

Session 485 - Visual Cognition: Decision Making

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485.08 - Do decision-related firing rates of dorsal premotor cortex neurons “ramp” or “step” on single trials?

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Abstract

Dorsal premotor cortex (PMd) is a brain region thought to be important for somatomotor decisions. We recently showed that trial-averaged firing rates (FRs) of a subpopulation of PMd units that increased their FR after visual stimulus onset (“Increased units”) had an organized relationship to stimulus difficulty, choice, and RT (Chandrasekaran et al., SFN ’13, ’14, ’15). These are consistent with the properties of a candidate decision-variable (DV) predicted by a drift-diffusion model (DDM). Here, as a first step, we examined if a recently developed Bayesian model comparison technique (Latimer et al., 2015) could shed light on whether this DV arises from averaging gradual DDM-like “ramps” or instantaneous jumps (a “step”) in FR that occur at different times on different trials.

Our database consisted of 131 Increased units recorded from PMd of two monkeys (T & O) performing a visual reaction time (RT) discrimination task with arm movements as the behavioral report (Decision times: up to 220 ms for O; up to 500 ms for monkey T). We used the method from Latimer et al. (2015) to fit the FRs for the preferred (“PREF”) and null (“NULL”) directions and then computed the penalized model comparison metric, Deviance Information Criterion score (DIC). Our analysis initially focused on the PREF direction because of the robust FR modulations observed. DIC scores for the majority of the PMd units argued against the step model as a descriptor of the single-trial FR dynamics in the PREF direction (75/131 had DIC < 0, 57%). Moreover, computing DIC only for long RT trials (>500 ms) suggested that PREF direction single-trial FR dynamics in an even greater proportion of PMd units were inconsistent with stepping (85/131 had DIC < 0, 65%, Shadlen et al., 2016). When we pooled over both PREF and NULL directions to compute the DIC score, we found the opposite result. Many units classified as rampers based on the PREF direction DIC score were classified as steppers based on the pooled DIC score. Now, when using the pooled DIC score, a majority (67%, 87/131 units had DIC > 0) of the population was better described by the step model.

Thus, using this method from Latimer et al. (2015) to conclude whether PMd FRs step or ramp on single trials appears to depend on properties of the trials used (i.e., tuning and RT). This sensitivity identified here might apply more broadly.

More generally, the sensitivity of this model comparison method to these factors and temporal complexity in decision-related FRs in PMd (Chandrasekaran et al., SFN '13) which perhaps make both "steps" and "ramps" poor models suggests that population-level techniques might be needed to understand how decision variables arise in PMd during decision-making.