

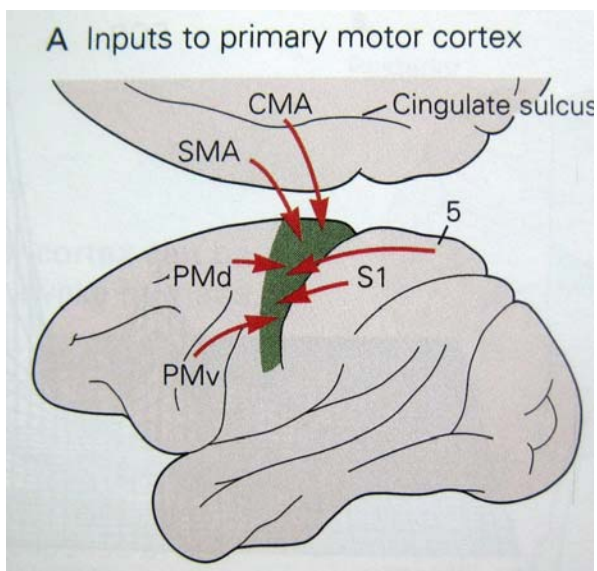
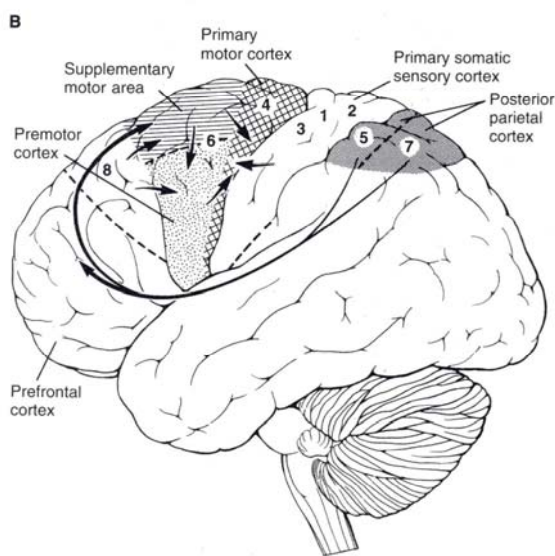
Higher motor areas

Emo Todorov

Applied Mathematics
Computer Science and Engineering

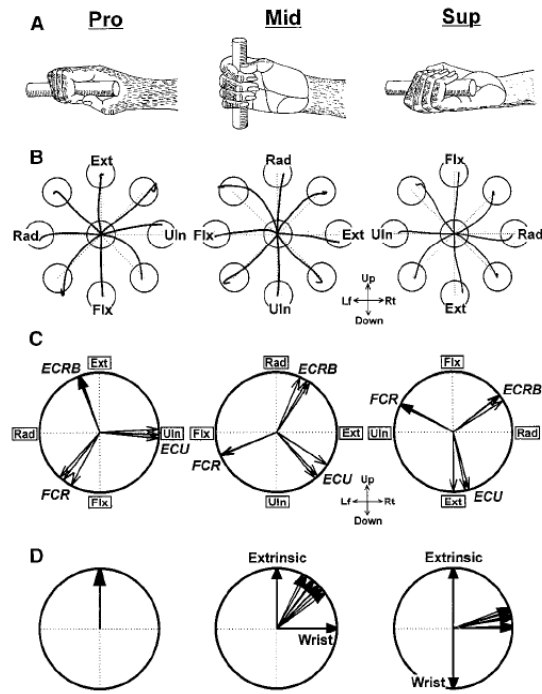
University of Washington

Higher-level areas involved in movement control



Wrist movement

(Strick)

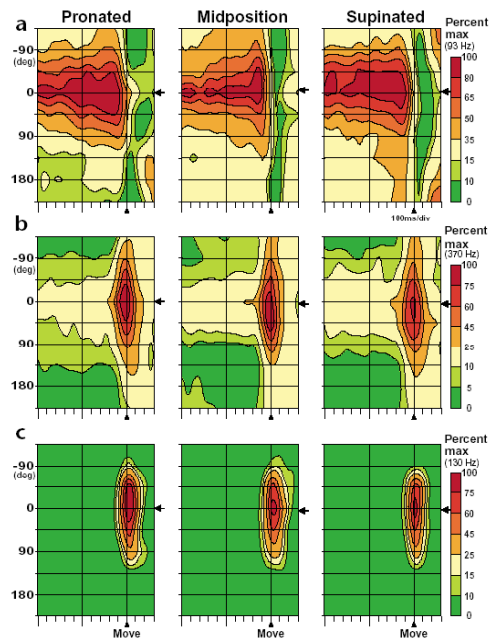
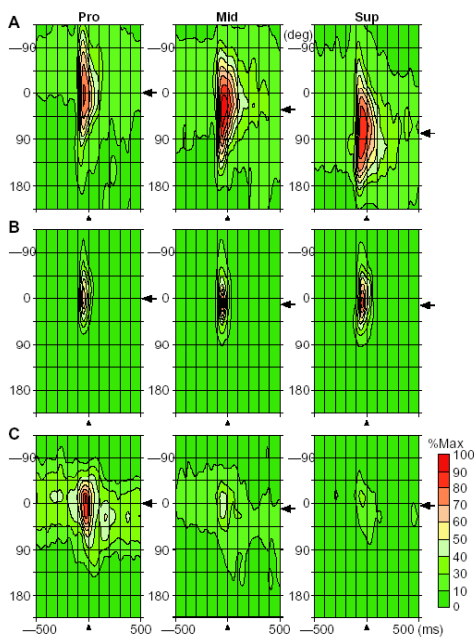


