

Does structure inform function:  
The cerebellum as a case study

Ascribing function to structure is a large chunk of what neuroscientists do.

Cajal – dynamic polarization

Structure and function can be described at several levels.

Behavior, usually some sort of motor readout, a goal directed behavior, response of individual muscle spindles – big areas and network activity, activity at the level of microcircuits, activity of molecules in cells

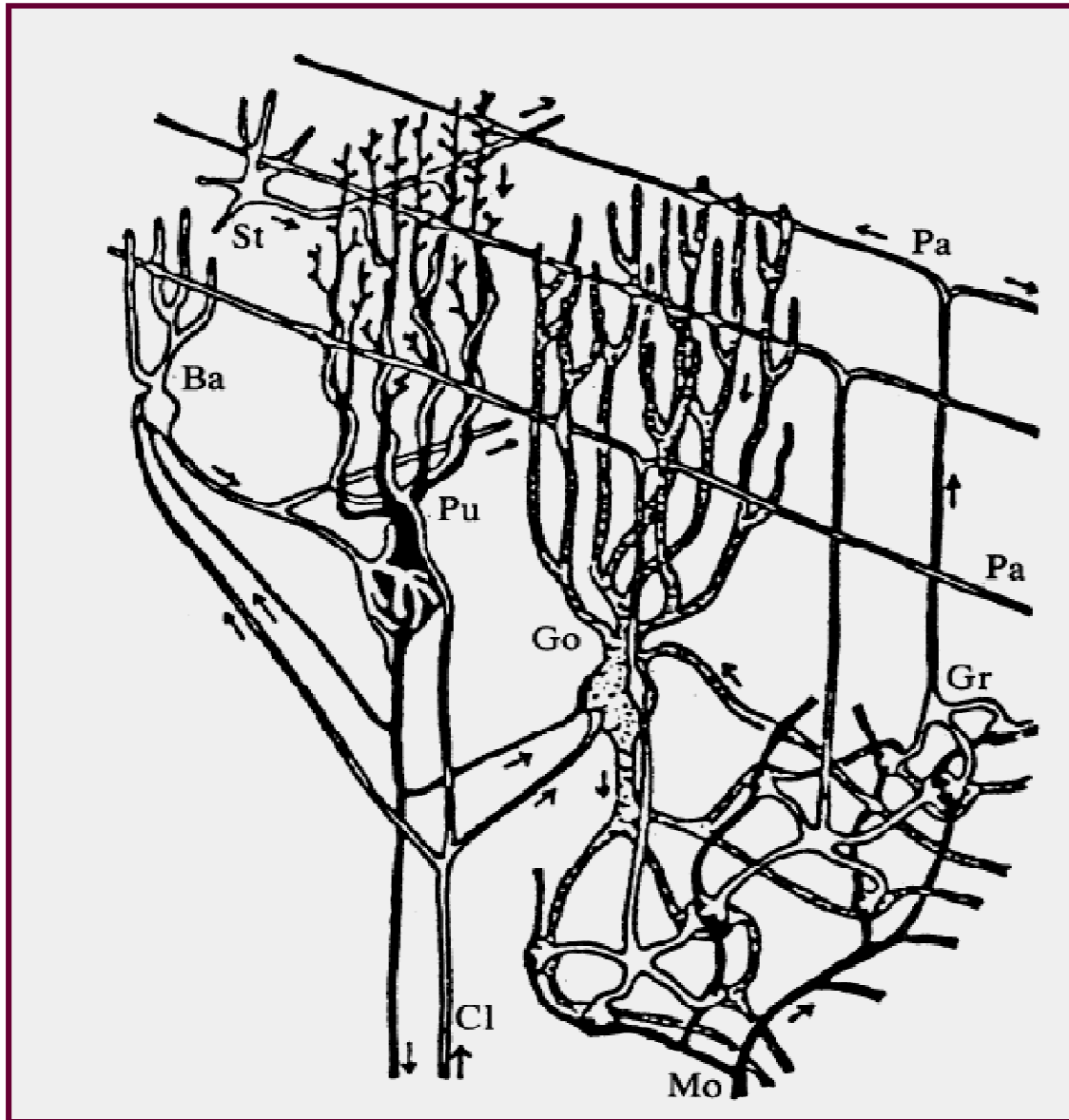
One fundamental question is the right level of structure to be looking at for a particular level of function.

