N I 209 (2020) 116488

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A R I C L E I N F O

G - t
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A B R A C

P t t t t t (. ., t); t t t tt t t t - (. ., t - t). D - t t - t t t tt - , t t , t t t t . H , t t t t t t t t t . t , t t t t t - t t t t t t, t t - t t t t . H , t MRI t t t - t t t t t t t (. ., t), - t t t (. ., - t). I t t (N = 90), t t t t t t t t - t. M t t tt (M PA) t t MRI t t t - t t tt t t t t t t. t t t t t t t t t .

1. Introduction

G t "t t t t t t t t A t t t t ” fi (I , 1991) t t t (M t t ., 2016; , 1986), t " t t t t ” fi t t t t t t t t (G , 2007). P t t t t t t t t t

1998; M G t t ., 2005). t t t t t - t t t t - t t (C t G - , 2006; Č ´-C t ., 2011), t t t - t (A t ., 2014; D t ., 2004; H -E , 2019; L t ., 2011; t ., 2019), t t- (A t ., 2007; P t ., 2005).

A t t - t t t t - t t t - t t t - (B t ., 2008; D t ., 1998; M G t t ., 2005), t t t tt : (1) D t - t t fl t t fl t t t t t fi t t ? t , t t t- t t t t, t t t t t t t ? (2) H t - t? fi , - t t t t? A t t I t E t (IE ; M t ., 2008; t M , 2015), - t t - t t t t t t, t t (R t ., 2008). I t t, t t D R H t (D R , 2003; M t t , 1993), t t t t t fi t t. E t t t, t t t t / . t t t , - t t t . t t t' t- t t t (K t ., 2013; t ., 2014). I t t, t t t t t t t t t t t; , t t " t" t t . , t t t t t t t t t t. L t , t - t t t fi t t t t t t t t- t t t (C t ., 2015; K t ., 2013; R t ., 2011; t ., 2014). M , t - t t . (2014) t t t t t t t (MCC) t (AI) t t t- t t t t t t t t t t t t , - t t , t t t (ACC) t t t (LPFC) (B t , 2015; C tt t ., 2017; G t ., 2008; M R t ., 2010). fi t t t t t t t t t t , , t - t t t , t t t tt t t t t (. ., MCC, AI). I , t t , t t - t t , t t t t - (. ., ACC, LPFC). t t t t , t t t t t t t t t (K t ., 2013; t ., 2014) t t t t t t t (D , 2018; Ott , 2016). I t , t t t' t t t t - / t- t t t t t t t t t tt t t , t t t t - / t- t t t t . fi , t t t t - (-) t t- (-) t t , t t t t t t t t - (-) t- (-) t t t t t . t t t t (E - t 1) 20 (. 3 D) t t t t (E t 2). t t , t t t t t t t t t , t t t t t t (K t A , 2003; G t ., 2018; t ., 2014). t t t - t - (t t t) t t , t - t t, t , t - t t t t t. I t , t t t t t tt (MP A) t t - t t t t t t (E t 2). I - t t t t - t t, t t t t t t t t t, t t t t M PA - fi t t - t.

2. Materials and methods

2.1.

F E t 1 (t), t 24 t - t (12 , 19.3 ± 0.8). F E t 2 (MRI t), t t -fi t- t t t t - t, t t (>3), 31 t t (19 , 21.3 ± 1.1) t . t t t E t 2 t t t t t t t t t t . N t t t t t . tt t t t t t t . t t t t t D t H t Et C tt t P C t , P t .

2.2.

2.2.1. 1 ( )

2.2.1.1. . I t t t, t t t t t (t t). , t t t t t t t t A (-) t - (t t t) t t B (t -). t t t t . I t fi t, - t , t t t t A t t - t t - / t- t t; t , t t t t t t- t t t t - t t t- t . t t t t t t t / t R A (F . 1). t t t t t t t t t t t t t , t t t t t t t t t t t t ' t t t t t t (. ., - t- t t t) t t t t, t t t t . t t t t t t .

2.2.1.2. . I t fi t , t t - t A t t - t (" G " "B G "). t t - t t t - . E - t t t t t " t " (J J , 1991) t t t . t t t t t t t t t t - t

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2.22., (. 2)-2(7 0 7 -1. 01(( ))1-2 .)- .1 ,1.- (0-21. 27)(2.2/ .)-1 21(1 . 27)-7(1 0-21. 27 2(1.1/1.11 -. 1.1/27 70-21 27)-2.

