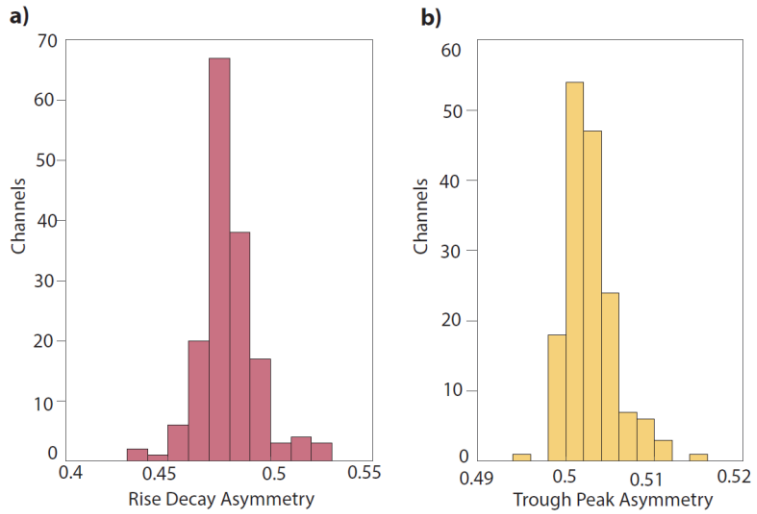
Supplementary Figures and Figure Legends



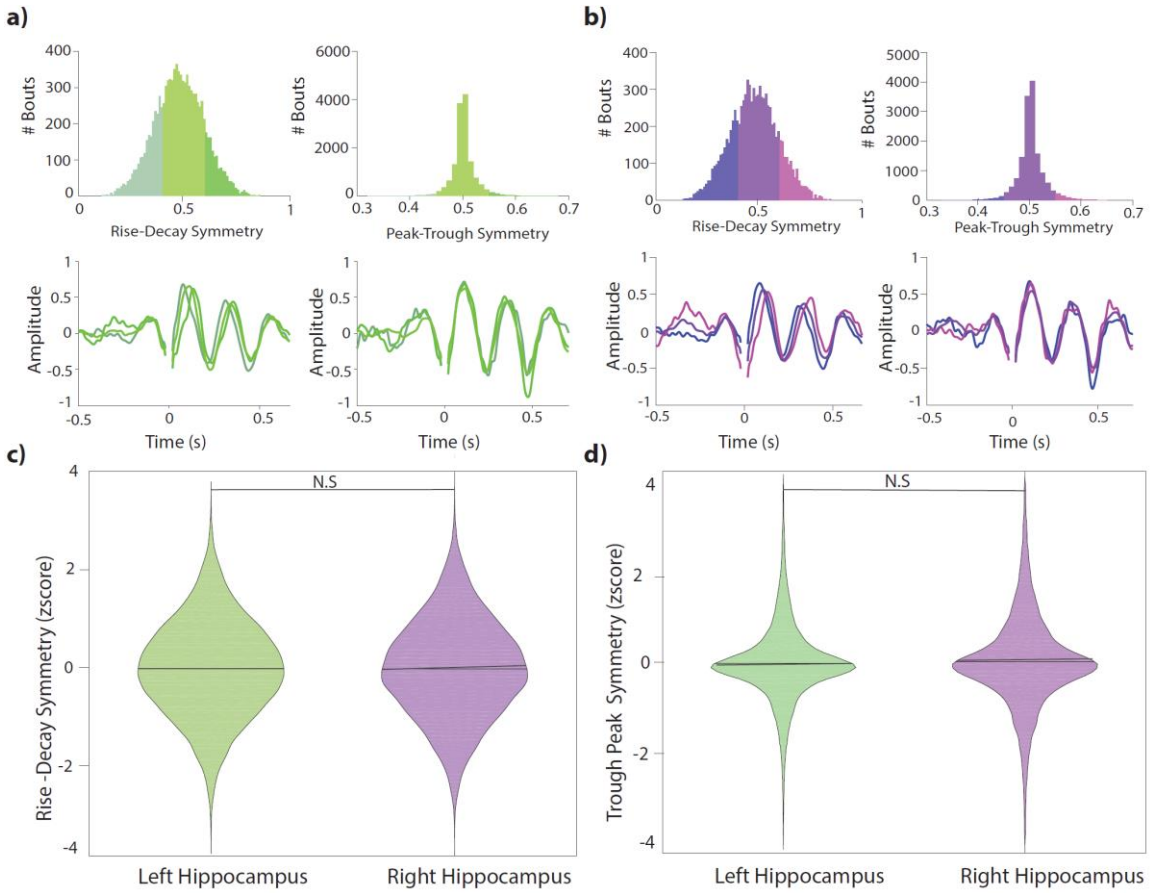
Supplementary Figure 1: **Subject statistics.** Number of usable microwires in each hippocampal hemisphere for every included session.