I will take the example of the cerebellum and pose this question more specifically.

The cerebellum has been shown to be a highly ordered structure of repeating units. The homogeneity of organization at a cellular and at a circuit level has led to the concept that there is a cerebellar module that executes a 'general cerebellar algorithm'. Linking many modules and given specific input-output connectivity gives functional diversity.

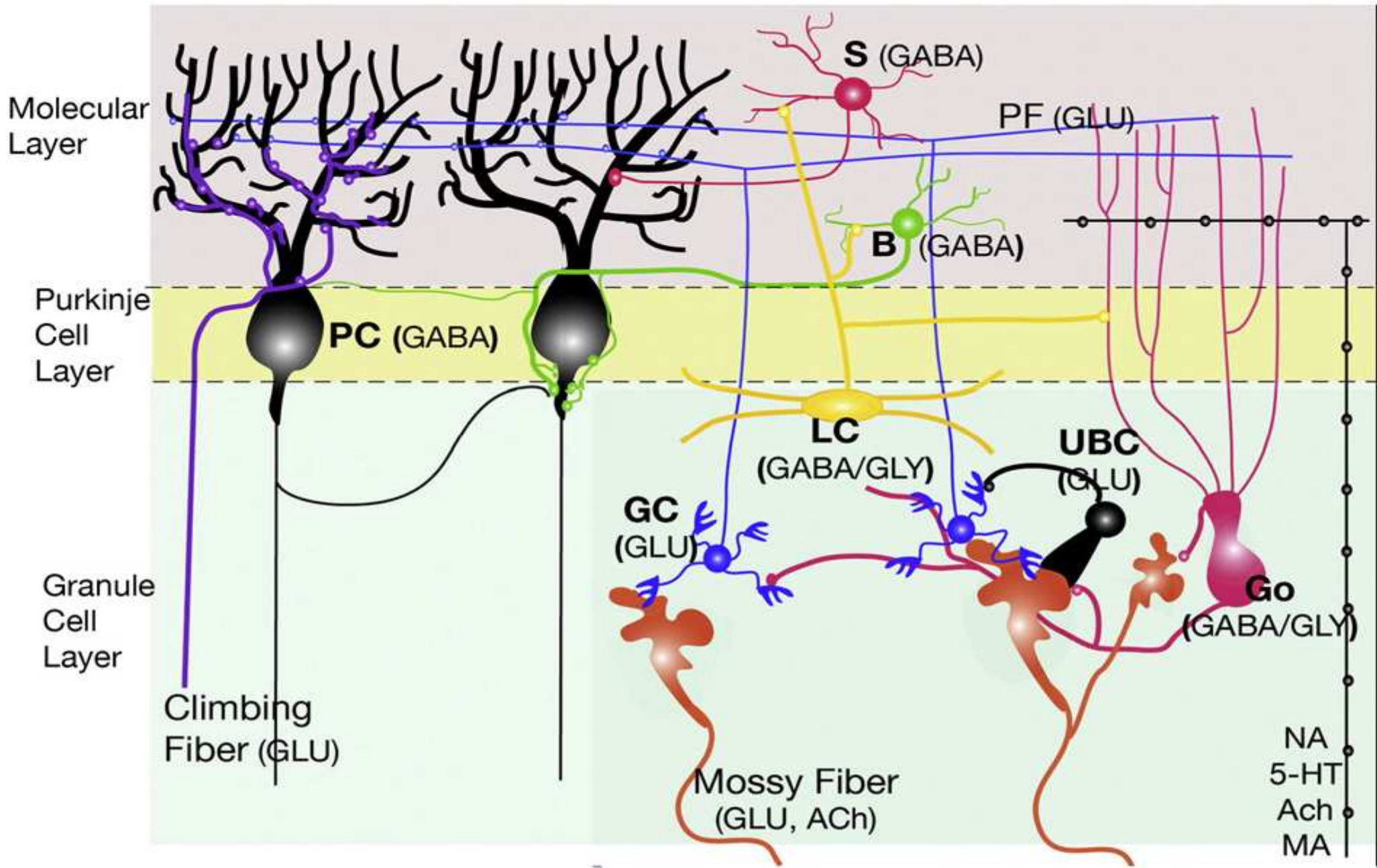
Marrs and Albus – the cerebellum as a computer

