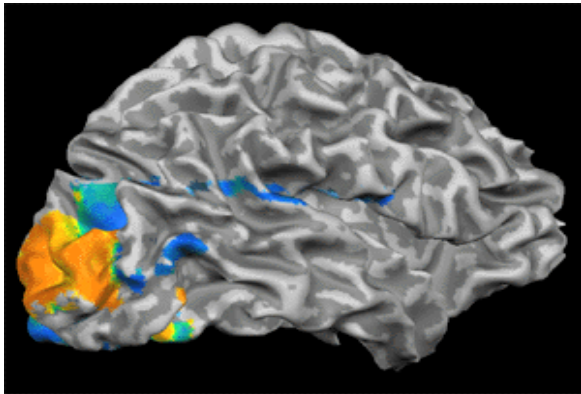


Visual perception across the lifespan

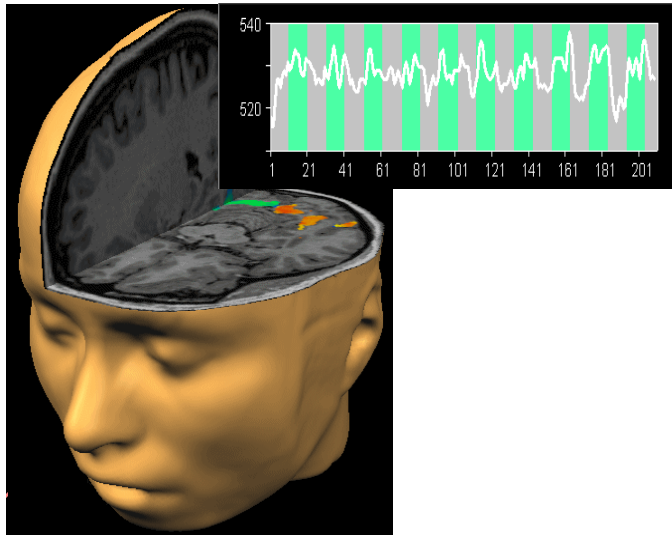


Prof Zoe Kourtzi
University of Birmingham
School of Psychology

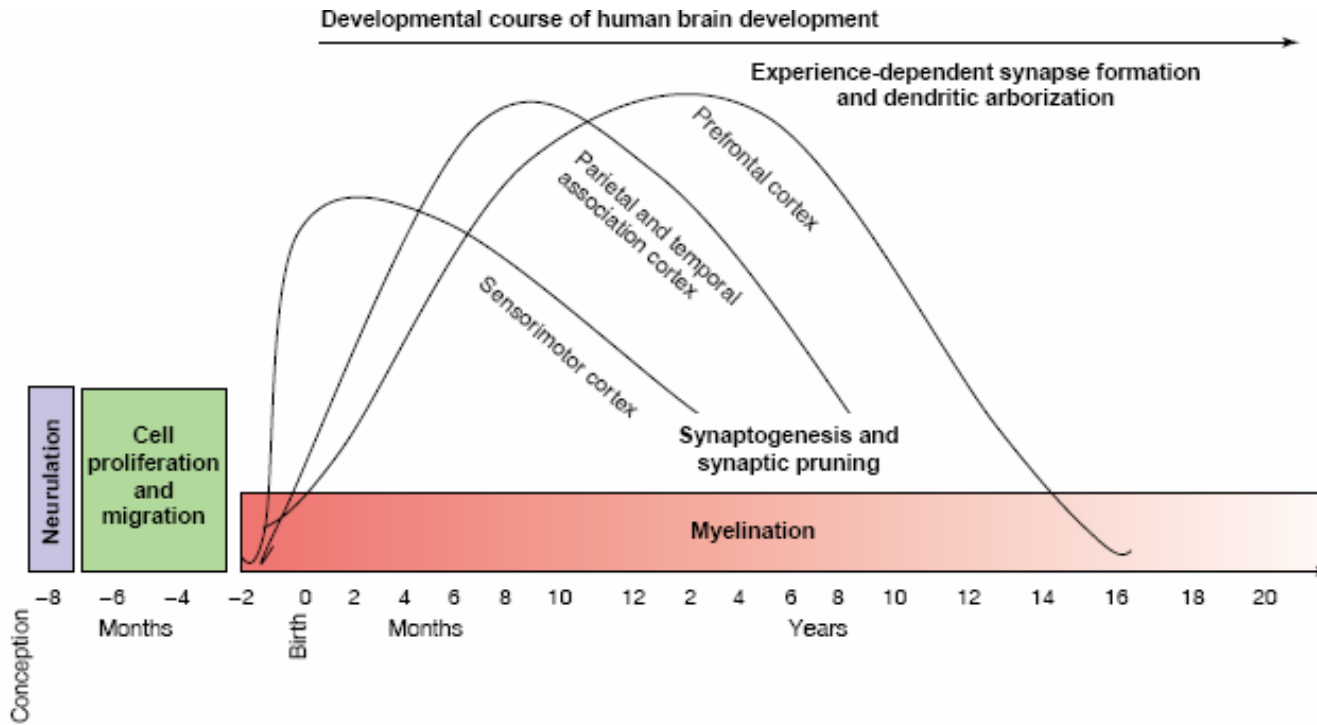


The million £ question in visual neuroscience

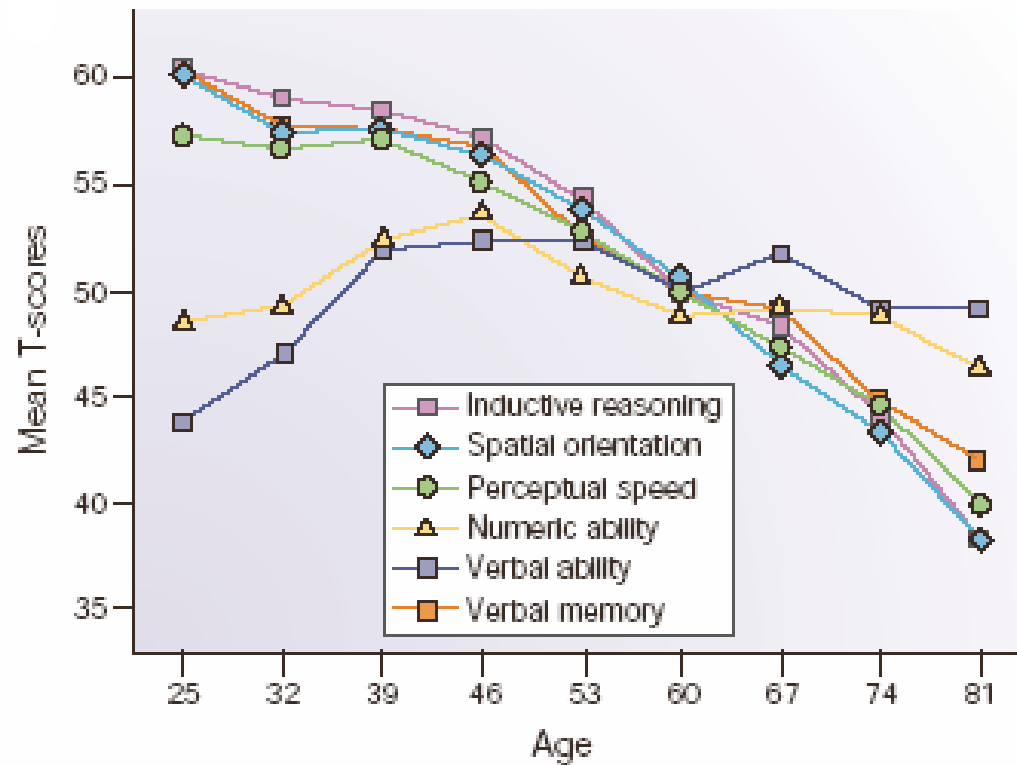
What brain computations mediate human behaviour in complex environments?



