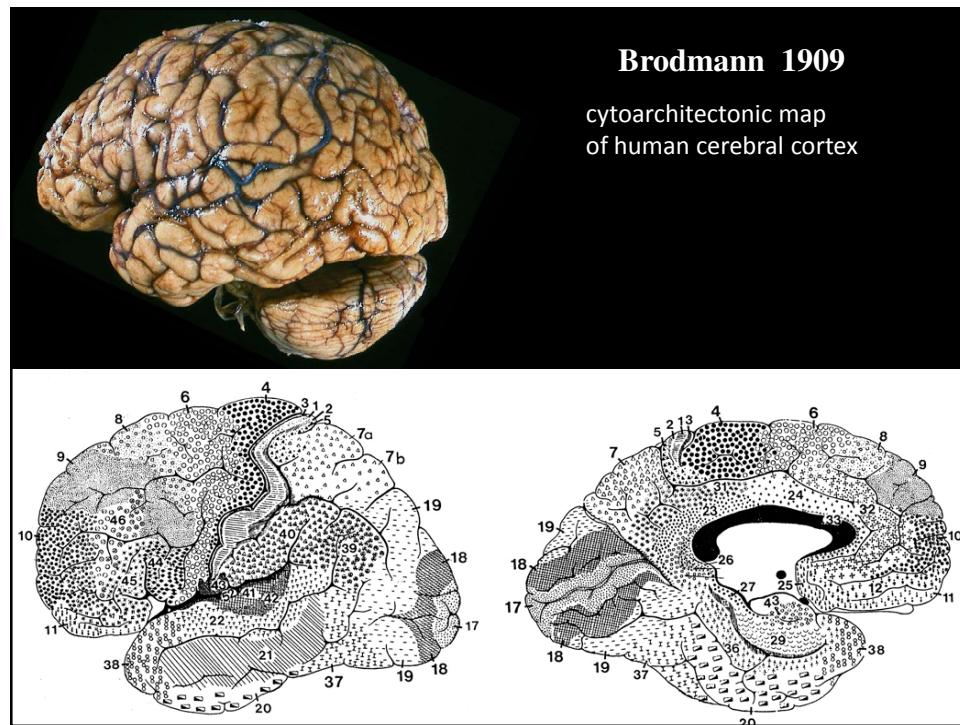
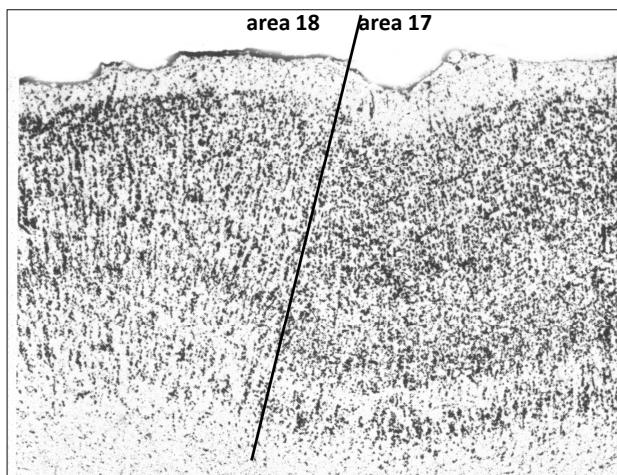
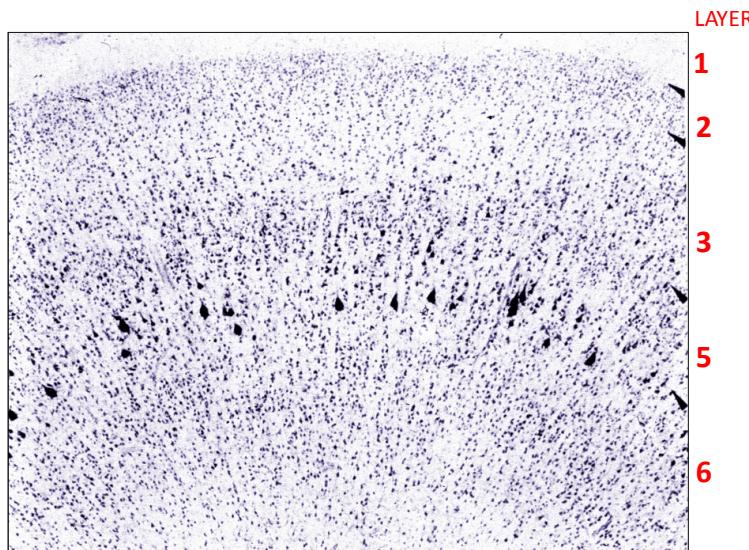


MULTIPLE VISUAL AREAS

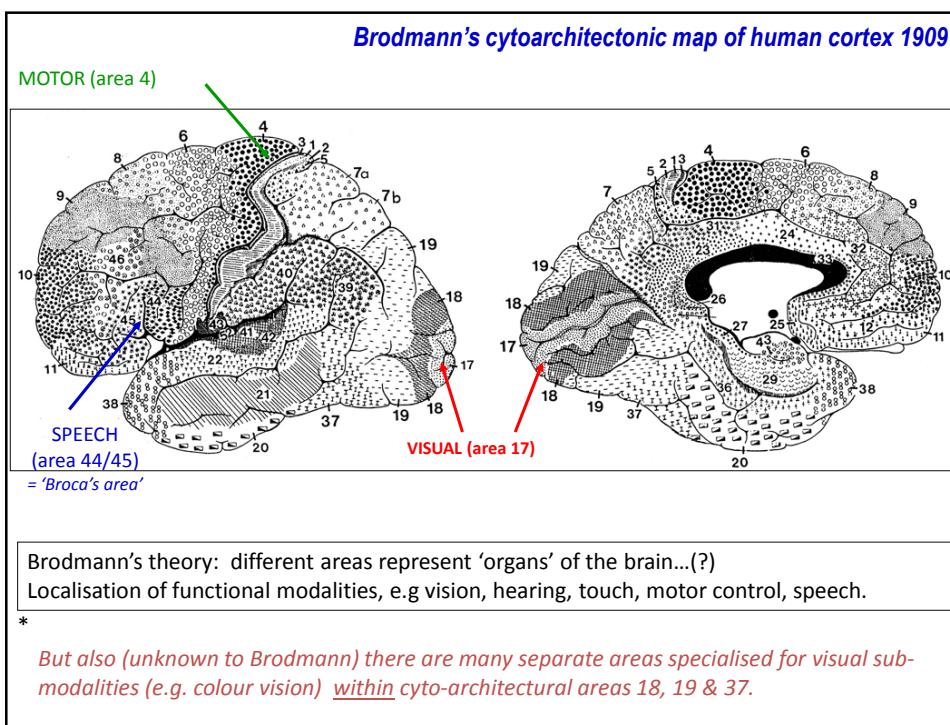
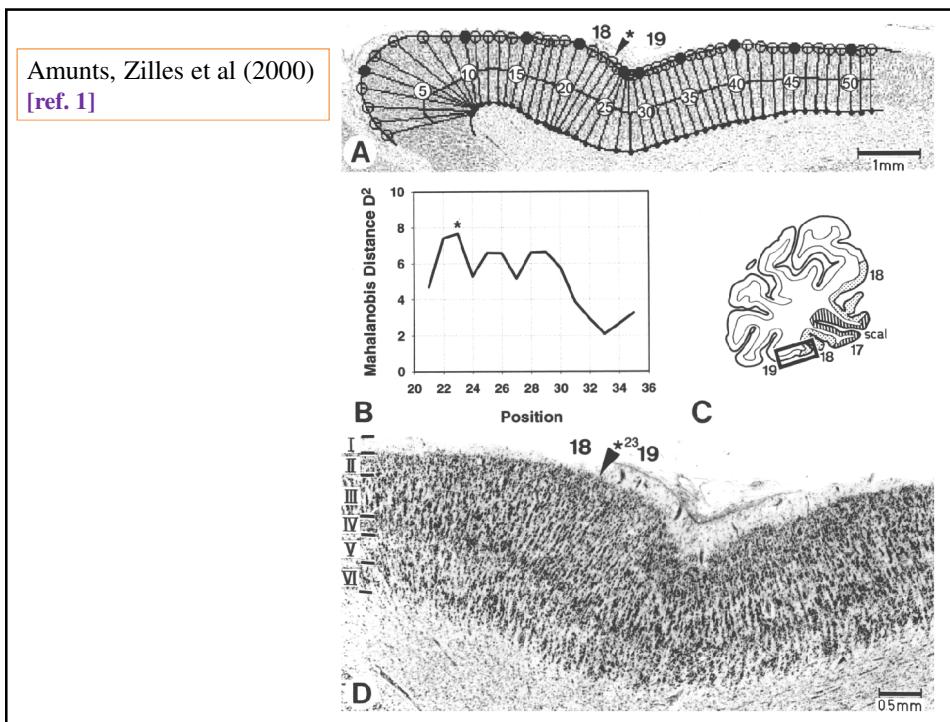
- 1: Definition of an 'area' of visual cortex
- 2: Discovery of areas in monkey visual cortex; functional specialisation
- 3: Use of imaging to chart areas in human visual cortex
- 4: Why are there multiple areas? A 'theory' of vision.



