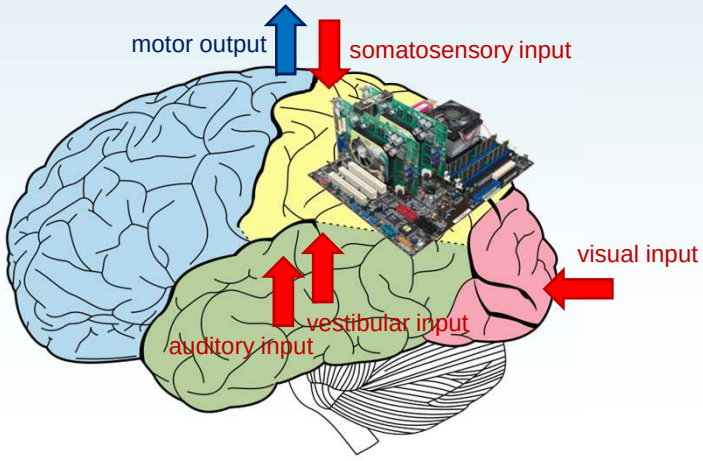
Attention and intention in the parietal cortex

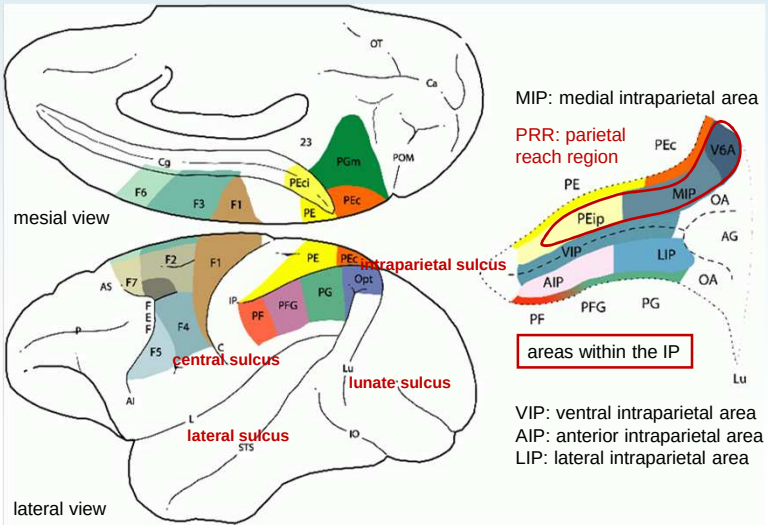
Alexandra Reichenbach



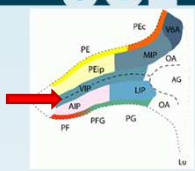
Outline

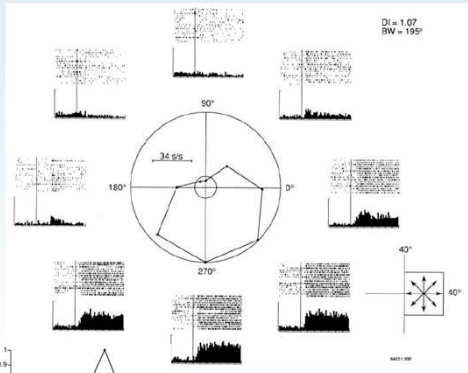
- Overview of the macaque PPC
  - Gist of what some PPC areas are doing
- Basic concepts in the PPC
  - Priority maps
  - Spatial transformations
- Discussion: macaques to humans

Anatomy of the macaque PPC

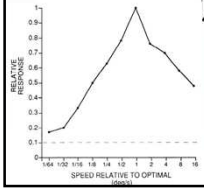


Ventral intraparietal area
"polymodal association zone"





