Interaction between oxytocin receptor polymorphism and interdependent culture values on human empathy

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Recent evidence suggests that the association between oxytocin receptor polymorphism (OXTR rs53576) and emotion-related behavioral/psychological tendencies differs between individuals from East Asian and Western cultures. What remains unresolved is which specific dimension of cultural orientations interacts with OXTR rs53576 to shape these tendencies and whether such gene × culture interactions occurs at both behavioral and neural level. This study investigated whether and how OXTR rs53576 interacts with interdependence—a key dimension of cultural orientations that distinguish between East Asian and Western cultures—to affect human empathy that underlies altruistic motivation and prosocial behavior. Experiment 1 measured interdependence, empathy trait and OXTR rs53576 genotypes of 1536 Chinese participants. Hierarchical regression analyses revealed a stronger association between interdependence and empathy trait in G allele carriers compared with A/A homozygotes of OXTR rs53576. Experiment 2 measured neural responses to others' suffering by scanning A/A and G/G homozygous of OXTR rs53576 using functional magnetic resonance imaging. Hierarchical regression analyses revealed stronger associations between interdependence and empathic neural responses in the insula, amygdala and superior temporal gyrus in G/G compared with A/A carriers. Our results provide the first evidence for gene × culture interactions on empathy at both behavioral tendency and underlying brain activity.

Keywords: ; a ; a ; MRI

INTRODUCTION

T a c a a d e e c a i d e a e i a e e d e c e a e a c e a e f e c e a d affec e c e e a e i a e d b b c a e e e c e (Ha a d N ff, 2008; K a a a a d U , 2011; C a e a., 2013; Ha e a., 2013) a d e e c a e- (Ha e a., 2006; B i a d We be e , 2010; Fa e a., 2012). T e e i d e e a e d c a e e c f e c e b a a c b c a e a a c e c d e d f c i f d d a i f d ffe e c e (Z e a., 2007; S e a., 2009; C e e a., 2011; de G e c e a., 2012; M a a e a., 2013; K a a a e a., 2014; Ma e a., 2014a) d ffe e e- e (Ha e a., 2002; Fa e a., 2013; Ma e a., 2014b; S a e e a., 2014). F a ce, de G e c e a. (2012) f d a, d e a c e i f a , C e e a d i e d i e e- d a c e i e e e f d i a e a e f a c e e e a Ge a i a f e d i e a c e e e a e a j c (TPJ), fe a d i e e a i (STG), a d e f d d e i a. C e e a. (2011) a i f d a, c a e d Ca ca a -A e ca i, K e a i e e d e e e c e a e e- a a d e c e d i e a c e e f TPJ e i e ( ) e be i' e a a. A e e e i d e- e a e d a, e i e c d i d f c a a e c e a c e a (fMRI), i e c e de i (SNP) (i 53576 a d i 1042778) e c e e e (OXTR) e e i f c a a i c a e d i e a e a d e d a c e- i i e c d i e b f a c e, a e c a e c e a d c a i (M c a i a e a., 2014). A e e f d i e c a a d e e c f e c e b a a c e a e d e i' e a i a e a d e i c a be a , da e, e e a e bee e a e fe e c a f d i e a d e e a i be e e e a d c e i a a b a a c e d i c a be a .