Brodmann area 4 (characterised by very large 'Betz' cells in layer 5)
[or 'PRIMARY MOTOR CORTEX', or 'AGRANULAR FRONTAL CORTEX']

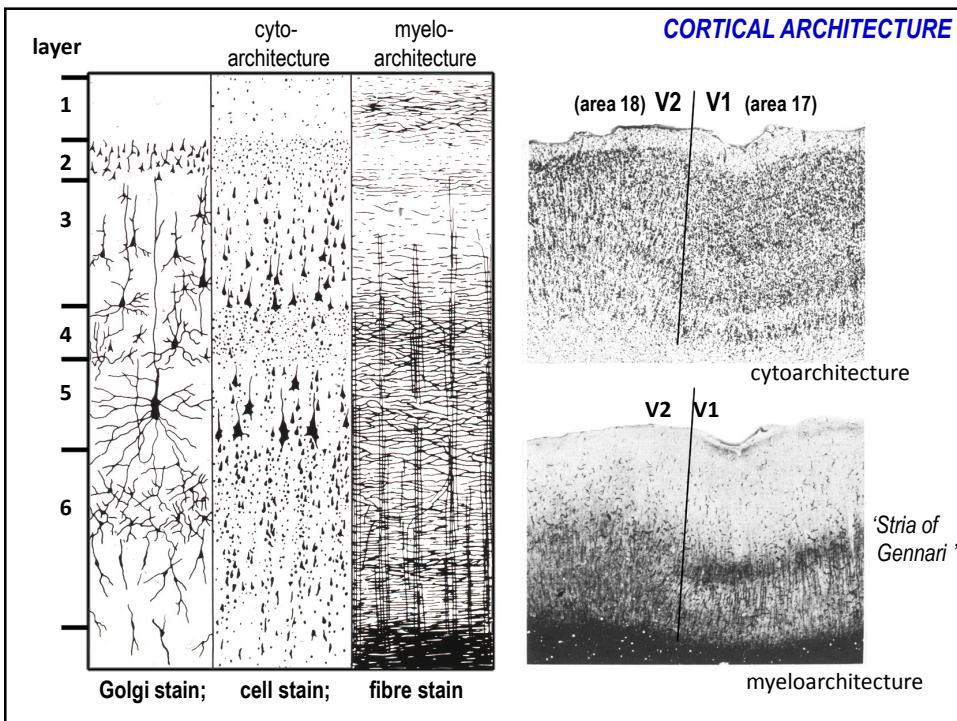


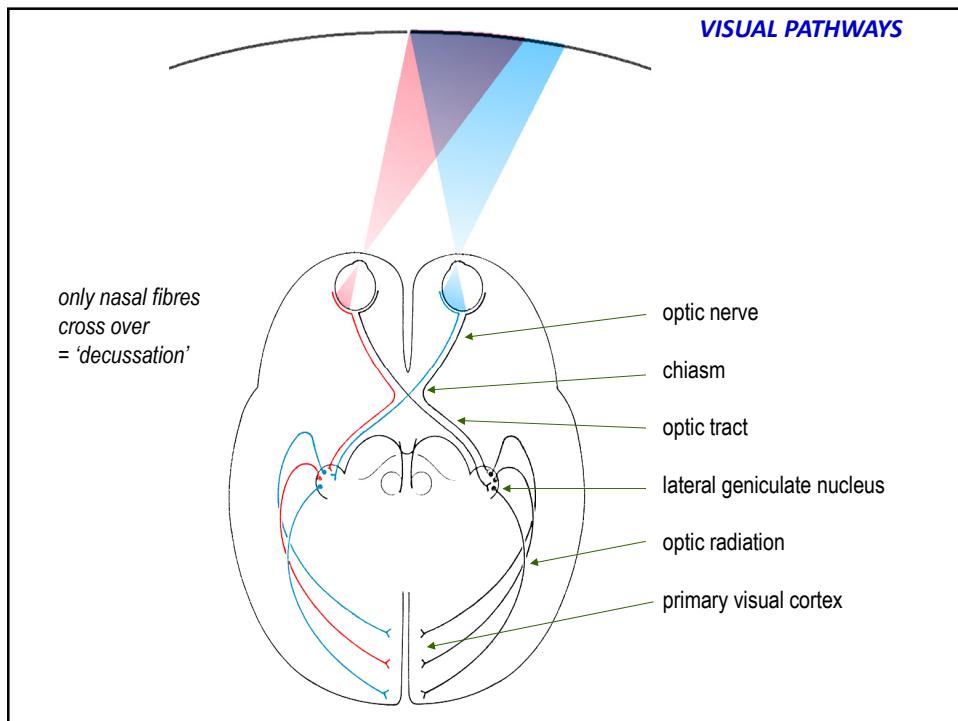
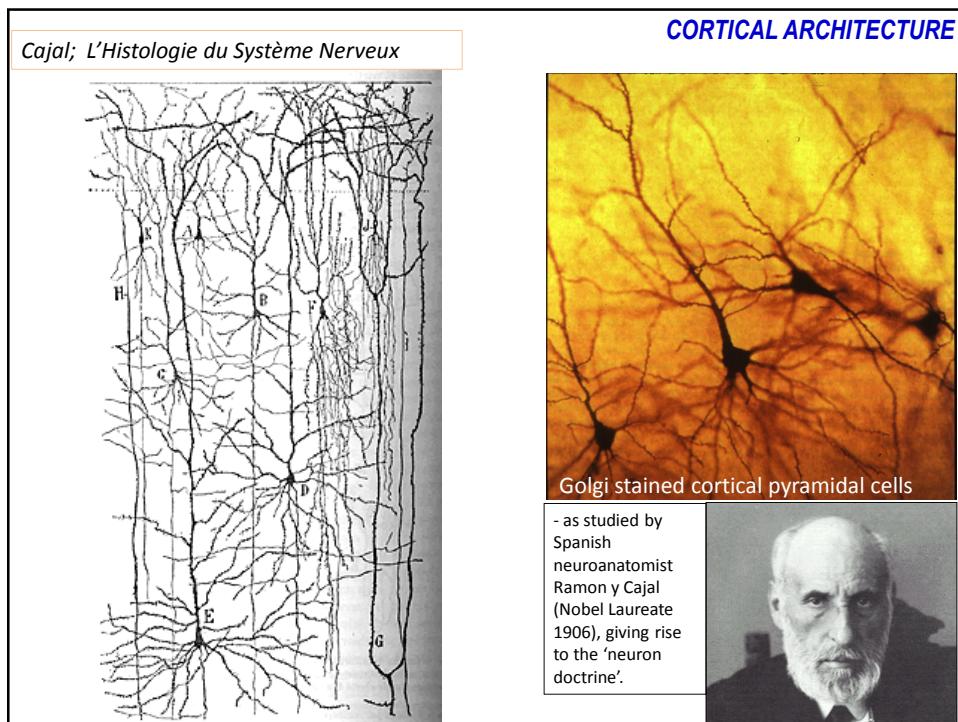
cytoarchitecture

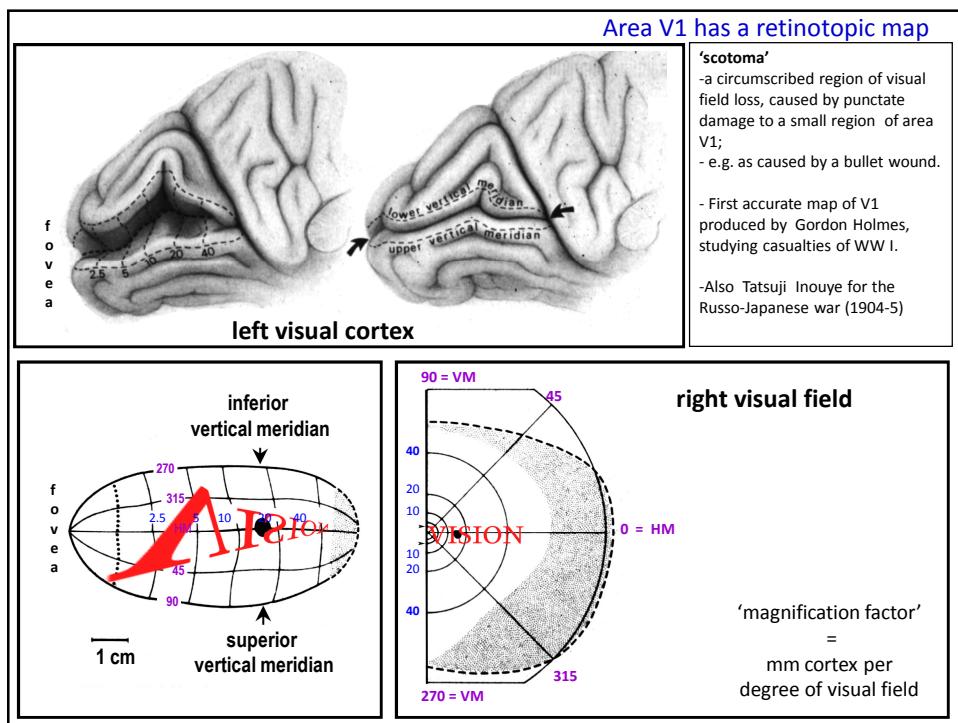
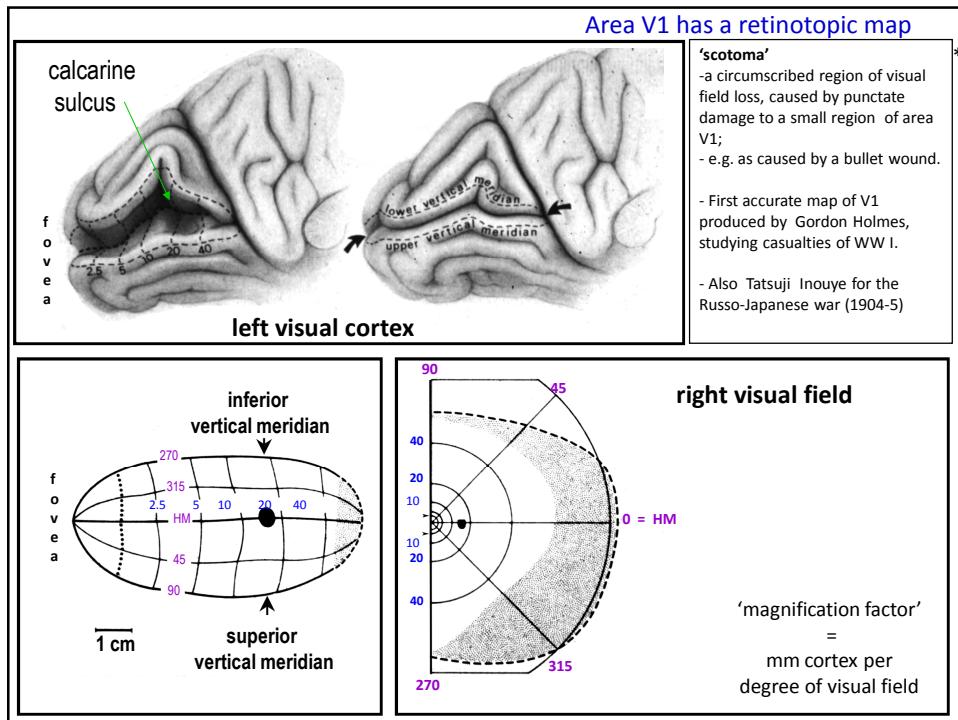


