

Giftedness and the brain

Day 2

Session 1: 1000-1130

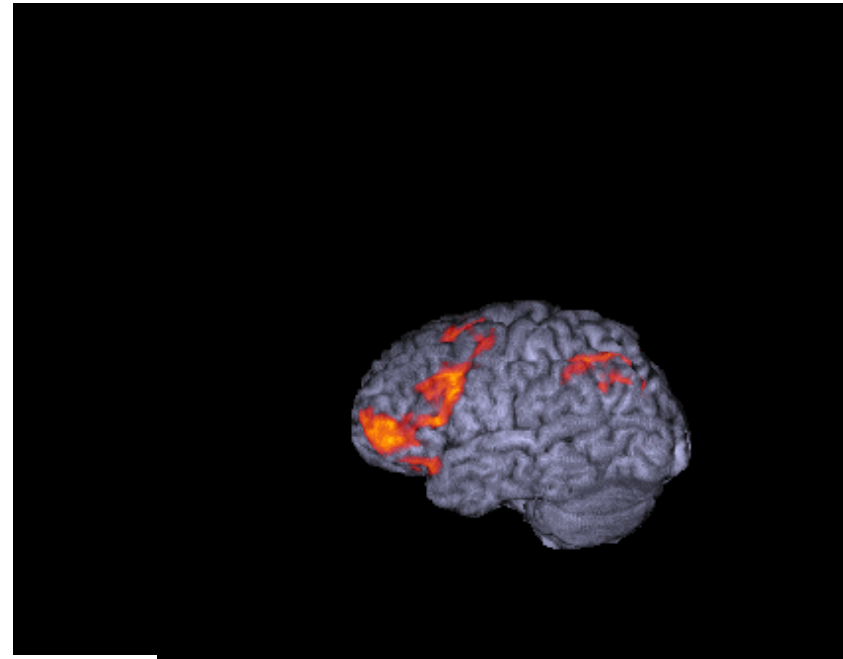
- What is the neural basis of intelligence?
- How are gifted children's brains different from others?

Session 2: 1200-1330

- What is the neural basis of creativity?
- How could we teach to optimise creative intelligence?

Session 3: 1430-1600

- Future directions in neuroscience?
- Future of educational neuroscience?

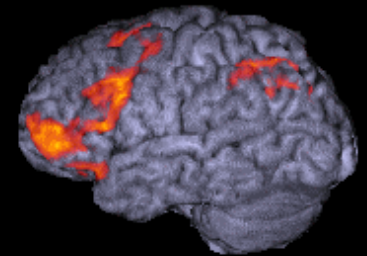


Giftedness and the brain

Day 2

Session 1: 1000-1130

- What is the neural basis of intelligence?
 - IQ test
 - Intelligent thinking
- How are gifted children's brains different from others?
 - When doing hard stuff
 - When doing dumb stuff



A definition of intelligence

Intelligence is context-appropriate cognitive activity involving abstraction, reasoning, learning and memory.