tuned to visual motion direction

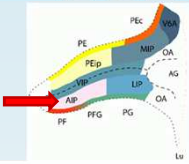


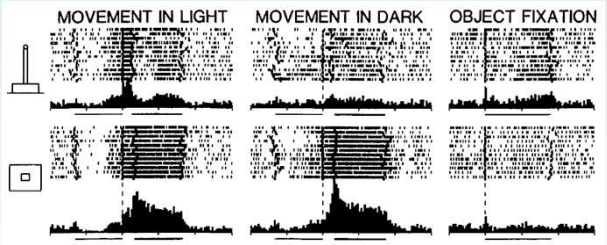
modulated by speed

Colby et al, 1993

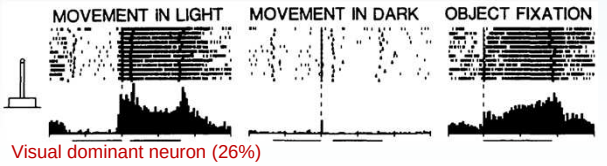
- Response to motion
- Visual, tactile, vestibular, & auditory
- Perception of self-movement and object movement in near extrapersonal space
- Control of defensive movements

Anterior intraparietal area
"grasping area"

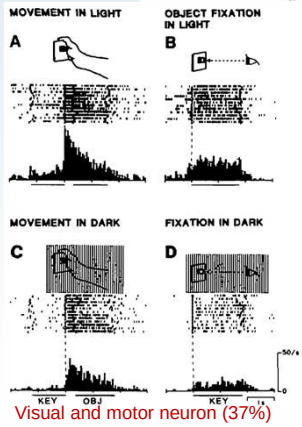




Motor dominant neuron (33%)



Visual dominant neuron (26%)

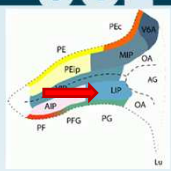


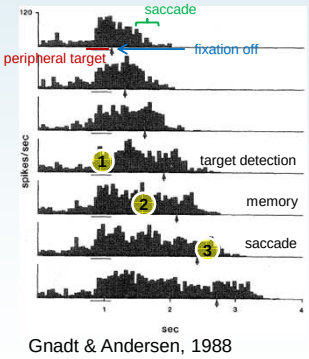
Visual and motor neuron (37%)

Sakata et al, 1995

- fixation and manipulation of objects
- highly responsive to size, shape and orientation of objects

Lateral intraparietal area
More than "just a saccade area"?





Gnadt & Andersen, 1988

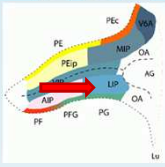
- Input from visual areas
- Interconnected with superior colliculus and frontal eye fields
- Eye-centred coordinate frame

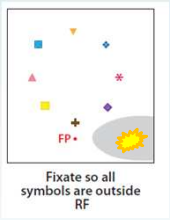
BUT do the neurons rather encode

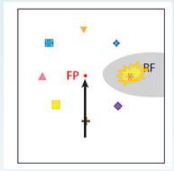
- locus of attention? (saliency maps)
- target selection? (decision processes)
- reward expectancy? (value)

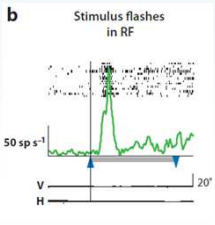
The priority map in LIP

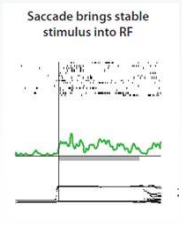
Attention, Intention, and Priority in the Parietal Lobe (Bisley & Goldberg, 2010)

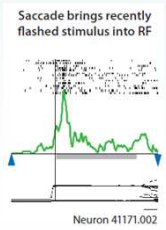












Bottom-up visual input: salience

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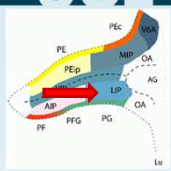
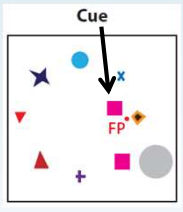
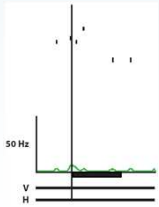
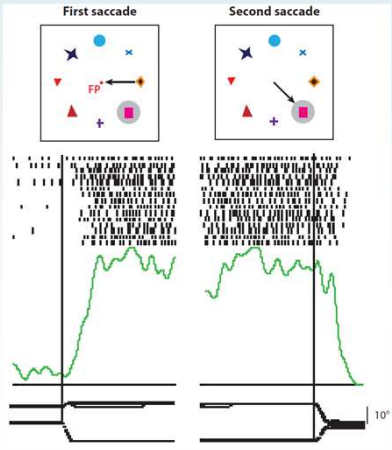
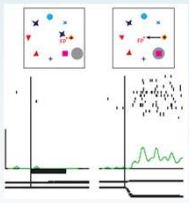
Attention, Intention, and Priority in the Parietal Lobe (Bisley & Goldberg, 2010)







