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  Extending our reach: Exploring the neural mechanisms of arm movement control

  We move effortlessly and accurately. Underneath the apparent simplicity of our natural movements are intricate neural computations that unfold in an instant. For example, the brain must convert from its visual representation of a desirable object to a pattern of muscular contractions that can bring the hand to that object. I will describe research in behaving monkeys that helps reveal how this reference frame transformation is performed by the brain. I will show that reach plans are encoded in a visual reference frame in parietal cortex. The neural strategy of specifying reach plans in visual coordinates may underlie the accuracy and flexibility of our movements. However, such a signal - a reach goal in visual coordinates - is not sufficient to provide a useful command to the muscles. The parietal cortex sends an anatomical projection to the premotor cortex, where the further elaborations needed to specify a motor command might occur. Using multielectrode arrays, we have explored the contribution of premotor cortex to the reach reference frame transformation. Premotor cortex appears to mix visual and motor reference frames. This result surprised us, since studies from other laboratories had suggested that the transformation to limb coordinates is complete at the level of premotor cortex. Two important questions emerge from these studies. First, where (if anywhere) in the brain are limb-centered reach plans finally specified? Second, how do neurons that employ different reference frames interact to perform the reference frame transformation between them? Finally, a hypothesis on the parallels between the neural mechanisms for reaching and the neural basis for higher-level, cognitive behaviors will be presented.

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