Anterior cingulate cortex specialization and development for appraisal of self through adolescence

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Introduction

What is the Self?

- One's episodic memories and personal semantic knowledge are at the core of one's identity [1, 2].
- The brain network involved in self-related processes includes the medial prefrontal cortex (mPFC), rostral anterior cingulate cortex (rACC), precuneus and posterior cingulate cortex (PCC) [3].
- The rACC has been proposed to be at the core of the concept of Self [4].

What is adolescence?

- Adolescence is marked by the development of a cohesive sense of Self and one's personal identity [5, 6].
- Self-development during adolescence is associated with structural and functional changes in regions important for the Self (e.g. mPFC , rACC) [5, 6, 7].

➡ **Yet, little is known about the link between the development of self and changes occurring in the adolescent brain.**

Aims

Understanding how age-related changes in the brain are related to the development of the self during adolescence.
1 / Do appraisals of Self and Others share a common brain network?
2 / What are the distinct regions associated to appraisal of Self and Others?
3 / What are the effects of age on the regions underlying appraisal of Self?
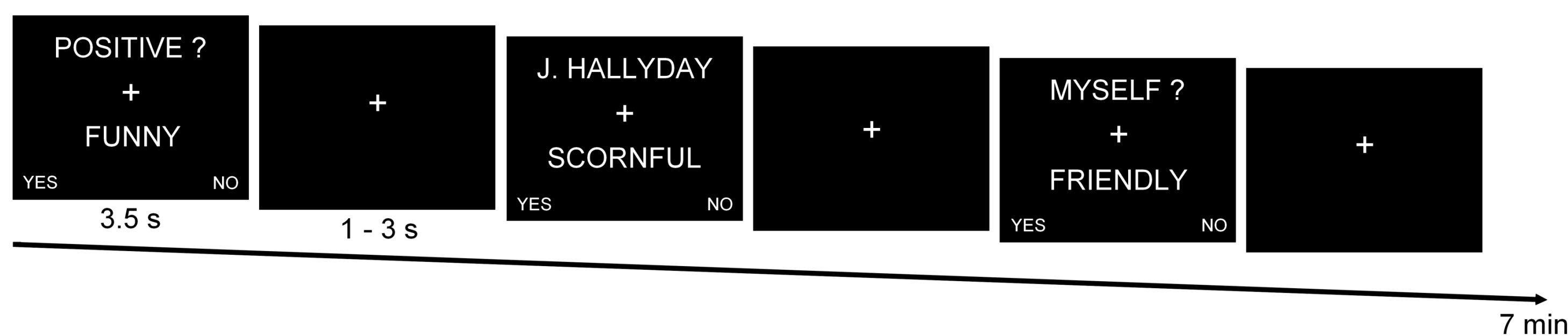
Method

Participants

30 adolescents (15 females) aged 13 to 18 years old (15.92 ± 1.66 years)
WISC-IV [9]:
- Perceptual Reasoning : 108.3 ± 3.3
- Verbal Comprehension : 112.7 ± 3.3

Self-reference task

POSITIVE ? + FUNNY   YES NO   3.5 s

+   1 - 3 s

J. HALLYDAY + SCORNFUL   YES NO

+

MYSELF ? + FRIENDLY   YES NO

7 min

Conditions

Self: Does the adjective characterize myself?
Other: Does the adjective characterize J. Hallyday or N. Sarkozy?
**Semantic**: Is the adjective positive or not?

fMRI analysis on SPM5

Flexible factorial (p_{unc} < .001 ; k = 93 voxels)