Wrist movement

(Strick)

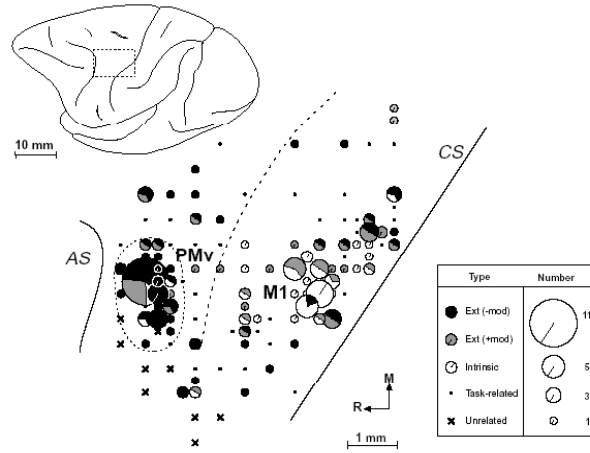
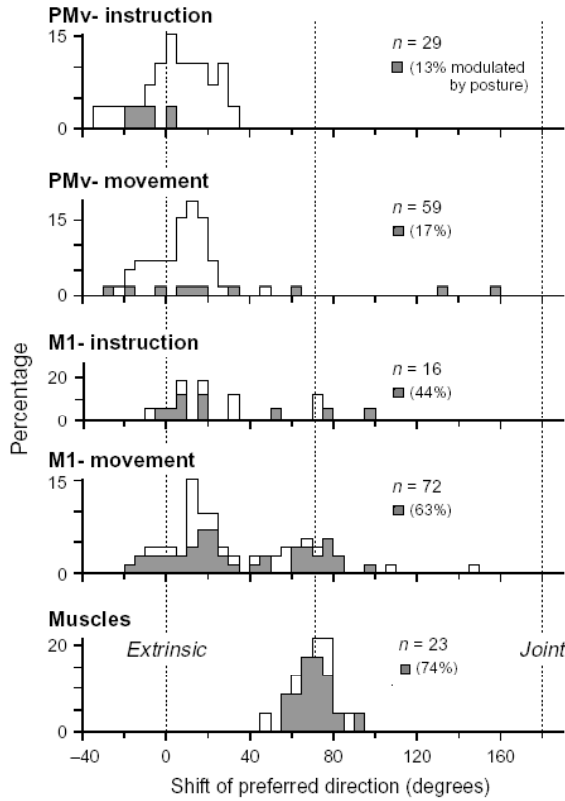
M1

PMv



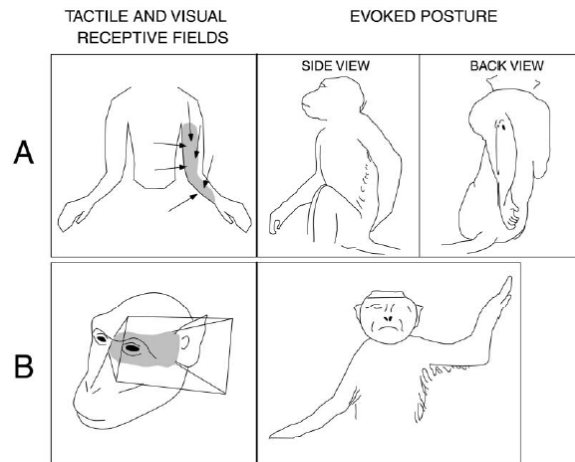
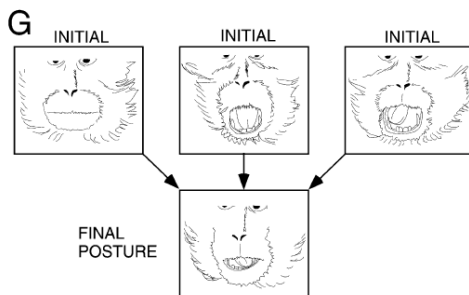
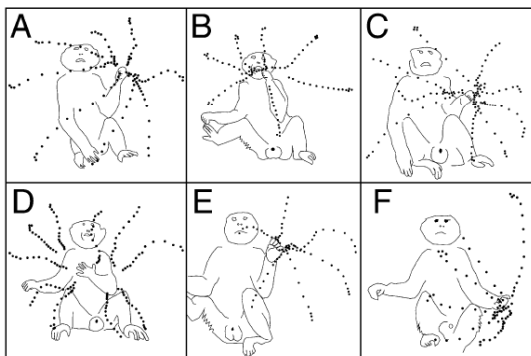
Wrist movements