Life-long Development

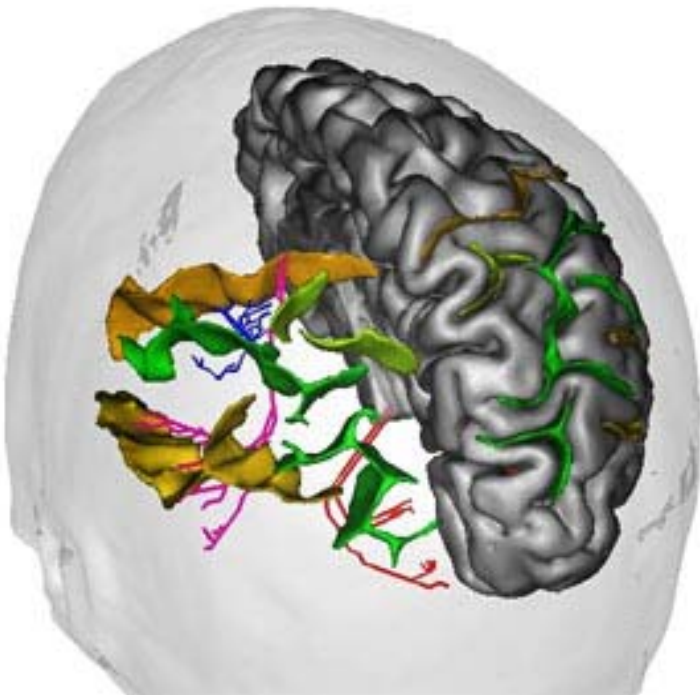


Ageing: behavioural changes

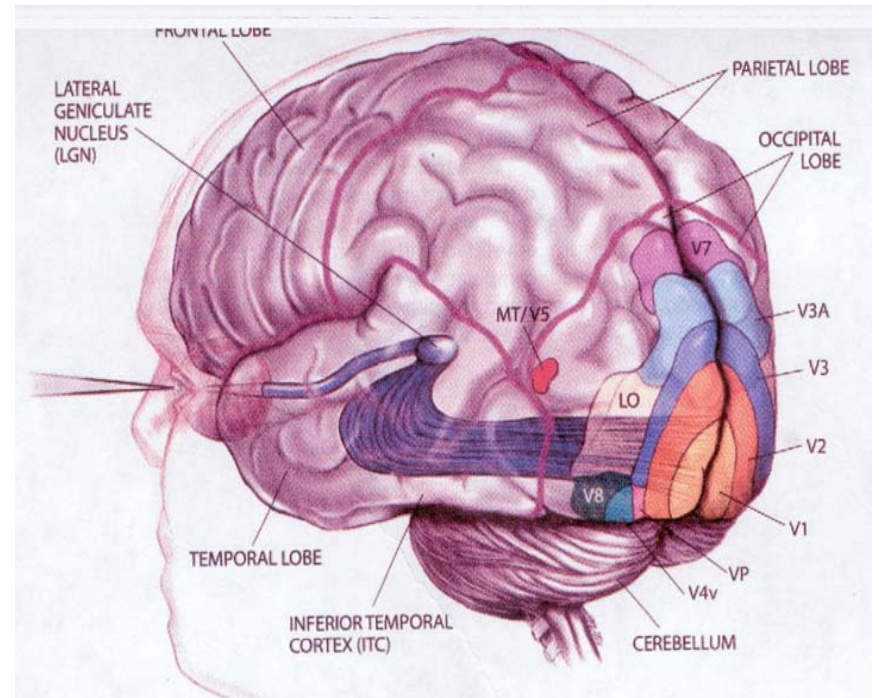


From MRI to fMRI

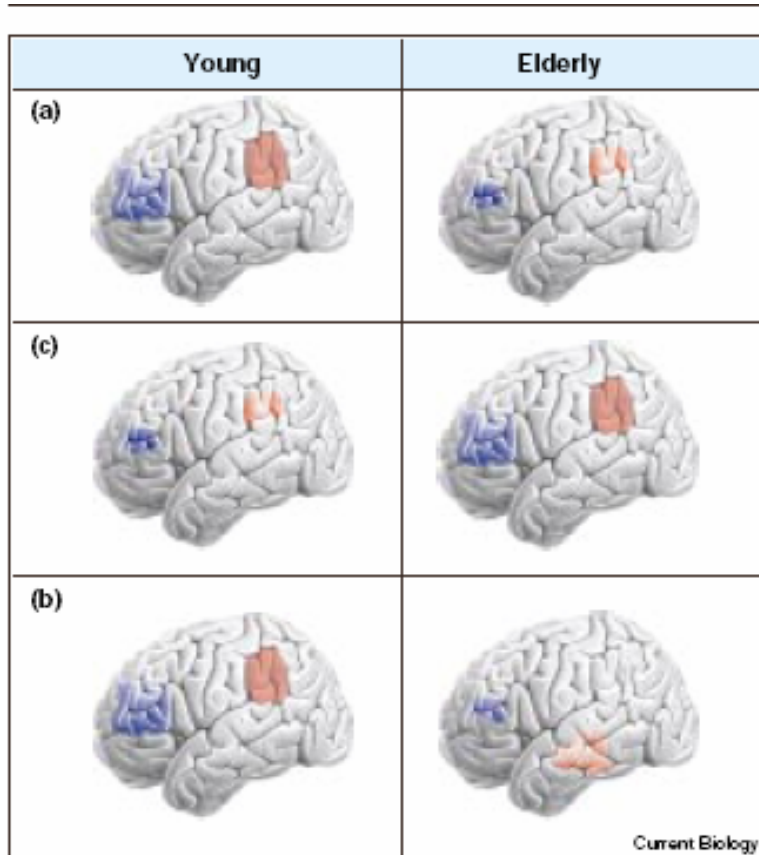
MRI: brain anatomy



fMRI: brain function



Ageing: functional changes



Three scenarios :

1. Similar activation patterns for young and old individuals but greater activation for young individuals.
2. Similar activation patterns for young and old individuals but greater activation for old individuals.
3. Different patterns of activation with new alternate areas recruited in old individuals to compensate for cell changes.

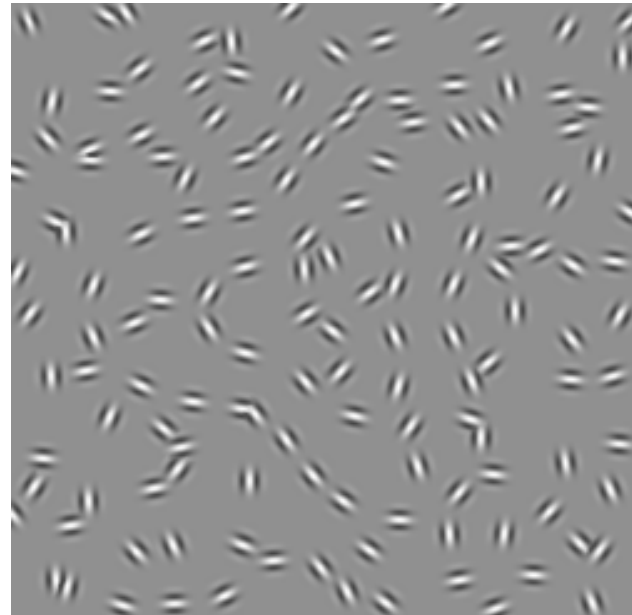
Questions and Aims

What are the brain mechanisms that mediate decisions in complex environments across the lifespan?