1/ Common brain network: conjunction analyses between Self > Semantic and Other > Semantic contrasts.
2/ Specific brain networks: direct comparison between Self and Other conditions (Self > Other and Other > Self).
3/ Age effect: correlations between age and neural activity in clusters obtained from Self > Other contrast.
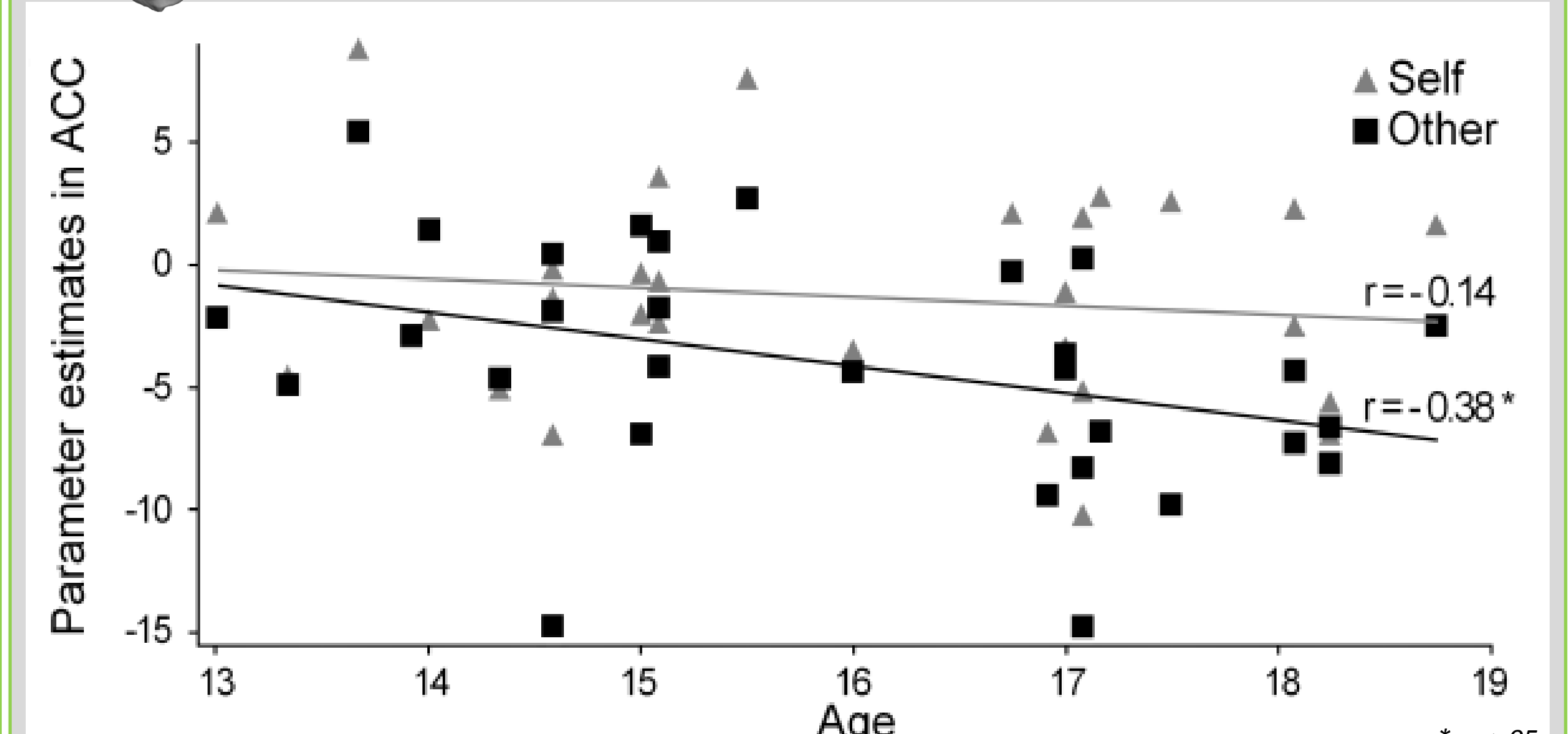
Results