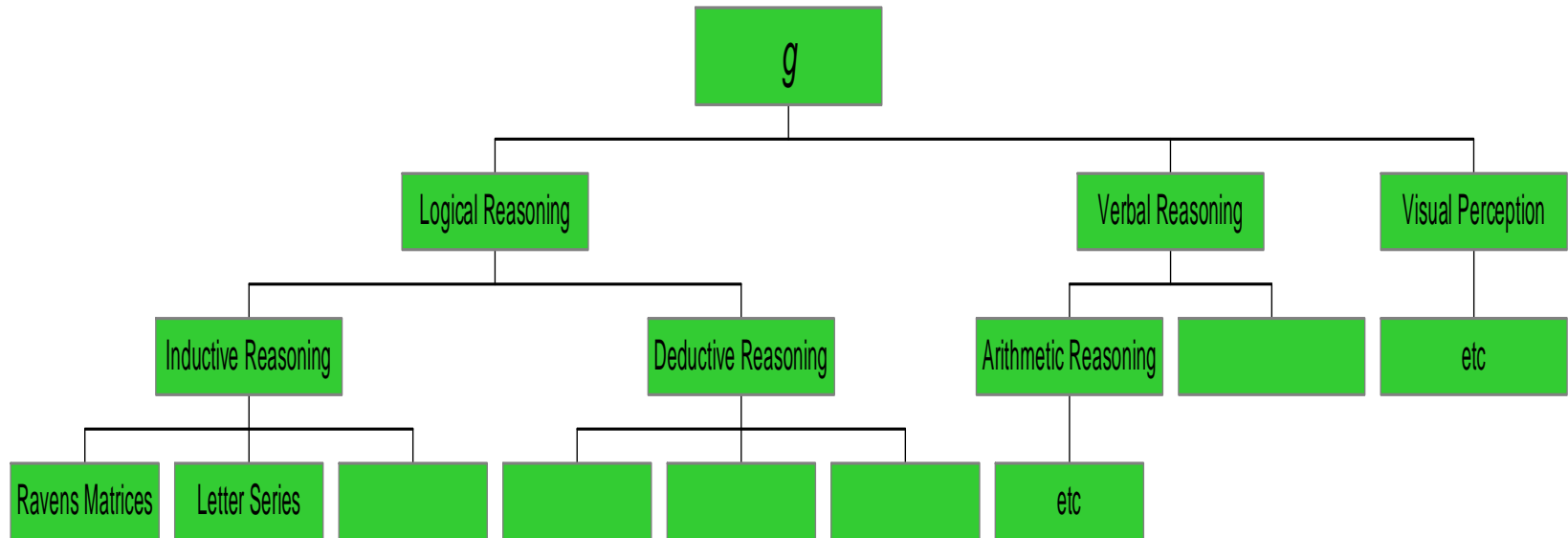
Some dimensions of intelligence

- education + reproduction (Spearman, 1920s)
- convergent + divergent (Guilford, 1940s)
- fluid + crystallised (Cattell, 1960s)
- analytic + creative + practical (Sternberg, 1980s)
- 3 strata: narrow < broad < general (Carroll, 1990s)

BUT ...

modest positive significant correlations
between dimensions = g

g as super-ordinate factor



g as shared or common variance



g as a common brain-based variable

Context specific?

Carroll, 1993, meta-factor analysis of 40,000 intelligence test results.

All measures of intelligence are positively correlated (average $r = .35$).

Physiological correlates of g

Measures of g are positively correlated with

- Reaction times
- Inspection times
- Nerve conduction speeds

Neural correlates of general intelligence g

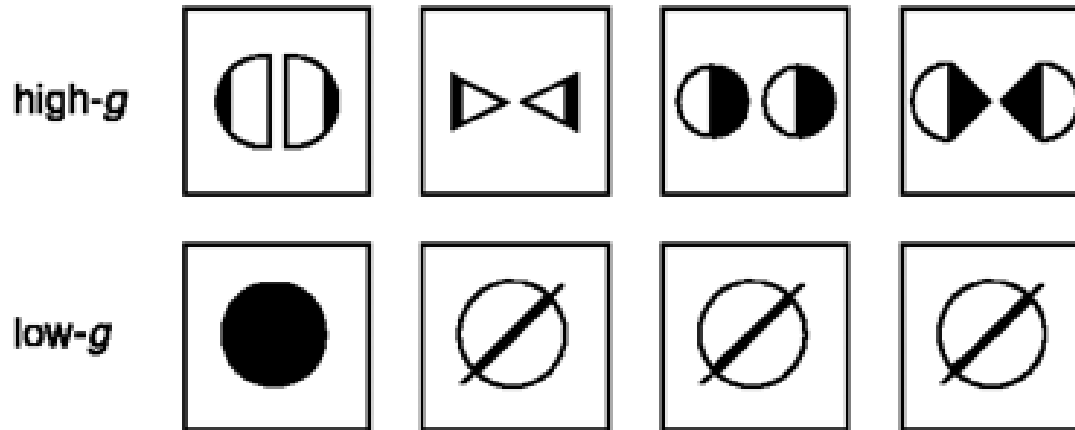
How does the brain solve difficult problems?