C e e e a a e a e e a be e e e a d c e a b a d d a e e i e d c a c e a e a c e e i a e a b a a c . T e e e–c e c e e i a e a c e c e a e e e i de c e e c i e e c e a e a d e e c i e e c c a i e c a e f e c e a d e a a c e c e fac a e a i i- i f i e c a a e (B a d a d K , 2004; R c e i e a., 2010). C i e e e e–c e c e e , e c e i d e e e d e de c e f e a i c a be e e c e c i c- a a e a d a e c f e e c f e e e, . e. e i e a i- e f c a i (5-HTTLPR) (C a a d B i , 2010) a d e OXTR i 53576 (L a d Ha , 2014). P a i d- a e d b i e c e c i c a e c i e e d d a i ca- e i ( ) a e e f 5-HTTLPR a d e d d a i ca e A a e e f OXTR i 53576. M e e, a e e f e e c a d c a a e a e e e e d e a e a e c e f e a b e i c a c e a e d f e e c f i a e e c a e i e d c i dec e a e d a e a d d d i de e a e c e c e a e d c e c i c c a a e (C a a d B i , 2010) a d A a e e f e e c f OXTR i 53576 e d c i a j de e i d i de e a e c e a c i i a i a d i c a i c a e d i e d a e d b c e c i c c a a e (L a d Ha , 2014). T e e f d i e a b a e e e a i be e e c e f a a d e e c i e e c e a c e- a c e i e a d e a d e e e c a f d ffe e a e e c f e c e a c i c e b a a c e a de a be a- . I a bee i e e d a c a a e a i e e a d a e f c- i b i c a be a e d c e i c a a d e e a i fac i a d e e f e e c a i a a e e e a ba a a e a d e f c a i a d c e e i e de- i a d f c e (C a a d B i , 2010).

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[illegible] (HTR1A) [illegible] (S/S) [illegible] 5-HTTLPR [illegible] (S/L [illegible] L/L [illegible]) [illegible] (Ka [illegible], 2014).

[illegible] (Ka [illegible], 2010b). [illegible] (Ka [illegible], 2010a), [illegible] (Ka [illegible], 2011). [illegible] (Ab [illegible] et al., 2014). [illegible] (Pa [illegible] et al., 2014). [illegible] OXTR [illegible] (Ba [illegible] et al., 2012), [illegible] (Ka [illegible] et al., 2010a), [illegible] (Ka [illegible] et al., 2012). [illegible] (Ma [illegible] et al., 2014a). [illegible] (Ja [illegible] et al., 2014; Wa [illegible] et al., 2015). [illegible] OXTR [illegible] 53576 [illegible] (HTR2A). Ma [illegible] et al. (2014c) [illegible] (HTR1A) [illegible] (Ma [illegible] et al., 2010). [illegible] (Se [illegible] et al., 2013) [illegible] (Ma [illegible] et al., 2014b). [illegible] (Ma [illegible] et al., 2014c). [illegible] (Ma [illegible] et al., 2014d). [illegible] (Ma [illegible] et al., 2014e). [illegible] (Ma [illegible] et al., 2014f). [illegible] (Ma [illegible] et al., 2014g). [illegible] (Ma [illegible] et al., 2014h). 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[illegible] (Ma [illegible] et al., 2014ys). [illegible] (Ma [illegible] et al., 2014yt). [illegible] (Ma [illegible] et al., 2014yu). [illegible] (Ma [illegible] et al., 2014yv). [illegible] (Ma [illegible] et al., 2014yw). [illegible] (Ma [illegible] et al., 2014yx). [illegible] (Ma [illegible] et al., 2014yy). [illegible] (Ma [illegible] et al., 2014yz). [illegible] (Ma [illegible] et al., 2014za). [illegible] (Ma [illegible] et al., 2014zb). [illegible] (Ma [illegible] et al., 2014zc). [illegible] (Ma [illegible] et al., 2014zd). [illegible] (Ma [illegible] et al., 2014ze).

ı e f-c ı a ı c e . e L/L a S/S e f e 5-HTTLPR a C . e e. T e e ı ı a e a . e ac be- ee a ı ec f c e e c ı a d a c a a a . d d a ı f e ı a e c a b d d de ı a e e e × c e . e ac ı b be a a / ı c ca e de - c e a d b a ac .