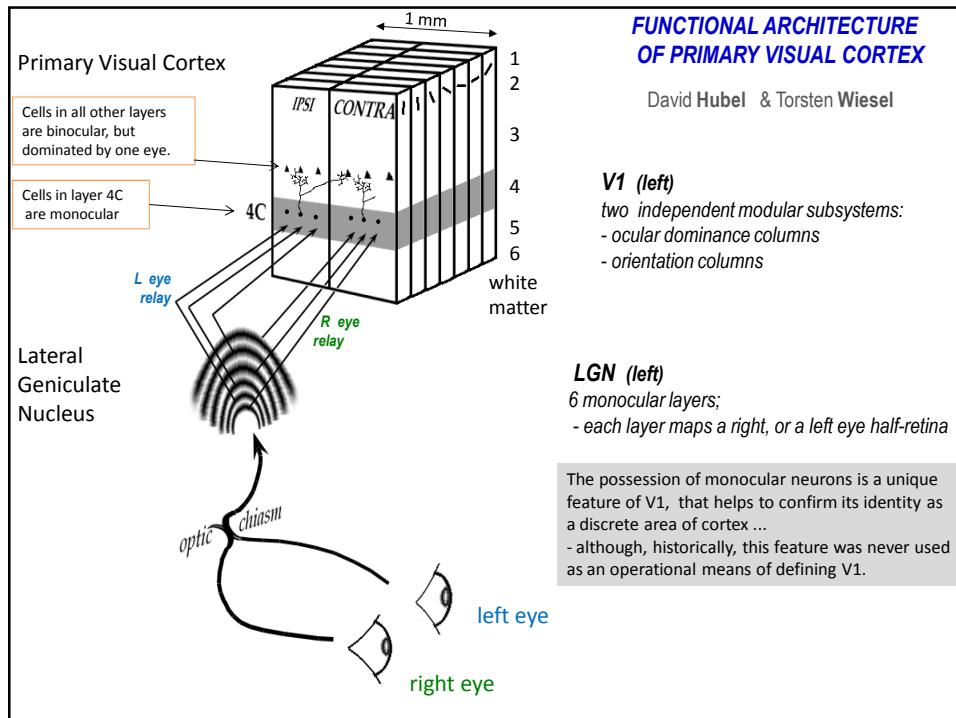
1. Definition of an ‘area’ of visual cortex

- architecture
- connectivity
- functional map (e.g. map of retina, or of other sensory surface)
- specific functional properties







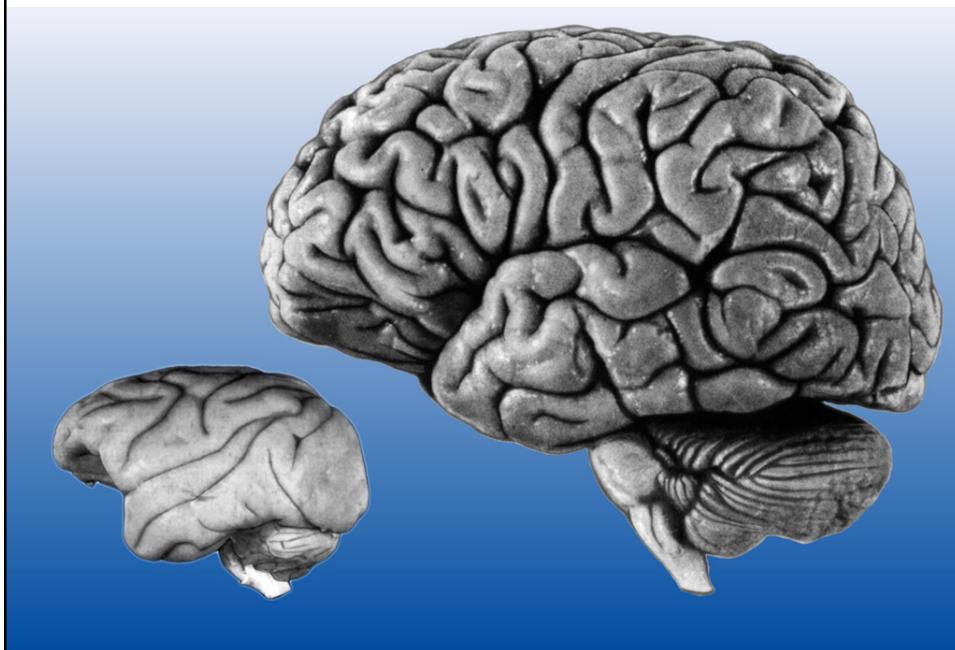


To recap: multiple terminology reflects historical convergence of separate concepts:

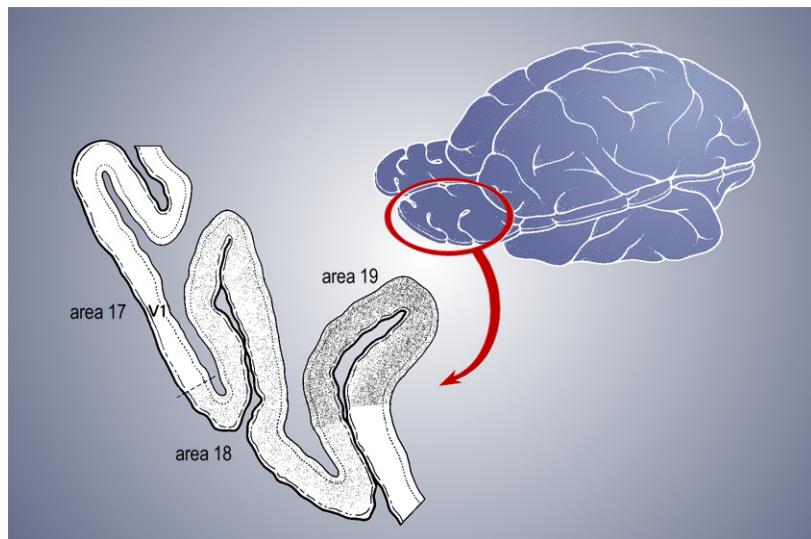
- striate cortex** (myeloarchitecture; stria of Gennari)
- = **area 17** (cytoarchitecture; e.g. Brodmann)
- = **primary visual cortex** (connectivity, i.e. area of distribution of optic radiation)
- = **area V1** (first map of visual field; e.g. Holmes)

* Definition of other, non-primary visual areas depends on similar combinations of separate criteria;
- experimental aim is to find congruent evidence for borders between neighbouring areas.

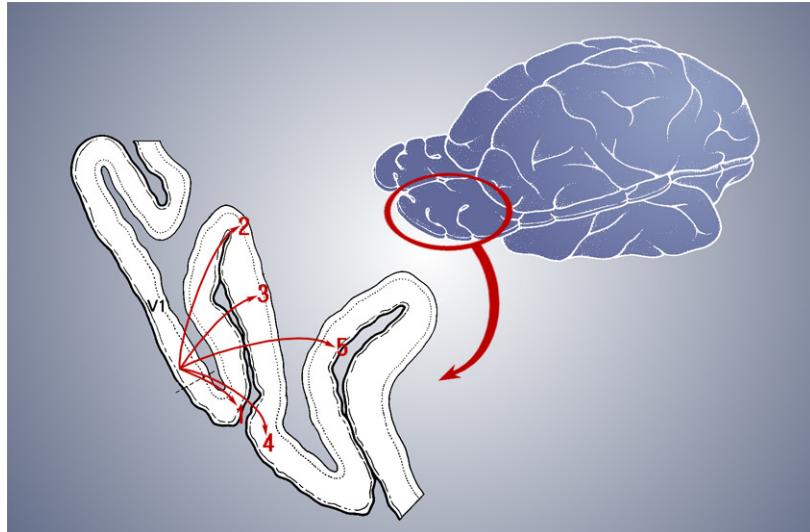
2. Discovery of areas in monkey visual cortex; functional specialisation



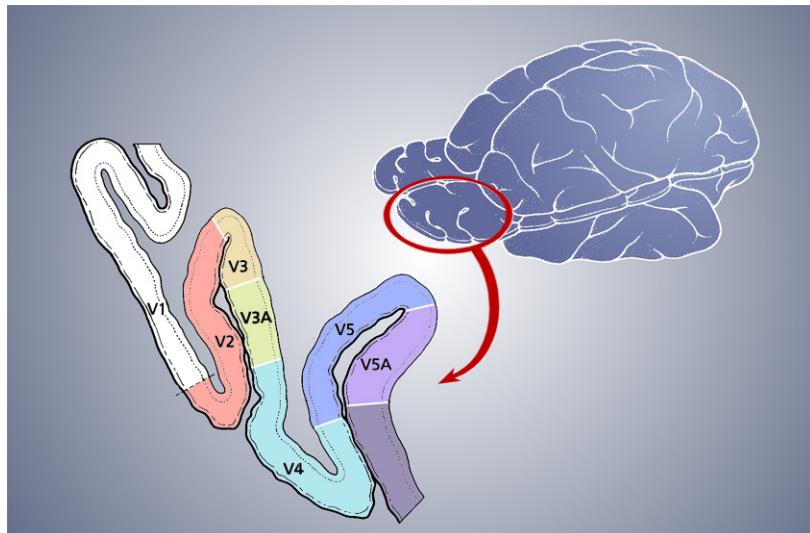
Brodmann cytoarchitectonic areas in macaque monkey



