Congress of Neurological Surgeons (CNS) Annual Meeting (2004)
San Francisco, CA

# The speed at which reach movement plans can be decoded from the cortex and its implications for high performance neural prosthetic arm systems

**Stephen I. Ryu, Gopal Santhanam, Byron Yu, Krishna V. Shenoy**

## INTRODUCTION

It will be possible to decode cortical motor signals to enable a robotic arm to accurately and quickly assist spinal cord injured patients. Understanding how quickly the brain plans reaches is important to quantify the performance limits of such a system.

## METHODS

We trained a rhesus monkey to touch a center point on a video screen and to hold for 200-1000 ms while one of several targets arranged around a circle on a touch screen was shown. These included layouts with 2, 4, or 8 directions at a 10 cm radial distance and layouts with 4 or 8 directions at 6 and 12 cm radial distances. After a cue, he then performed reaches out to the specified target. Given a target location, the distribution of spike rates for each trial was modeled as a multivariate Gaussian. Models were computed on neural data from a microsurgically implanted a 96-channel electrode array into the premotor cortex. We then computationally predicted the upcoming reach from 100-275 ms of neural activity starting 150 ms after the target was shown. Given a successful prediction, the subject was rewarded without executing a real reach.

## RESULTS

Using just 200 ms of neural activity the correct target location could be predicted using a maximum likelihood estimator on 80% of trials for the 1 of 8 target layout. When wrong, the predicted target was typically adjacent to the actual target. Prediction computation required ~20 ms. Up to 10 targets in a row were predicted from neural planning activity alone with no real reaches performed. Over 3.5 reach plans could be decoded in under one second for the 1 of 2 target layout.

## CONCLUSIONS

Our prosthetic system is capable of fast and accurate positioning of prosthetic icons, faster than real reach capabilities.