Inhibition of a response to a social stimulus: a developmental study

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Introduction

- Social perception skills are still developing during adolescence. Areas linked to "the social brain" such as the medial prefrontal cortex, the superior temporal sulcus and the fusiform cortex continue to mature both functionally and structurally (Peelen et al. 2009, Blakemore 2008, Scherf et al. 2007).
- Performance in executive function tasks and tasks requiring inhibitory control also continues to improve during adolescence; in line with MRI studies showing developments in frontal and prefrontal cortex during adolescence (Blakemore and Choudhury 2006, Velanova et al. 2008).

Objectives:

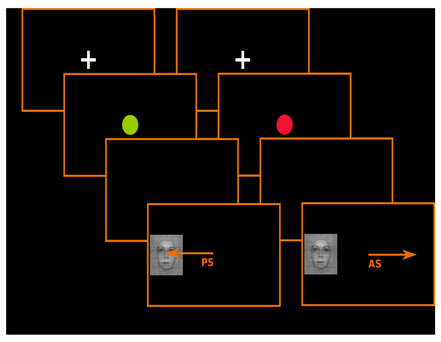
To understand how the interaction between **cognitive control** and **social perception** changes from late childhood until adulthood, by highlighting the maturing brain areas involved in these processes.

We used the **anti-saccade task**, a classical task used to study inhibitory control in development. It has been previously shown that adult participants have more difficulty inhibiting a saccade towards a social stimulus (face) than towards a non-social stimulus (car) (Morand et al. 2010).

Behavioural experiment

Materials and Methods

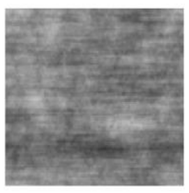
The anti-saccade task



Stimuli

Face
(social stimulus)
Shown 168 times

Car
(non-social stimulus)
Shown 168 times



Noise
(non-significant stimulus)
Shown 168 times

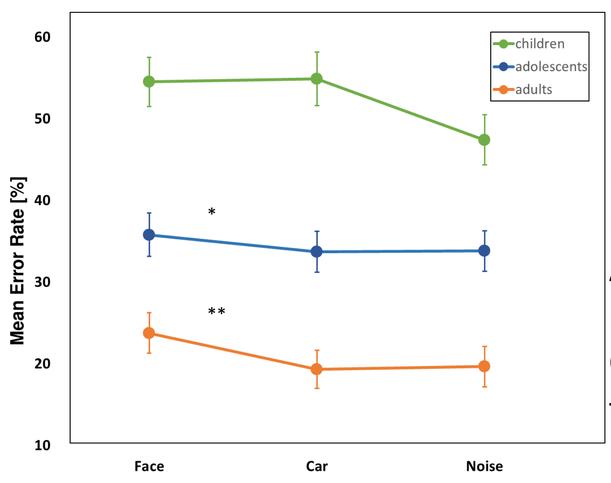
Participants

113 subjects included in the study

- 31 **children** aged 8-11 (9,52 ± 1,1)
- 51 adolescents aged 12-17 (14,47 ± 0,9)
- 31 **adults** aged 18-22 (19,52 ± 1,09)

Results

Main finding



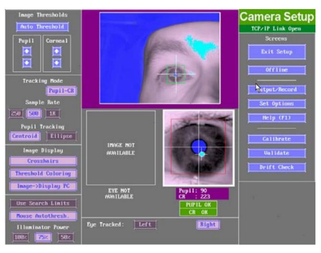
⇨ Anti-saccade error rate decreases with age

⇨ Adults have more difficulty inhibiting a reflex towards a social stimulus than towards a non-social stimulus.
Adolescents show the same effect, albeit reduced.
Children have the same impaired performance for faces and cars compared to noise pattern

fMRI experiment

Materials and Methods

The anti-saccade task in the fMRI



Stimuli

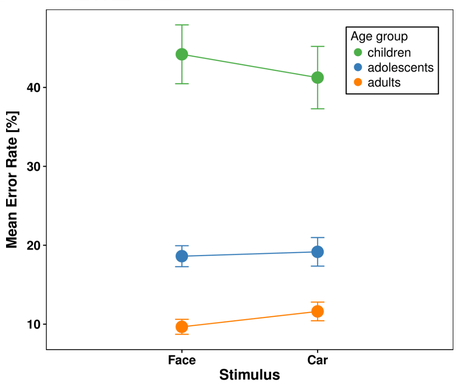
Face
(social stimulus)
Shown 120 times

Car
(non-social stimulus)
Shown 120 times

Participants

55 subjects recruited so far

- 16 **children** aged 8-11 (9,75 ± 1)
- 20 **adolescents** aged 12-17 (14,2 ± 1,47)
- 19 **adults** aged 24-40 (27,32 ± 5,11)