PET study of high- g vs low- g IQ test items

John Duncan et al,

MRC Brain and Cognition Unit, Cambridge, UK

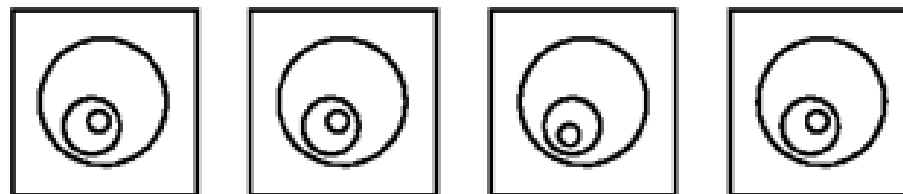
A Spatial



B Verbal

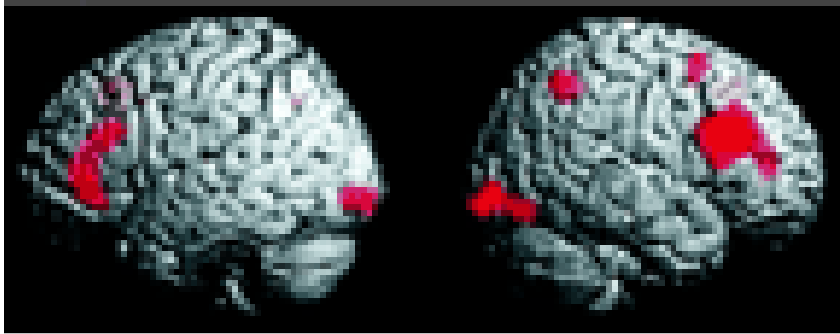
high- <i>g</i>	L H E C	D F I M	T Q N K	H J M Q
low- <i>g</i>	O P Q S	G H I J	L M N O	I J K L