1/ Appraisal of Self and Others: Common brain network

Self > Semantic ● Other > Semantic
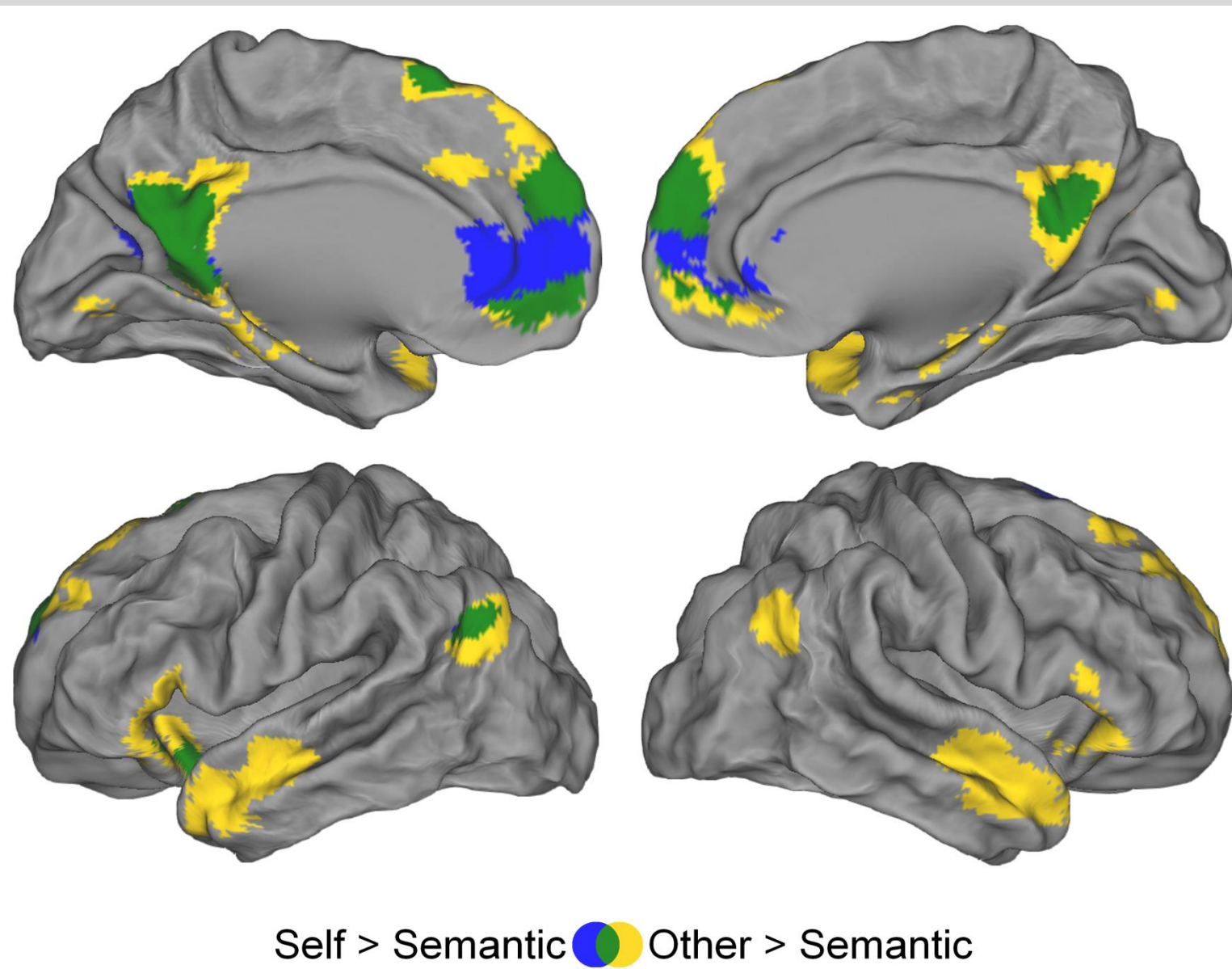
2/ Appraisal of Self and Others: Distinct brain networks