# Computational unit of the cerebellum



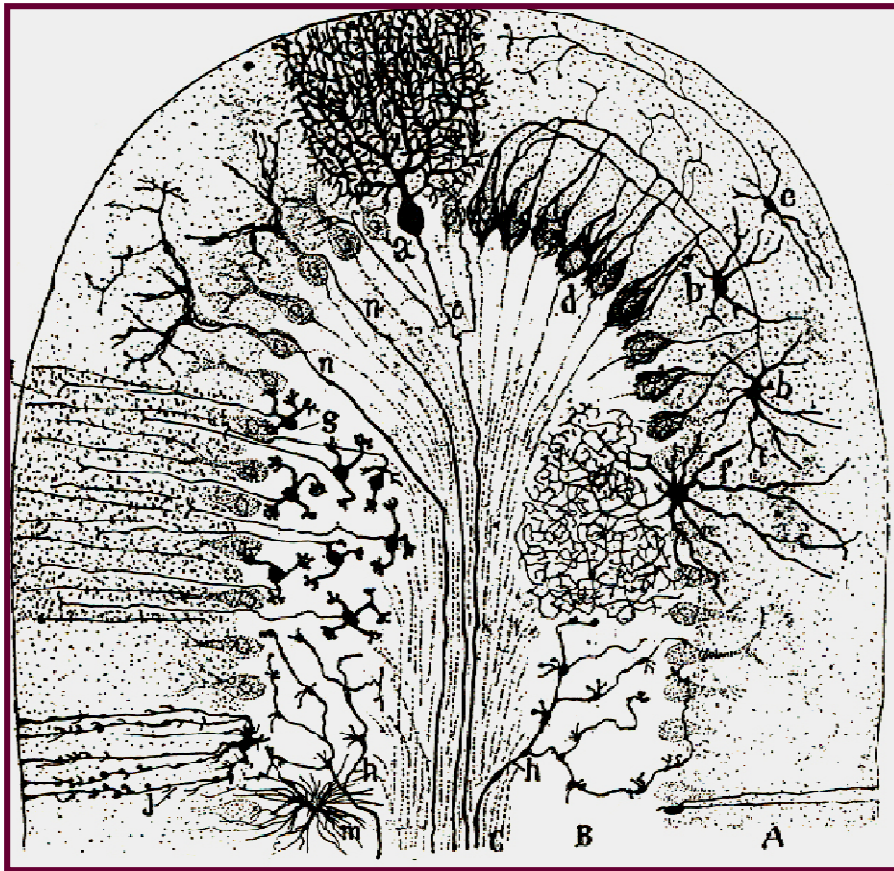
- Each PF makes contact with about 300 Pur cells
- Each Pur cell makes contact with about 100,000 parallel fibers
- Each mossy fiber contacts about 400-600 granule cells
- Each granule cell receives input from only about 4-5 mossy fibers
- Number of granule cells per Purkinje cell increases systematically across the phylogenetic scales