Supplementary Figure 2: Comparison of theta power during relative to after and before a detected theta bout. Power within detected bouts was significantly increased. (a) Average z-scored theta power during a bout relative to theta power in a window from -2 to -1 seconds before the detected bout (Absence of a difference would be z=0; Average observed value (line) is 0.45, ttest vs. 0 $p<1\ e^{-5}$). (b) Average z-scored theta power during the detected bouts relative to theta power in a window from 1 to 2 seconds following the detected bout (average value (line) is 0.442; ttest vs. 0 $p<1e^{-5}$).

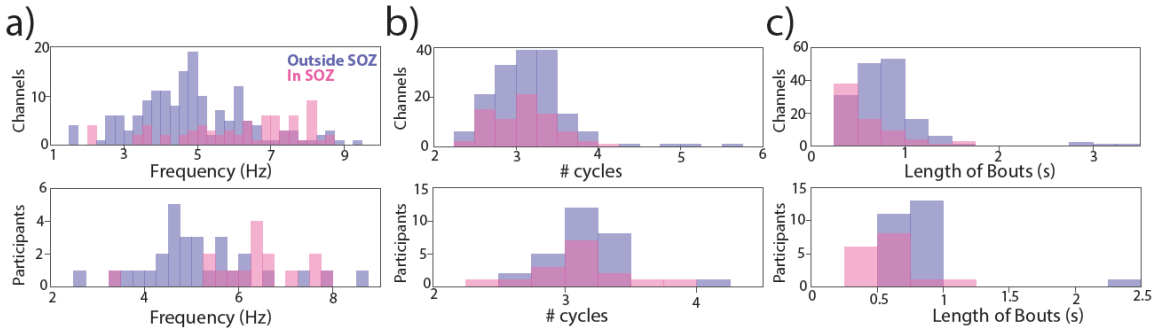


Supplementary Figure 3: Theta bout waveform asymmetry on a channel-by-channel basis. (a) Average rise-decay symmetry metric for every channel with detected theta bouts. Lower values indicate a theta bout that has a longer falling phase. Bouts were significantly skewed towards the falling phase (Average value marked by gray line; Average value=.479, 10/161 6.2% had values above 0.5 while 151/161 93.4 % had values below 0.5 sig; chi square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$). ttest compared to 0.5, $p<1e^{-5}$). (b) Peak-trough symmetry metric for all detected theta bouts. Lower values indicate a theta bout that spends a greater portion of a cycle in the trough of an oscillation. Bouts were significantly skewed towards the peak period (0.5 is marked by gray line. Average value=0.503, 19/161 11.8% had values below 0.5 while 142/161 88.1 % had values above 0.5 sig; chi square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$).