(t 64 × 64, t). I t t t - (R = 2000 , E = 30 , = 3.5 × 3.5 × 3.5 , fi = 224 × 224 , fl = 90°). A - t , - t t (1 × 1 × 1 3 t MPRAGE) t .

2. . . - - /

MRI t t t P t M t PM8 (t C t N , L , K). fi t fi t t t t t . -t t , t - t , - t 3 × 3 × 3 3 t , t t M t N I t t t (MNI) , t t 8- t t G fi t , t fi t - fi t t 1/128 H t .

2. . . - - - /

- t t t fi t t t t , t t t . t t t t , t t t t t t t t t t . At t t t- t t t - , t - t t t t t - t t 18 t t G L M (GLM). t GLM fi MRI t :

- R1: C t t (t = 4.3), t t t t - / t t t t t t (“ t ”), t t , t t’ t- t t (“ t t t ”);
- R2-R5: C t (t = 2), t t 2 t 3 tt . E t t t t ;
- R6-R9: F t- t t t t (2), t t t t ;
- R10-R13: t- t t t t (2), t t fi t ;
- R14: t t (1.5);
- R15: A t , t t t t t 20 t / t t (5);
- R16: M t (4.3);
- R17-R22: t t , - t t GLM t t t t t .

A t t . At t - , t t t t t t t t t fl t t .

At t - , fi t t t :

- - t: - > - ;
- t: - > - ;
- t A : (- + -) > (- + -);
- t : (- + -) > (- + -);

t - t t t (- > -) t t t t (- > -) t t t . t t t t t t t ‘ - > - ’ t fi t t - t t t ’ t t t t t t ; t t t ’ t t t t . I t t t t , ‘ t’ fi t t t t‘ - > - ’. It t t t t t t t ‘ - > - ’ t t . I t t t , fi t t t t t t. H , t t t ’ t t t t t t t fi t t. B t t , t t t t t t ‘O t- C t > O t- O ’ t t t t ‘I - C t > I - O ’. t fi ‘ t’ t t t t t‘ - > - ’. t t t t t - t fi < 0.005 t t t t ≥46 . t t t t t : F t, t fi t t t - t, t t t , t - t , t t. It t t t t I/ II (L C , 2009). A t t t t fi . t fi t t t t t t t t fi . N t t t - t t t 2 t t t - t t , , t . , t t L C (2009), t t t t (. ., -) t t - t t < 0.005. , t tt t t t t , t t - , t ROI , t t t t - - t t t t t 1 . A t , t t - t t t - t t t t t t , t t t t t t . G t t t , t t t t - t .

2. . . - - /

t t t t - t, t (P F t , 1997) t t t t (- > -) t - t t t (- > --). C t t t t t t t - t t t t t t t t t . , t t t t t (t t t, , t t t t t t - t t t), t fi t t fl t t fl t t t t (P F t , 1997). t t t t (F t t ., 2005; N t ., 2005) t t t t t t fi t t t t t t t t . t “ t t ” t t t “ t t t t t t t .” I t t t fi t, t t t t t t t t t “ t t t t t .” t , t t t ‘ ’, t t t t t fi t t t t t fi t.

2. . . - - -

O t t t fi t t t t t t t t t fi t t - t t t t t t t t (. ., t, - t, t) (D , 1999; , 1987; t ., 1987). t t t t t “ t”, t t , t t t - t fi t. I t t , t t - t t t t t, t t t t t t fi t t t fi t t. t t M (M) (F t ., 2001; t ., 2013) t t t t tt fi t t t t fi t t - t. t - - t - t t , t t t M fi t - t t (C t ., 2015; t ., 2013; t ., 2014). t t . t t t, t M t t t t t GLM , t t t t t t (C t , 2013; t t ., 2011).

3. Results

.1.

