# Cortical control of a prosthetic arm for self-feeding

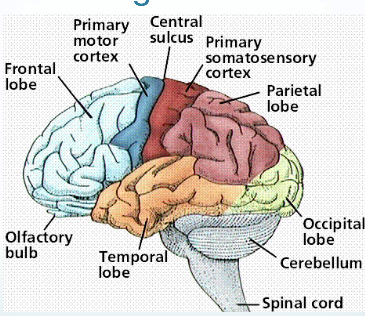
Rachel Lee and Yan Ma

## Contribution

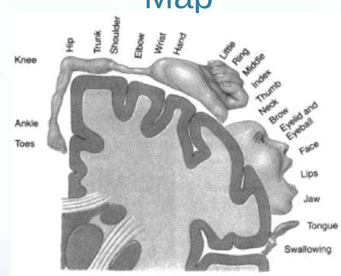
- Authors: Meel Velliste, Sagi Perel, M. Chance Spalding, Andrew S. Whitford, & Andrew B. Schwartz
  - Conducted at the University of Pittsburgh and Carnegie Mellon University
  - Other articles published in the field of prosthetics
    - i.e. Brain–machine interfaces show how cursors on computer displays can be moved in two- and three dimensional space
- Journal Source: Nature

Andrew Schwartz Univ. Pittsburg MOTORLAB

## Background Info

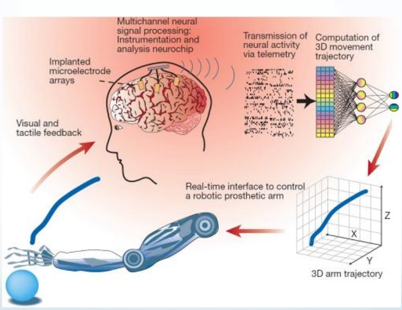



## Primary Motor Cortex: Motor Map




Primary motor cortex controls body parts movements.

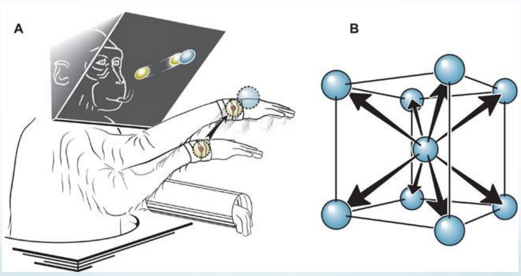
## Brain-Computer Interfaces



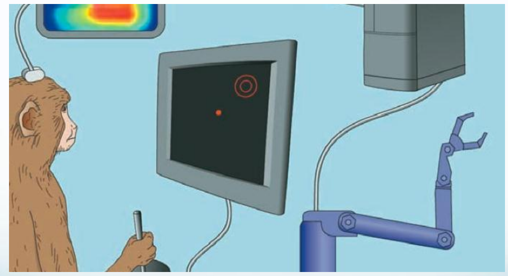

## Relatedness and Significance to Other Research Topics

- Previous studies
- Has been tested on humans, and those that came back from war have implanted new prosthetic limbs
- Discussion Question: What does the joystick and the cursor control experiment do?

## Cursor Experiment




## Joystick Experiment



## 4-D

- What is the added component to the experiment that makes it 4-D?

## Purpose

- To demonstrate use of cortical signals to control a multi-jointed prosthetic device for direct real-time interaction with the physical environment

## Methods

- Observation-based training
- Open-loop cortical control vs. Closed-loop cortical controls contribute to algorithm
- Use of 4-dimensional anthropomorphic arm in everyday tasks (self-feeding)

- Intracortical microelectrodes were implanted in the proximal arm region of the primary motor cortex. Spike signals were acquired using a 96-channel Plexon MAP system (Plexon Inc., Dallas, TX, USA).

## Video

- http://www.nature.com/nature/journal/v453/n7198/suppinfo/nature06996.html
- (V1)

## Discussion

- How is the prosthetic arm controlled by the monkey's cortical signals in the primary motor cortex? Does the monkey's actual arm respond to the signal as well?

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- What are the differences between Monkey A and P?
- How did the tests for Monkey A and P differ? Why was Monkey P's success rate higher?

