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POSTER AND SHORT ORAL PRESENTATION

Preparatory tuning in premotor cortex relates most closely to the population movement-epoch response

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A common practice in systems neuroscience is to examine neural activity that precedes movement, in the hopes of better understanding the mechanisms that determined that movement. This approach has led to an understanding of the basic mechanisms that trigger saccades, and the more cognitive mechanisms underlying decisions regarding where to saccade. It is generally agreed that preparatory activity encodes the upcoming saccade vector, and that a saccade is triggered when the strength of preparatory activity crosses a threshold. Models of the reach system often assume a similar pattern: rising preparatory activity leading to a similarly tuned burst of movement-related activity. Alternately, we have proposed that preparatory activity does not rise in strength, but rather needs to be brought to a particular state before movement onset. While different, both frameworks suppose that preparatory activity and movement activity are causally linked and thus closely related. Despite this presumed link, most studies of neural tuning account for preparatory and movement-related responses using different, albeit related, parameters (e.g., target location versus reach velocity). Thus, the following open questions remain. First, what is preparatory activity tuned for? Second, how do activity patterns during the two epochs - preparatory and movement - relate to one another? We analyzed four datasets from three monkeys performing delayed-reach tasks. 550 single neurons were recorded from motor and premotor cortex, using single-electrode and array recording techniques. We found that a neuron's tuning during the preparatory epoch typically showed little straightforward relationship to its tuning during the movement epoch (mean tuning correlation = 0.21, 0.19, 0.06, and 0.10 across the datasets). Despite this, the preparatory activity of individual neurons could be predicted rather well by the population-level pattern of movement activity. To assess this, we assumed that each neuron's preparatory activity was determined by a preferred direction in the space of movement-epoch firing-rate patterns. That space was constructed by applying principal component analysis to a matrix where each row contained the movement-epoch responses of all neurons. Preferred directions in this abstract space accounted for preparatory tuning better than did preferred directions in any of the more traditional spaces we tested, including spaces based on target location, hand velocity, and EMG activity. Furthermore, preferred directions were more stable (when assessed across different subsets of conditions) in this abstract space than in any of the other candidate spaces. We conclude that the reach system is very different from the saccadic system. In particular, the motor burst is not a simple burst, but a pattern of activity that bears no superficial relationship to the preceding pattern of preparatory

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activity. Nevertheless, activity during the two epochs is lawfully related once one takes the entire population into account. This supports the idea that there is a close causal relationship between preparatory and movement activity, despite the lack of congruent tuning at the single-neuron level. It further suggests that preparatory activity exists not to represent external parameters, but to provide an initial state that determines the subsequent pattern of movement activity. Support: BWF, HHW, Stanford/NSF graduate fellowships, NIH-CRCNS-R01

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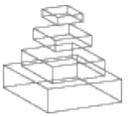
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