Llinas, 1975

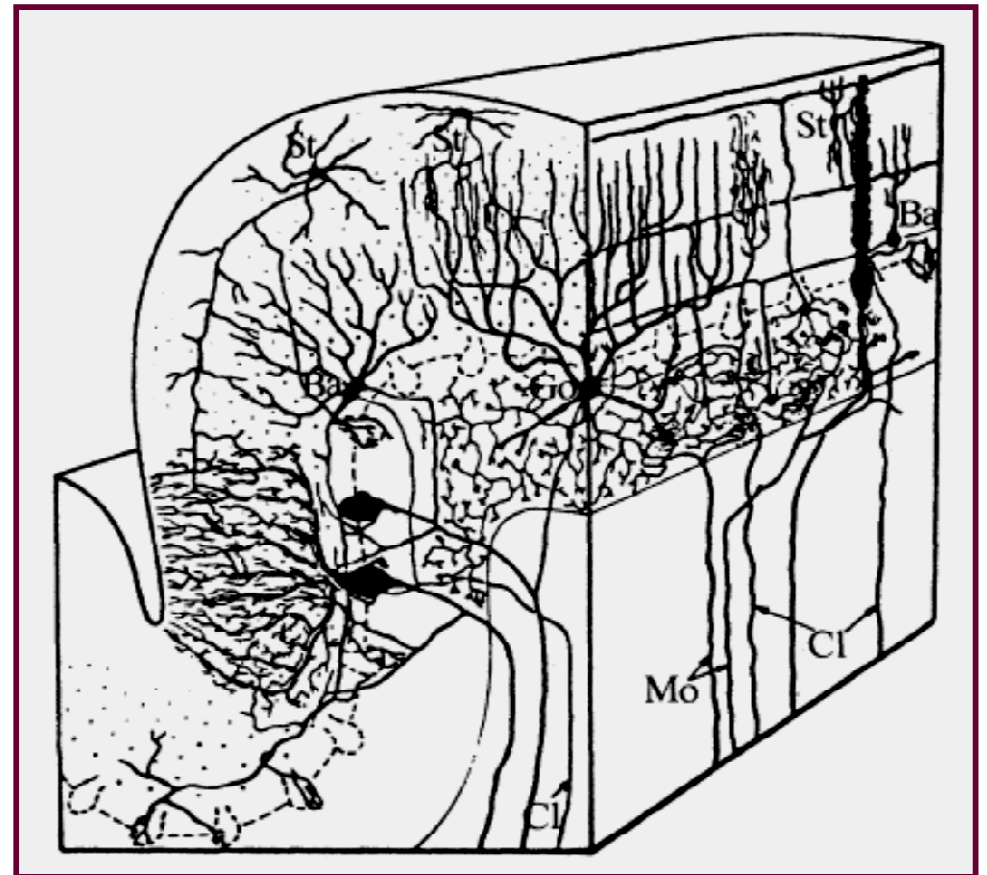


Sotelo, 2010

# Arrangement of network