



Longitudinal Changes in Neural Substrates of Inhibitory Control from Childhood to Adolescence among Youths with and without ADHD: A Counting Stroop Functional MRI Study

Cheng-Yu Hsieh¹, Susan Shur-Fen Gau^{2,3}, Tai-Li Chou^{1,3}

¹Department of Psychology, National Taiwan University ²Department of Psychiatry, National Taiwan University Hospital

³Graduate Institute of Brain and Mind Sciences, National Taiwan University, Taipei, Taiwan

Introduction

- Inhibitory control in children with attention-deficit/hyperactivity disorder (ADHD) may improve when they enter adulthood.
- The right inferior frontal gyrus (rIFG) and dorsal anterior cingulate cortex (dACC) are consistently reported to be impaired in ADHD during inhibitory control tasks. Whether the dysfunction in these brain regions would normalize is still inconclusive.
 - Some researchers argued that little dysfunction in frontal lobe was observed when patients with ADHD reached adulthood (Cortese et al., 2012; Lei et al., 2015).
 - Others still found significant ineffectiveness in brain functions in adults with ADHD (Hart et al., 2013; McCarthy et al., 2013).
- It may be that these studies are cross-sectional neuroimaging studies.

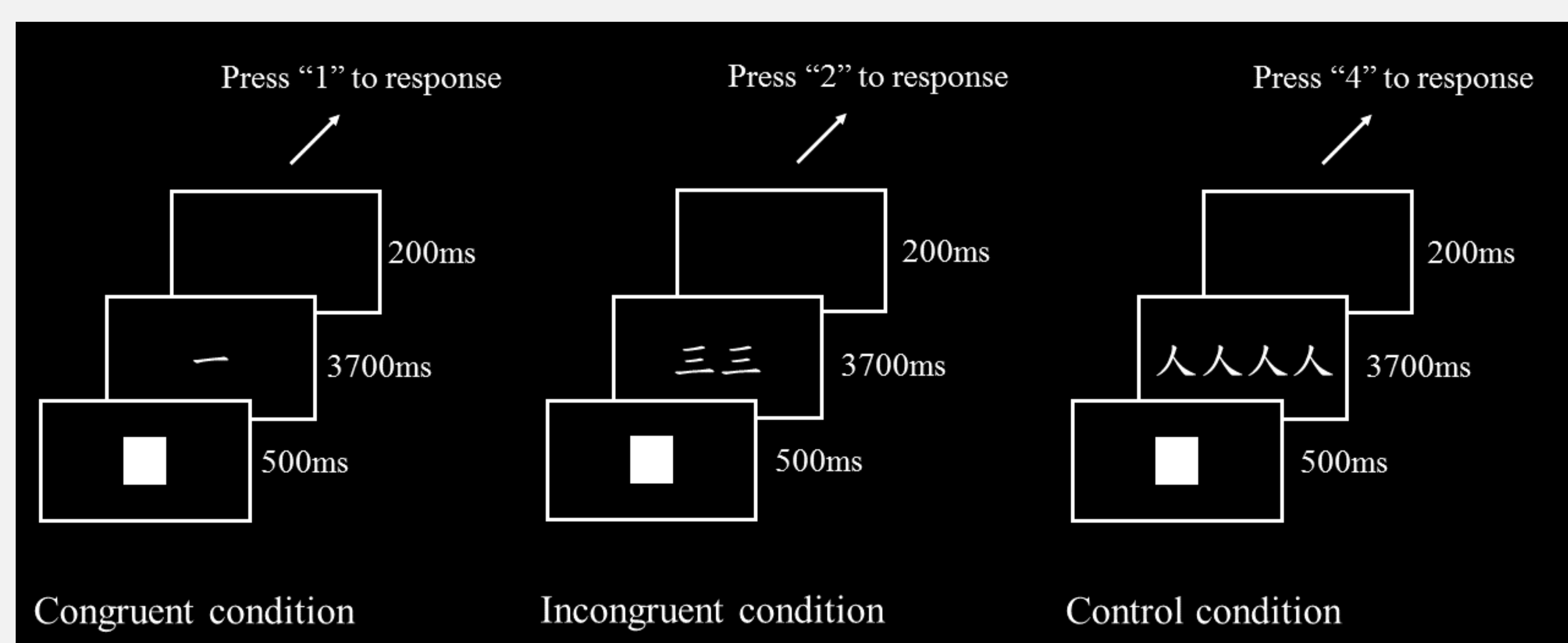
Method

Participants

	ADHD (N = 40)	TD (N = 38)	p value
Gender (M:F)	36:4	32:6	.51
Handedness (L:R)	3:37	3:35	N/A
Age at time 1 (SD)	11.4 (2.1)	11.2 (2.1)	.66
Age at time 2 (SD)	16.2 (1.9)	15.6 (2.7)	.25
Follow-up interval	4.8 (0.6)	4.3 (1.5)	.11
FSIQ	107.7 (11.0)	111.8 (9.8)	.08

Materials

- Counting Stroop Task (Bush, 1998; Fan et al., 2014)
 - An event-related fMRI paradigm
 - 2 runs × 36 trials (12 trials for each condition)
 - Report the number of words (one to four) by pressing buttons
 - Complete within a scanner twice with a 4-year interval

