Session 247 - Reaching: Neurophysiology

Add To Itinerary

247.23 / TT5 - Electrical microstimulation in primate premotor cortex hijacks local neural activity

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Presenter at Poster
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Session Type
Poster

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Disclosures
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Abstract
Intracortical electrical microstimulation (ICMS) is a powerful tool for probing neural circuit function and organization. Evidence from behavioral studies and intrinsic, functional MR, and calcium imaging suggest that the activity evoked by high frequency ICMS is spatially and temporally complex. However, the responses of local neural populations to ICMS are typically challenging to record directly due to the large electrical artifact. Consequently, it is unclear how ICMS engages local neural populations and how these activation patterns interact with the dynamics of normal task-related activity. Here, we developed an artifact removal method to directly record the local effects of high frequency ICMS delivered to dorsal premotor cortex (PMd) in a rhesus macaque engaged in a reaching task. We find that neural activity near the stimulation site no longer reflects pre-existing task-related activity.
We stimulated in PMd (60 ms, 333 Hz biphasic pulses) and verified that twitches of the arm and shoulder were evoked above threshold. Within 1 mm of the stimulating electrode, we acutely recorded neural activity using a linear multielectrode array (Plexon V-probe). During the task, we stimulated on a subset of interleaved trials (3 distinct timepoints, 5 reach directions). For currents below 40 uA, the recorded artifacts did not saturate the amplifier. We developed a method to remove the artifact by exploiting the common structure of the artifact over electrodes, pulses, and trials, enabling us to detect spiking activity during and after the stimulation. 59 / 77 neurons' firing rates were altered by stimulation ($p < 0.05$).
For each of 61 neurons exhibiting significant modulation during the reaching task ($p < 0.05$, ANOVA), we summarized the contribution of the underlying task-related neural activity to during-stimulation activity using an index ranging from 0 (no task contribution) to 1 (purely additive interaction). The median index across the population was 0.25 (0.15-0.47, 95% CI), indicating that ICMS-evoked activity mostly replaced, rather than superimposed with, task activity. Immediately after stimulation, many neurons were suppressed for > 150 ms; the index recovered to pre-stimulation level only 180 ms following stimulation. These results provide direct neural evidence for the hypothesis that ICMS can "hijack" local neural circuitry (Griffin et al., 2011), and contrasts with earlier reports that optogenetic stimulation interacts additively with task-activity (O'Shea et. al, SFN 2013) in PMd. The results highlight that combining stimulation with recording and artifact rejection methods can provide precise, causal insight into neural computation.