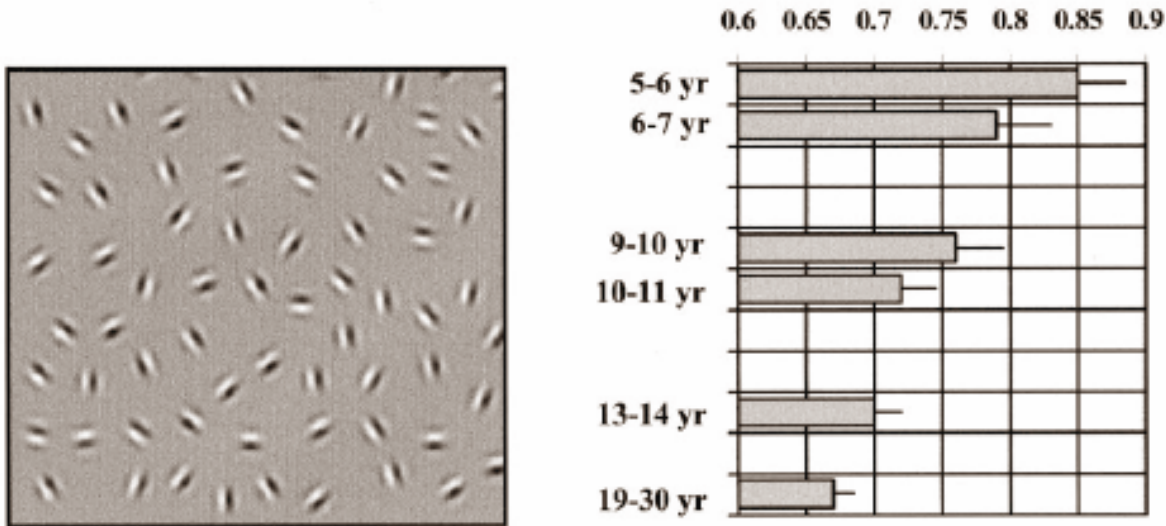
We aim to identify biomarkers of cognitive ageing by combining: behavioural measurements with structural and functional imaging and advanced mathematical modelling



How does the brain solve the puzzle of coherent visual perception?



What is the developmental timecourse of coherent visual perception?



Glass patterns

Signal 100%

Signal 50%

Signal 0%

Radial



Concentric



Development of coherent visual perception: functions that mature later decline faster

Concentric



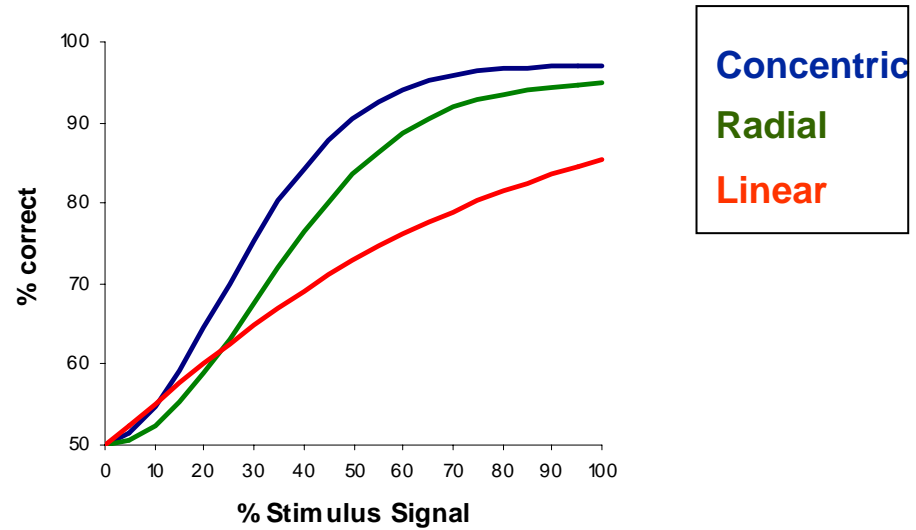
Radial



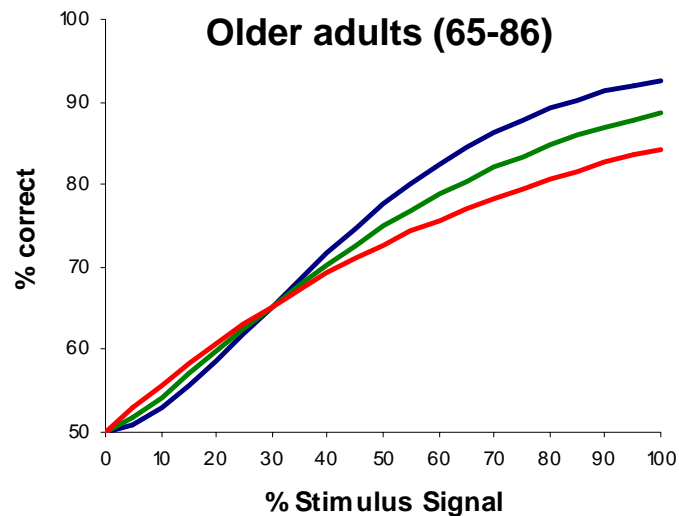
Linear



Young adults (19-35)

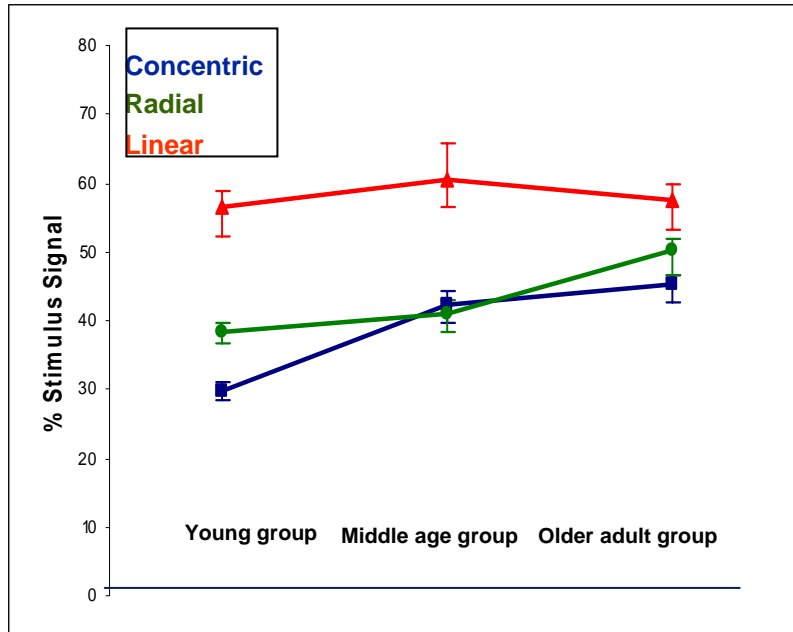


Older adults (65-86)