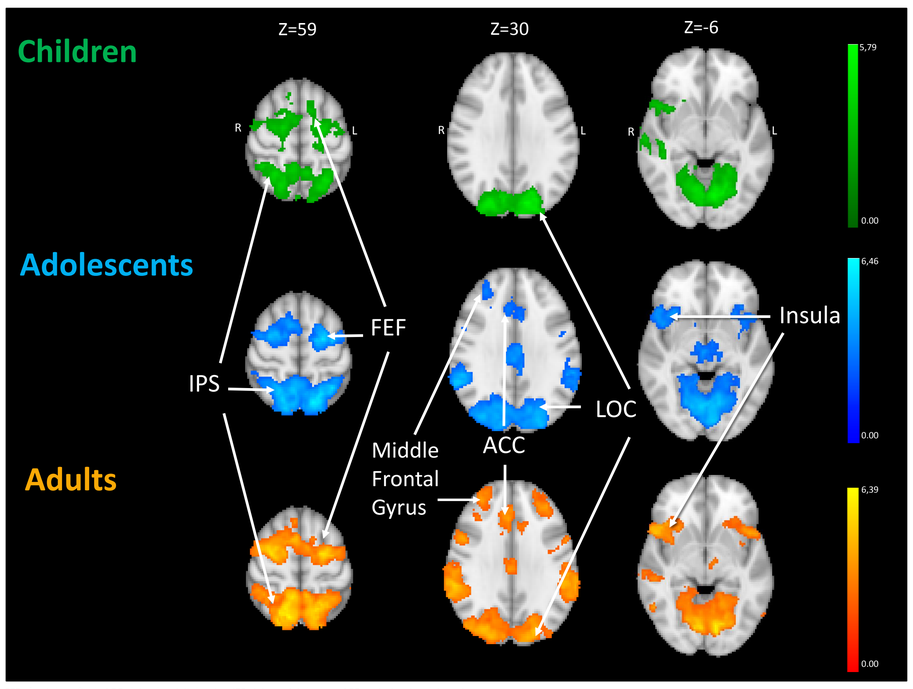


⇨ The stimulus effect previously observed in adults could not be replicated.

FMRI data processing was carried out using FEAT (FMRI Expert Analysis Tool) Version 6.00, part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). Z (Gaussianised T/F) statistic images were thresholded using clusters determined by Z>2.3 and a (corrected) cluster significance threshold of P=0.05 [Worsley 2001].

Preliminary results

Anti > Pro (for correct trials only)

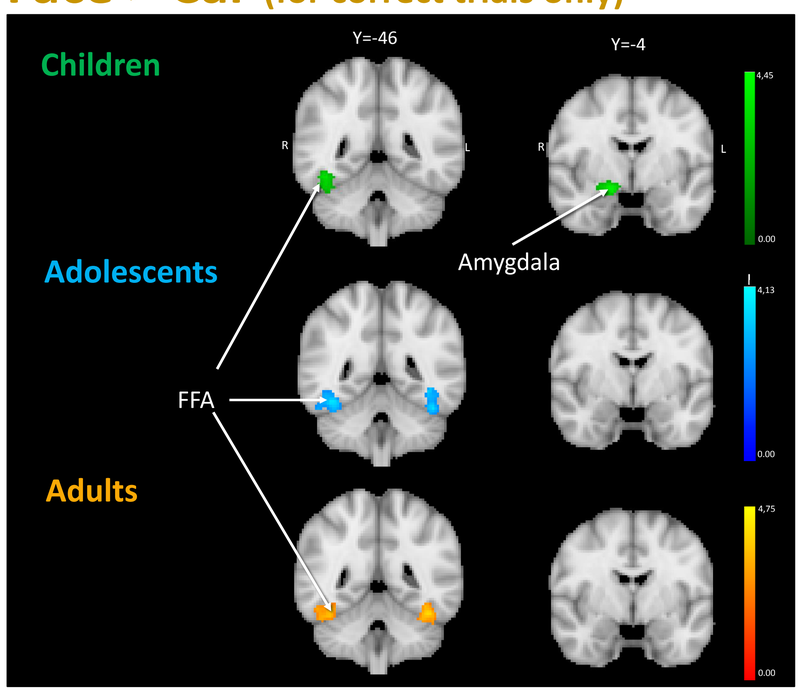


FEF= frontal eye fields, LOC= lateral occipital cortex, IPS= intraparietal sulcus, ACC= anterior cingulate cortex

→FEF, LOC & IPS activation in the three groups.

→ACC activation in adolescents & adults.