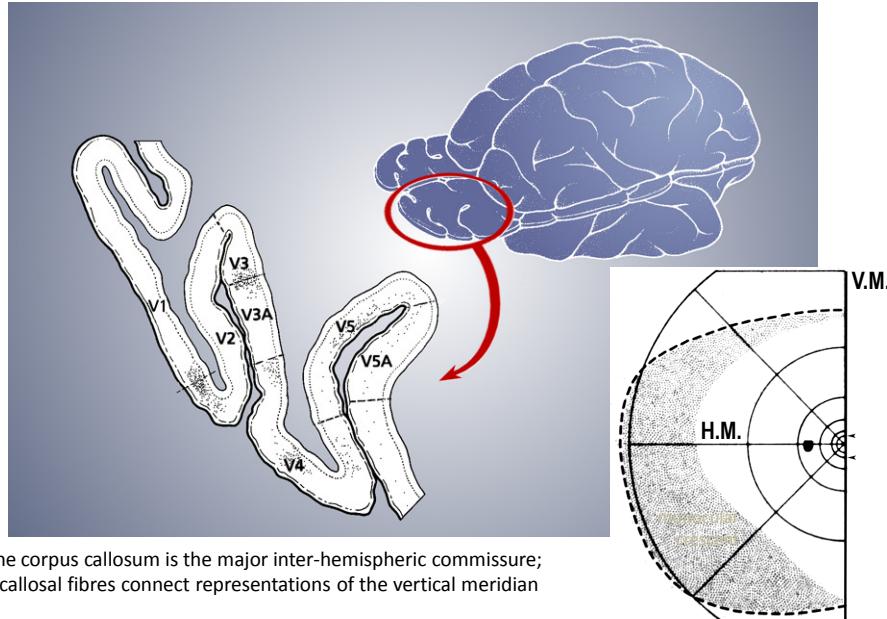
Multiple outputs from V1 to sites in prestriate cortex of macaque monkey
-implies parallel pathways & multiple visual maps (Zeki, 1969)



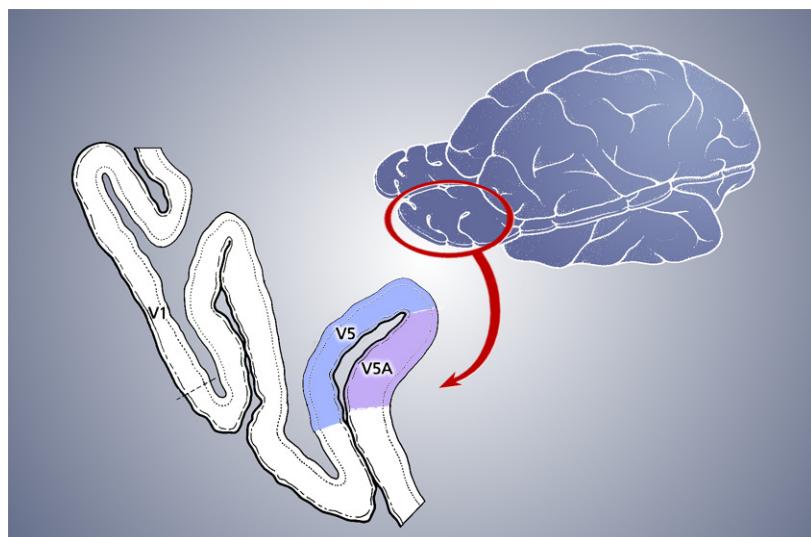
Multiple visual areas in prestriate cortex of macaque monkey
(Zeki 1978)

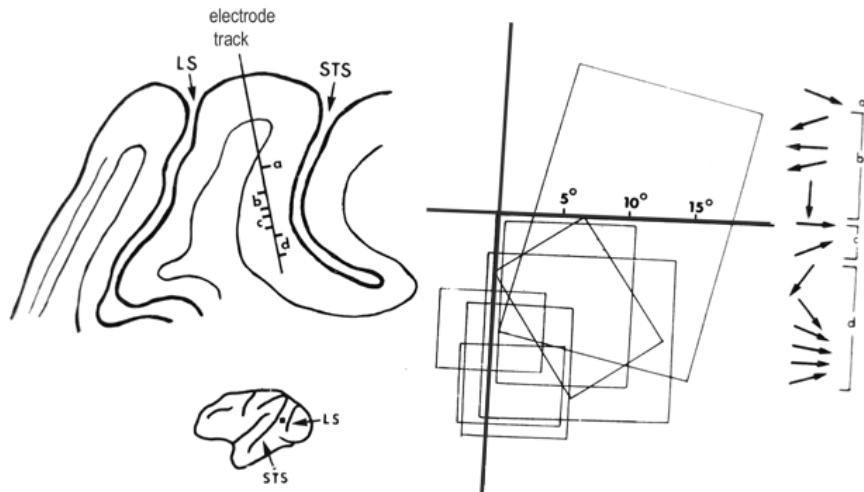


Using callosal connections to chart the borders of visual areas
(Zeki 1978)



Prestriate areas have varying specialised functions
e.g. areas V5 & V5A (or MT, MST & FST) are motion areas

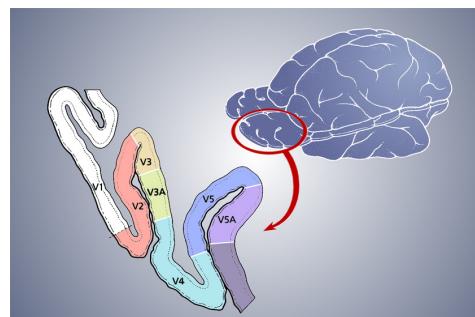


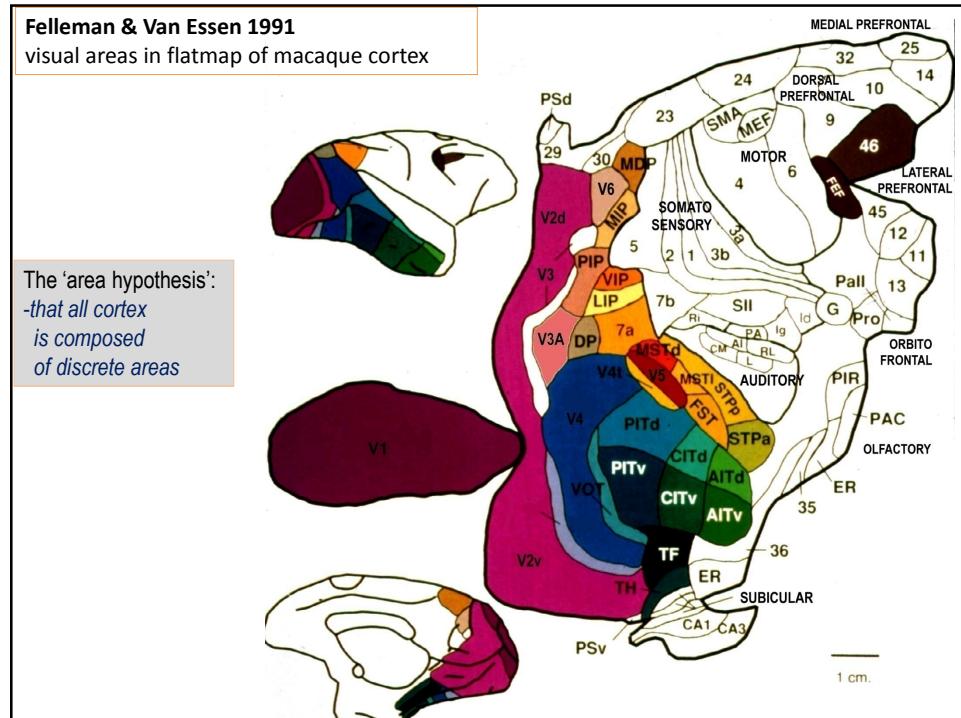
Zeki 1974*early recording from area V5****Definition of area V5:***

- V5 is an isolated projection field of V1
(neighbouring cortex within STS does not receive input from V1).
- V5 has a very high proportion of direction-selective cells
V4 has little direction tuning;
V5A also has many direction-selective cells, but they have larger receptive fields than V5 cells.
- V5 has a distinct myeloarchitecture

BUT..

The visual map in V5 lacks a high degree of topographic order, and it is therefore difficult to use the map to define the border of V5.