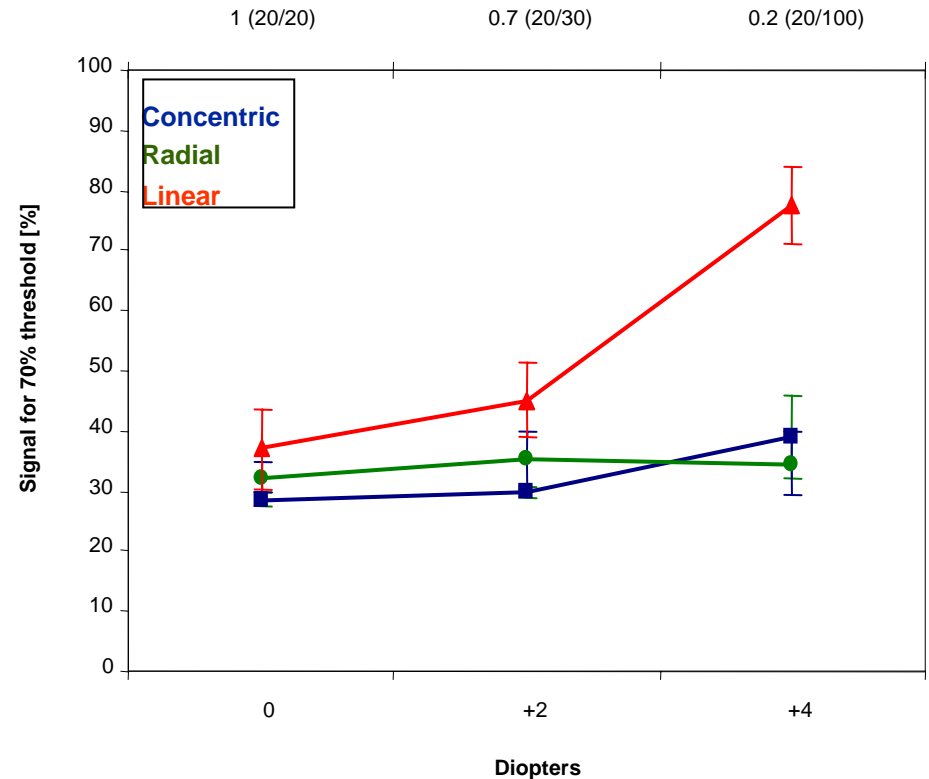


Development of coherent visual perception: functions that mature later decline faster

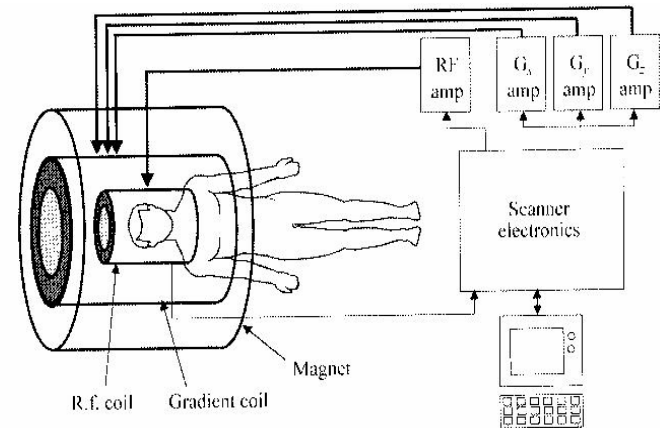
75% Threshold performance



Visual Acuity (Snellen)

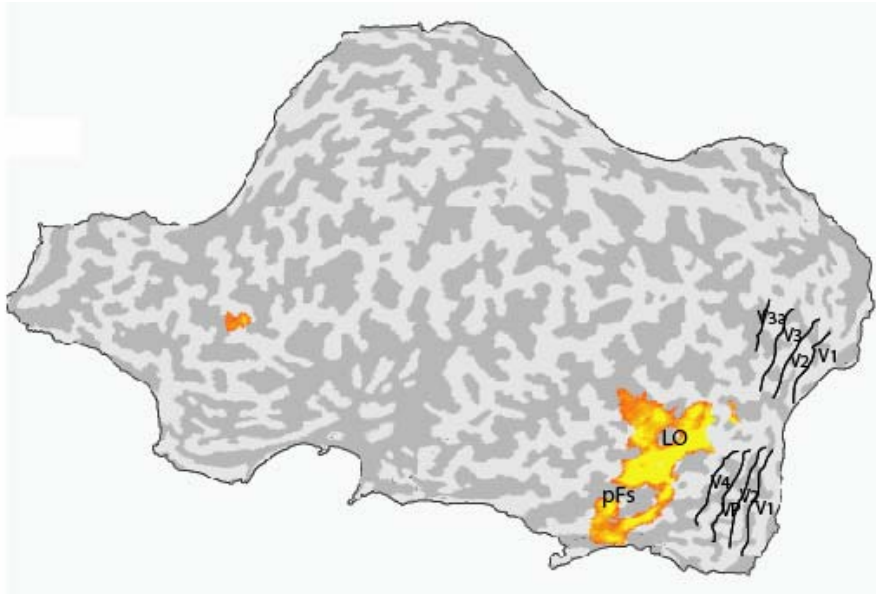


Brain Imaging at 3T

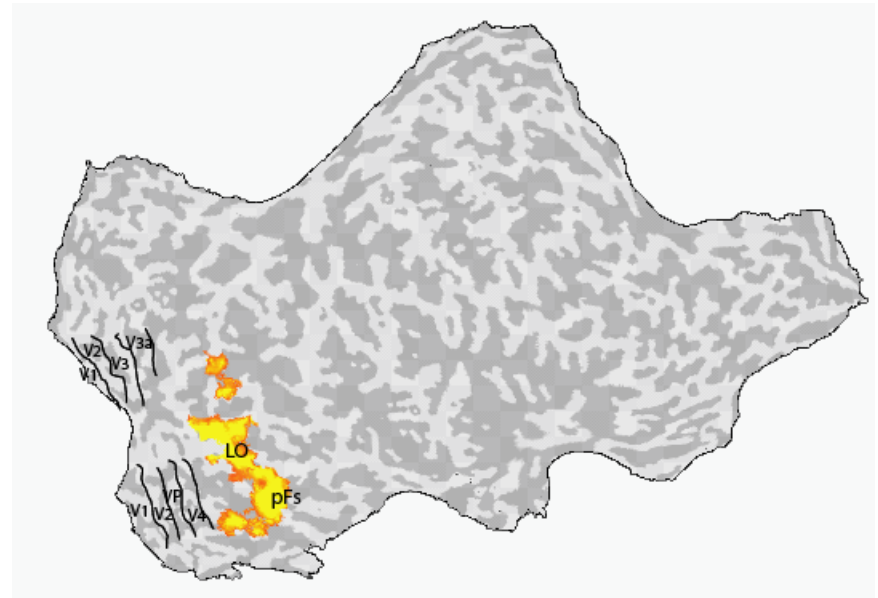


Functional Localisation of visual areas in young adults

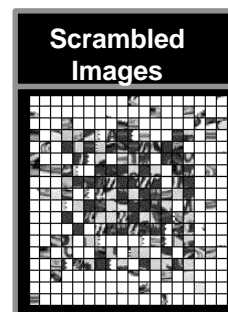
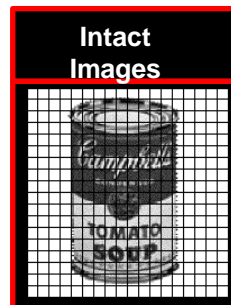
p (Bonf) < 0.01 t(2336) 5.15  8