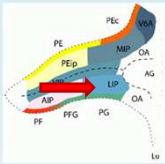


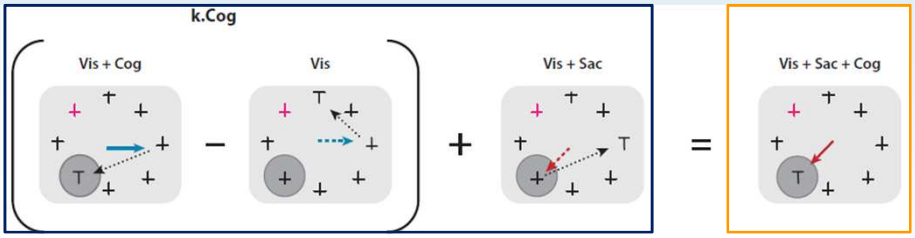


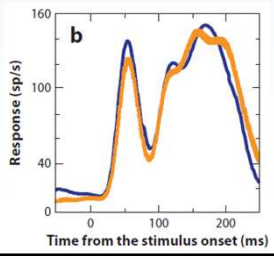
cued target not in receptive field

Top-down influence: target of the next saccade

The priority map in LIP
Construction of the priority map

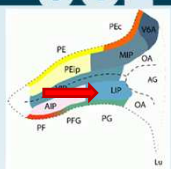


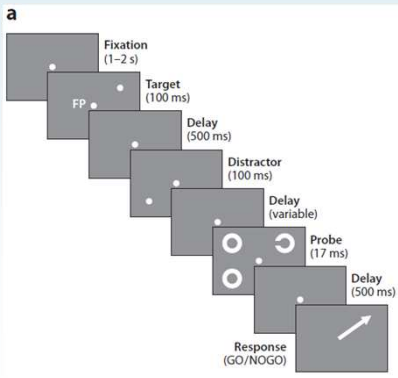


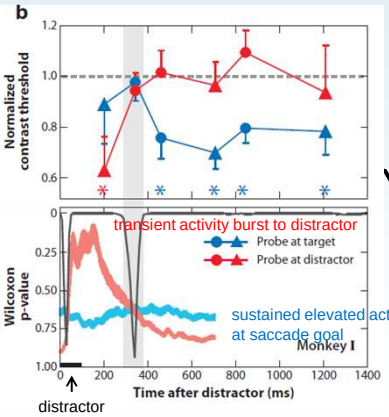


The whole is just the sum of its parts!

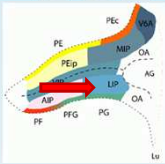
The priority map in LIP
Priority map ➔ covert attention



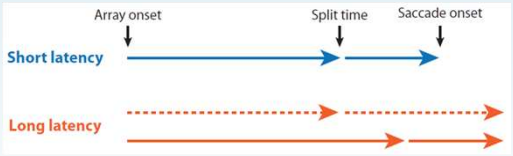




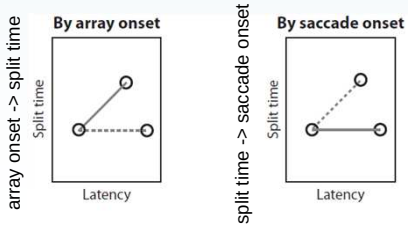
The priority map in LIP
Priority map ➔ saccades



