with dense-array scalp EEG (dEEG), we identify specific oscillatory bands within specific brain network nodes directly modulated by precise SCCwm-DBS [3]. We then develop a phase-oscillator network model for three likely DBS mechanisms in order to hypothesis-test the patient data. Two results are presented here: a network-level oscillatory signal indicating adequate stimulation of critical SCCwm tracts, and a data-driven model of SCCwm-DBS mechanism. This investigation is a critical first step in understanding how DBS of SCCwm engages and modulates brain network activity, and how that engagement induces TRD remission. The results presented here will directly improve clinical implementation of SCCwm-DBS to optimize anatomical and functional engagement of brain networks associated with depression, enable further scientific studies into the link between brain network electrophysiology and complex higher-level behavioral dynamics, and inform engineering of closed-loop DBS devices able to automatically and rationally program stimulation settings to optimally modulate network-level brain states.

III-78. MAP inference in linear models with sparse connectivity using sister mitral cells.

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Sensory processing is hard because the variables of interest are encoded in spike trains in a relatively complex way. A major goal in sensory processing is to understand how the brain extracts those variables. Here we revisit a common encoding model (Olshausen and Field, 1996) in which variables are encoded linearly. Although there are typically more variables than neurons, this problem is still solvable because only a small number of variables appear at any one time (sparse prior). However, previous solutions usually require all-to-all connectivity, inconsistent with the sparse connectivity seen in the brain. Here we propose a principled algorithm that trades speed for connection sparsity to provably reach the MAP inference solution. Our algorithm is inspired by the mouse olfactory bulb, but our approach is general enough to apply to other modalities; in addition, it should be possible to extend it to nonlinear encoding models.

III-79. Decoding arm force from neural population dynamics in PMd and M1 during reaching

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A number of experiments have characterized the tuning properties of individual neurons in PMd and M1 of rhesus monkeys when loads are applied to the arm [e.g., Sergio 2005], but the relationship between population-level neural dynamics and forces generated during reaching is less well understood. Here, we report how neural dynamics in PMd and gyral M1 change when controlling the arm while it supports different external weights. We demonstrate that the arm's output force along the anti-gravity (vertical) axis can be decoded from the neural population before and during movement. Importantly, neural correlates of force are small and heterogeneous across individual electrodes, but form an orderly readout at the level of the motor cortical population that can be easily decoded. We used a support vector machine to identify a vertical force axis (VFA) in the high-dimensional neural population state space using pre-movement threshold crossings from two 96-channel arrays in PMd and

M1 for reaches with either 200g or 0g attached to the arm. The cross-validated classification performance on single trials was 77% for monkey J (monkey R: 59%). To test whether this axis meaningfully encodes force information throughout the trial, we made several predictions regarding projections of neural state onto the VFA. First, when moving to upward targets, neural activity should move towards the high-force end of the force axis when accelerating, then to the low-force end when decelerating. The opposite should be true for reaches to downward targets, which require little vertical force early but higher vertical forces to decelerate. Lastly, we predict that intermediate targets should display graded VFA projections between the upward and downward targets during acceleration and deceleration. The data support each of these predictions, suggesting that the VFA serves as a meaningful and reliable readout of vertical arm force while reaching.

III-80. Selective involvement of mouse prefrontal activity during an auditory discrimination task

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Goal-orientated decision making is crucial for animal survival, and the prefrontal cortex is known to play a central role in the decision making process. Many of our understandings of prefrontal cortex are from human, monkey, and rat; yet, relatively little is known about the prefrontal areas in mouse, a popular animal model with many genetic tools. Here we recorded and characterize the spike activity and local field potential (LFP) from mouse prefrontal area while mice were performing a 3-choice auditory discrimination task. Our results showed that the spike activity exhibited a transient, task stage-dependent modulation. Moreover, the neurons could carry the information regarding either the presence or absence of a specific sound. Interestingly, while LFP oscillations were modulated across various frequency bands at different task stages, the spike-field coherence showed cell-type specific modulation at beta frequency ($\sim 15-30Hz$). Overall, we demonstrated that mouse prefrontal area is involved in auditory discrimination, and auditory evoked prefrontal responses are selectively modulated by behavior. While different oscillations are dynamically regulated during auditory discrimination, interneuron network is likely selectively involved in beta oscillations and associated behavioral outcomes.

III-81. Neural coding of leg proprioception in Drosophila

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Proprioception, the sense of self-movement and body position, is critical for the effective control of motor behavior. In the absence of proprioceptive feedback, animals are unable to maintain limb posture or coordinate fine-scale movements of the arms and legs. However, despite the importance of proprioception to the control of movement in all animals, little is known about the neural computations that underlie limb proprioception in any animal. We have developed new methods to record from proprioceptive neural circuits in the fruit fly, Drosophila. Each fly leg contains approx. 135 proprioceptive stretch receptor neurons positioned at the joint between the femur and the tibia. We used in vivo 2-photon calcium imaging to record from the axons of this proprioceptor population while manipulating leg position and movement with a magnetic control system. With unsupervised clustering methods, we have identified anatomically distinct subpopulations of proprioceptor neurons that encode specific kinematic variables such as leg position, velocity, acceleration, and direction. Imaging from more specific genetic driver lines, we found that single sensory neurons are sharply tuned for combinations of these variables. We then identified two populations of second-order neurons that process sensory information from leg proprioceptors. Targeted whole-cell recordings revealed that these two populations are specialized for encoding leg position and directional