C Circles

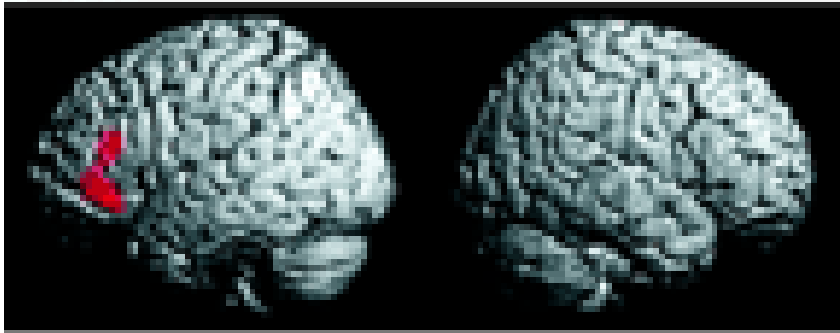


High-g vs low-g contrast

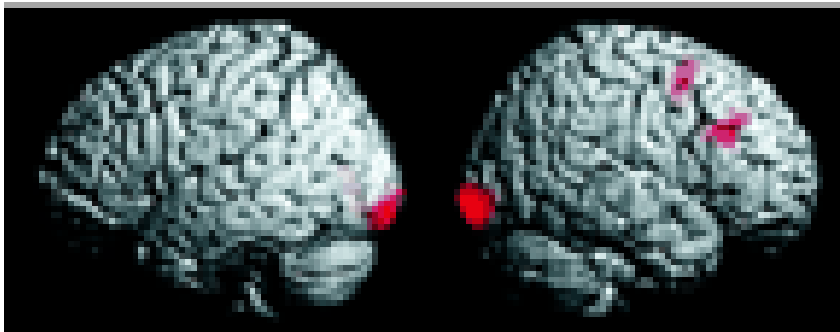
A Spatial



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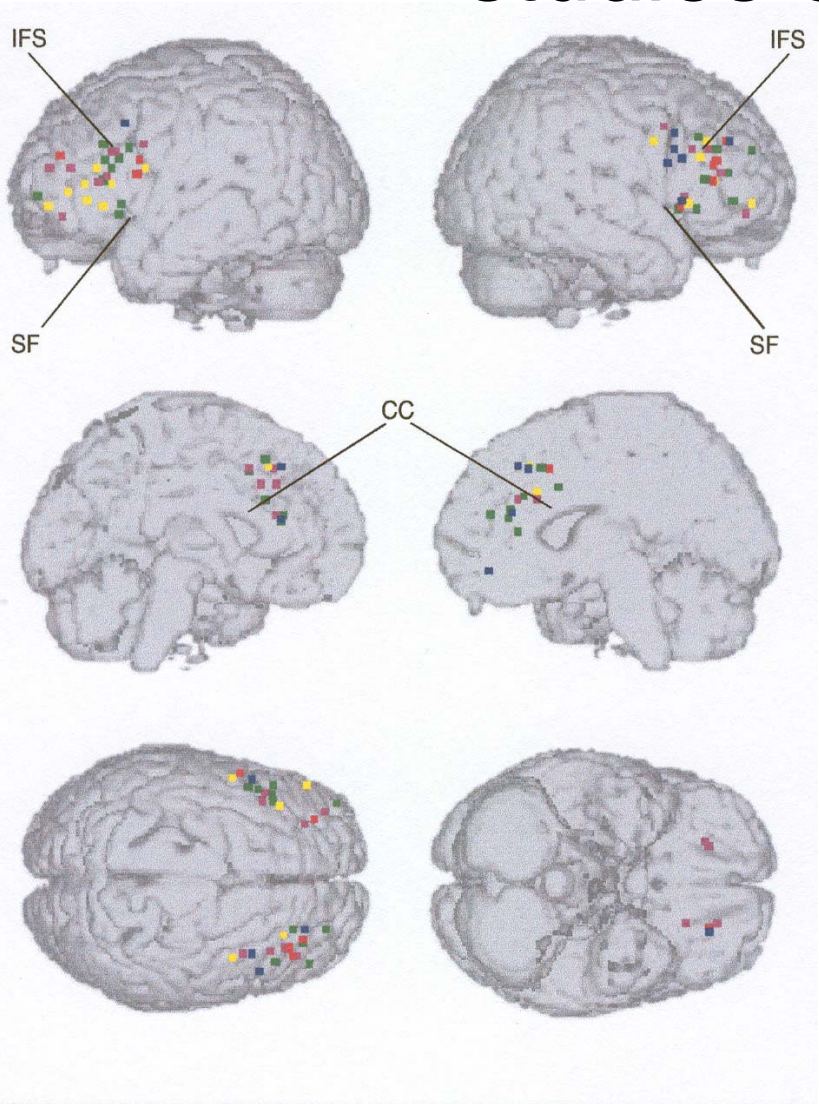
C Circles



Bilateral inferior prefrontal cortex activations for high-g over low-g items

for both spatial AND verbal tasks

Meta-analysis of 20 neuroimaging studies of cognition



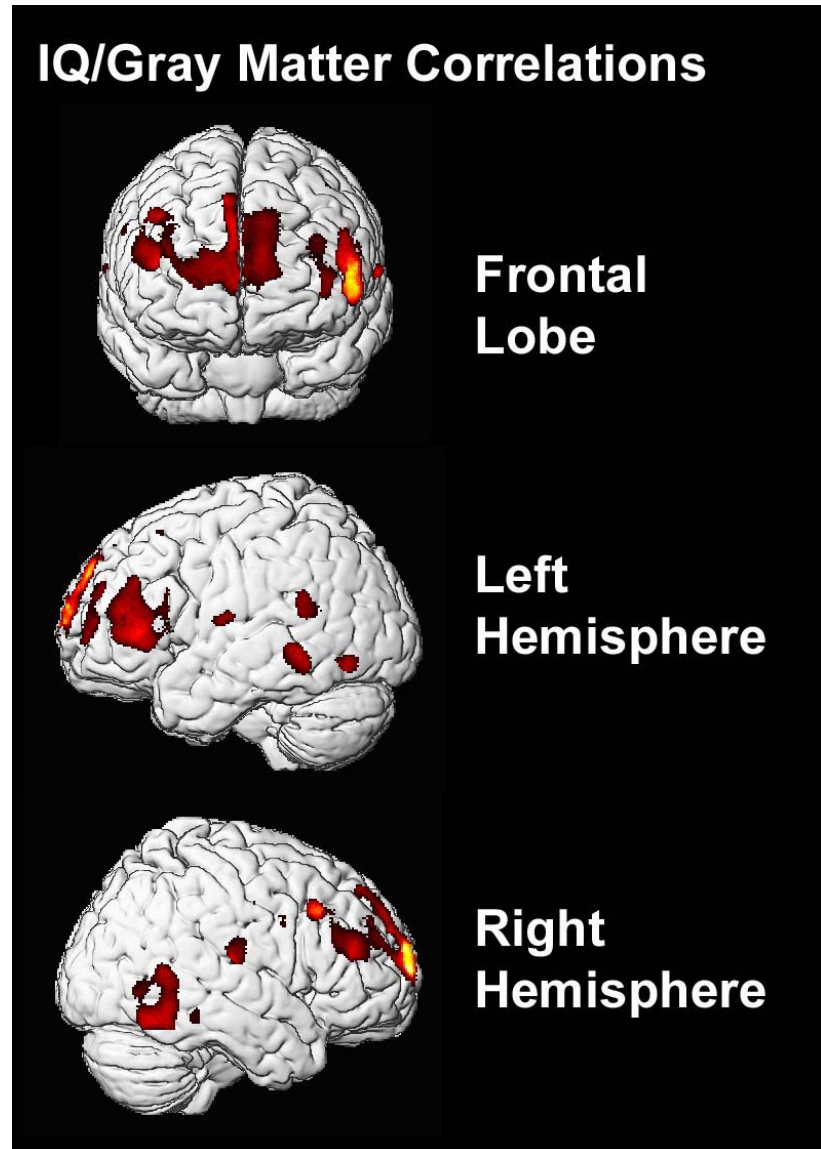
Neurons in selected frontal regions adapt their properties to code information of relevance to current behaviour, pruning away ... all that is currently task-irrelevant.