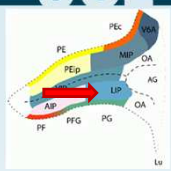
activity in LIP

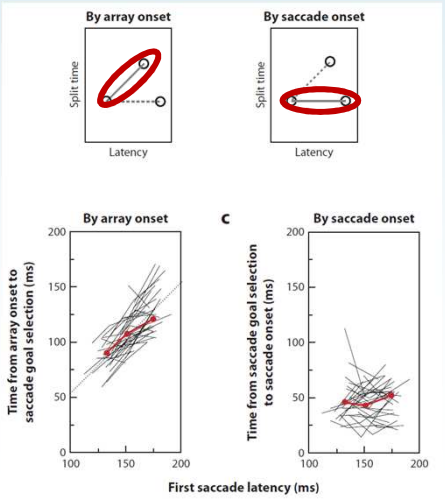


post LIP processing prolonged
pre/within LIP processing is prolonged
➔ LIP activity is driving saccade



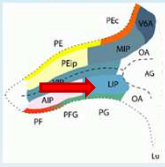
The priority map in LIP
Priority map ➔ saccades





LIP activity is driving saccade

The priority map in LIP



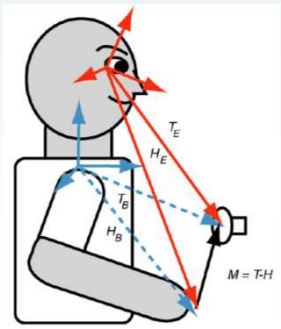
What do you think of this concept?

Do you think this concept can be generalized to other actions?

Further reading: Ptak (2012)

Medial intraparietal area
part of the "parietal reach region"

- Planning, execution, and monitoring of reaching movements
- Detection of "movement errors"

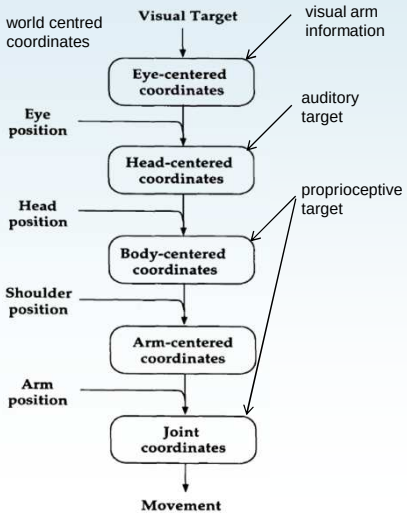


coordinate transformations

Buneo & Andersen, 2005

Coordinate transformations

Spatial Transformations in the Parietal Cortex Using Basis Functions (Pouget & Sejnowski, 1997)

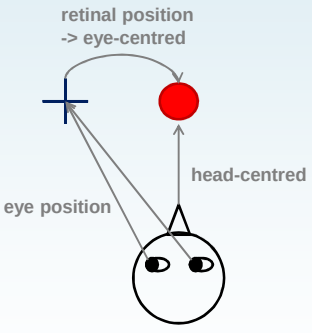


Coding possibilities

- (Sequential) series of subtransformations?
  ➔ different representations in different cortical areas
- Parallel processing of several coordinate frames?
- Switching between coordinate frames depending on task requirements?
- One “common” reference frame?
  ➔ multiple reference frames in same neuronal pool

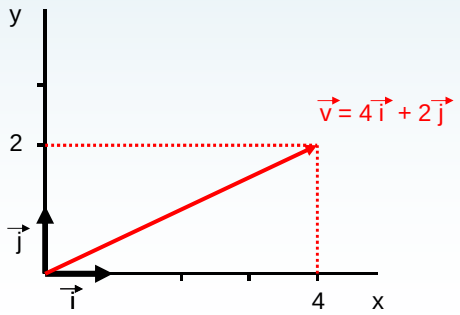
Coordinate transformations

Why gain fields and basis functions?

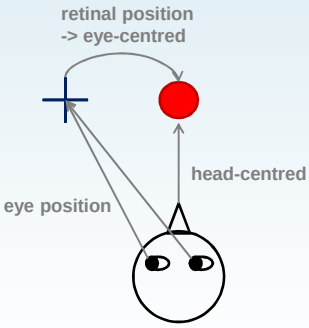


H = E + R ???