Left Hemisphere



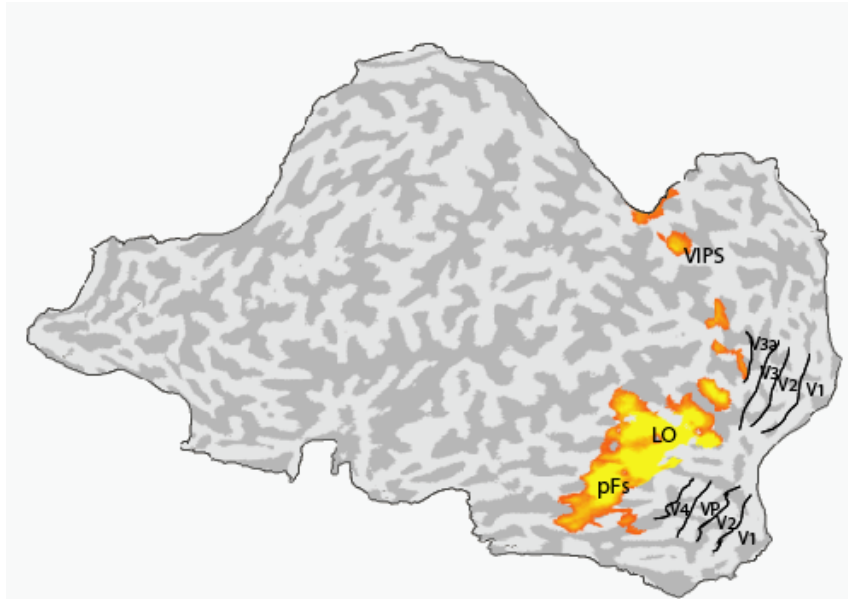
Right Hemisphere



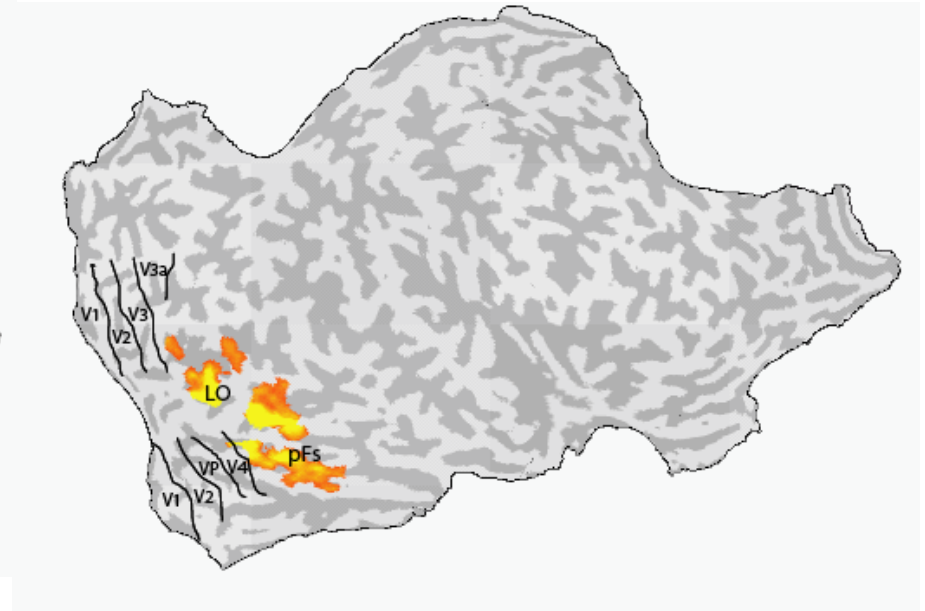
Grill-Spector et al., 1998
Kanwisher et al., 1996
Kourtzi & Kanwisher, 2000
Malach et al., 1995

Functional Localisation of visual areas in older adults

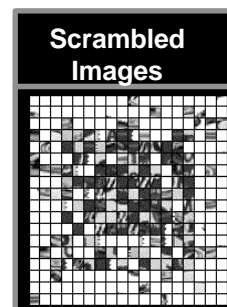
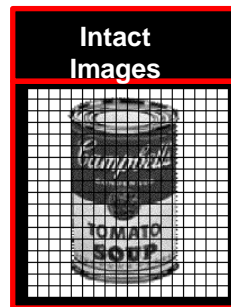
p (Bonf) < 0.01 t(2336) 5.15  8



Left Hemisphere

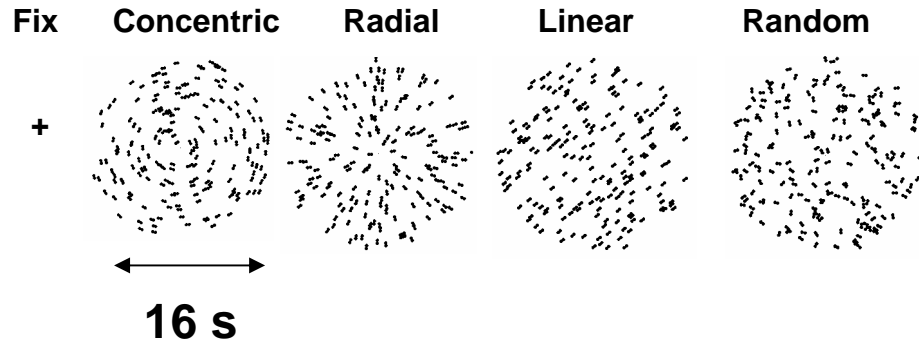


Right Hemisphere



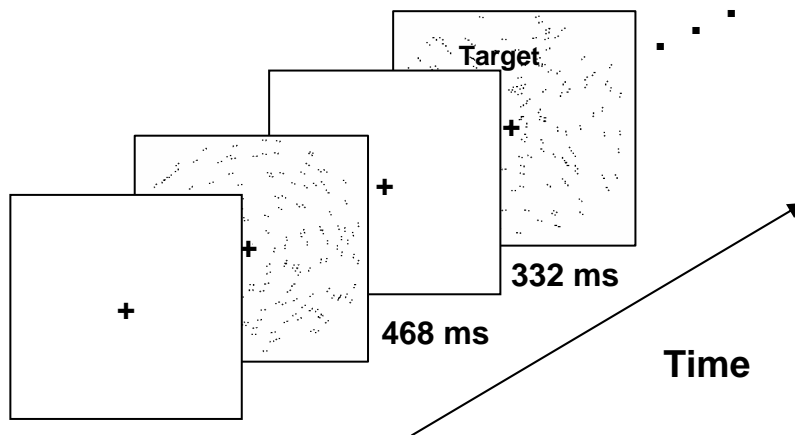
Grill-Spector et al., 1998
Kanwisher et al., 1996
Kourtzi & Kanwisher, 2000
Malach et al., 1995

Design



3 Tesla Phillips Achieva
TR 2000 ms
2.5 x 2.5 x 3 mm Voxels

Observer's Task



Target detection

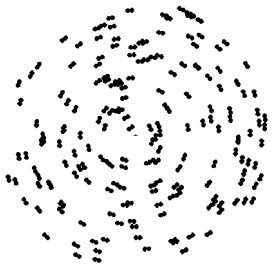
Young adults: hyperbolic pattern

Older adults: denser pattern

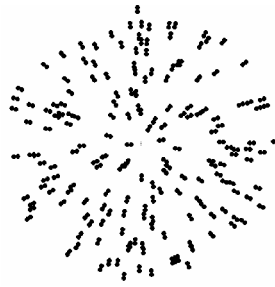
Mapping areas involved in the analysis of global patterns