MRI of which grey matter determines IQ

Voxel-based morphometry (VBM) shows that grey matter volumes (about 6%) which correlate with IQ are distributed in the brain.

Most are in frontal lobes, but also parietal lobes for older subjects, and temporal lobes for younger subjects.

Different patterns for males and females in grey and white matter clusters.



Structure-function relationships between grey matter density and IQ

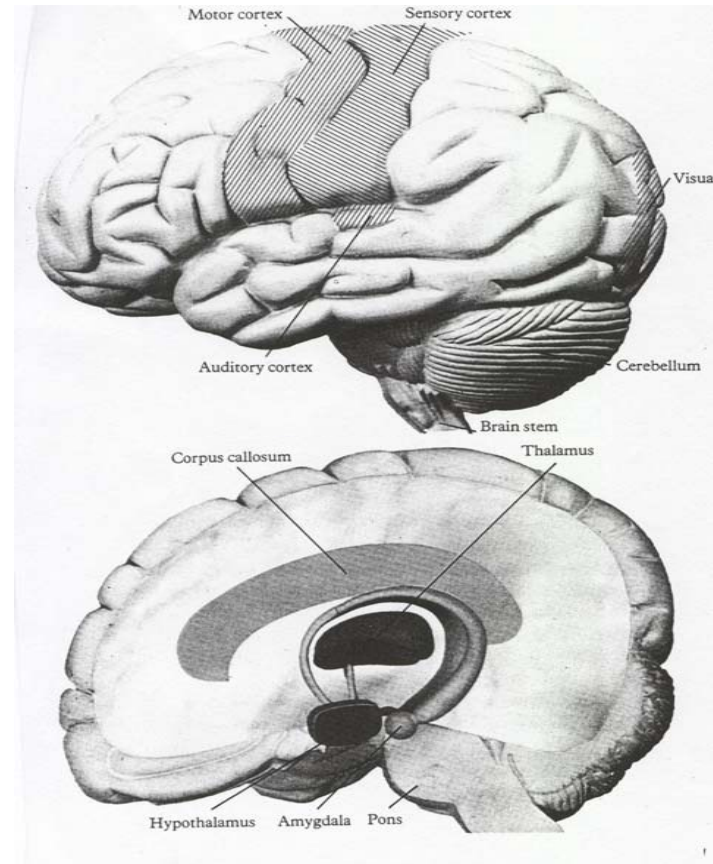
Positive correlations in:
orbitofrontal cortex
cingulate gyrus
thalamus
cerebellum

for

- finger tapping
- memory retention
- IQ

Paradiso, Andreasen, O'Leary, Arndt & Robinson, *NeuroReport*, 1997

Frangou, Chitins, Williams, *NeuroImage*, 2004



The neural bases of intelligence

- The efficacy of modular functions, especially those enabling working memory in the lateral prefrontal cortex
- The density and distribution of grey matter (neurons) and white matter (myelination) that enable information processing
- The cytoarchitecture (gyri and sulci) of cortex in key areas
- The interconnectivity of functional modules