Basis:
can be used to describe any point in space, e.g. Euclidian basis



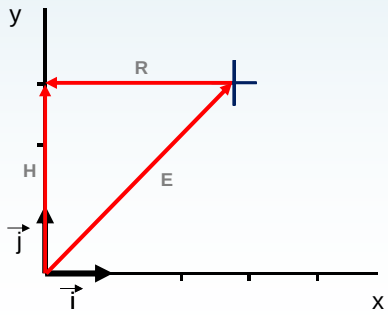
Coordinate transformations
Why gain fields and basis functions?



H = E + R ???

World centred coordinates

H = E + R ☑



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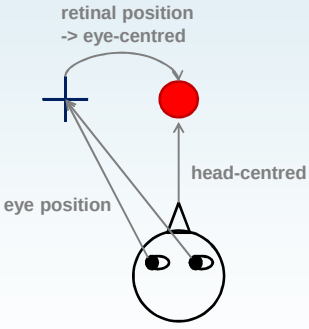
Why gain fields and basis functions?



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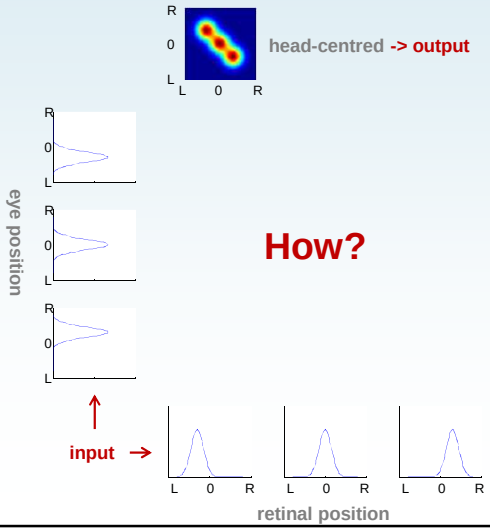