(Strick)



Effects of prolonged microstimulation in M1 and PMv

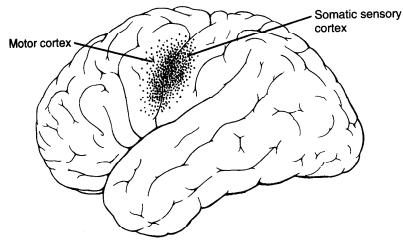
(Graziano)



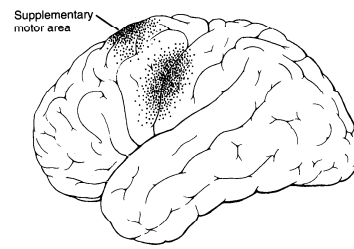
Supplementary motor area: Sequences

(Roland)

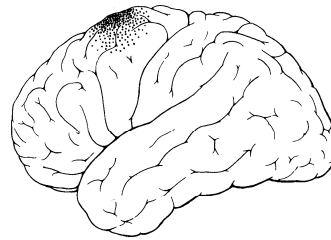
Simple movement



Movement sequence



Imagined sequence

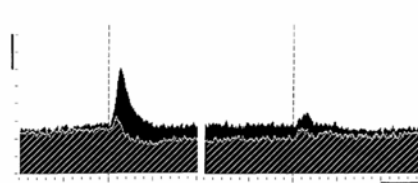
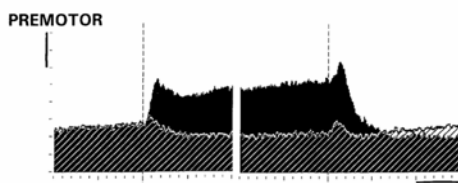
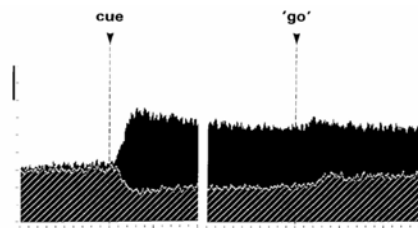
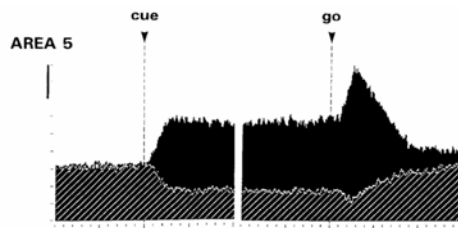


Differences between PMd and parietal area 5

(Kalaska)

Go Trial

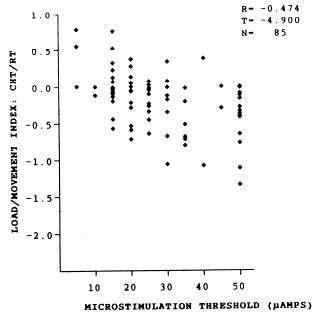
No-Go Trial



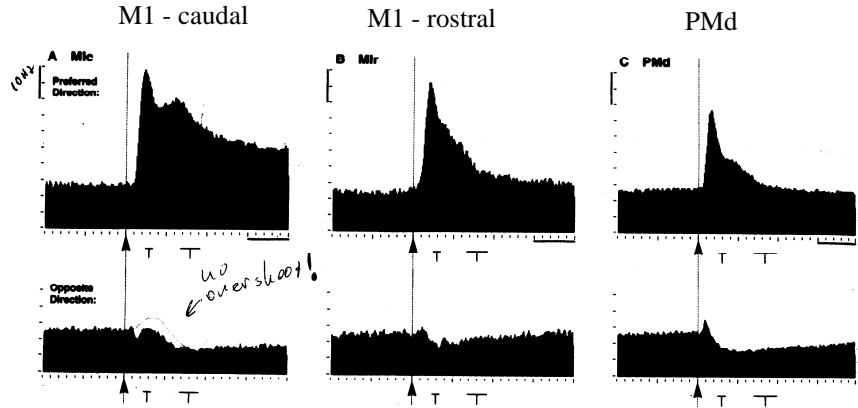
Response differences in reaching tasks

(Kalaska)