I ı ı d , E e e 1 ea ed ı e f-c ı a ı ı e Se f- C ı a Sca e (S e ı , 1994) a d e a a ı e I e e ı a Reac I de (IRI) (Da ı , 1994) f C . e e ad ı e e a ı e ed f OXTR ı 53576.[1] T ı a ed ı e a . e e e e e ı a a ı ca be ee a c a e- a (.e. e de e de ce) a d a e a a a d e e ı a ı ca ı de a ed b OXTR ı 53576. E e e 2 f e e a ed e e e de e de ce ca ed c e a c e a e ı e e ı ' ı ffe a bjec e ea e f e a b ı ca A/A a d G/G ı f OXTR ı 53576 ı fMRI. E a c e a e ı e e ı ' ı ffe e e a f ed b c - a e ce ed a f - a f ı a ed e ı , ı a e e ı e ea c (S e e a ., 2004; Jac ı e a ., 2005; G a d Ha , 2007; Ha e a ., 2009; X e a ., 2009; L e a ., 2014). I a c a , E e e 2 a ı e ı ed e e OXTR ı 53576 de a e e a ı ca ı be ee e de e de ce a d e a c e a e ı e . T e be a a a d e a e ı a ı e a e e e e e a e c ı ı e e e × c e . e- ac ı b be a a / ı c ca e de c e a d b a ac a d de e ı e e a de ı a ed a e e e × c e . e ac ı a e a . Ta e e e , b e a be a a ea e f a a e e ed ı a e a d b a a ea e f a ı a e ed ı a e, de e ed a e c a e ı c e ce a ac a a ı ı - e a e e e × c e . e ac ı a ı ca c . T e f d ı a e a ca ı f de ı a d e . e- a be ee a ı ec f c c a e a a d e e ı a e a ı ca be a a d de e a ec a ı ı .

MATERIALS AND METHODS

Experiment 1: behavioral investigation

Participants

E e e 1 ec ed 1536 de ad a e a d ad a e C . e e ı - de ı a a d ee ı (a e = 826, fe a e = 710; 15–33 ea ı , ea ± ı .d. = 19.41 ± 2.43; ı ee Tab e S1 f add a de a c f a). F ı bjec ı e e e c ded f da a a a ı ı d e e fa e. A a ı ed ea e a a e e ed b e ı e . I f ed c ı e a b a ed e ı d . A e e e a ced e c f ed de e ı e b e C de f E f e W d Med ca A ı ca f He ı a d e e a ed b a ca e c ee.

Genotyping

OXTR ı 53576, c ı ca ed e d f OXTR, a ı e ec ed f e . T ı SNP a e ed b ı Ta Ma e a f . T e Ta Ma be e e de ed f e A ı a ı De a d ı ı e f e A ed B ı ı e ı (A ed B ı ı e ı , F ı e C , CA, USA, :// .a edb ı ı e ı . c). Ge a e f ed 5 µ ı ı e c a 2.5 µ f Ta Ma U e ı a PCR Ma e , 0.25 µ f 20 × Ta Ma be a d 1 µ e c DNA ı R c e L C c e 480 II (R c e D a ı c , Be , C a). A e e ca a e f ed ı L C c e CW 1.5 ı f a e (R c e D a ı c). B e ca a e a d c c da ce f d ca e ı a e e e < 0.95. T e e - e d ı b f ı 53576 (= 688 A/A, = 683 A/G, = 161 G/G) d d de a e f Ha d –We be e b ($P > 0.6$).

Measures

A a c a ı c e ed e IRI (Da ı , 1994) a a ea e f e - a a ı . T e a 28- e e a e c ı ı ed f f 7- e ı b ca e (Fa a , Pe ı ec e Ta , E a c C ce a d Pe ı a D ı e ı), c ea e ı e a a e b e c e a ed c e ı f e a . A e E a c C ce a d Pe ı ec e Ta ı b ca e c e d e d ec e c ce a def f e a a e a ed e e e a ce (B a d a d K , 2004), ı d f c ı ed IRI a ı c e a d E a c C ce a d Pe ı ec e Ta ı b ca e ı ı a e e ı e ea c (Wa e a ., 2003; B a d a d K , 2004; J ffe a d Fa , 2006). T e a a e ab ı a e a 0.78 f IRI a ı c e, 0.71 f E a c C ce ı b ca e a d 0.65 f Pe ı ec e Ta ı b ca e. I e ı e e e e ed a ı a e e ı a d a c a ı a ed e a ee- e a 5- L e - e ı ca e (1 = d e de c be e e , 5 = de c be e e). T e Se f-C ı a Sca e (S e ı , 1994) c - ı ı ı f 24 e ı f a ı e ı d d a d ffe e ce de e de / e de e de ı e f-c ı a ı a 7- L e ı ca e (1 = ı d ı a ee, 7 = ı a ee). S a e e ı e ea c (C a e a ., 2010; Ma e a ., 2014a), e ca c a ed a ea e f e de e d- e ce b ı b ac e ea ı c e f e 12 de e de ı e f- c ı a e ı f a f e 12 e de e de ı e f-c ı a e ı .

