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PHOTODISC

Getting ready to reach

The act of reaching for an object involves a complex series of coordinated muscle activations, but it begins with preparatory activity in a neural network that includes the premotor and motor cortices; before movement is initiated, this network generates a movement plan. A new study in monkeys shows that the dorsal premotor cortex encodes such preparatory information in a way that reflects both the complexity of the reaching task and the strategy used to perform the task.

It has been difficult to define how the firing rate of neurons in the dorsal premotor cortex relates to movement parameters because factors such as target direction and movement direction are usually correlated with each other. To tease apart these parameters, Pearce and Moran used a virtual-reality delayed reaching task in which monkeys had to move their hands around obstacles to reach the target, so that the initial movement direction was different from the target direction. During the task, the monkeys first saw a target appear, then had to wait for an obstacle to appear, and then had to wait for a further delay before being cued to initiate movement. During the delay periods, the authors recorded neuronal activity in the dorsal premotor cortex.

The authors subsequently used population vector analysis to investigate how these neurons encoded the position and velocity of the hand during reaching movements. During the delay period between obstacle presentation and reaching, the velocity-based population vector predicted the initial direction of movement needed to avoid the obstacle rather than the direction of the target. Interestingly, the two monkeys used in this study seemed to use different strategies to plan their movements, which were reflected in the development of preparatory neuronal activity over time. Monkey G showed no movement prediction until the obstacle appeared, after which the vector developed in the direction of the initial movement. Monkey H, by contrast, seemed to plan a direct movement to the target during the first delay (before the obstacle appeared) but then changed to plan a movement to avoid the obstacle after it became visible. This difference in strategy was reflected in the results of 'catch' trials in which the 'go' signal was given when the monkey was expecting the obstacle to appear. At this point, monkey H, who had a plan in place for a direct movement to the target, performed the task more accurately than monkey G, who had not formulated a movement plan.

Further analysis showed that population activity in the dorsal premotor cortex during the final delay contained information about the target direction as well as the initial movement direction. Single neurons also showed tuning to both target direction and movement direction. These results show that challenging reaching tasks can reveal the existence of complex spatial information in the neural activity of the dorsal premotor cortex during action planning.

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ORIGINAL RESEARCH PAPER Pearce, T. M. & Moran, D. W. Strategy-dependent encoding of planned arm movements in the dorsal premotor cortex. *Science* 19 Jul 2012 (doi:10.1126/science.1220642)