A Neural Interface for Dexterity

The emphasis on neural populations as the substrate for information processing is the most important recent advance in systems neuroscience. The change in emphasis from the single neuron to the neural ensemble has made it possible to extract high-fidelity information about movements that will occur in the near future. This ability is due to the distributed nature of information processing in the brain. Neurons encode many parameters simultaneously, but the fidelity of encoding at the level of individual neurons is weak. Because encoding is redundant— parameter representation in individual neurons is weak but consistent across the population-- extraction methods based on multiple neurons are capable of generating a faithful representation of intended movement. The realization that useful information is embedded in the population has spawned the current success of brain-controlled interfaces. Since multiple movement parameters are encoded simultaneously in the same population of neurons, we have been gradually increasing the degrees of freedom (DOF) that a subject can control through the interface. Our early work showed that 3-dimensions could be controlled in a virtual reality task. We then demonstrated control of an anthropomorphic physical device with 4 DOF in a self-feeding task. Currently, monkeys in our laboratory are using this interface to control a 7-DOF arm, wrist and hand to grasp objects in different locations and orientations. Our recent data show that we can extract 11-DOF to add hand shape and dexterity to our control set.

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