Data analyses

H e a c ca e e ı a a ı e e e c d c ed e a e e e OXTR e e affec ed e e a ı be ee e de e de ce (IV) a d d d a ı ' e a (DV). T e IV (e de e de ce) a d e de a (OXTR e e) e e a ed bef e e e a c - ca e e ı a a ı ı . T e e ac ı be ee e de e de ce a d OXTR e e e e ca c a ed b e a ed a - ab e e e (A e a d We , 1991). N a ed e de e de ce, OXTR e e a d e e ac ı e e e ı e e a e e ed e e a c ca e e ı . T e de a effec a d ca ed b a ı f ca e ac f e de e de ce a d OXTR e e d d a ı ' e a a ı .

Experiment 2: neuroimaging investigation

Participants

E e e 2 ec ed 30 G/G d d a ı a d 30 A/A d d a ı f e ı a e E e e 1, e e a a ab e f fMRI ı ca - a d a c ed e de . T ı ı a e ı e a de e ed ba ed e e ı f e ı e ea c a e a ed e ı a e ı e f e a e ab e be ee - d ffe e ce fMRI ı a ı (Ma e a ., 2014a). G/A d d a ı e e e ed E e e 2 beca ı e be a a ea e E e e 1 ı ed e ab e d ffe - e ce be ee G/G a d A/A d d a ı . A a c a ı e e a ded, ad a c ec ed- - a ı , a d e ed ab a e ca ı . A e, a e a a d ı e f-c ı a ea e d d d ffe ı f ca be ee e e ed ı ($P_s > 0.1$, Tab e S6). I f ed c ı e a b a ed f a a c a ı bef e ı ca .

[1] We actually tested not only rs53576. At an early stage of our research, we tested rs2254298 and rs1042778 in a sample of 700 subjects. Because the results of this sample suggested interactions of interdependence by rs53576 (but not rs2254298/rs1042778) on empathy traits, our further behavioral and neuroimaging work focused on rs53576.

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Stimuli and procedure

S [illegible] ed d [illegible] fMRI ca [illegible] c [illegible] ed f 48 de c [illegible] a [illegible] ed [illegible] A a de [illegible] (ee a [illegible] a d ee fe a [illegible]) a d [illegible] Ca ca a de [illegible], ad ed f e [illegible] (X e a., 2009). A a a d Ca ca a de [illegible] e [illegible] ed de e a e OXTR [illegible] 53576 × e de e de ce e ac e a e [illegible] ac a a d e be [illegible]. H e e, e e-b a e-a c ca e e [illegible] a a [illegible] d d [illegible] f ca OXTR [illegible] 53576 × e de e de ce e ac e a e [illegible] Ca ca a face [illegible]. T [illegible], e e ed e e [illegible] e a ed A a face e e [illegible] e [illegible]. T e e e f de c [illegible] f eac de c e/ e ece ed a f (eed e e a) - a f (Q- c) [illegible] a ed e ef c ee [illegible] e a e e [illegible]. Eac c a ed f 3 [illegible] a d [illegible] b e ded a [illegible] a a e f 21° × 17° (d × e) a a e d a ce f 80 c . Af e eac de c a c a [illegible] e e a ed d ca e e e de a fee a b a b e [illegible] e de dd e f e .