components

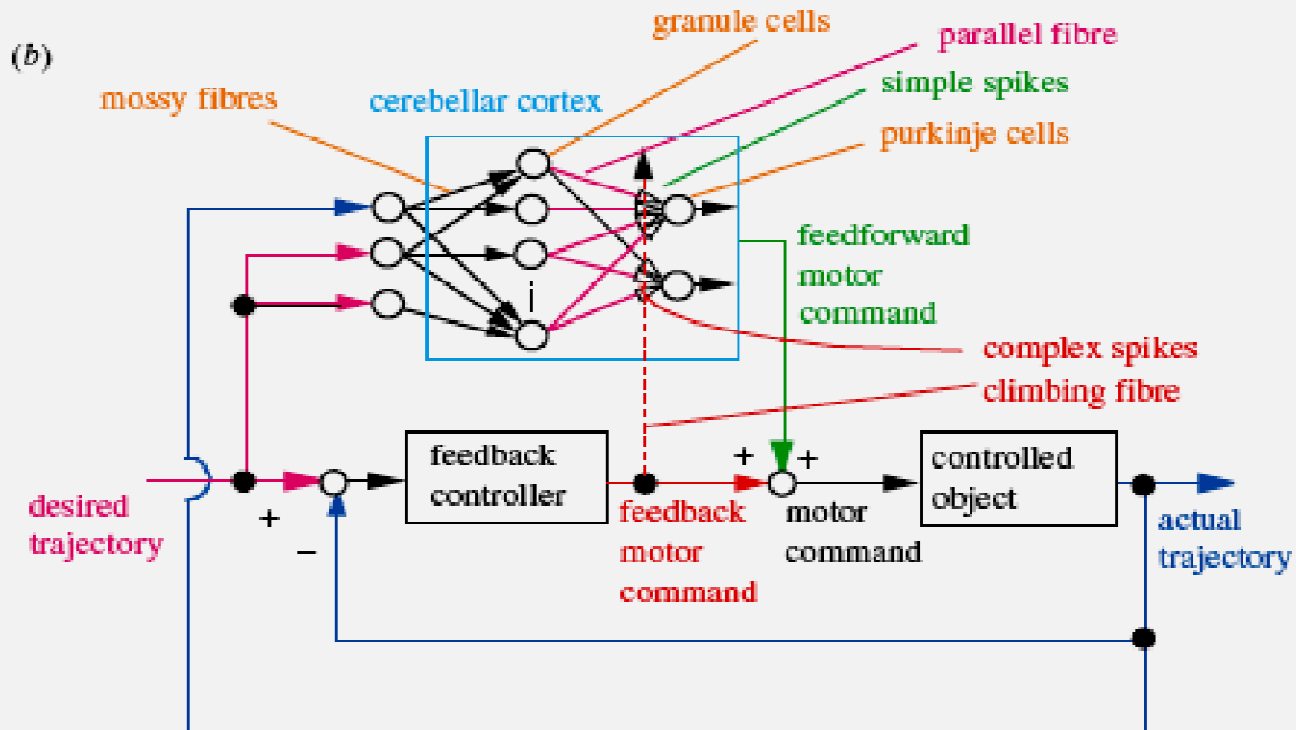
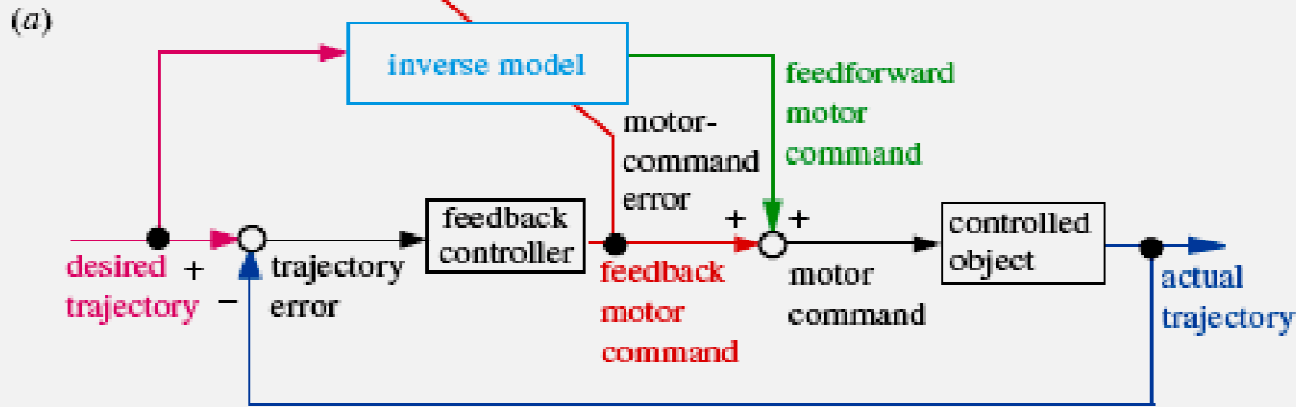