A



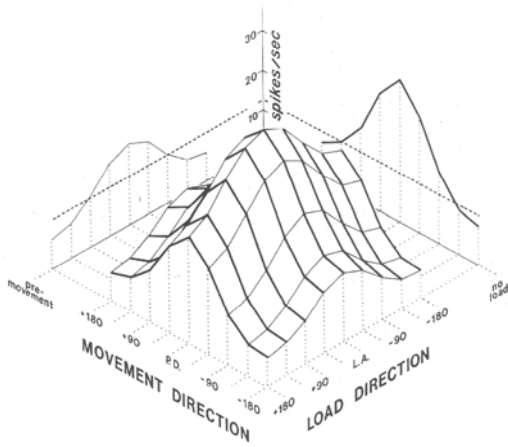
Cells with lower stimulation thresholds are more sensitive to loads



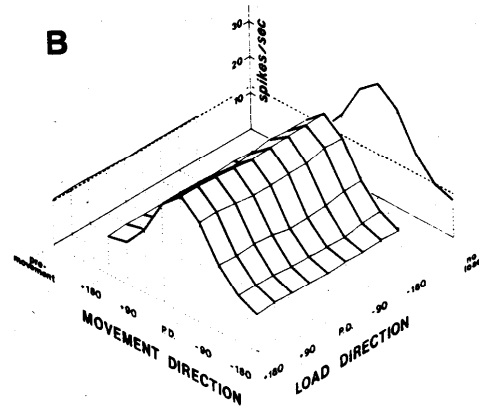
Load sensitivity in M1 vs. parietal area 5

(Kalaska)

M1

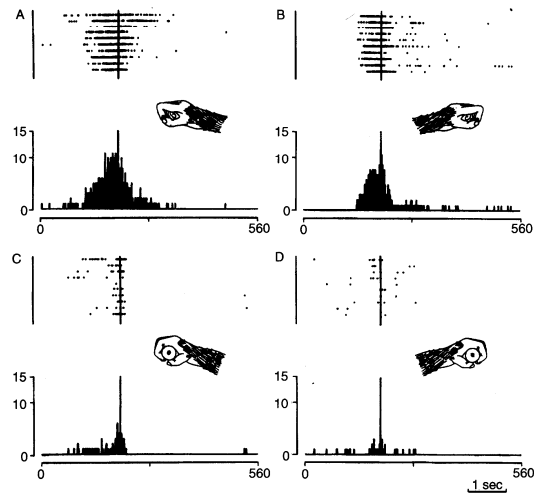


Area 5



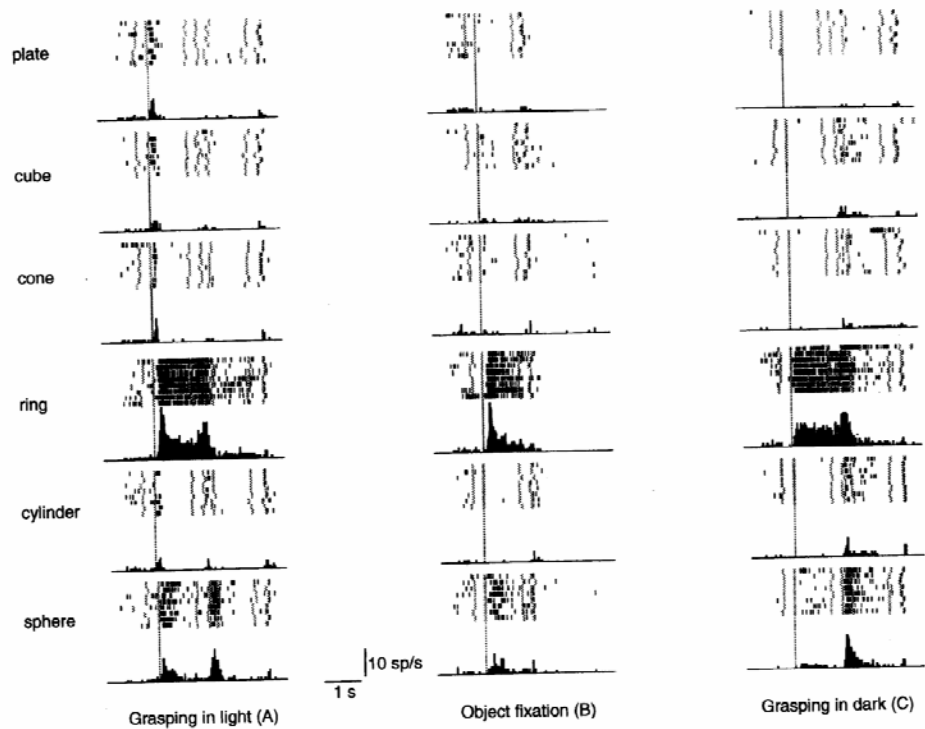
High level action representations in premotor cortex