Self > Other ■ Other > Self
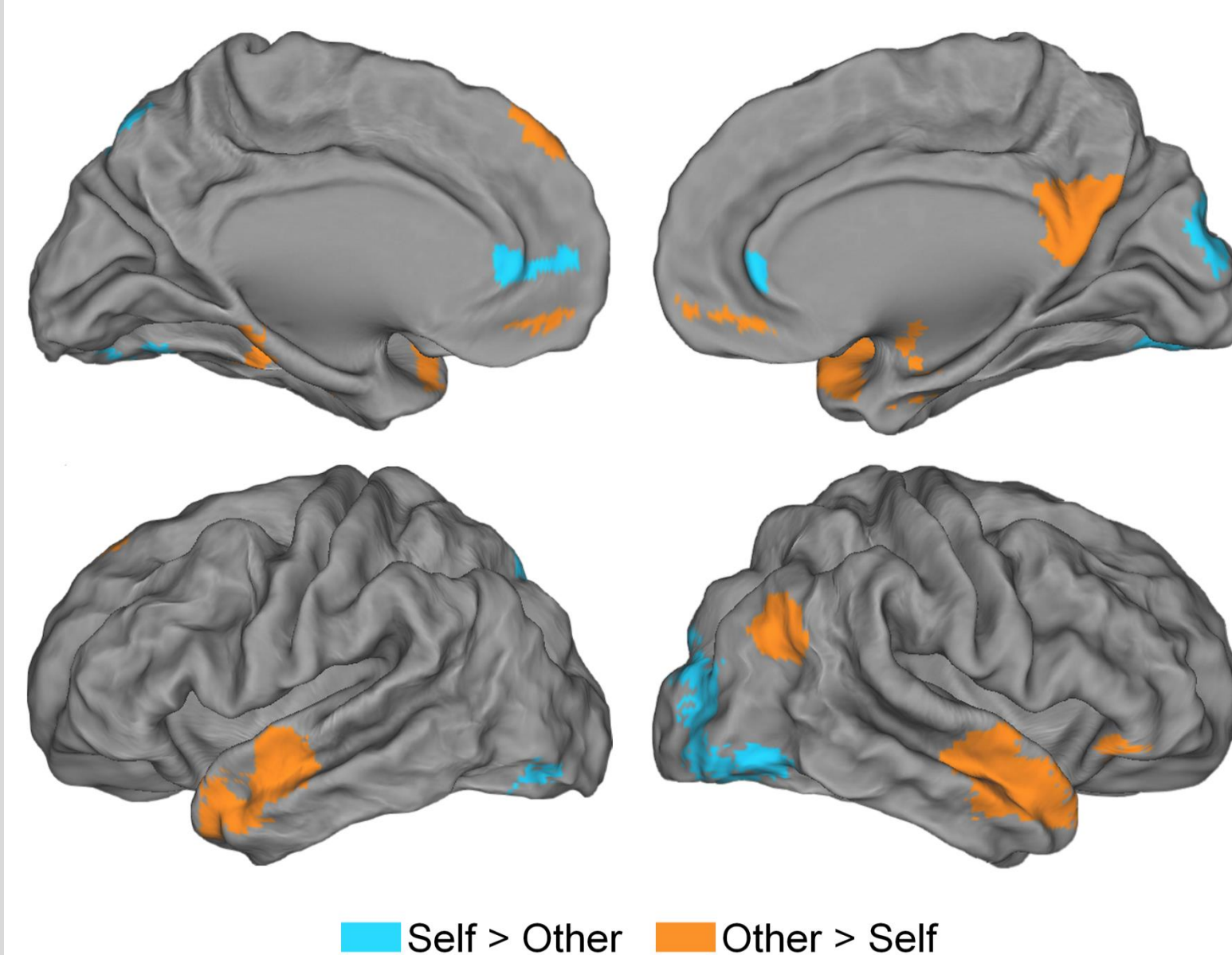
3/ rACC becomes gradually specific for the Self from 13 to 18 years old

▲ Self ■ Other
r=-0.14
r=-0.38 *
Parameter estimates in ACC / Age
* p < .05

Discussion

Appraisal of Self and Others share a common brain network of regions implicated in social cognition and self-reference processing (mPFC, PCC and precuneus) [10].

➡ **Making a judgment of another person may require the same cognitive processes as making a judgment of oneself does.**

Appraisal of Others recruits regions associated with the third-person perspective (PCC and dorsal mPFC) [11] and access to social knowledge (temporal pole) [12].

➡ **Implies taking a third-person perspective and memory retrieval of social knowledge.**

Appraisal of Self recruits the rACC specifically. Younger adolescents recruit rACC for both appraisal of Self and Others, whereas older recruit rACC specifically for Self appraisal.

➡ **Changes occurring in rACC could be related to the development of the Self from early to late adolescence.**

Our findings support the proposal that brain development contributes to changes in behavioral and cognitive abilities [13].
This study is the first to explore the relation between brain maturation and development of Self in adolescents older than 13 years old.

References [1] Conway, 2005 ; [2] Conway & Pleydell-Pearce, 2000 ; [3] Northoff & Bermpohl, 2004 ; [4] Martinelli et al., 2013 ; [5] Pfeifer & Peake, 2012 ; [6] Sebastian et al., 2008 ; [7] Mills et al., 2014 ; [8] Pfeifer et al., 2013 ; [9] Wechsler, 2005 ; [10] Saxe et al., 2006 ; [11] Ruby & Decety, 2004 ; [12] Frith & Frith, 2003 ; [13] Casey et al., 2000.
This study is in press in Child Development journal.