T e e e f f c a ca [illegible] a d eac ca c [illegible] ed f 12 de c [illegible] f A a de a e e e ed a a d de . Ha f f e de c [illegible] ed a f [illegible] a d a f [illegible] ed - a f [illegible] . T e e a 9 [illegible] e [illegible] e a be ee [illegible] cce [illegible] e c [illegible] d c a c a [illegible] f a ed a ce a c [illegible]. T e a de c eac [illegible] ca a f ed b a 12 [illegible] f a . Af e [illegible] ca , a c a [illegible] e ed a e de c [illegible] a a [illegible] de e [illegible] ca e a d a ed e e [illegible] f a e e e ced b eac de ('H a f d e de fee [illegible] ?') a d e ea a e [illegible] a - ca ed e [illegible] ('H ea a d fee e h e e de c ?', 1 = a a a f ea a , 10 = e e e a f ea a). Pa c a [illegible] a c e ed e IRI ca e (Da [illegible], 1994), Se f-C [illegible] a Sca e (S e [illegible], 1994), Se f-E ee (R [illegible] e be , 1965) a d S bjec e S ca a d Ec c S a [illegible] Sca e (K a c a d Ca , 1960), e ec e .

fMRI imaging data acquisition

B a a e e ac ed [illegible] 3.0 Te a S e e [illegible] T a e Be j MRI Ce e f B a Re ea c . B d e e e de e de ad e ec a a a e e b a ed [illegible] a 12-c a e ead c [64 × 64 × 32 a 3.44 × 3.44 × 5.0 [illegible] a a e , e e e (TR) = 2000 [illegible], ec e (TE) = 30 [illegible], f a e = 90°, f e d f e = 24 × 24 c] e a c a [illegible] e f ed a j d e [illegible]. A - e T1- e ed [illegible] c a a e (256 × 256 × 144 a a [illegible] a a e f 1 × 1 × 1.33 , TR = 2530 [illegible], TE = 3.37 [illegible], e [illegible] e = 1100 [illegible], f a e = 7°) a [illegible] h e e ac ed.

fMRI data analysis

T e f c a a da a e e a a ed b [illegible] e e e a ea de f e e - e a ed de [illegible] SPM8 (e We c e T [illegible] Ce e f Ne a , L d , UK). I de c e [illegible] a e f de a [illegible] a [illegible] ca ed ac [illegible] e d ffe e ce be ee [illegible] ce d e e e a a , f c a da a e e f [illegible] e-c ec ed. F c a a e e e ea ed e f [illegible] ca c ec f ead be ee [illegible] ca [illegible]. A a e e e [illegible] a a - ed e M ea Ne ca I [illegible] e (MNI) e a e a d e a ed b a a e a e [illegible] e f 2 × 2 × 2 . F c a a e e [illegible] ed [illegible] a Ga [illegible] a f e e f - d / a f- a a a e e [illegible] e 8 . T e e e - e a ed e a ac a de ed [illegible] a ca ca e d a c e [illegible] e f c .

F ed effec a a [illegible] e e f [illegible] e f ed e a e effec [illegible] a eac e a d c a e e a [illegible] ec f c effec [illegible] eac d d a a c a [illegible] ea c a [illegible]. T def e a [illegible] ec f c e a ac - a [illegible], e c a f a f - a f [illegible] a ca c a ed. We e c d c ed a e-b a e a c ca e e [illegible] a a [illegible] e a e e e ac be ee OXTR [illegible] 53576 e e a d e- de e de ce e e a ac e [illegible] e [illegible] e [illegible] ' [illegible] ffe . We f [illegible] a ed e de e de a ab e (IV) (e de e de ce) a d e c a a e a ab e (e e). Ge e a c ded a a d- c [illegible] d a ab e c 0 e e ed A/A ca e [illegible] a d 1 e e ed G/G ca e [illegible]. T e e ac [illegible] be ee e de e de ce a d e e e ca c a ed b e a ed a ab e e e (A e a d We , 1991). N a ed e de e de ce (IV), e e (de a) a d e e ac [illegible] e e e ed a e e [illegible] e SPM e e e [illegible] a a [illegible] a eac a c a ' c a a e f a f - a f . B a ac e c a ed e eac f e e a d e de e de ce d ca ed [illegible] f ca e ac f e de e de ce a d OXTR [illegible] 53576 e b a ac - e . S f ca b a ac a [illegible] c a ed e e ac f e de e de ce a d OXTR [illegible] 53576 e e de f ed [illegible] a e d f $P < 0.05$ (Fa [illegible] e d [illegible] c e a e (FDR) c ec ed f e c a - [illegible]). S e e e [illegible] a a [illegible] e e a [illegible] c d c ed f eac e - e f e e a e e e a [illegible] be ee e de e de ce a d e a e [illegible] e ' [illegible] ffe .