Cajal

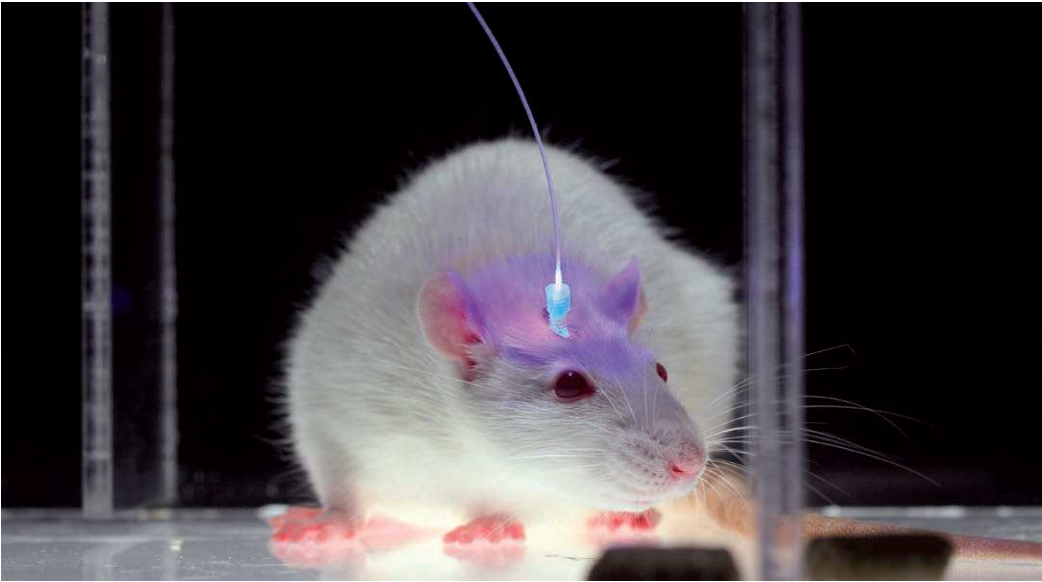


Eccles

# Feedback-error learning



Wolpert D et al; 1998  
Kawato M; 2008

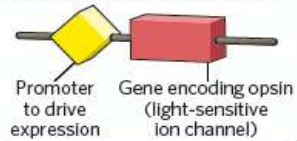


### SIX STEPS TO OPTOGENETICS

With optogenetic techniques, researchers can modulate the activity of targeted neurons using light.

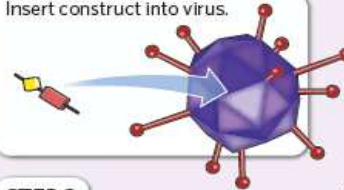
#### STEP 1

Piece together genetic construct.



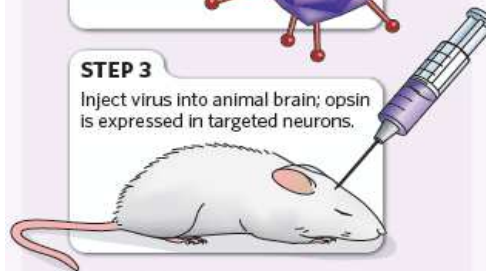
#### STEP 2

Insert construct into virus.



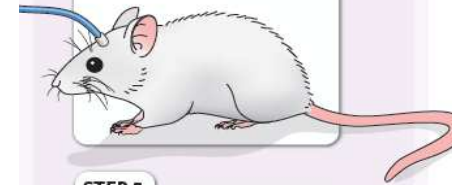
#### STEP 3

Inject virus into animal brain; opsin is expressed in targeted neurons.



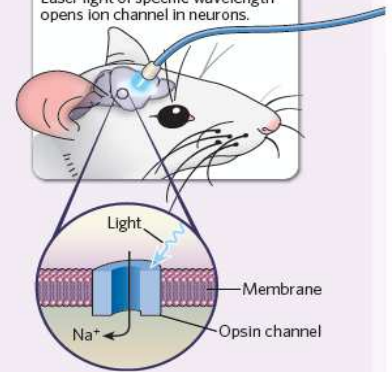
#### STEP 4

Insert 'optrode', fibre-optic cable plus electrode.



#### STEP 5

Laser light of specific wavelength opens ion channel in neurons.



#### STEP 6

Record electrophysiological and behavioural results.



NATURE|Vol 465|6|May 2010



We can change the size of the cerebellum

