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Presentation Abstract

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Presentation Title: Neural dynamics of movement execution following incomplete or incorrect planning

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Abstract: Reaction time (RT) is faster when subjects have time to prepare an action before moving. This has led to the idea that during preparation, motor cortical activity achieves a state ("optimal subspace") which is beneficial for generating the planned movement. We asked what happens if neural activity is outside the optimal subspace when we require movement initiation. While it is expected that RT will suffer, it is unclear what will occur neurally. It is unknown whether neural trajectories must pass through the optimal subspace prior to movement generation. If not, it may be because neural trajectories can take a more direct path (constrained by the dynamics of the system) to generate movement, without redirecting through the optimal subspace. This is akin to arm movements, which do not respond to perturbations by returning to a pre-computed path, but instead follow a new optimal path to reach the same goal.
We trained monkey N to perform a reaching task where blocks of trials with a variable delay between target presentation and go cue were alternated with blocks of trials with no delay. Neural activity was recorded from two 96-electrode arrays (M1, PMd). We computed low-D neural trajectories by performing PCA on PSTHs generated for each neuron and condition. We asked whether neural trajectories in non-delay trials would pass through the optimal subspace identified using long-delay trials. We observed that the neural trajectories in the non-delay trials did not appear to pass through the heart of the optimal subspace. Instead the non-delay trajectories tended to overshoot the long-delay trajectories, taking a path

which did not re-converge with the long-delay trajectories until after movement onset.
To then ask whether neural activity optimized for reaching to an incorrect target must pass through the correct target's optimal subspace, we trained monkey N to perform an instructed delay task in which the cued target switched locations in 20% of trials. We compared trials in which the target switched locations at the time of the go cue to trials in which the target remained constant. As expected, we found that incorrectly planned movements suffered an RT penalty (switch trials ~334 ms, non-switch trials ~304 ms). As observed for the incompletely planned (non-delay) trials, here we observed that incorrectly planned (switch) trials did not pass through the heart of the optimal subspace and gradually re-converged with the correctly planned (non-switch) trials over the course of movement generation. These experiments indicate that while being inside the optimal subspace at the time of the go cue reduces RT, passing through the optimal subspace is not obligatory for movement generation.

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