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Presentation Abstract

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Title:	The tuning of plan activity in premotor / motor cortex is best captured by intrinsic parameters derived from the movement-period population response
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Abstract: Using the delayed-reach paradigm, many studies have examined ‘plan’ activity in premotor and motor cortex. A common goal is to explain the tuning of plan activity in terms of experimentally-measurable parameters (e.g., cosine tuning for direction). Such parameters can be ‘extrinsic’ (hand, eye, or target location) or ‘intrinsic’ (muscle activity or joint motions). Here we consider whether plan activity might be tuned for a more deeply intrinsic set of parameters: those describing the subsequent movement-related neural activity. In contrast to extrinsic task features, which are naturally parameterized (e.g., cosine direction tuning can be captured by a linear dependence on two parameters: x and y position), movement-related neural activity is less easily parameterized. Such activity is temporally complex, multi-phasic, and heterogeneous across neurons. Nevertheless, principal components analysis can capture those patterns with a small number of parameters. When this is done at the population level, the extracted parameters capture how the population movement-related response varies across conditions. This is critical, as the plan activity of an individual neuron is typically a poor predictor of its own subsequent movement-related activity. We analyzed data from 3 monkeys (352 neurons from PMd / M1) performing variants of a delayed-reach task. For each monkey, half the neurons were used to parameterize movement-related population activity. For the other half, plan activity was regressed against those parameters (a linear tuning model). Tuning for the intrinsically-derived parameters was consistently more robust than tuning for more traditional parameters, such as reach velocity, distance, etc. This was assessed in three ways. First, fit quality (R2) was better for the intrinsic parameters. Second, generalization performance was better for the intrinsic parameters. Third, the preferred direction was more stable when expressed in the space defined by the intrinsic parameters. These results suggest that the tuning of plan activity should be thought of not simply in terms of traditionally-measured parameters, but also in terms of the intricate population-level patterns of movement activity. This is perhaps not surprising. If plan activity is causally most proximal to movement-related neural activity, it may bear its simplest relationship to that activity, rather than to more causally-distant parameters such as the distance the hand will travel. Indeed, for a certain class of dynamical systems, the initial state will be 'tuned' for the subsequent dynamic trajectory, in a manner analogous to the tuning of plan activity for movement-related activity.

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