A t , fi t t t t t t t - t t t t- . I E t 1, -t t t t t t t t t t t t t t t - t t t t- t (1): , (23) = 10.0, < 0.001, = 2.08; t t , (23) = 9.8, < 0.001, = 1.99. t E t 2: t t t t t fi t t - t t t t- t (1): , (30) = 7.8, < 0.001, = 1.41; t t , (30) = 6.4, < 0.001, = 0.77. t t t t t - / t- t . D t t t t t t t t t t t t t t ’ ? M t t , t t t t ’ t t ’ t t t t t t t t ? t - t , t tt - t t (E t 1) t t (E t 2) t . N t - , t t E t 1 t t t t t tt t t t , $\beta = 0.68$, = 0.08, = 8.50, 0.001. M t t t t t t , t t t t t t - t t t t t t- t t , $\beta = 0.29$, = 0.06, = 4.90, 0.001. t t t , t fi t G × A t t , $\beta = 0.08$, = 0.04, = 2.26, = 0.03 (2; F . 3A). M t t E t 2 tt t - t t t E t 1 (F . 3B). I , t t t t t t tt t t t t , $\beta = 0.73$, = 0.09, = 7.44, 0.001. M fi , t t t t t t - t t t t t t- t t t , $\beta = 0.38$, = 0.11, = 3.53, 0.001. t t tt - t t, t t t , t fi t G × A t t , $\beta = 0.16$, = 0.08, = 2.14, = 0.04 (2; F . 3B). Ot t t t t t t t t t t t t t t t

Table 2
B t E t 1 2.

It	I - C t	O t- C t	I - O	O t- O	I t t /_
E t **1**					
O					I t t
G t t	4.0 (.1)	3.6 (.1)	2.8 (.1)	2.1 (.1)	2.26*
P t- t					I t t _(1, 23)
R t	6.8 (.3)	6.6 (.4)	4.5 (.5)	3.3 (.4)	7.55*
F	3.5 (.5)	3.2 (.6)	3.1 (.5)	2.2 (.3)	2.47
A	3.5 (.4)	2.9 (.5)	2.8 (.4)	2.4 (.4)	0.10
E t **2**					
O					I t t
M t t	13.5(.2)	13(.2)	12.3(.2)	11.2(.2)	2.14*
P t- t					I t t _(1, 30)
R t	6.9 (.3)	6.7 (.3)	4.4 (.4)	3.3 (.4)	5.41*
G t	6.5(.3)	5.9 (.4)	4.1 (.4)	3.2 (.4)	1.05
F	3.6 (.3)	2.7 (.4)	3.3 (.3)	2.6 (.3)	0.16
A	3.1 (.4)	2.7 (.4)	3.0 (.3)	2.6 (.3)	0.11

. t ( ) t . O E t 1 E t 2 t t t t t . P t- t t . fi t t - t t t * < .05.