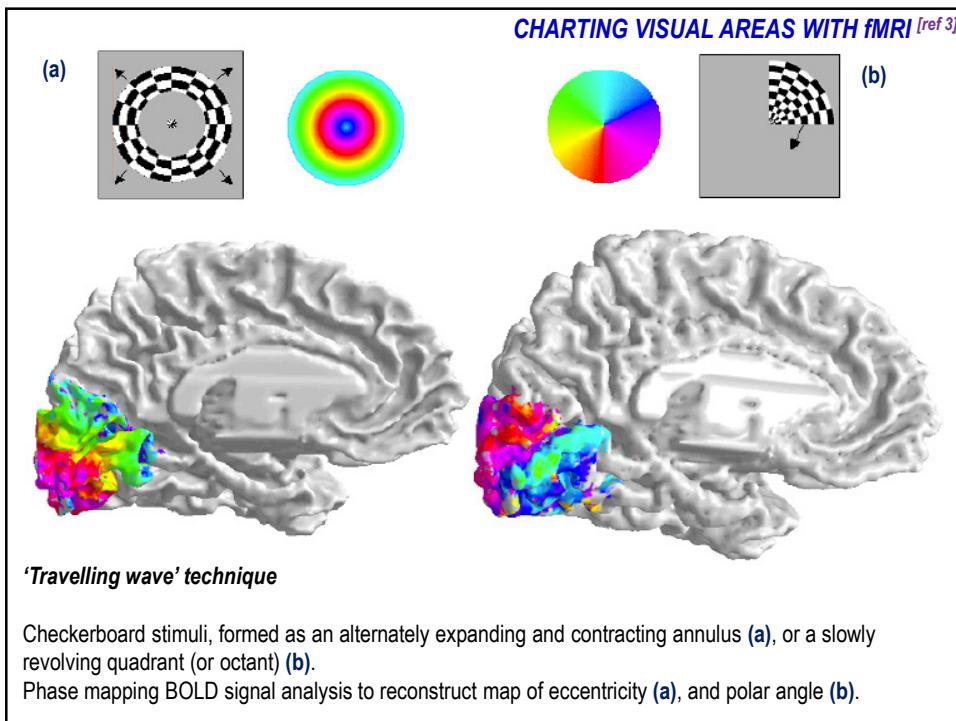
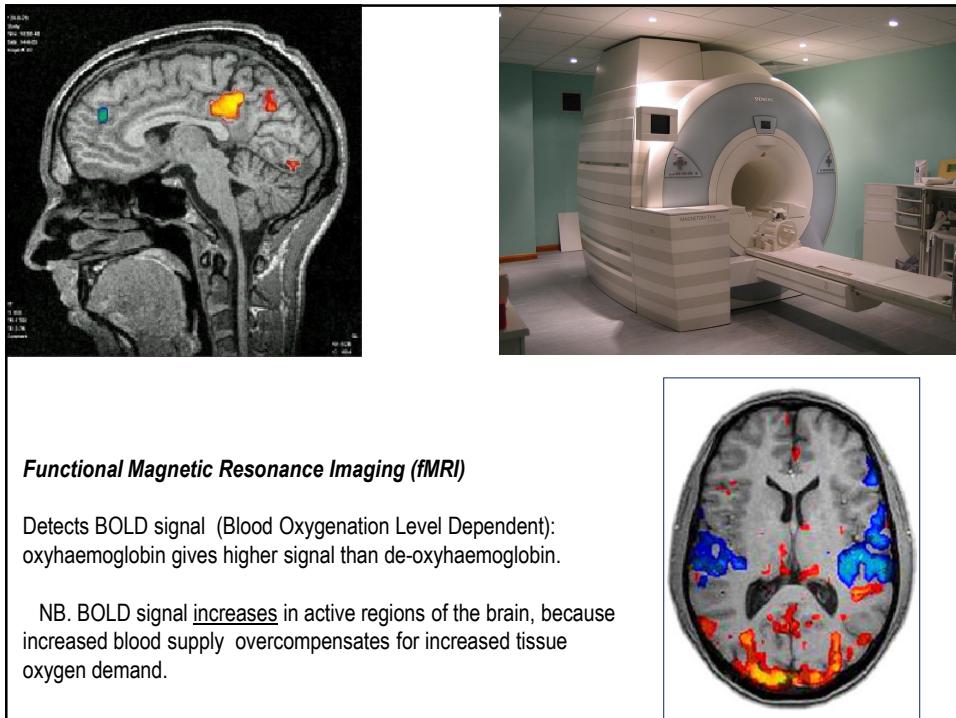
Can we use the same methods to identify human visual areas?

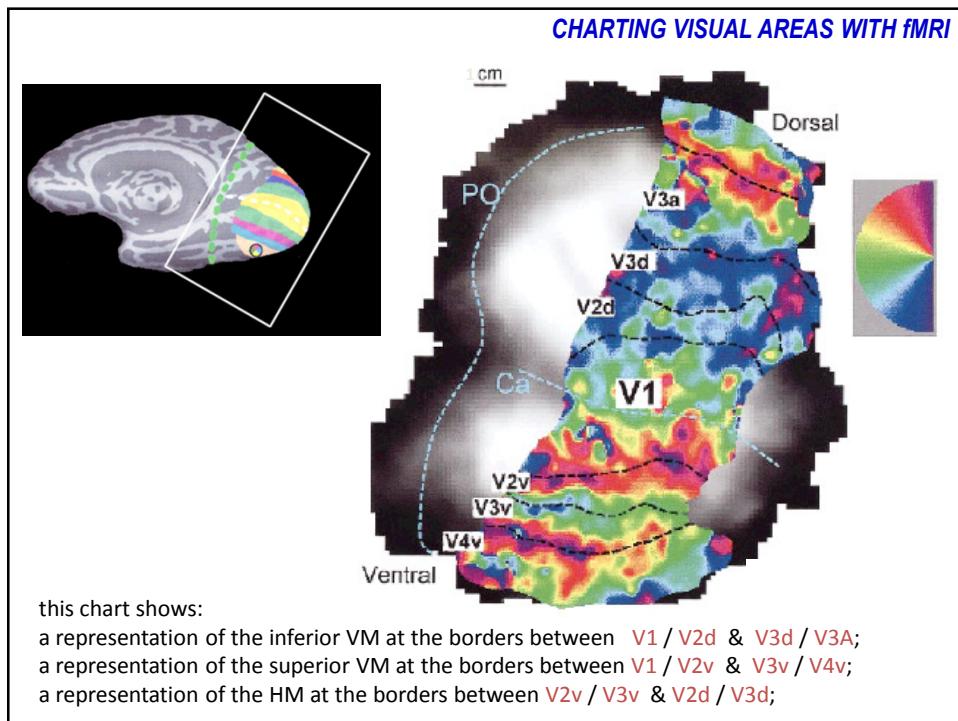
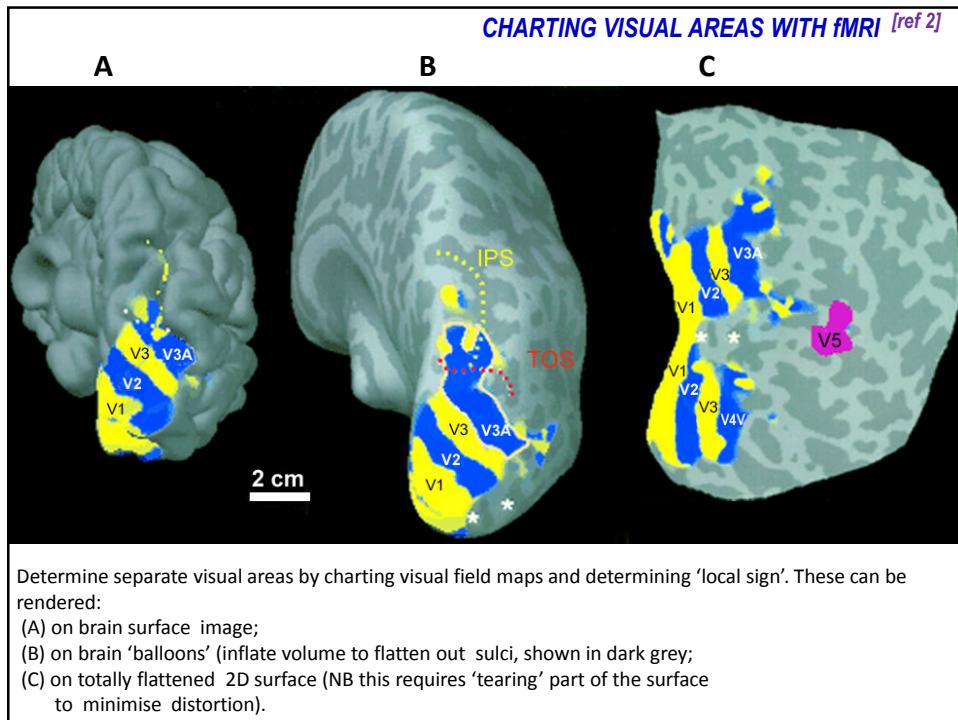
- Invasive methods for tract-tracing are impermissible;
- Single unit physiology is only obtainable under special circumstances;
- Post-mortem cortical architecture cannot be correlated with other criteria;

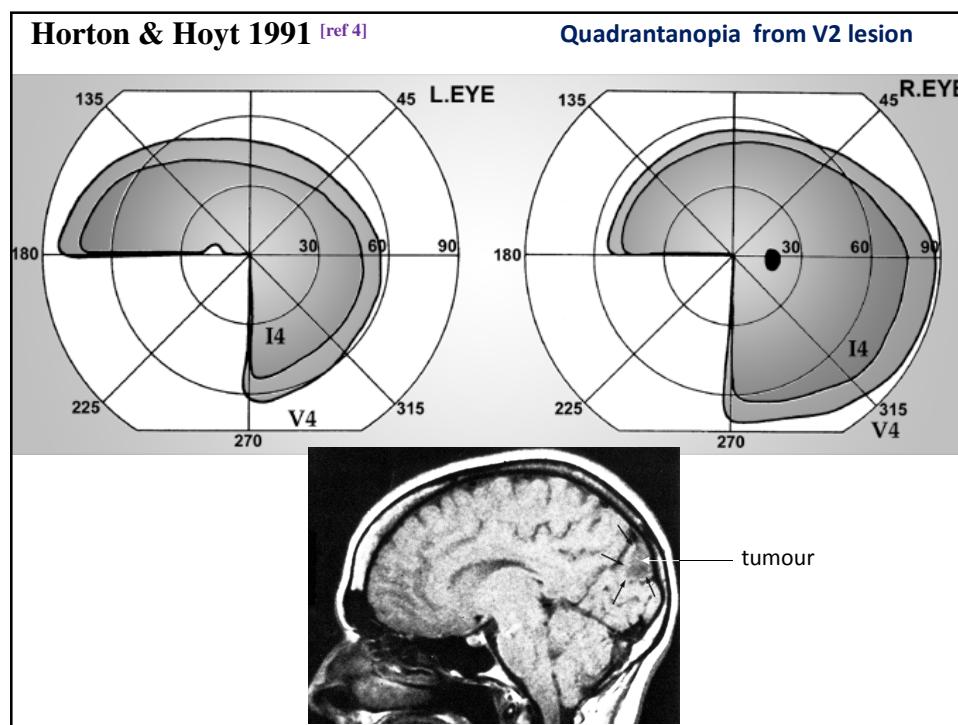
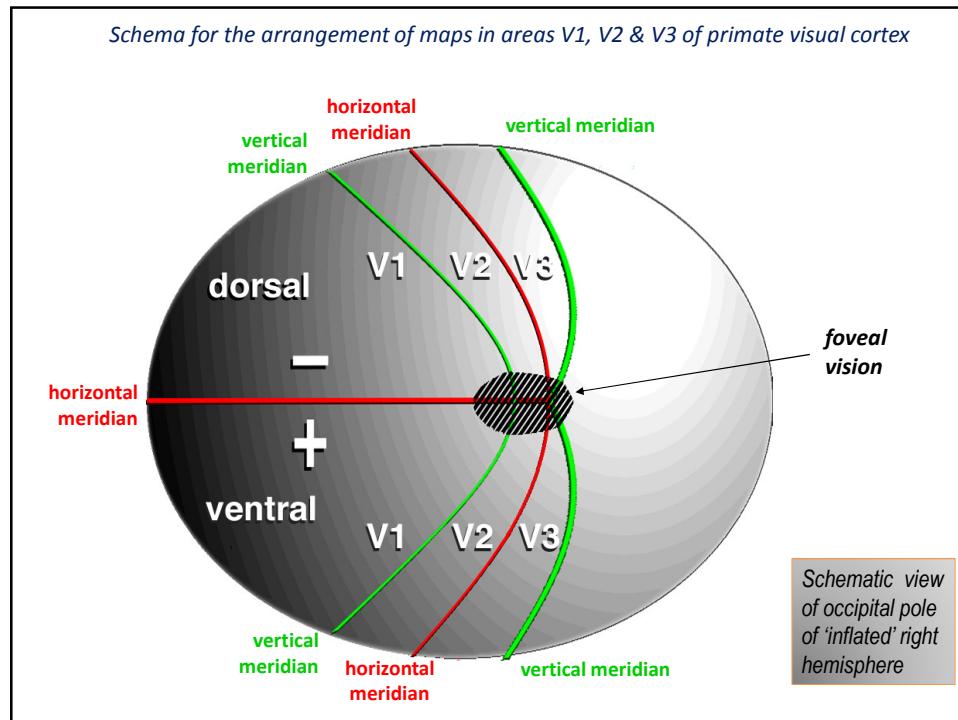
-BUT...