Face > Car (for correct trials only)

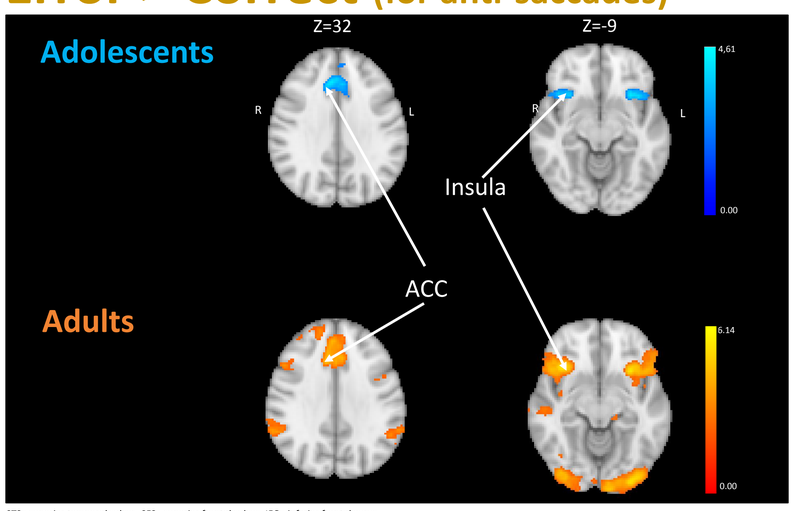


FFA= fusiform face area

→FFA activation for all groups.

→Amygdala activation **only** in children.

Error > Correct (for anti-saccades)



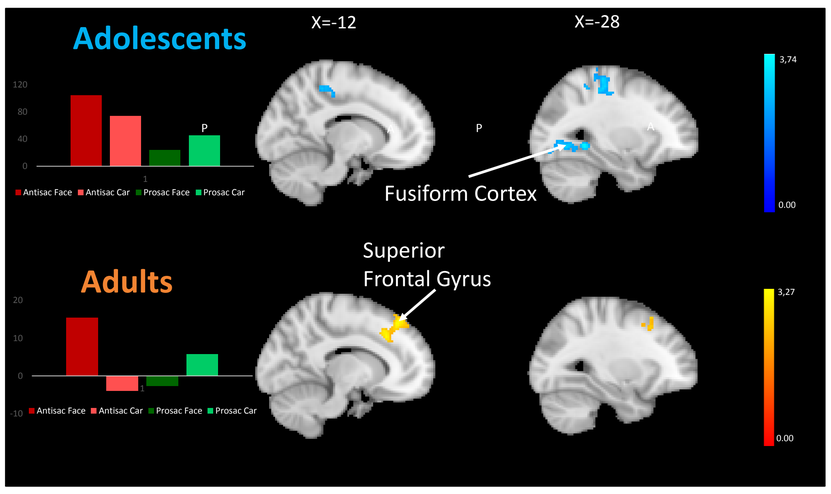
STS= superior temporal sulcus, SFS= superior frontal sulcus, IFG= inferior frontal gyrus

→ACC and insula activation in adolescents & adults. Further activations in STS, SFS, IFG, caudate & thalamus only in adults.

→No activation observed in children.

The inverse contrast yielded higher BOLD response in the paracentral lobule, posterior to the SEF, for all participants, and the putamen , for children only.

Task-Stimulus interaction (=higher differences between anti and pro-saccades for faces than for cars)



→Fusiform cortex in adolescents (as well as superior temporal gyrus & posterior cingulate gyrus) and superior frontal gyrus in adults.

→No interaction observed in children.

Conclusion: These results suggest that the age difference in stimulus effect on anti-saccades may be related to age related differences in brain activation. Children, who did not show an interaction between the type of task and the stimulus in the behavioural experiment, show the same level of activity for anti-saccades towards faces or cars. In contrast, both adolescents and adults show an increased activity for making anti-saccades towards faces – in visual regions for adolescents and cognitive control regions in adults.

References

- Blakemore, S. J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *47*(3-4), 296–312
- Blakemore, S.-J. (2008). The social brain in adolescence. *Nature Reviews. Neuroscience*, *9*(4), 267–277.
- Morand, S. M., Grosbras, M. H., Caldara, R., & Harvey, M. (2010). Looking away from faces: influence of high-level visual processes on saccade programming. *J Vis*, *10*(3), 1–10
- Peelen, M. V., Glaser, B., Vuilleumier, P., & Eliez, S. (2009). Differential development of selectivity for faces and bodies in the fusiform gyrus. *Developmental Science*, *12*(6), 16–25
- Scherf, K. S., Behrmann, M., Humphreys, K., & Luna, B. (2007). Visual category-selectivity for faces, places and objects emerges along different developmental trajectories. *Developmental Science*, *10*(4)
- Velanova, K., Wheeler, M. E., & Luna, B. (2008). Maturational changes in anterior cingulate and frontoparietal recruitment support the development of error processing and inhibitory control. *Cerebral Cortex*, *18*(11), 2505–2522.