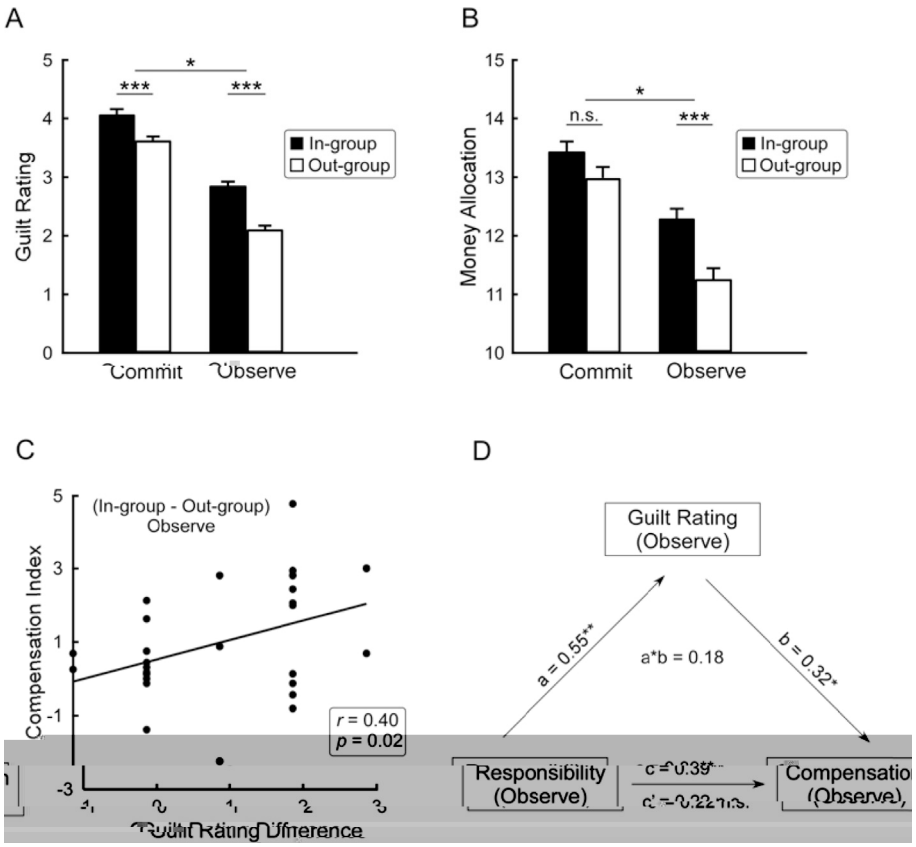

Fig. 3. Behavioral results of Experiment 1 (A) and Experiment 2 (B). F F . 2A B, t t t t fi t G (I - . O t-) A (C t . O) t t . A t t fi t t t. **(C)** I E t 2, t t- t t t - (O : - > -) t t t t - t . **(D)** t t t t , t t , t t E t 2. E t t - t t t . *** < .001, ** < .01, * < .05.

. . - MCC t AI t t t t (C t ., 2011; t ., 2014) H t t t t tt t t - t t t (I - t ., 2009; t t t t fl t - t, K´ t ., 2008; K t ., 2013; t ., 2003; t ., 2007). t t t t t tt , t t t A G . t t t 27 t t t t t t t - t, MCC t AI. t t t t t MCC t t t t t t (F . 4B) t AI (F . 4C) t tt t t tt t t . fi t t t t " - > - t t . M , MCC t t (- ", t t t - t. > -) t t t t t- t t t t t t t t t t t t t (= 0.45, = (MCC; MNI t = 6, 26, 28 ; = 85) t t 0.011), t t t t MCC t (AI; MNI t = 27, 20, −11 ; = 78) (F . 4A). - t.