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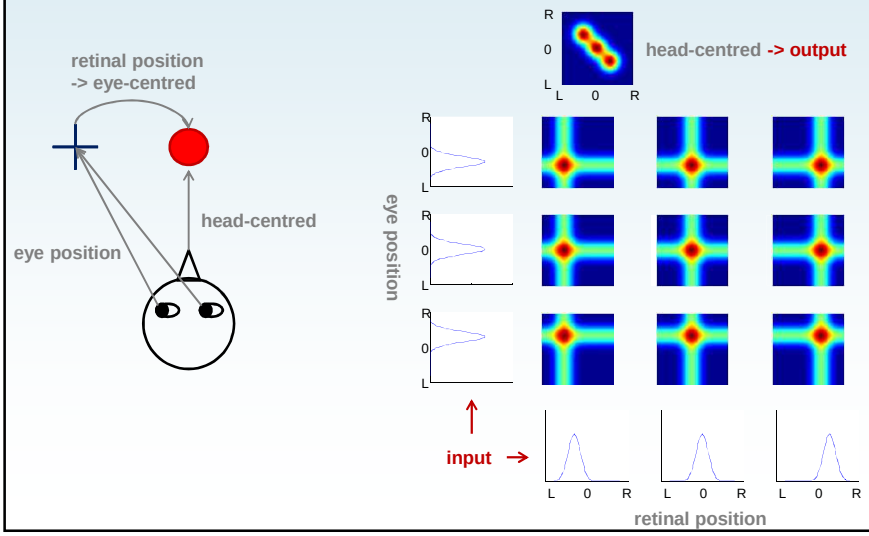
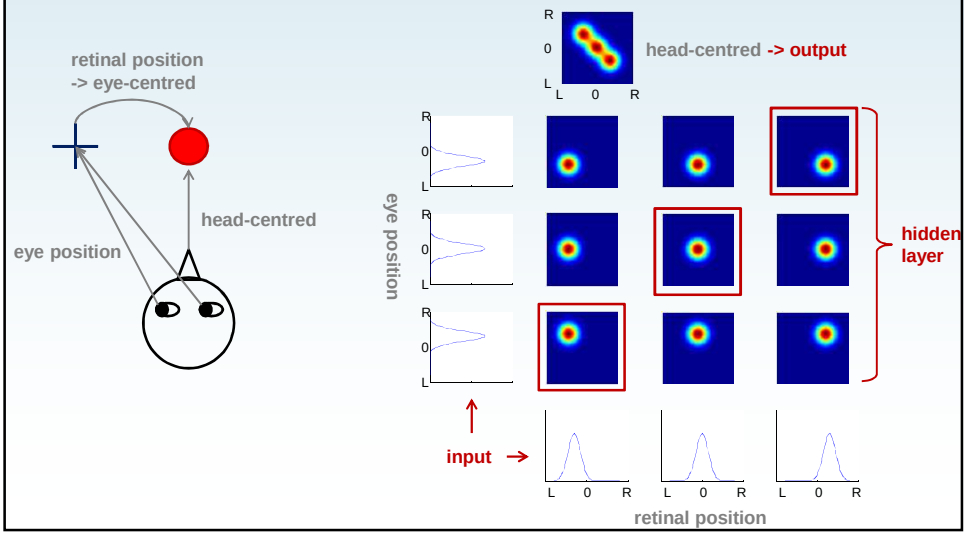
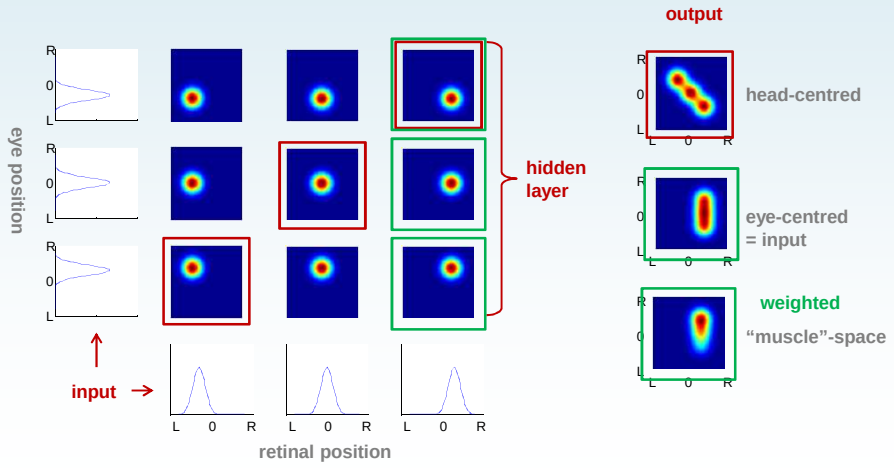
Why gain fields and basis functions?



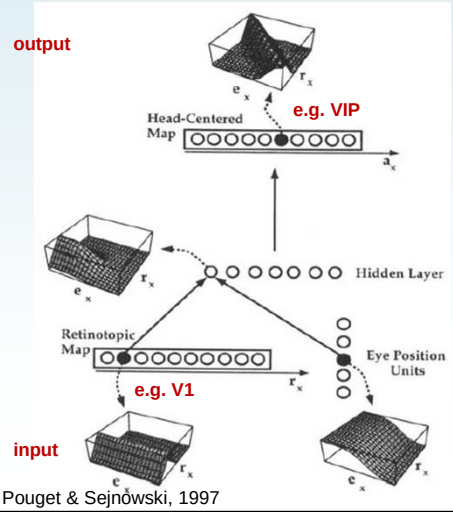
Coordinate transformations
Why gain fields and basis functions?



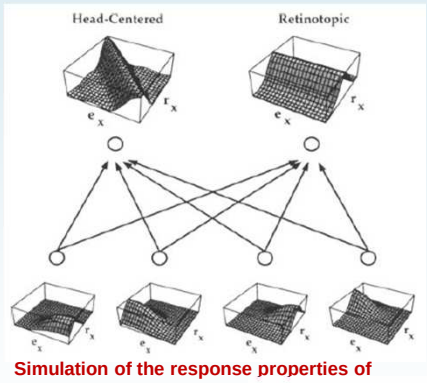
Coordinate transformations
Why gain fields and basis functions?