3: Use of imaging to chart areas in human visual cortex

- *Functional magnetic resonance imaging (fMRI) can:*
 - obtain retinotopic maps;
 - examine functional specialisation;
 - trace fibre bundles through white matter = DTI ('diffusion tensor imaging').

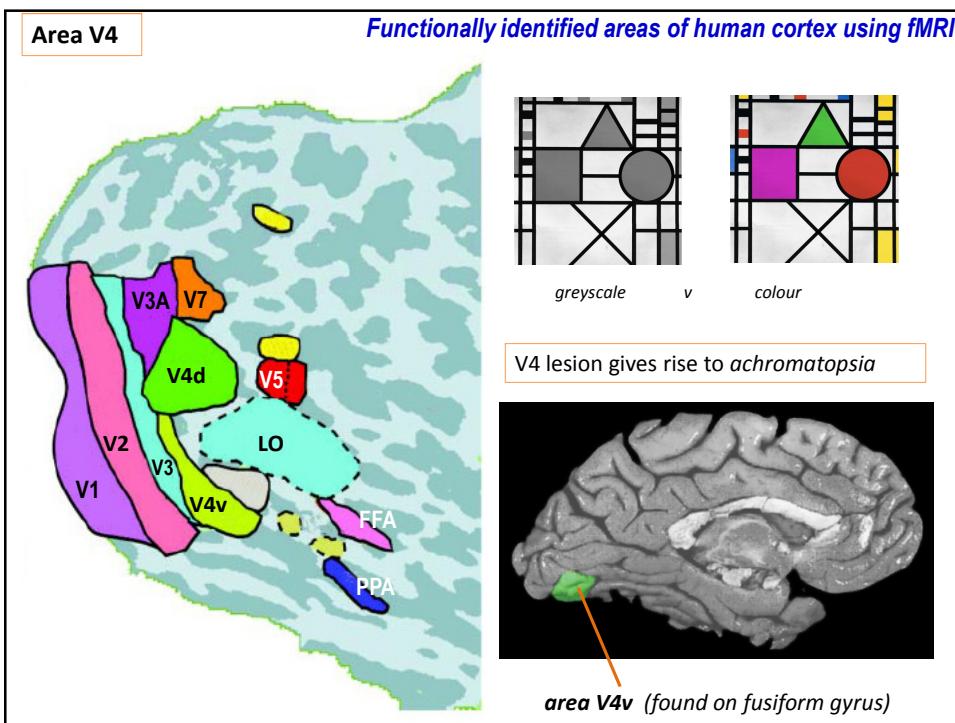


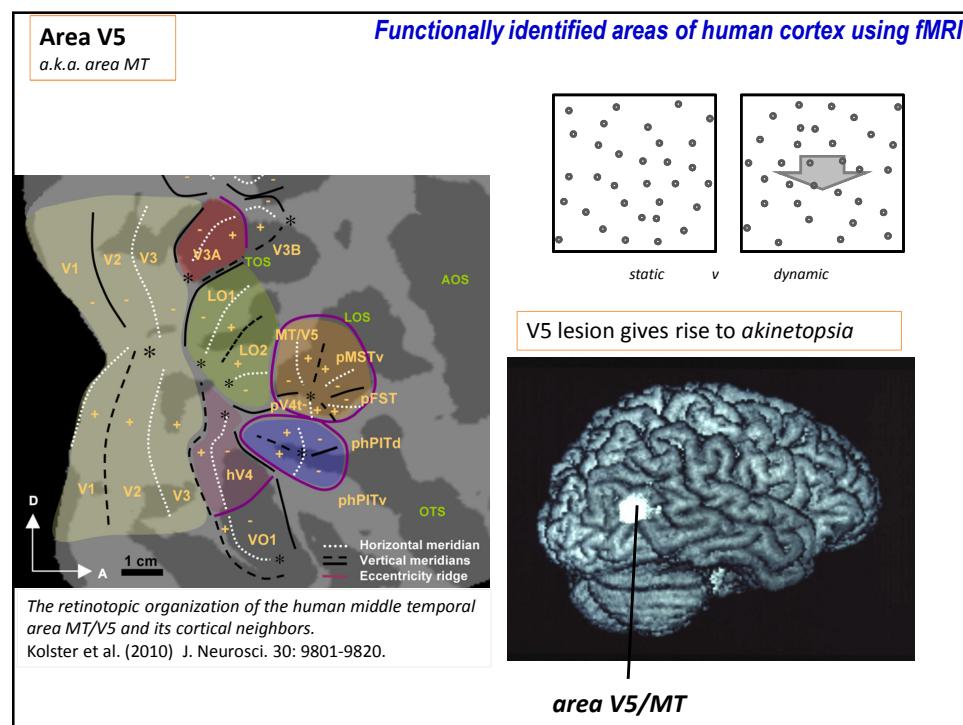
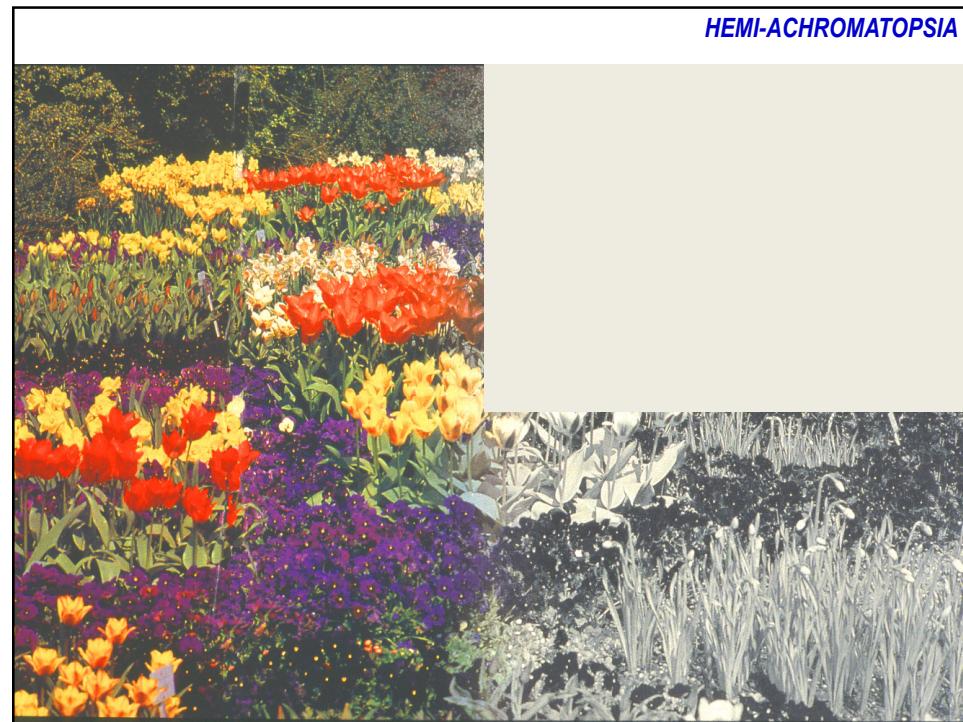