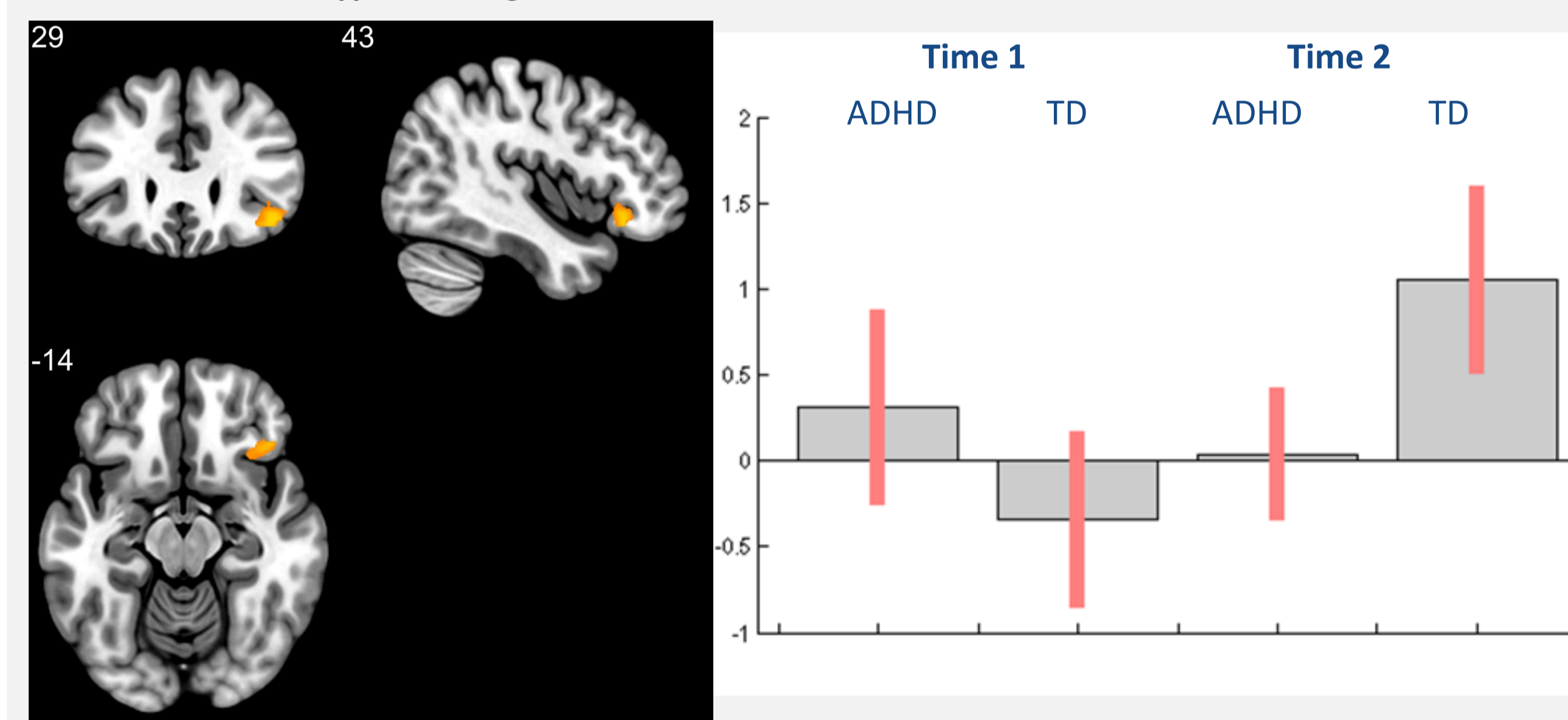


Imaging Results