(Rizzolatti)



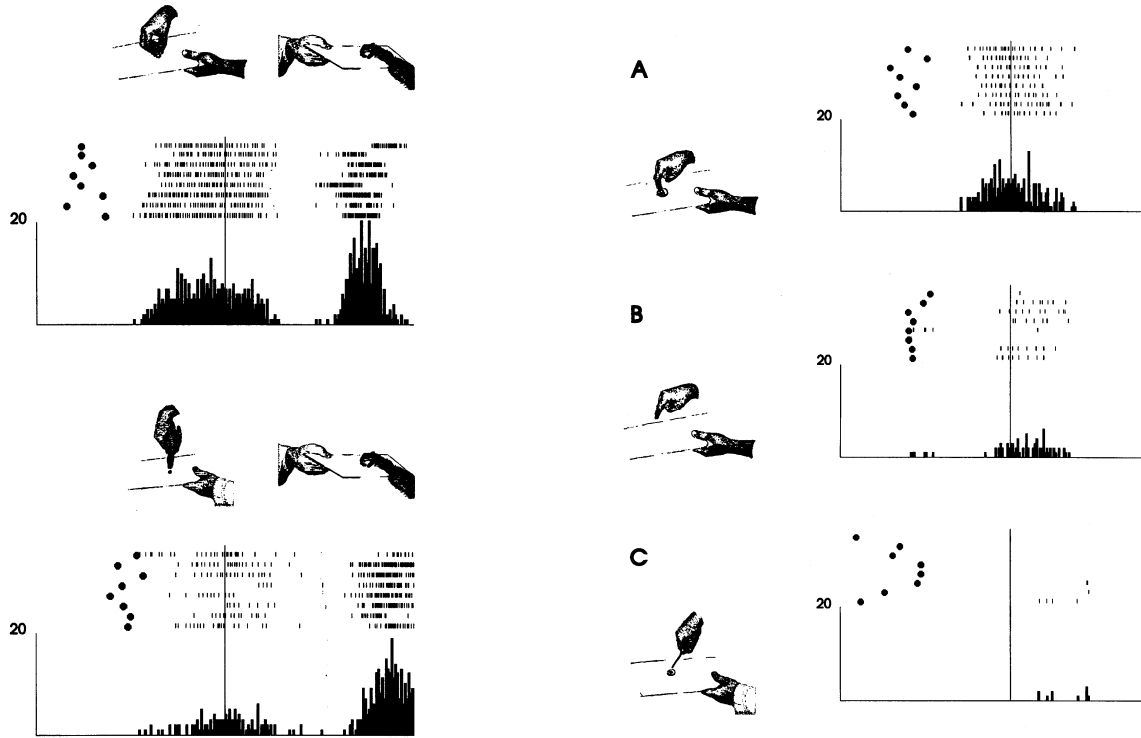
High level action representations in premotor cortex

(Rizzolatti)



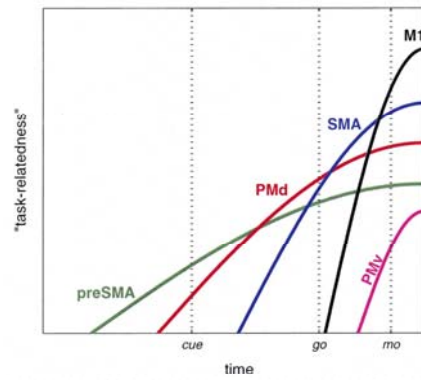
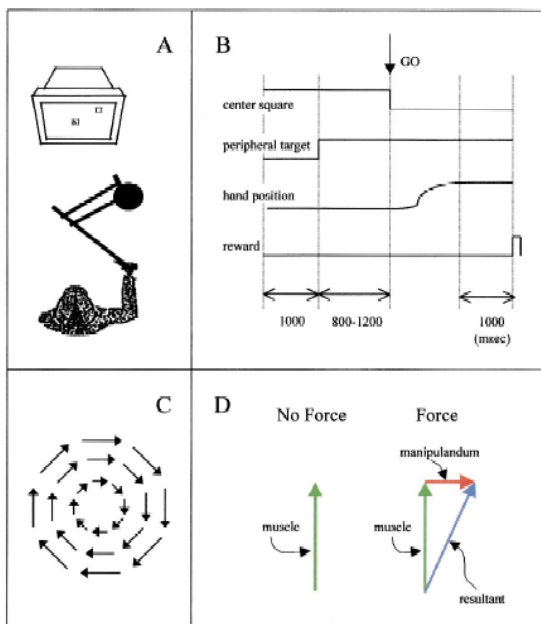
Mirror neurons in PMd

