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Free - paced target estimation in a delayed - reach task

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Translating neural activity into prosthetic control signals is an area of active research. In addition to estimating where a prosthesis should move, it is important to determine when the patient intends to move and when *not* to move. Real-time decoders to date have not explicitly tried to determine solely from neural data when neural activity reflects desired movement as opposed to desired hold. We report the design, offline simulation, and online validation of algorithms capable of detecting when pre-motor cortical (PMd) activity represents an upcoming arm movement using neural activity alone.

We have used a finite state machine (FSM) to perform this detection. This FSM uses only neural signals as input and implements a set of transition rules between states ("baseline", "plan", and "move") to determine when the monkey is planning to a target. This FSM could be used for both continuous and discrete movements, as both paradigms require the detection of when measured neural signals represent movement. The average delay between when the target was presented and when this was detected by the FSM offline was ~350ms+/-150ms (mean+/-SD).

When a target is presented, there is a ~150ms delay before PMd activity reflects planning to that target. In order to decode an 8-target delayed reach task with an accuracy of 93%, we have found previously that ~200ms of neural activity is necessary (96 electrodes). Thus, since the FSM's latency is <350ms, prosthetic performance can be maintained.

Once the FSM determines the beginning of a plan period, a separate decoder determines which target is being planned towards. In offline simulations, the target was decoded correctly 90% of the time by this FSM-decoder combination for the same 8-target data set as above.

We also implemented this system successfully in online proof-of-concept experiments. Such free-paced studies are a step toward systems that allow patients to determine when and when *not* to move a prosthesis.

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