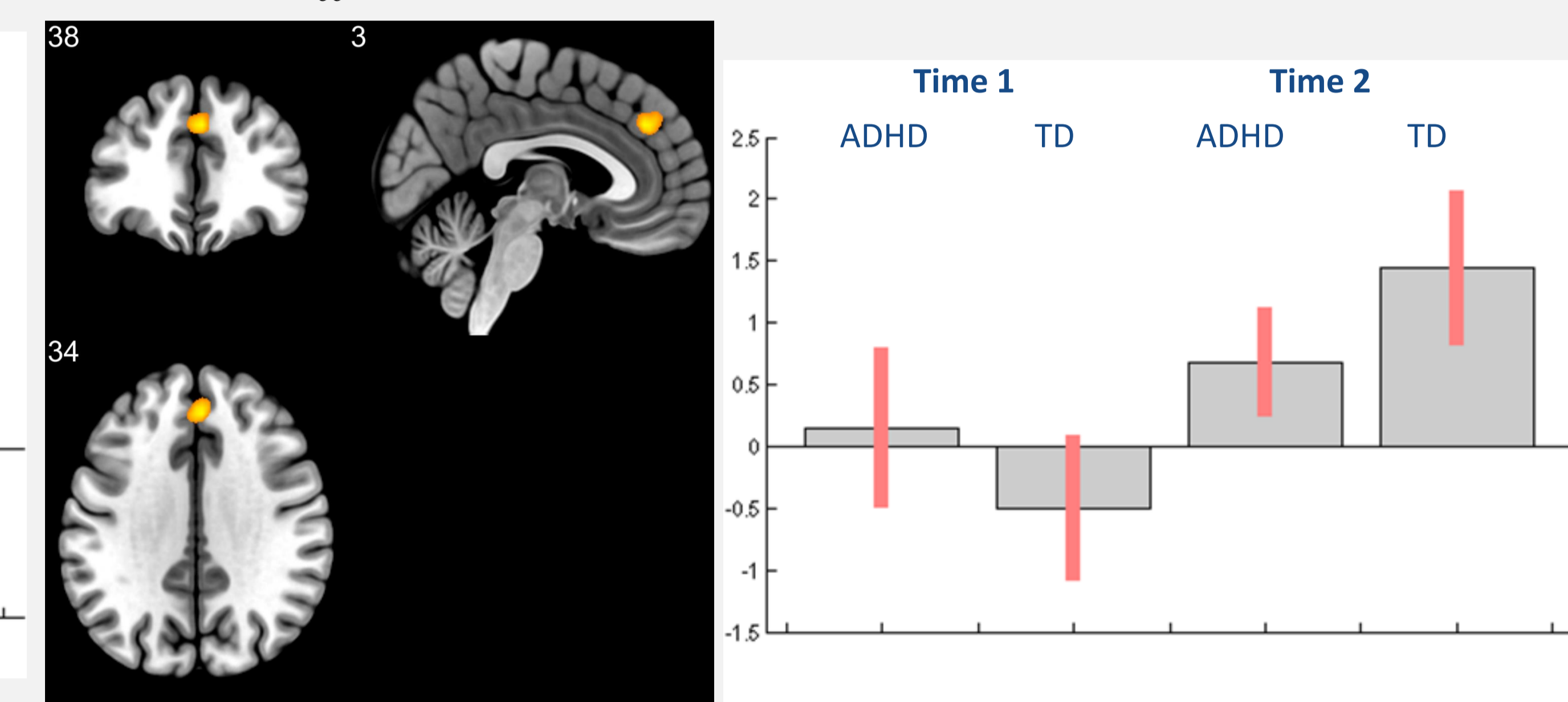
Image analysis: group by age factorial design