(Rizzolatti)



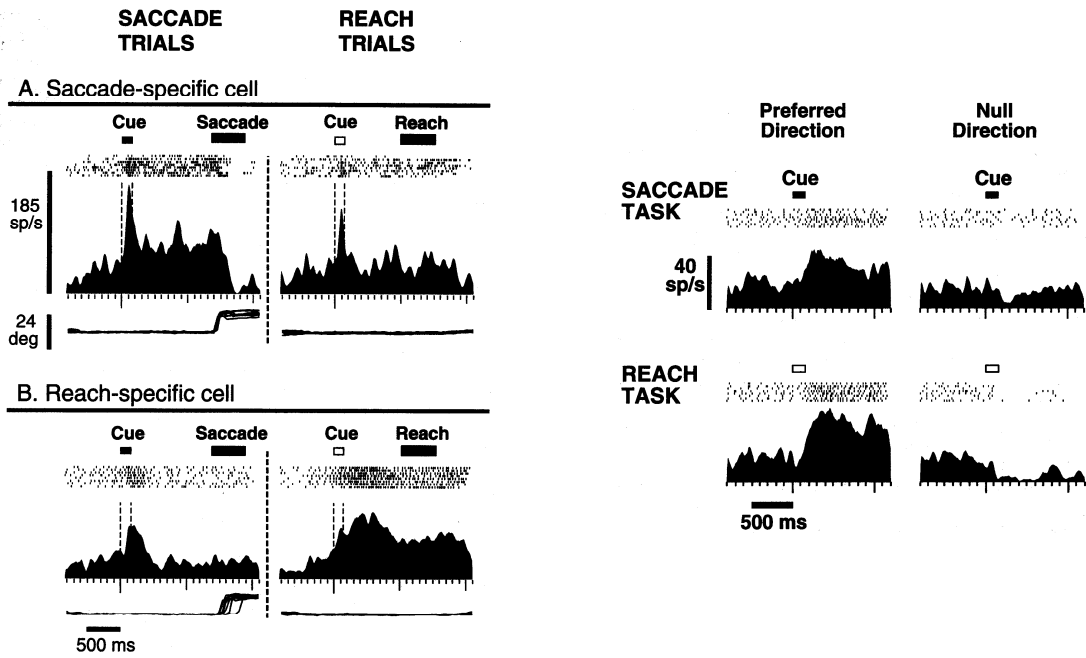
Force field adaptation in monkeys

(Bizzi)



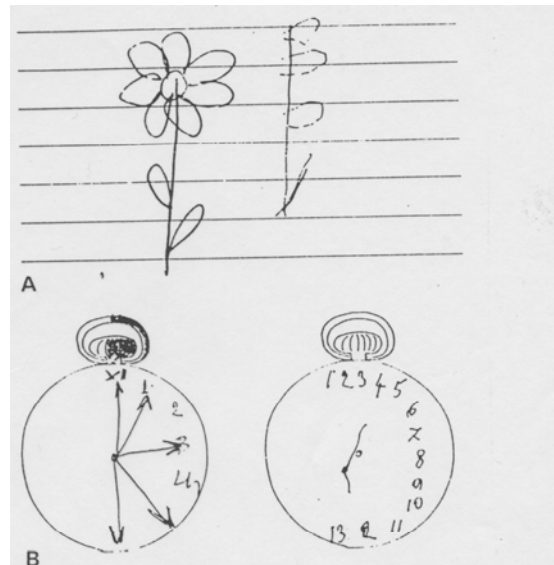
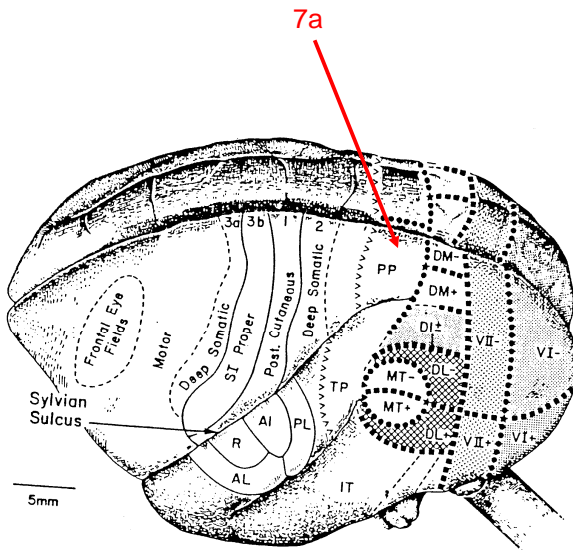
Parietal cortex: PRR and LIP

