

Adolescent development of the neural circuitry for understanding intentions

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Introduction - brain development during adolescence

- MRI studies have shown development of prefrontal cortex (PFC) during adolescence [1,2]
- Cellular studies have shown that myelination and synaptic pruning occur in PFC during this time
- Medial PFC is associated with intentionality and understanding of other minds [3,4].

Aims of fMRI study

We investigated how the neural processing of intentions understanding changes during adolescence. Given the evidence for the involvement of the medial PFC in understanding intentions [3,4], we predicted a difference in medial PFC recruitment between adolescents and adults during intention understanding.

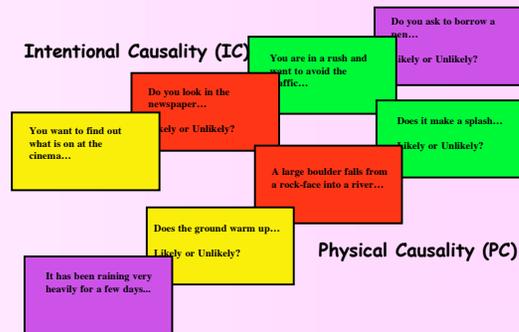
Method

Subjects

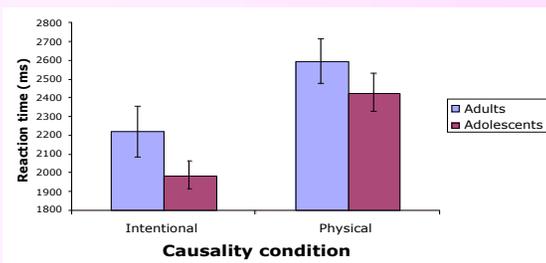
- 19 adolescents (all female; aged 11-17 years), and
- 11 adults (all female; aged 21-37) took part in this fMRI study.

Mixed factorial design

- Between subjects factor was age group: adolescents and adults
- Within subjects factor was task: Intentional Causality (IC) or Physical Causality (PC)



Behavioural results



There was a significant main effect of Task ($F(1,28)=98.29$; $P<0.0001$); both groups had significantly shorter RTs for Intentional questions than for Physical question. There was no significant interaction ($F(1,28)=0.52$; $P=0.48$); nor was there a significant difference between the groups ($F(1,28)=1.92$; $P=0.18$).

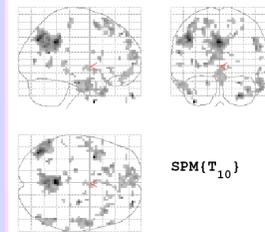
References

1. Sowell et al. *Nature Neuroscience*. 1999
2. Giedd et al. *Nature Neuroscience*. 1999
3. Amodio & Frith. *Nature Reviews Neuroscience*. 2006
4. Den Ouden et al. *Neuroimage* 2005

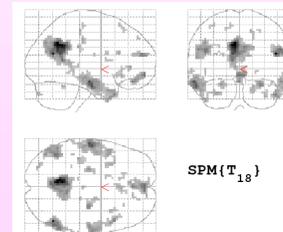
fMRI results

Comparison between Intentional Causality and Physical Causality (IC-PC)

Adults



Adolescents



When thinking about Intentional Causality compared with Physical Causality, adults and adolescents activated similar regions :

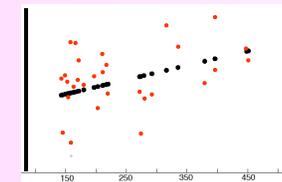
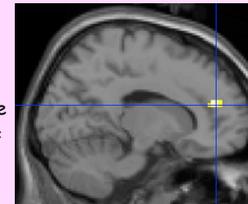
- medial PFC
- superior temporal sulcus (STS)
- temporal poles
- precuneus/posterior cingulate cortex

These brain regions are consistently activated by "Theory of Mind" tasks [3,4].

Comparison between adults and adolescents when thinking about Intentional Causality relative to Physical Causality (interaction between group and task)

Adults > adolescents

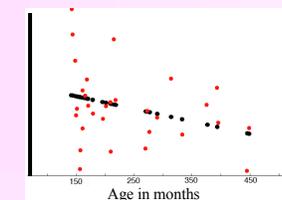
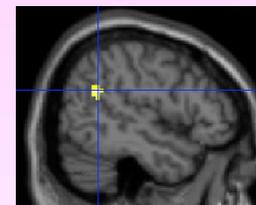
When thinking about IC compared with thinking about PC, adults activate the medial PFC (MNI: 12 45 18 = BA 10) more than adolescents



Correlation between medial PFC activity (in IC-PC) and age

Adolescents > adults

In the same contrast, adolescents activate the right temporo-parietal junction (TPJ: 51, -51, 24) more than adults



Correlation between TPJ activity (in IC-PC) and age

Discussion

- Both adults and adolescents were quicker to answer questions about intentional causality than questions about physical causality - perhaps because intentionality is more "intuitive" than physical causality [4].
- Medial PFC was more active in adults than in adolescents for intentional causality (relative to physical causality).
- There was a significant correlation between activity in medial PFC during intentional causality and age.
- Adolescents might be using a different strategy to answer IC questions, involving right TPJ, which was activated more in adolescents than adults during intentional causality

Acknowledgements

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