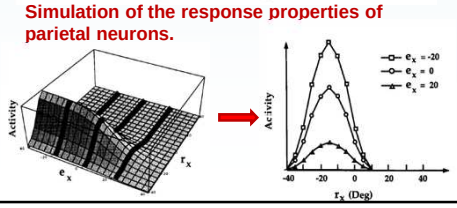
Coordinate transformations in the PPC



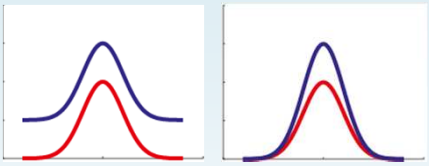
Pouget & Sejnowski, 1997



Simulation of the response properties of parietal neurons.

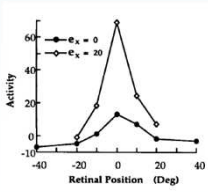


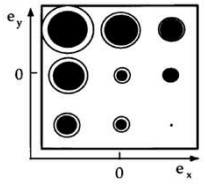
Coordinate transformations in the PPC

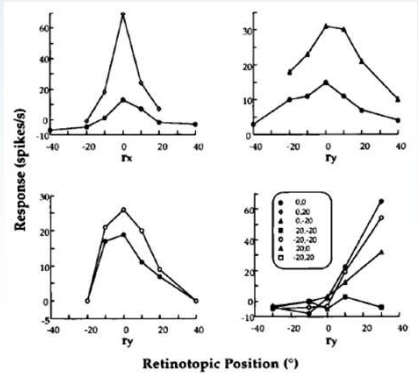


Which one would be the receptive field of a parietal neuron?

Recording of parietal neurons.

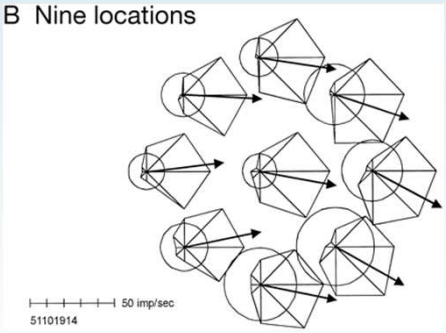




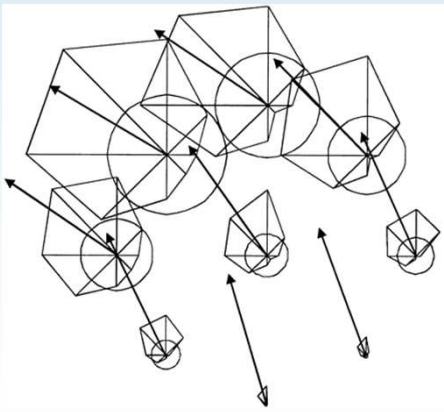


Pouget & Sejnowski, 1997

… and in M1

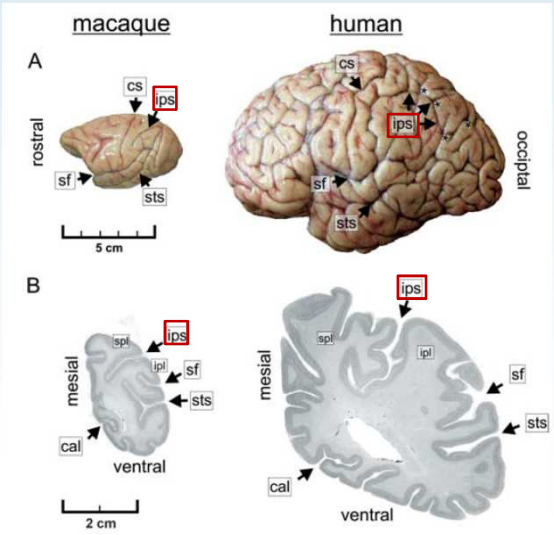


Force direction sensitive neurons in M1
- modulated by the position of the hand
➔ hidden layer / gain field response



“read out”: EMG activity from anterior deltoid
➔ response in “muscle space”

Translating monkey research to human brain functions



Grefkes & Fink 2005

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