(Andersen)

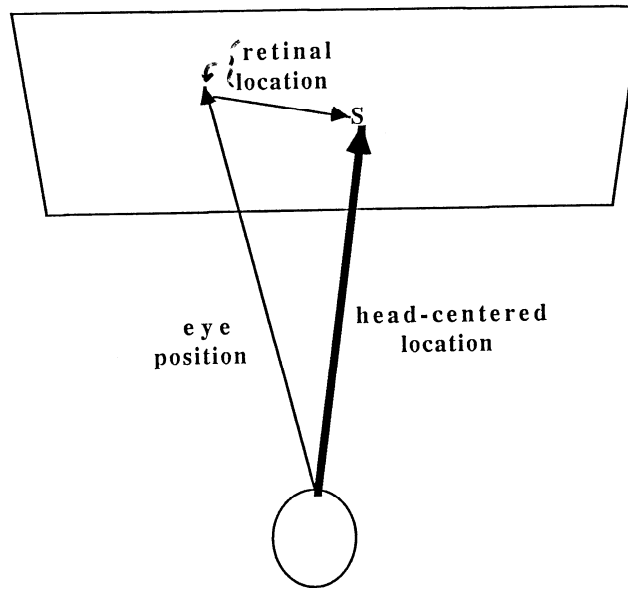


Parietal cortex and the representation of space

Damage to parietal cortex causes spatial neglect

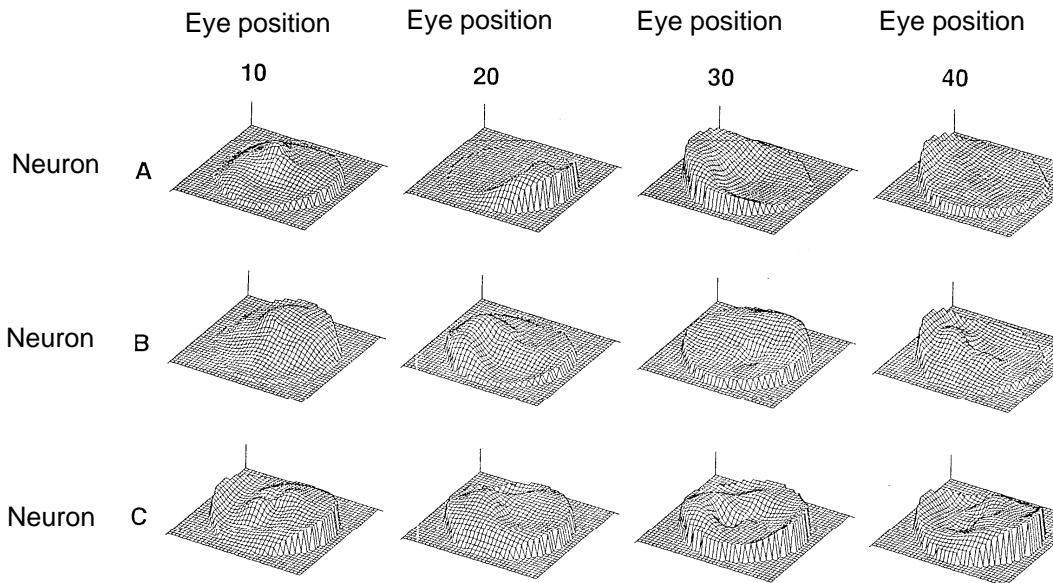


Frames of reference



What frame of reference is used in parietal cortex?

Neuronal responses



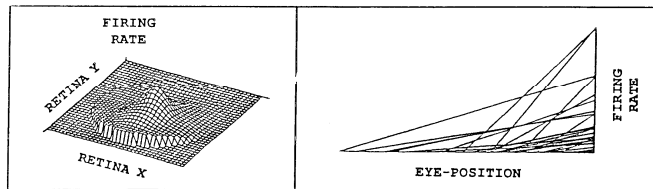
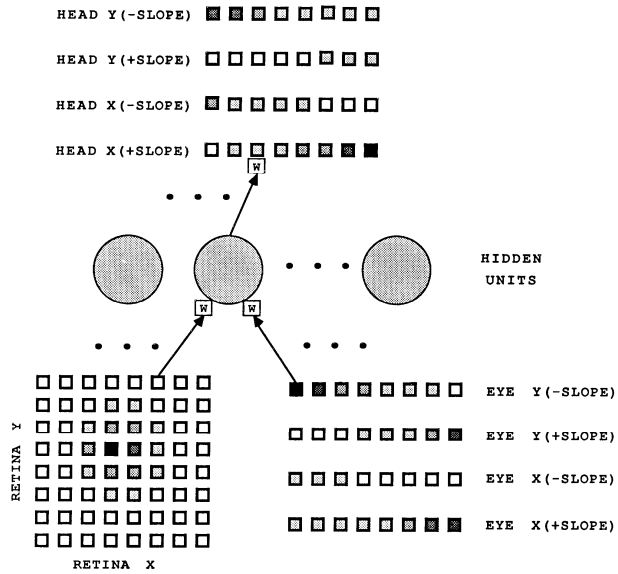
A mixed frame of reference seems to be used... why should that be?