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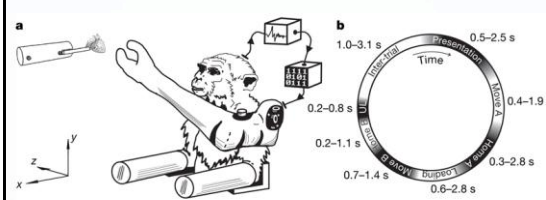


Figure 1

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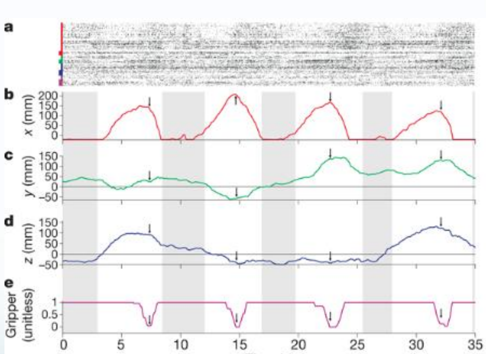


Figure 2

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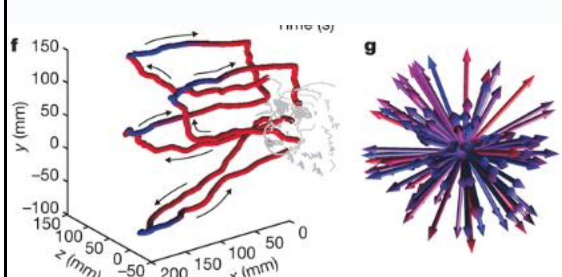


Figure 2 (continued)

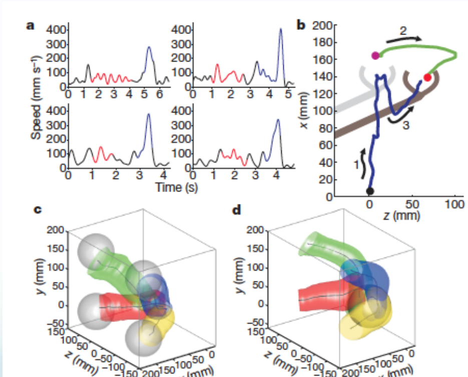


Figure 3

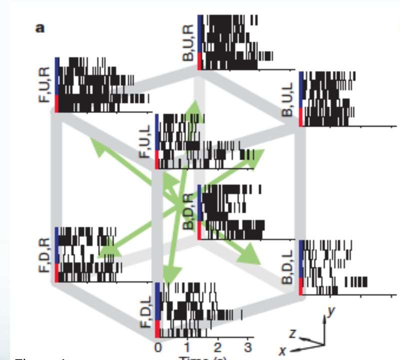


Figure 4

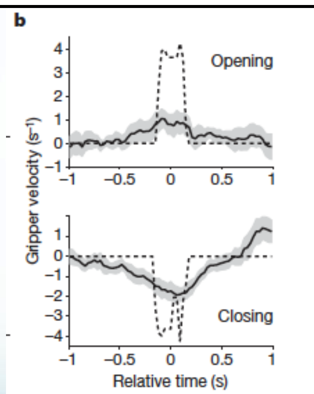


Figure 4 (Continued)

# Reiteration of Research

- Connection between brain computer interfaces and neuroprosthetic implants
- Science is evolving! Progression from 1-D to 4-D (addition of gripper component)
- Weakness: 2 subjects tested
- Strength: Calibration before Tests (control of variables)

# Further Questions

- Some things to think about:
  - Electrode failure to conduct movement in prosthetic limbs over time
  - Full motor control of prosthetics in future?
  - How do electrode implantation in humans work?

# Bibliography


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- http://www.plexon.com/product/Plextrode___Floating_Microelectrode_Array.html
- http://www.edoctoronline.com/media/19/photos_1ED5955B-D892-4FC4-A189-68E209191EC6.gif
- http://www.thebigview.com/mind/brain-motor-cortex.gif
- http://www.sciencemag.org/content/296/5574/1829/suppl/DC1
- http://biomedicalcomputationreview.org/sites/default/files/u6/the-dawn-3.png
- http://en.wikipedia.org/wiki/Brain%E2%80%93computer_interface
- http://www.sciencemag.org/content/296/5574/1829/suppl/DC1

- Special thanks to Dr. Carl

# Additional Videos

- http://www.nature.com/nature/journal/v453/n7198/suppinfo/nature06996.html