Human Spike Recordings Acquired in the Context of an Open-source, Intraoperative Paradigm

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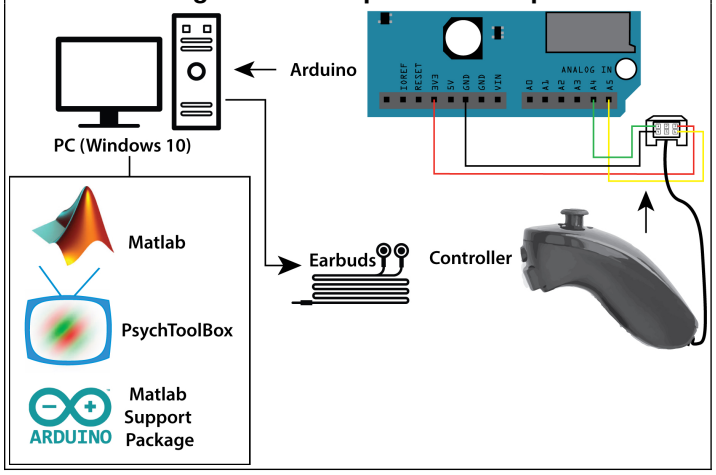
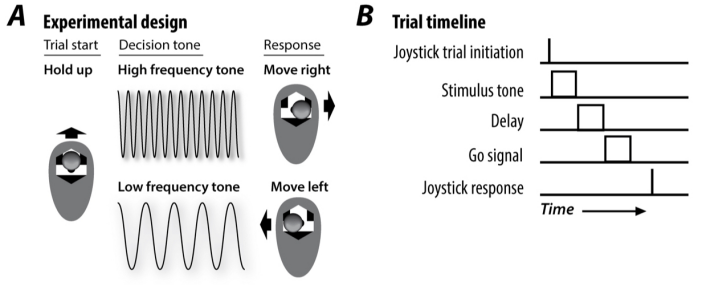
Introduction: Neurosurgical interventions that use active patient feedback create an opportunity to conduct human behavioral experiments during the acquisition of invasive neurophysiology. Here, we present a modular, inexpensive system for intraoperative stimulus presentation and collection of motor responses. We characterize behavioral responses and analyze the temporal pattern of substantia nigra pars reticulata (SNr) spiking relative to specific task events.

Figure 1: Intraoperative Setup



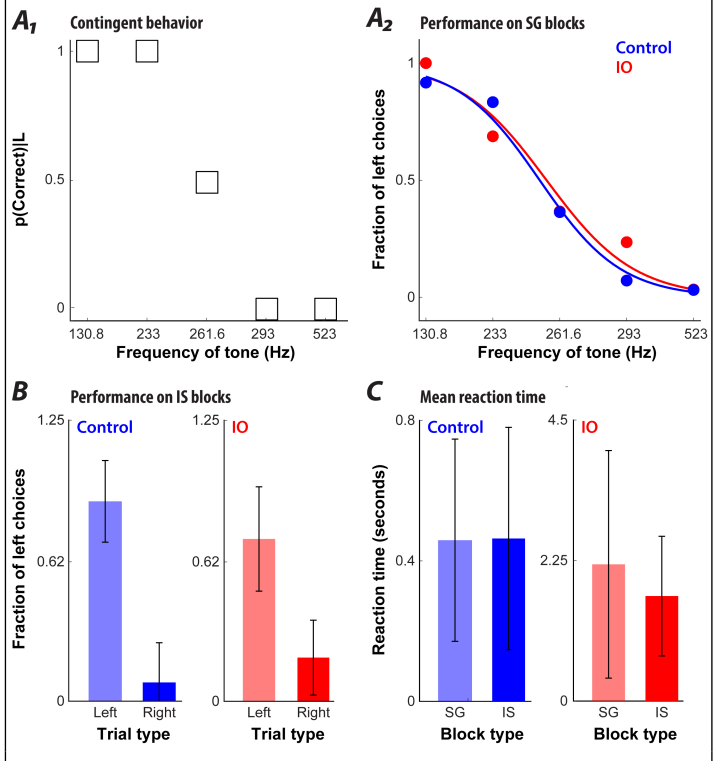
Methods: We have created a perceptual decision making task using the PsychToolBox suite developed in Matlab. Task responses are collected using an Arduino based single-hand held controller that has been customized with a 3D printed attachment. Neural activity is recorded from microelectrodes via an NeuroOmega system (Alpha Omega, Alpharetta GA). Task and neural data are aligned according to TTL signals sent from DATAPixx (VPixx Technologies, Montreal, Quebec), triggered by Matlab.

Figure 2: Intraoperative Task Design



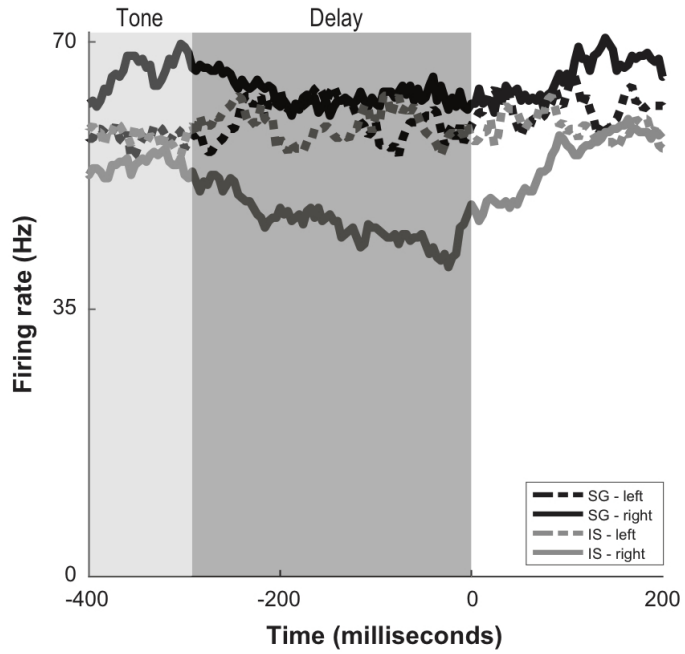
Results: Analysis of behavioral results indicate that our task is appropriately calibrated for use in the operating room (Figure 3) and neural analysis demonstrates that single-unit activity can be aligned to events within our task (Figure 4). We have made key components of our task, including custom-generated program files like 3D printed schematics, freely available on GitHub (https://github.com/neuropil/IO_2AFC). For a more complete description of our task please see Tekriwal et al. 2018 Journal of Neuroscience Methods.

Figure 3: Results - Behavioral



A1) Ideal responses for stimulus guided trials A2) Psychometric performance plots corresponding to A1 (control (n=3); intraoperative (n=3)) B) Average fraction of left choices during internally specified blocks C) Average reaction time for stimulus guided (SG) blocks compared to internally specified (IS) blocks.

Figure 4: Peri-stimulus time histogram of representative SNr neuron



Neuronal activity aligned to the go cue at t=0. Activity is modulated dependent on trial condition (stimulus guided (SG – black lines) or internally specified (IS – grey lines)) and movement (left (dotted lines) or right (solid lines)).

Conclusions: For very low cost and minimal effort, clinical neural recording system can be adapted for concurrent intraoperative behavioral testing using our framework. Barriers to conducting intraoperative electrophysiological studies in awake behaving human subjects remain high, but our work should significantly decrease the effort needed to implement a system with rich recording capabilities.

Learning Objectives: 1) Understand the unique opportunity provided by conducting intraoperative electrophysiological studies to elucidate cognitive processes. 2) Discuss how our single neuron findings fit with past work in animal models.

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