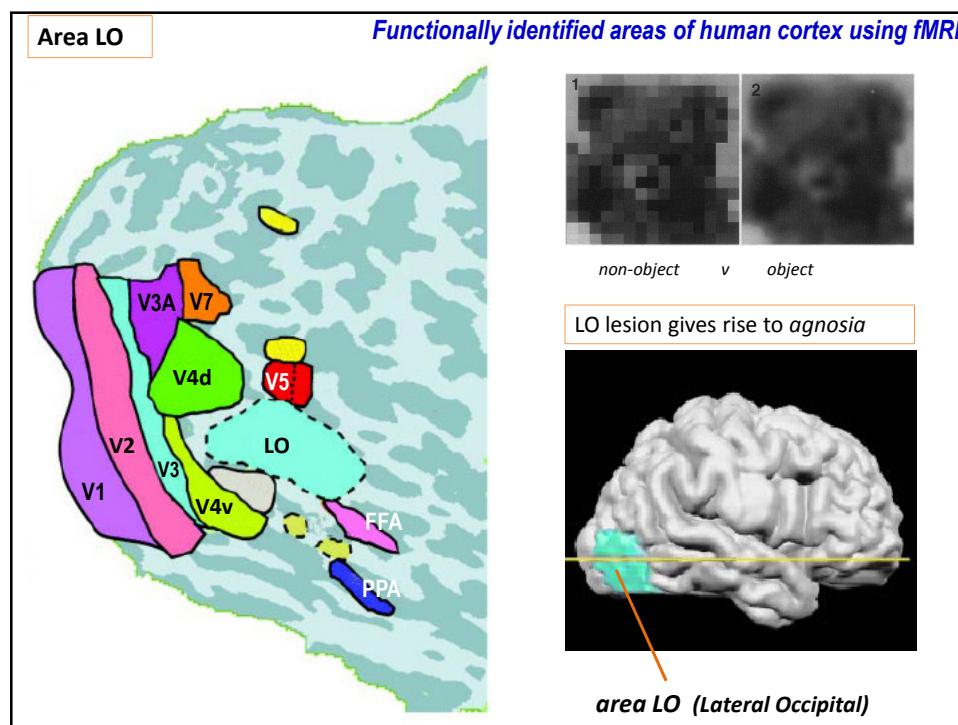
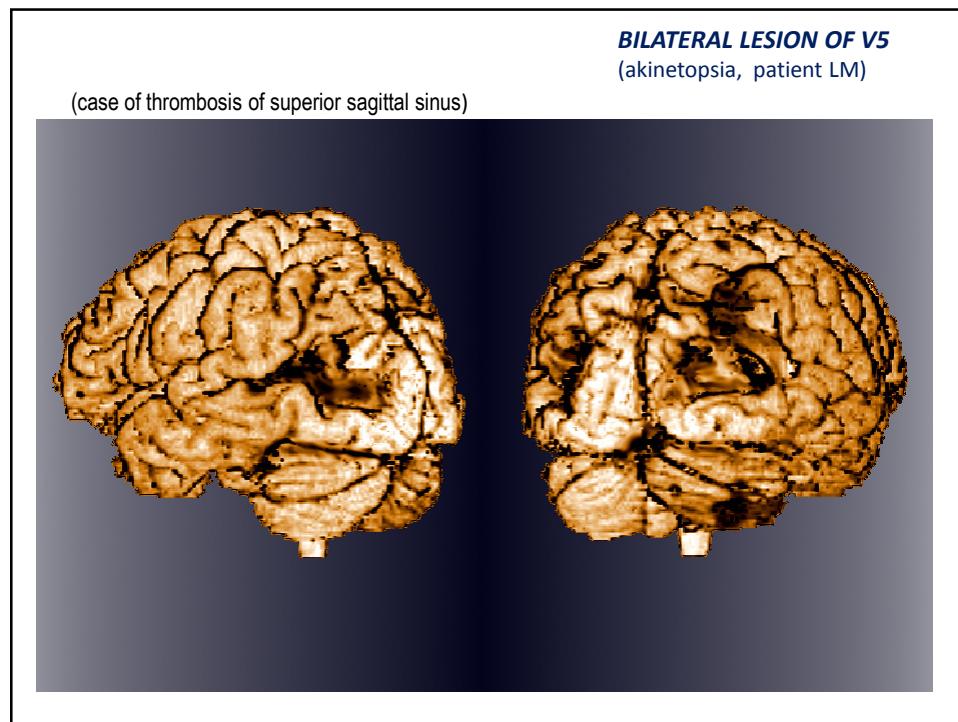


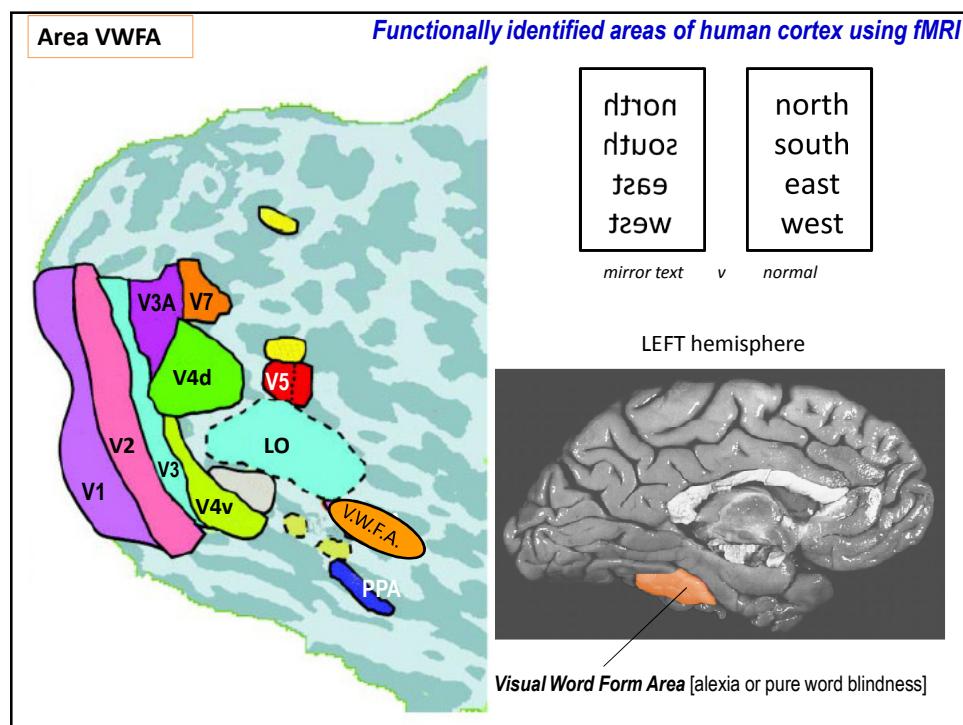
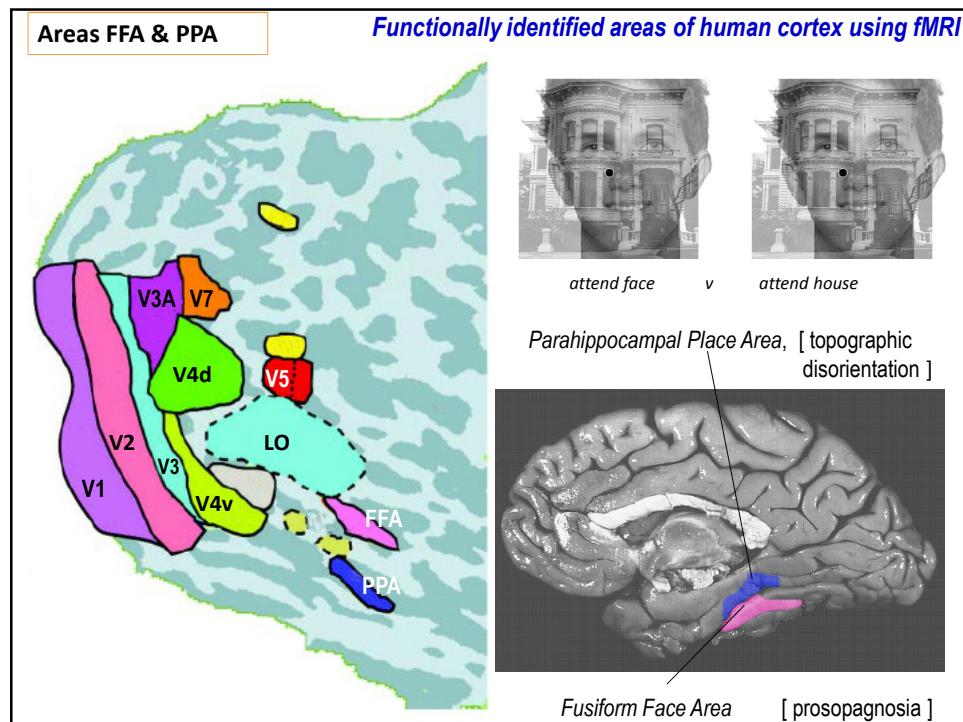
Use of fMRI to determine areas in human visual cortex