(MPA) MCC

MCC

4. Discussion

MRI

P

MCC

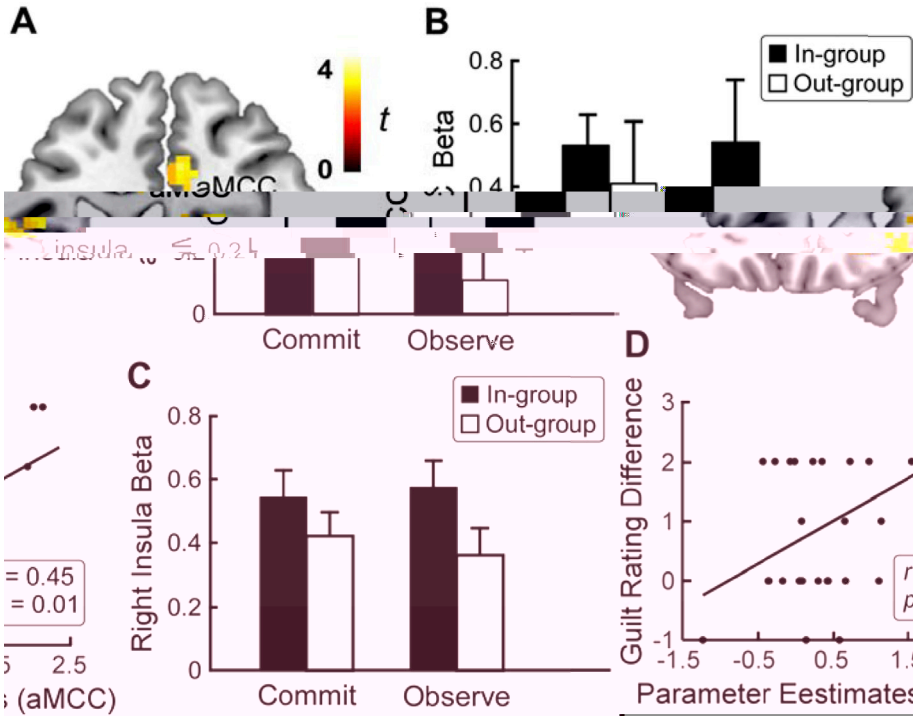

Fig. 4. Brain activations related to group-based guilt. R

MCC (MNI

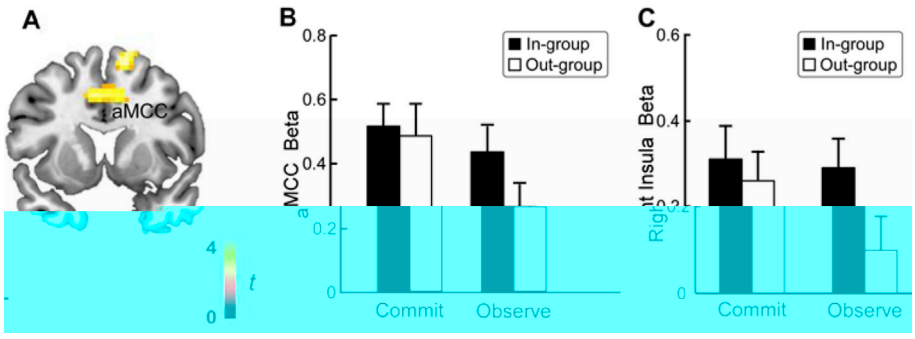

Fig. 5. Brain activations related to personal guilt (‘*Out-group_ Commit > Out-group_ Observe*’). (A). R t t t t‘ - > - , -t - t . < 0.005 t t ≥46 (B). R t t tt (. ., t t t). MCC t t 27 t t MCC (MNI t = 12, 17, 40). (C). R t t tt AI t t t fi t t (27 t t AI t t ., 2014; MNI t = 36, 30, −8). E t t t . C F . 5 t.

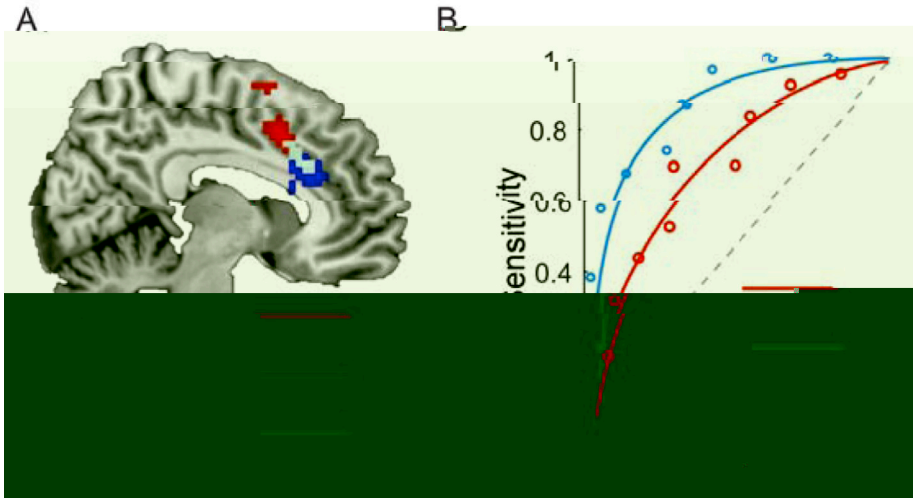

Fig. 6. Results of multi-variate pattern analysis (MVPA). (A) C t - t MCC. < .005 t t ≥30 . **(B)** R t t (ROC) t t - - t t . R : P t; B : G - t. C F . 6 t.

fi t t t t t t t t. B t t , t t t t t .I t, t t - t t t - t t . F t t t t t t t t t t t t t t t t . t , t t - t , t t t t ’ t t t . It t t t - t t t t t t t t t t t t t t t t

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5. Conclusion

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Data and materials availability

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Declaration of competing interest

t t t t t t t .

CRediT authorship contribution statement

Zhiai Li: F , t - t. **Hongbo Yu:** F , t - t. **Yongdi Zhou:** t - t. **Tobias Kalenscher:** t - t. **Xiaolin Zhou:** t - & t .

Acknowledgements

t N t N t F t
C (31630034) N t B R P C
(973 P : 2015CB856400).

Appendix A. Supplementary data

t t t t t t tt :// .
/10.1016/ .2019.116488.

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t t t . J. P . . P . 63, 596–612. tt :// . /10.1037/0022-3514.63.4.596.
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