Neural network model

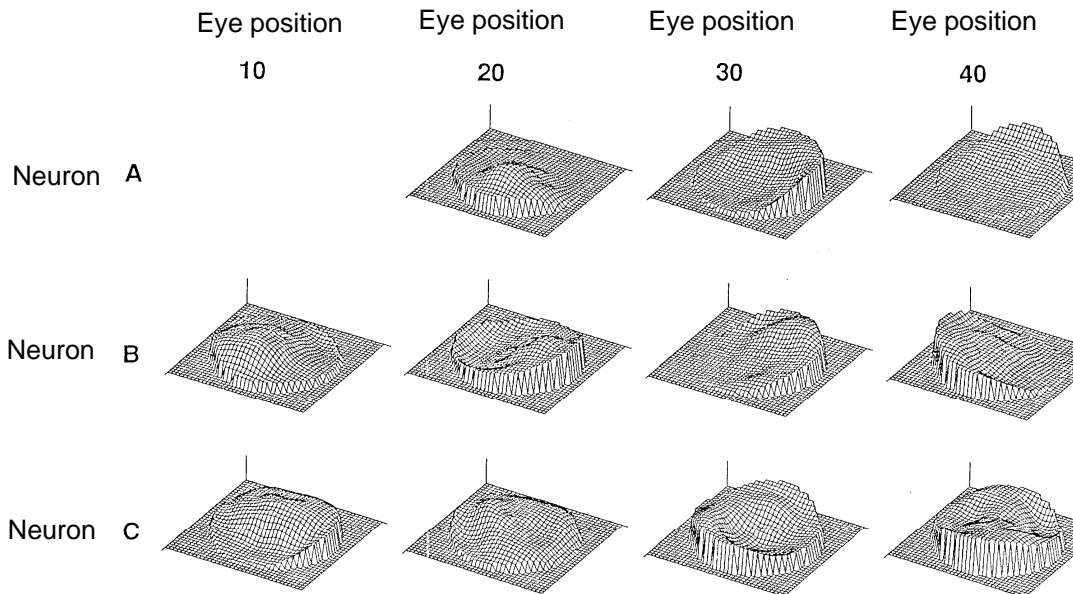
Computational problem:

Compute object position in a head-centered frame of reference, given position on retina, and eye position

The hidden units in the network correspond to parietal cortex



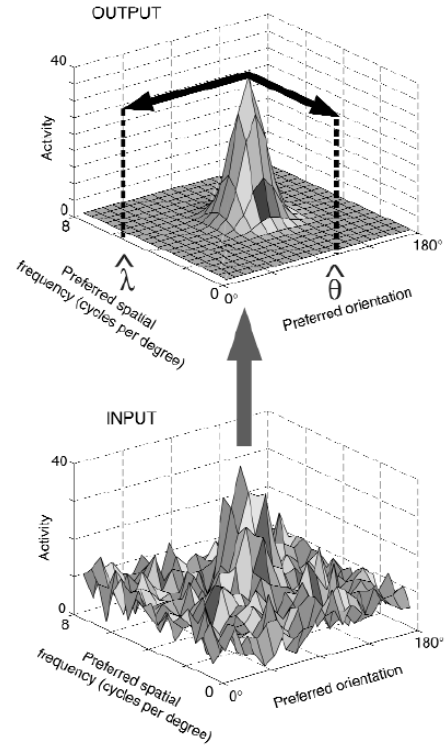
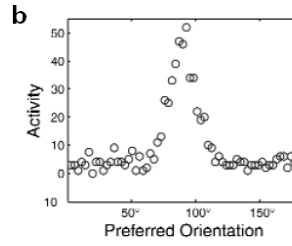
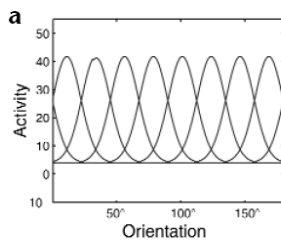
Model predictions



Bottom line: A mixed frame of reference is a good intermediate representation for computing head-centered coordinates from retinal position and eye position

Noise cleanup in basis-function networks

(Deneve, Pouget, Latham)



Cue Integration