Young adult group

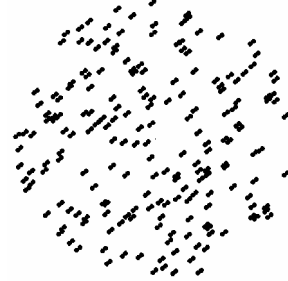
Concentric



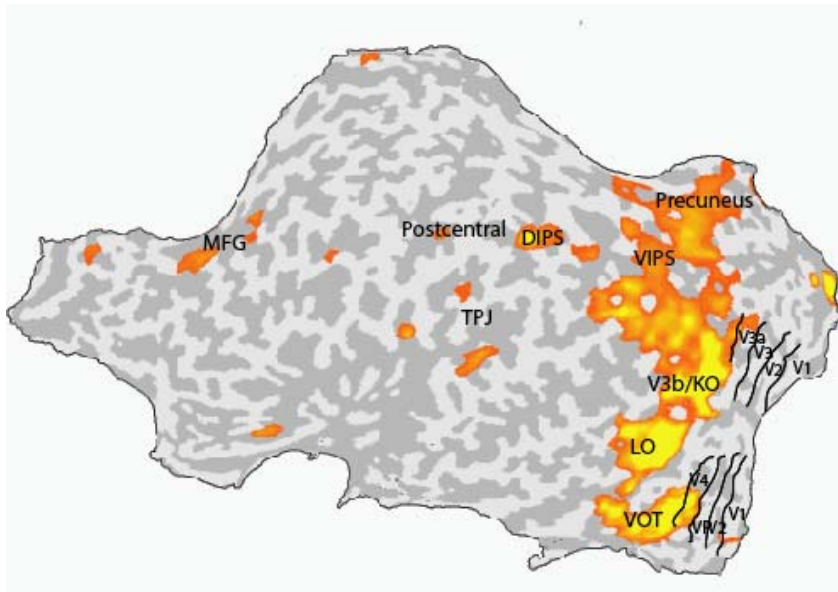
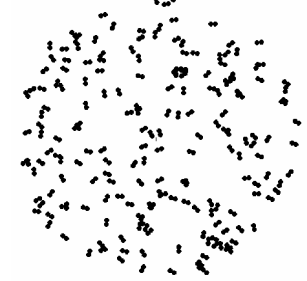
Radial



Linear

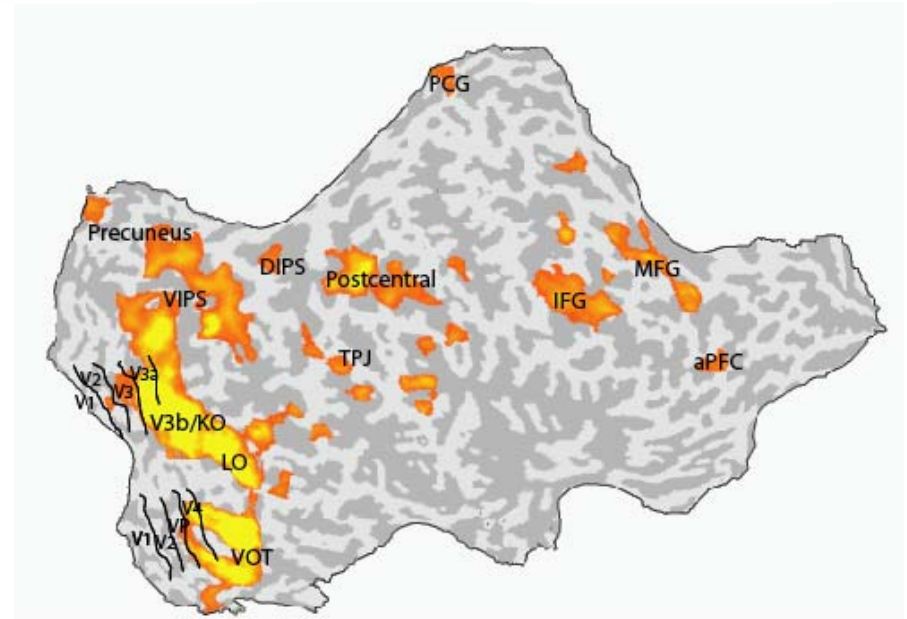


Random



Left Hemisphere

$p(\text{RFX}) < 0.05$



Right Hemisphere

$t(11) 2.2$  4

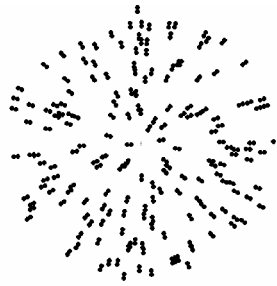
Mapping areas involved in the analysis of global patterns

Older adult group

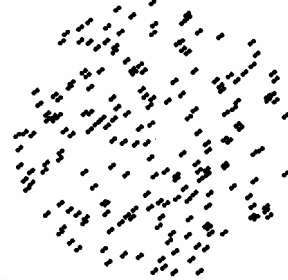
Concentric



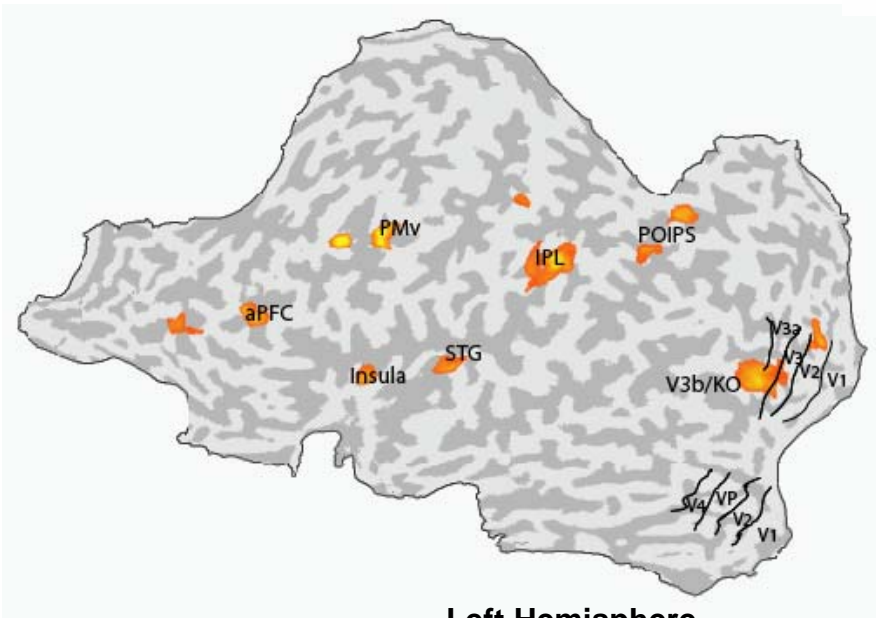
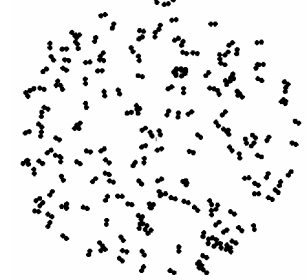
Radial