Supplementary Figure 4: Theta waveform asymmetry comparison between brain hemispheres. (a) Left Hippocampus. Top left depicts rise decay symmetry in the left Hippocampus. Lower values indicate a skew towards the downswing phase and higher values indicate a skew towards the upswing phase. 67.6% of oscillations had rise-decay symmetries that were at least five percent different from 0.5, with more oscillations skewed towards the downswing phase (8172/13997 58.4% had values below 0.5 while 5807/13997 41.5% had values above 0.5 (sig; chi square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$). Overall, the mean value was 0.475. Bottom left shows average theta bouts for the left hippocampus with frequencies 3-4Hz that fall within the 'Decay Skewed', 'Symmetrical', or 'Rise Skewed' categories. Top Right depicts the trough to peak symmetry in the left Hippocampus. Bouts with trough to peak asymmetry values lower than 0.5 were skewed towards the trough, while bouts with a value higher than 0.5 were skewed towards the peak. 3.865% of detected bouts had trough to peak symmetries that were at least five percent different from 0.5. 51.0% of bouts had peaks that were less than 0.5 and 46.8% has trough to peak symmetries that were greater than 0.5 . sig; chi square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$). Bottom right shows average theta bouts in the left Hippocampus with frequencies 3-4Hz that fall within the Trough Skewed', 'Symmetrical', or Peak Skewed' categories.
(b) Right hippocampus. Top left depicts rise decay symmetry in the right Hippocampus. 68.7% of oscillations had rise-decay symmetries that were at least five percent different from 0.5, with more oscillations skewed towards the downswing phase (8580/14711 58.3% had values below 0.5 while 6104/14711 41.5% had values above 0.5 (sig; chi

square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$). Overall, the mean value was 0.474. Bottom left shows average theta bouts for the right Hippocampus with frequencies 3-4Hz that fall within the 'Decay Skewed', 'Symmetrical', or 'Rise Skewed' categories. Top Right depicts the trough to peak symmetry in the right Hippocampus. 5.97% of detected bouts had trough to peak symmetries that were at least five percent different from 0.5. 52.0% of bouts had peaks that were less than 0.5 and 45.6% has trough to peak symmetries that were greater than 0.5 . sig; chi square test of proportions, $p<1e^{-5}$, ttest compared to 0.5, $p<1e^{-5}$). Bottom right shows average theta bouts in the Right Hippocampus with frequencies 3-4Hz that fall within the Trough Skewed', 'Symmetrical', or Peak Skewed' categories. (c-d) Comparisons between left and right hippocampus. (c) Violin plots showing the difference in rise decay symmetry in the right and left hippocampus. Values were z scored based on frequency in 1 Hz steps on a per session basis. There was no difference between hemispheres (2 way t test p=.466). (d) Violin plots showing the difference in trough peak symmetry in the right and left hippocampus. Values were z scored based on frequency in 1 Hz steps on a per session basis. There was no difference between hemispheres (2 way test p=.728).



Supplementary Figure 5: Comparison of theta properties between electrodes inside and outside the SOZ, assessed on an individual participant and wire basis. . (a) (top) Distribution of average frequency of theta bouts averaged across all usable microelectrodes inside and outside of the SOZ. Average frequency was significantly different (2-sided t-test comparing frequency inside vs outside the SOZ $p<1e^{-5}$). (bottom) Distribution of average frequency of theta bouts averaged across individual sessions inside and outside of the SOZ (bottom). Average frequency was significantly different (2-sided t-test comparing frequency inside vs outside the SOZ p<.01). (b) (top) Distribution of number of cycles within each theta bout averaged across all usable microelectrodes inside and outside of the SOZ . The number of cycles was not significantly different (2-sided t-test cycle comparing number of cycles z scored on the basis of frequency inside vs outside the SOZ p=.47). (bottom) Distribution of number of cycles within each theta bout averaged across all sessions inside and outside of the SOZ (bottom). The number of cycles was not significantly different (2-sided t-test cycle number z scored on the basis of frequency p=.83). (c) (top) Distribution of the average cycle length of detected theta bouts averaged across usable microelectrodes inside and outside of the SOZ. Cycle Length was not significantly different. (2-sided t-test cycle length z scored on the basis of frequency inside vs outside the SOZ p=.71). (bottom) Distribution of the average cycle length of detected theta bouts averaged across included sessions inside and outside of the SOZ. Average cycle length was not significantly different (2-sided t-test cycle number z scored on the basis of frequency p=.06)