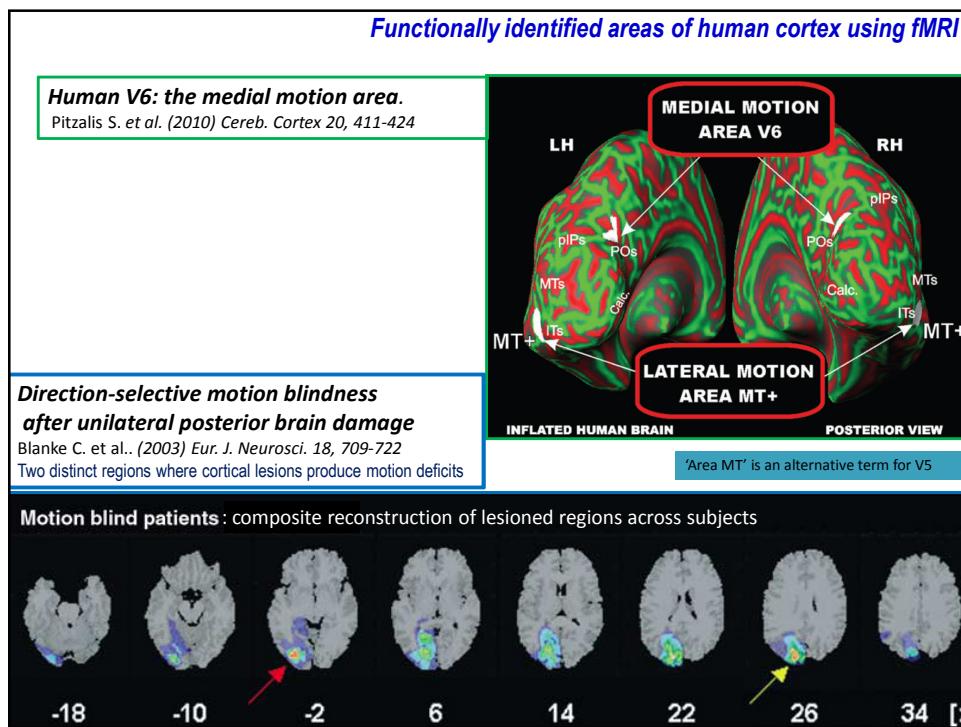
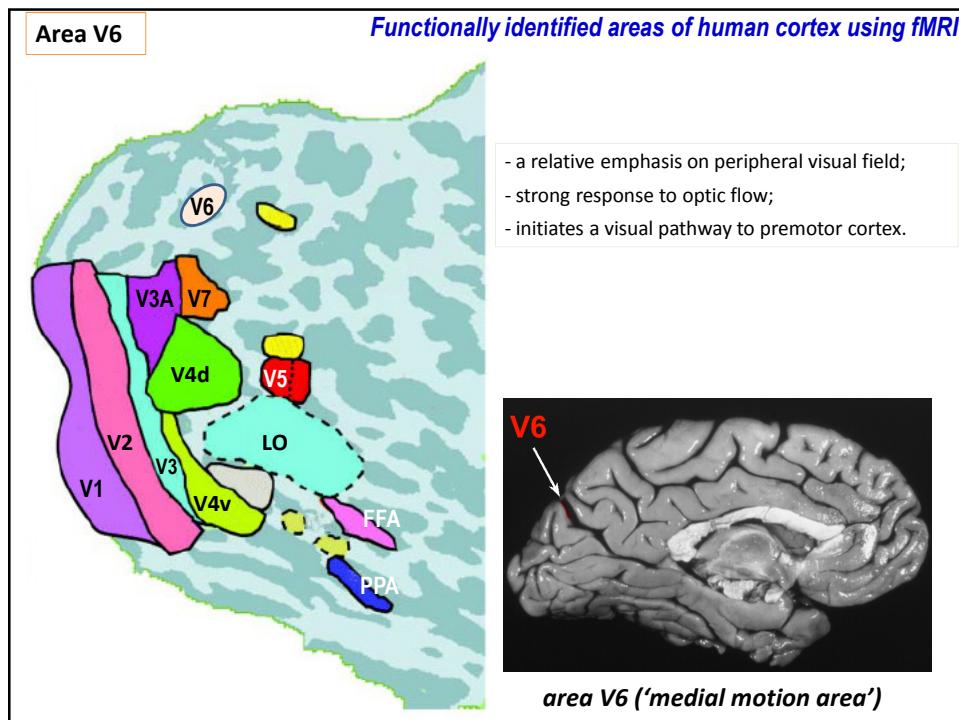
- (i) By charting retinotopic maps;
- (ii) By identifying regions with specific function (e.g. 'face' area).

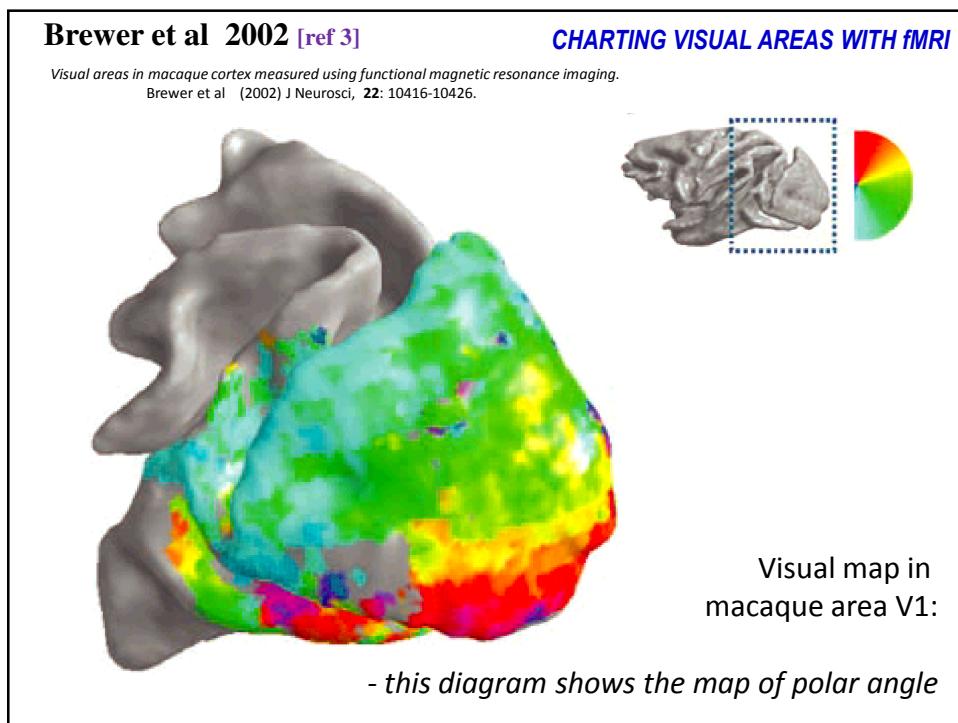
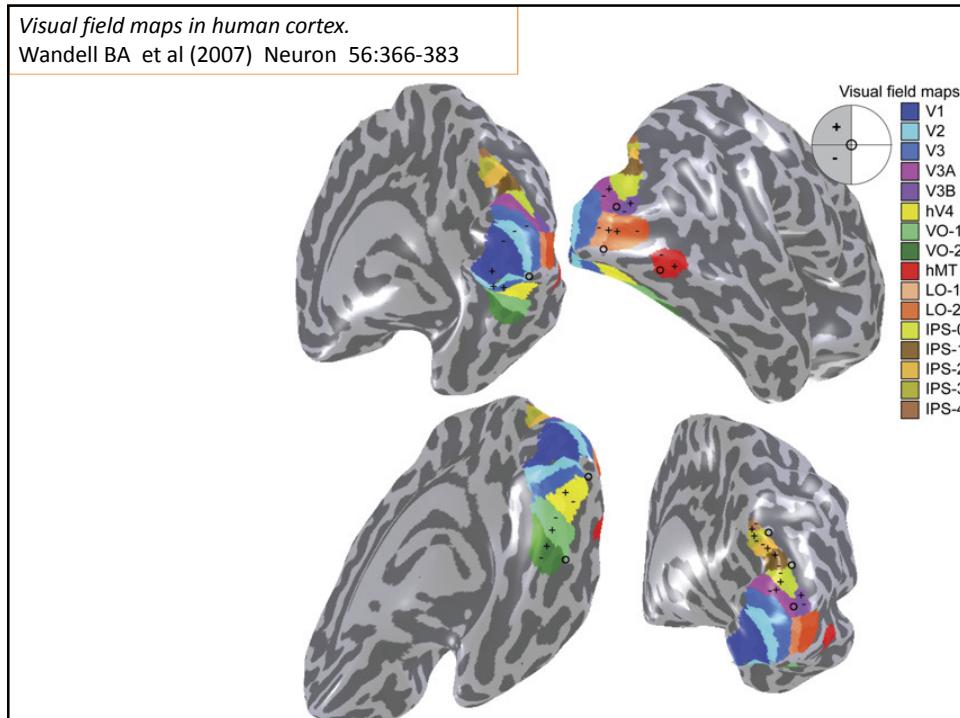




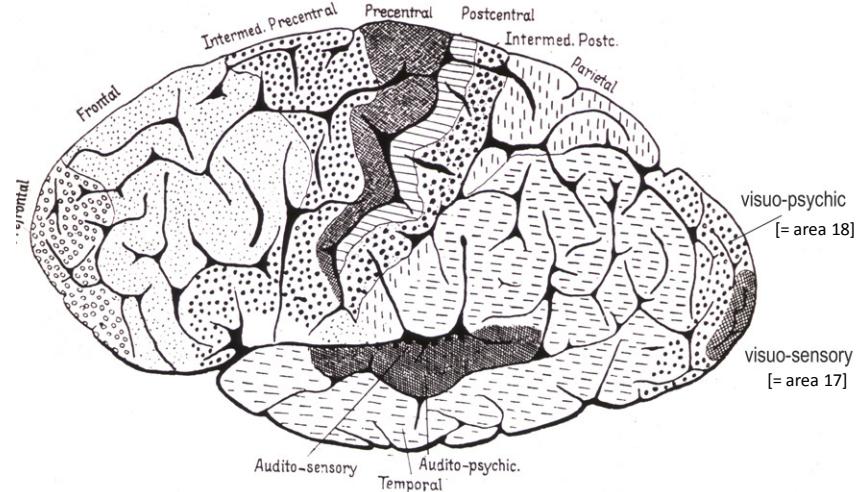








4. Why are there multiple areas? A ‘theory’ of vision



Campbell 1905



'homunculus'
theory of
vision &
brain function

visual processing requires
active synthesis of 'feature
detectors'

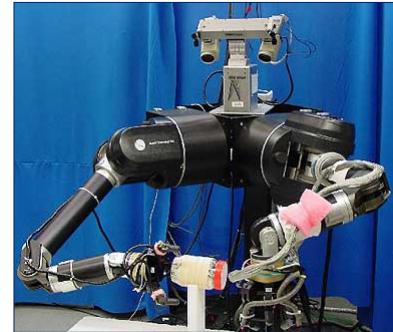
- colour
 - form/edges
 - motion
 - stereo depth
- +

hierarchical analysis of
feature combinations

Lessons from AI: machine vision

DAVID MARR

'SEEING': to know what is where by looking



Three levels of analysis by which to understand any seeing system (natural or artificial)

1. Computational goal
2. Algorithm
3. Physical implementation by computational hardware (biological or electronic)

Why are there so many visual areas... ?



COLOUR
FORM
STEREOSCOPIC DEPTH
MOTION

All require very different processing strategies
- most efficient if performed separately