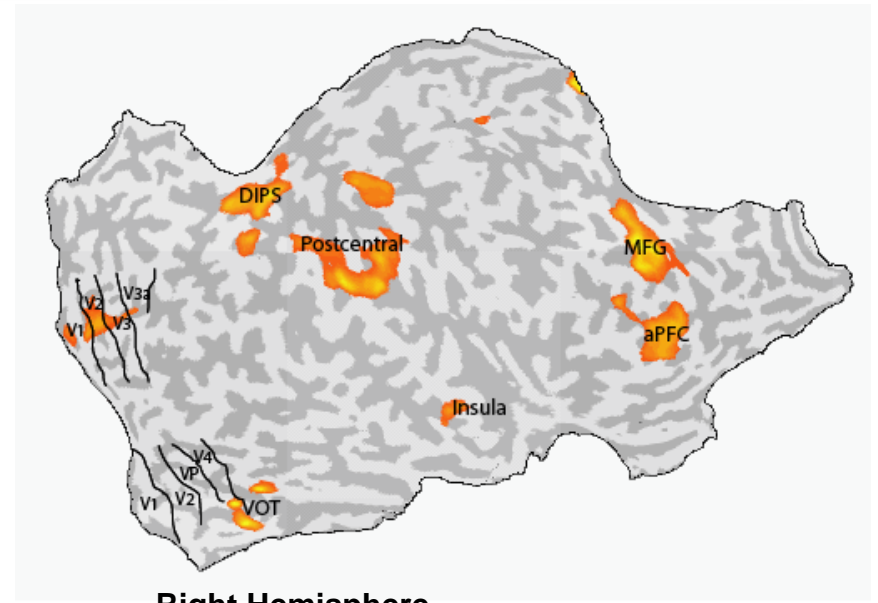
Linear



Random



Left Hemisphere



Right Hemisphere

$p(\text{RFX}) < 0.05$

$t(11) 2.2$  4

fMRI selectivity for global forms

Concentric



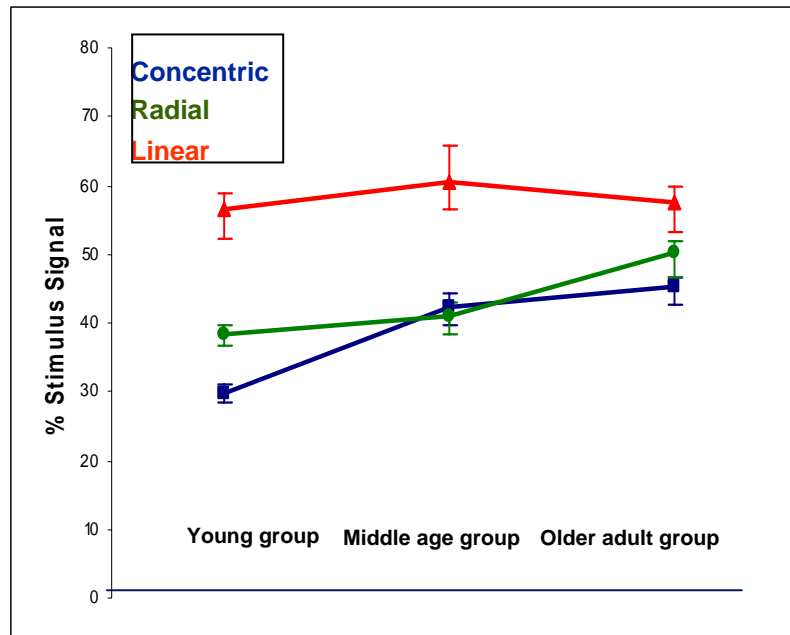
Radial



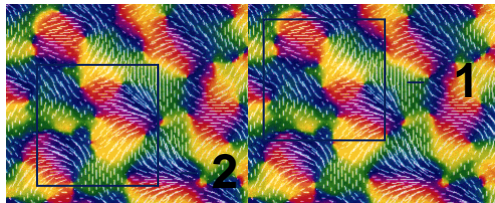
Linear



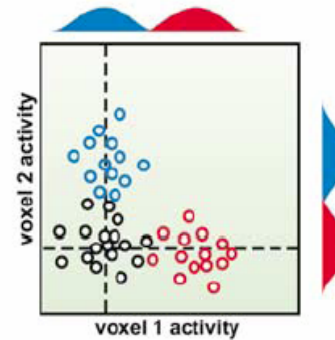
75% Threshold performance



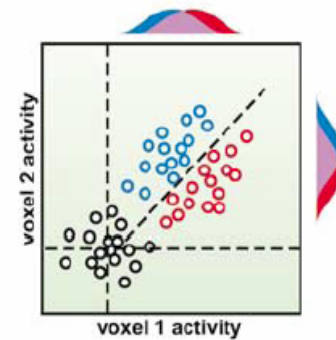
Studying neural selectivity with fMRI



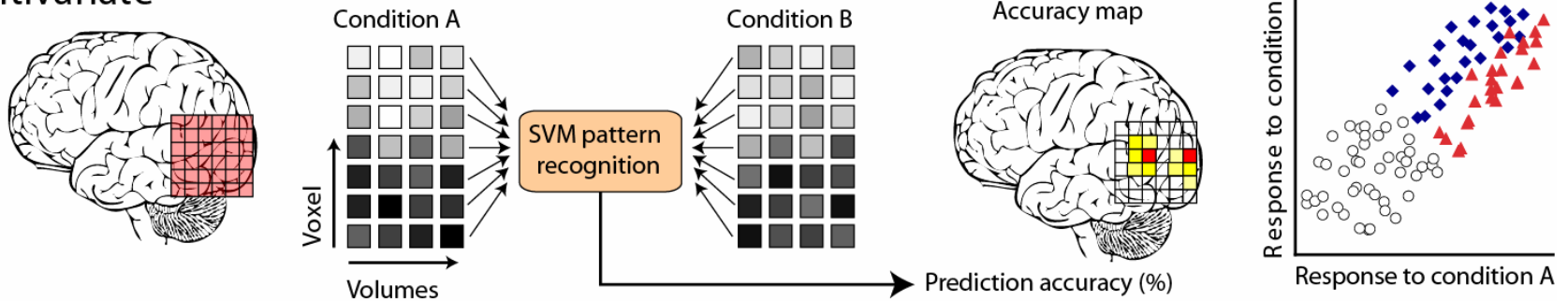
a. Ideal Univariate Situation



b. Linearly Separable

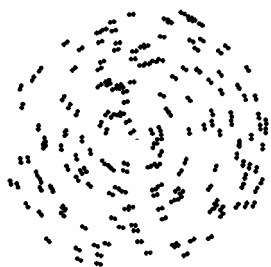


Multivariate



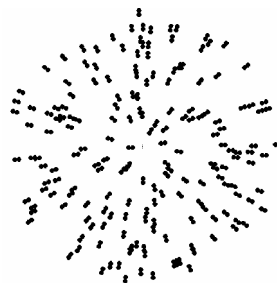
fMRI selectivity for global forms Young adult group

Concentric



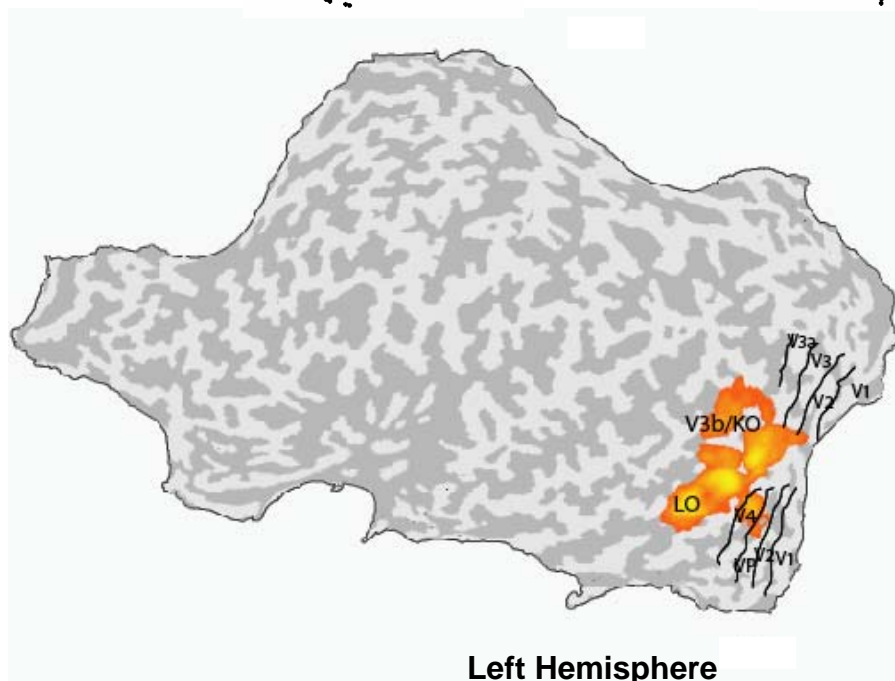
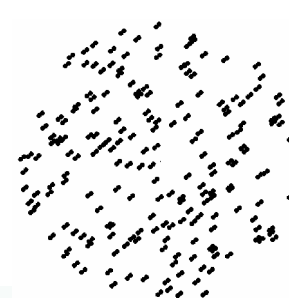
VS.