All reported regions: uncorrected $p < .01$ with cluster size greater than 10 voxels

interaction effect: right IFG

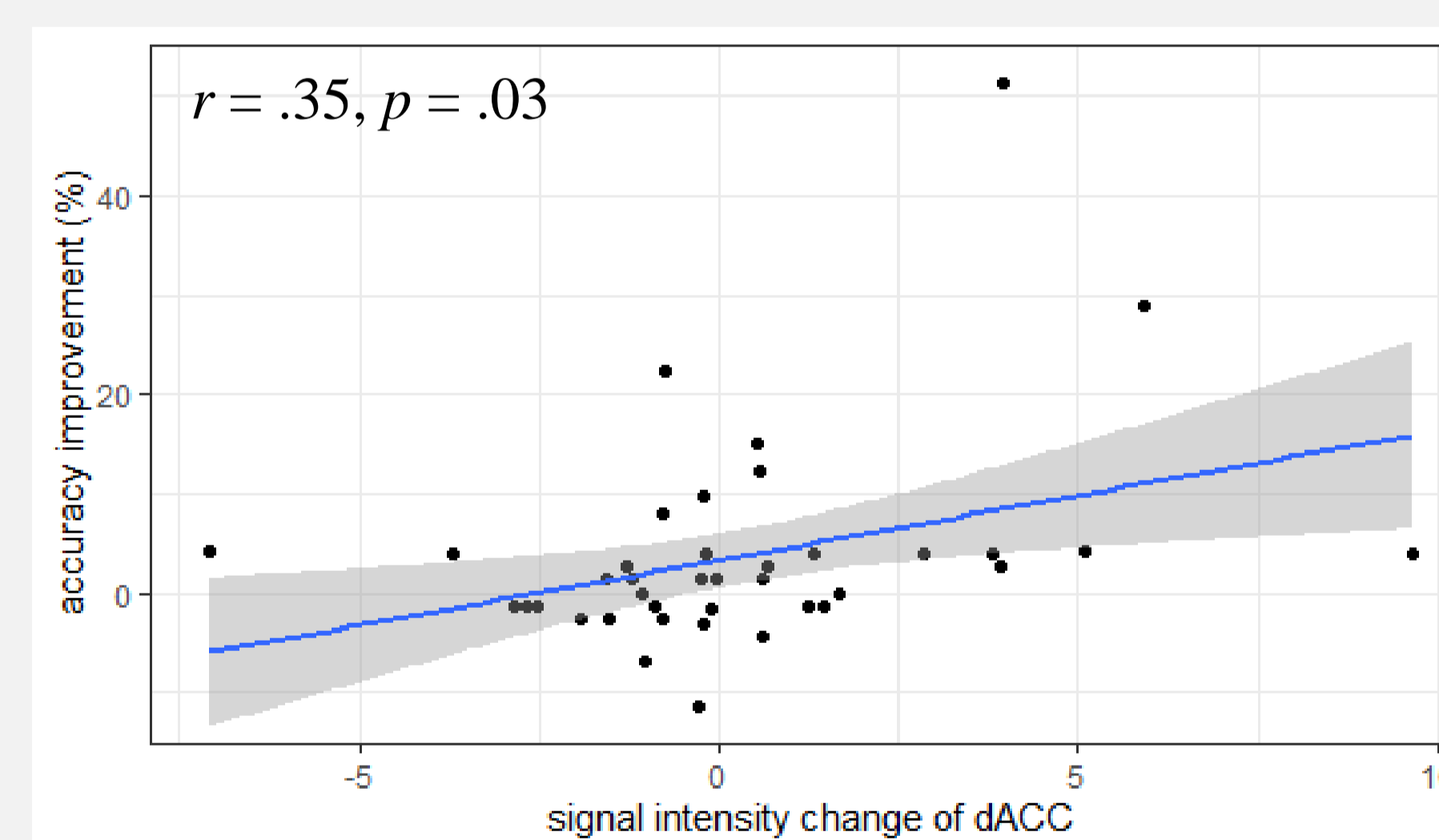


interaction effect: dorsal ACC



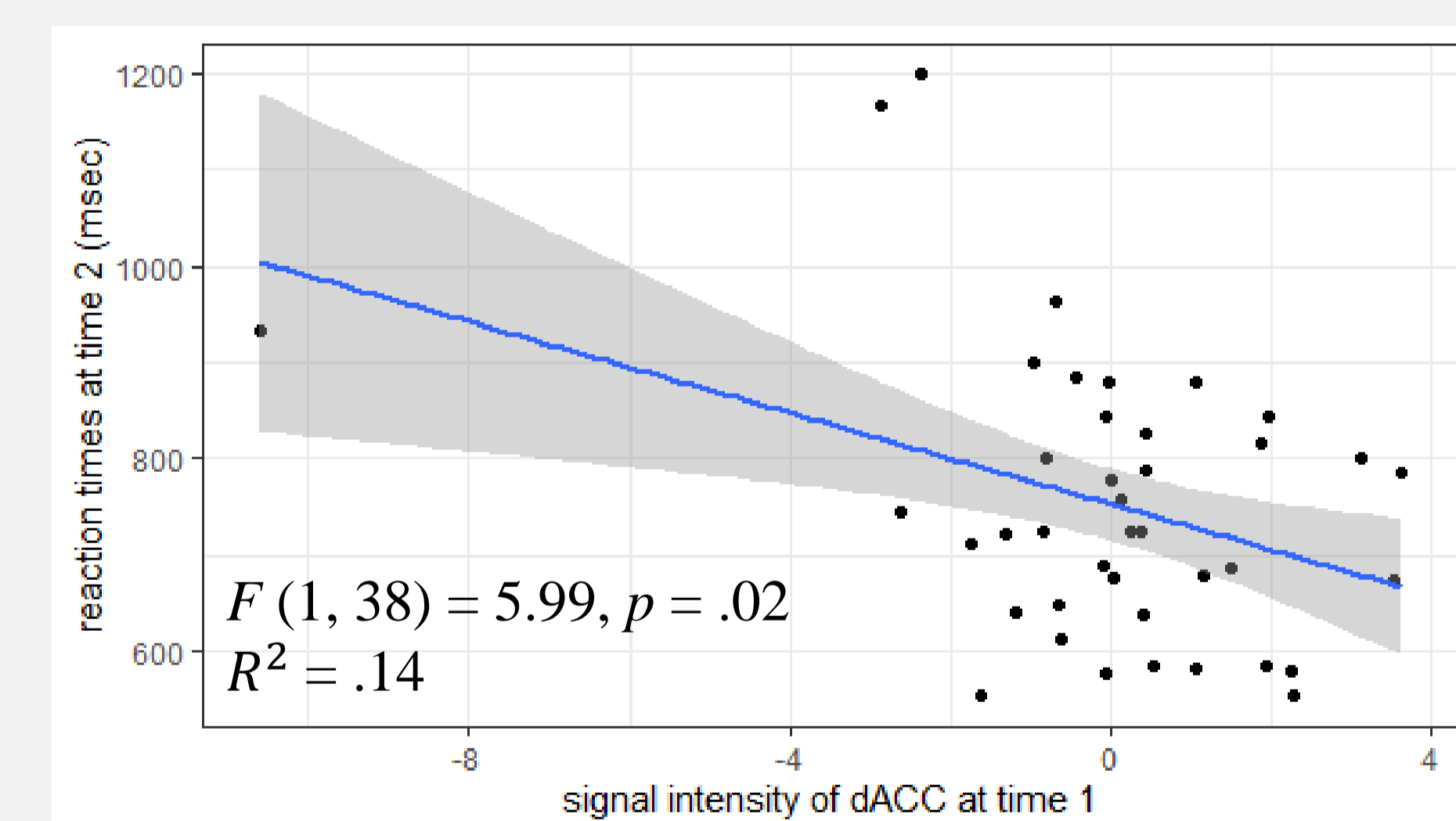
Correlation analysis for ADHD:

accuracy improvement and change of dACC activity (time 2 – time1)



Regression analysis for ADHD:

dACC activity at time 1 predicts reaction times at time 2



Discussion

- The developmental changes of rIFG activation is different from that of the TD group.
 - The development of initiating the inhibitory control process in ADHD is dramatically delayed.
- With age, the efficiency in recruiting the dACC increases in ADHD, but still lags behind the development of the TD group.
 - The improvement of the counting Stroop task is attributed to the enhancement of performance monitoring.
- In addition, the early maturation of dACC plays an important role in the development of inhibitory control.
- To conclude, when children with ADHD reach adolescence, their ability of monitoring performance enhances during inhibitory control, which makes their response more accurate; their ability of initiating inhibitory control is still aberrant even in adolescence.

Acknowledgments

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