Session 485 - Visual Cognition: Decision Making

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485.07 - Real-time decoding of a decision variable during a perceptual discrimination task

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Nanosymposium

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Disclosures
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Abstract
In dynamic environments, subjects often integrate multiple samples of a signal and combine them to reach a categorical judgment. This evidence integration process can be described by a time-varying decision variable (DV) reflecting the current judgment of the subject. We previously showed (Peixoto et al. SFN '14) that during a motion discrimination task, population firing rates in dorsal premotor cortex (PMd) and motor cortex (M1) carry choice-predictive signals that (i) are consistent with a DV representation and (ii) allow for high prediction accuracy during the evidence integration epoch. However, calculating single trial DVs and assessing the meaning of their fluctuations has remained extremely challenging. In this study we tackled these exact challenges, by (i) estimating the current DV in real-time and (ii) testing its relationship with decision commitment. To do so, we assembled a real-time setup that uses a logistic classifier to estimate an instantaneous DV every 10 ms using the last 50 ms of spiking data on 96-192 channels from 1 or 2 Utah arrays in PMd/M1. We obtained excellent online choice prediction accuracy: 93%/95%during the second half (600-1200 ms) of stimulus presentation for Monkey F/H. Leveraging our accurate real-time readout we performed 2 closed loop experiments in which the termination of the stimulus was contingent on the value and/or history of the DV. First, we established threshold values for DV that, if reached, stopped the stimulus and cued the monkey to report its decision. Strikingly, the choice probability observed for DVs that triggered termination closely followed the predictions from the logistic function (average difference 1.8%/1.5% for Monkey F/H) suggesting that, fluctuations in DV have a lawful relationship to choice behavior. Second, we triggered the stimulus termination on robust changes in DV sign, interpreted as potential "Changes of Mind" (CoMs), that met specific parameters within our control. The statistical regularities for our putative CoMs were the same as (i) those reported behaviorally in humans (Resulaj et al.2009) and (ii) estimated post-hoc from neural activity during the delay period of an identical task (Kiani et al 2014). We went beyond these previous studies by capturing covert CoMs online during evidence integration and directly validating the final choice of the subject.

In summary, our study shows that real time fluctuations in DV reflect meaningful fluctuations in the cognitive state, both in terms of choice probability and CoMs. These results open the possibility of using real-time closed loop experiments to shed light on other covert cognitive processes.