Radial

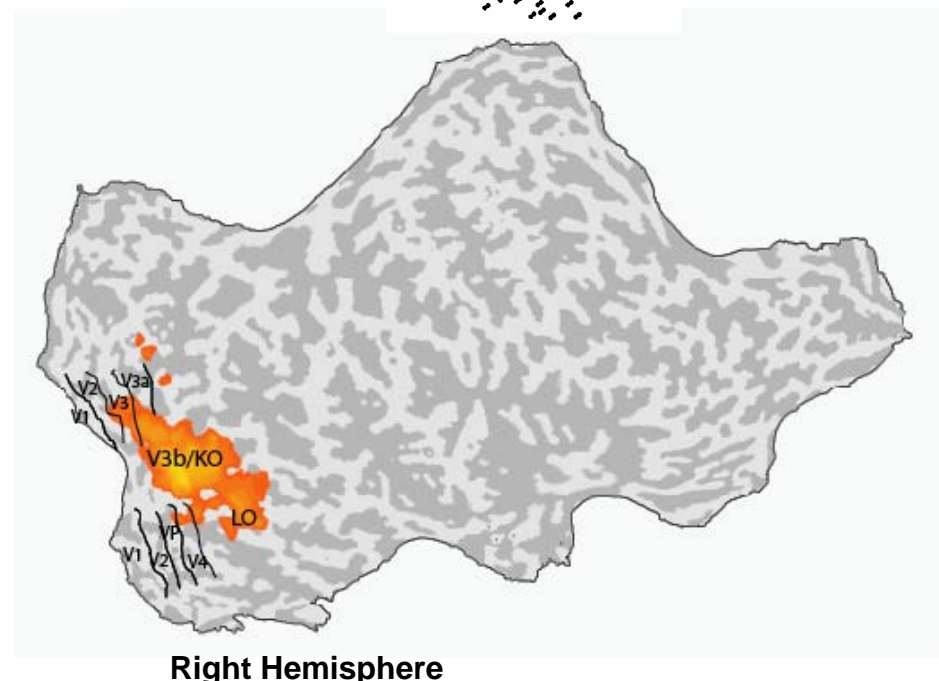


VS.


Linear



Left Hemisphere



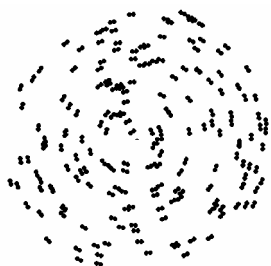
Right Hemisphere

Classification Accuracy 0.43  0.52

fMRI selectivity for global forms

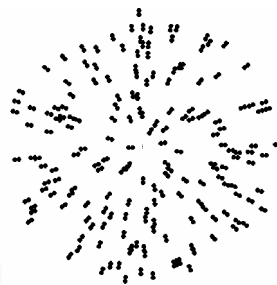
Older adult group

Concentric



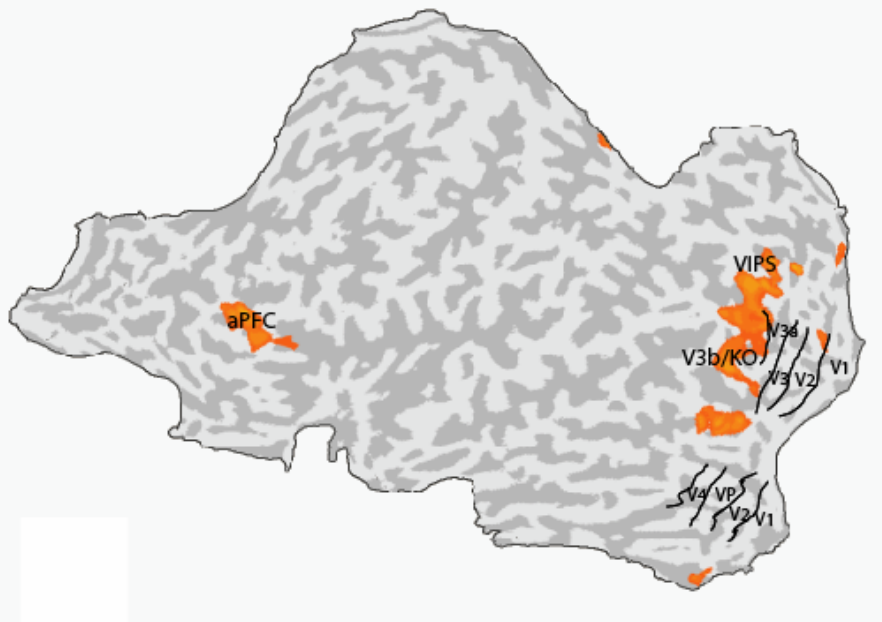
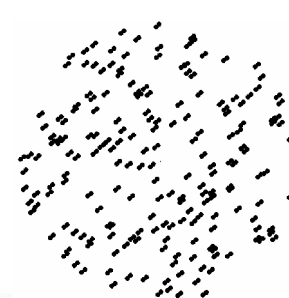
VS.

Radial

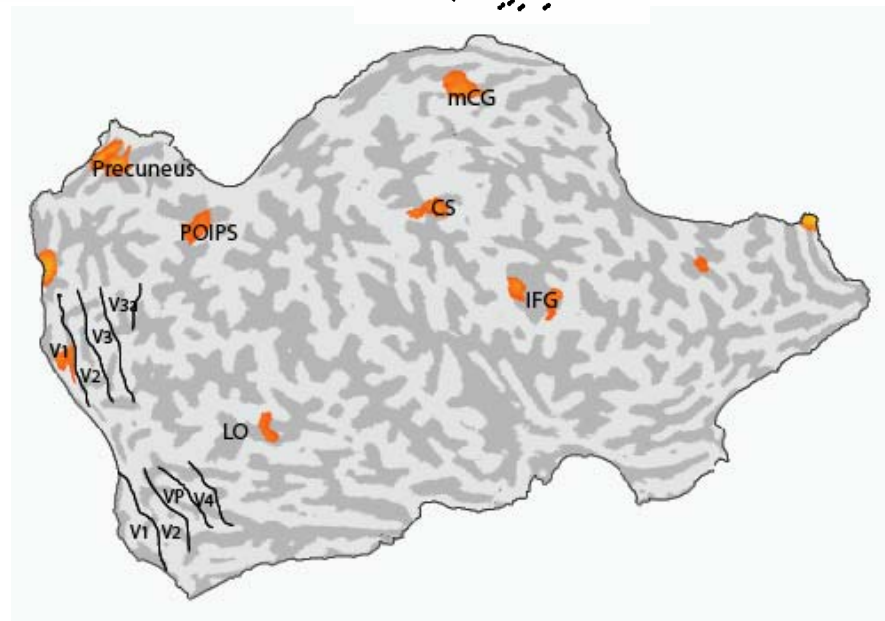


VS.


Linear



Left Hemisphere



Right Hemisphere

Classification Accuracy 0.38  0.43

Summary

- **Perceptual integration of global forms and decisions in cluttered scenes are mediated by perceptual processes that mature late and decline faster**
- **fMRI shows decreased involvement of temporal areas but additional recruitment of early visual areas potentially modulated by fronto-parietal networks in older adults**



Future questions

- How do behavioural and functional changes in ageing relate to changes in the morphology and connectivity of brain structures?
- What is the neural dynamics of perceptual integration and decisions and how do they change with age?
- Does learning shape the brain functions and cognitive abilities that mediate decisions across the lifespan?



Thanks to

Judith Lam

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Sheng Li

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