RESULTS

Experiment 1: behavioral investigation

E e e 1 ec ed 1536 a c a [illegible] (ee Tab e S1 f e a ed de a c f a). IRI a d e de e de ce [illegible] c e e a c ed a e e e e [illegible] (Tab e S2). T e e a c ca e e [illegible] a a [illegible] f [illegible] c f ed a e e a c f OXTR [illegible] 53576 e e a d e de e de ce e ab ed c ed a c a [illegible] ' IRI [illegible] c e (Tab e S3). Se a a e a a [illegible] e e a ed [illegible] f ca c e a [illegible] be ee I e de e de ce a d IRI [illegible] c e a e e e [illegible] (G/G: $\beta = 0.368$, $R^2 = 0.135$, $P < 0.001$; G/A: $\beta = 0.258$, $R^2 = 0.067$, $P < 0.001$; A/A: $\beta = 0.150$, R^2

effec (Tab e S5). Ta e e e, e e f E e e 1 d ca e a e e a f ca a c a be ee e de e de ce a d e e a a a d a a c a f ca de a ed b OXTR 53576. G/G e ed e be ee e de e d- e ce a d e a a a A a e e ca e f OXTR 53576.

Experiment 2: neuroimaging investigation

E e e 2 ec ed 30 G/G d d a a d 30 A/A d d a (Tab e S6) f f c a b a a . D ca b e - e de f ed a f a d - a f ac- c ac (>90%). Ra c e f a e a d e f- ea a e b a ed af e ca e e e f a f a - a f - [$F(1,58) = 580.63$ a d 198.40, P < 0.001], b d d d ffe be- ee G/G a d A/A (F < 1, Tab e S7). G/G e ed f ca a c a be ee e a c e f e - de e de ce a d IRI (= 0.479, P < 0.01), e ea A/A e d d (= 0.067, P > 0.7). S a , e e de e de c e e c e a ed e a c e f e ec e a a d e a c c ce b ca e f e IRI G/G b A/A d d a (e ec- e a : G/G: = 0.676, P < 0.001; A/A: = 0.029, P > 0.8; e a c c ce : G/G: = 0.504, P < 0.01; A/A: = 0.196, P > 0.3).

T e e-b a e a c ca e e a a f e fMRI da a f e ea ed f ca OXTR 53576 × e de e de ce e ac e a c e a e (. e c a f a f - a f

[illegible] A/A [illegible] (P > 0.05).

[illegible] G/G [illegible] OXTR [illegible] 53576 × [illegible] Table 1. [illegible] STG [illegible] ($\beta = 0.469$, $P < 0.05$; [illegible] $\beta = 0.185$, $P > 0.2$), [illegible] STG [illegible] ($\beta = 0.154$, $P > 0.3$; [illegible] $\beta = 0.564$, $P < 0.005$; STG: [illegible] $\beta = -0.038$, $P > 0.8$; [illegible] $\beta = 0.434$, $P < 0.05$).

DISCUSSION

[illegible] OXTR [illegible] 53576 [illegible] OXTR [illegible] 53576 [illegible] G/G [illegible] A/A [illegible] OXTR [illegible] 53576. [illegible] OXTR [illegible] 53576 [illegible] OXTR [illegible] 53576 [illegible] fMRI [illegible] affec– [illegible] (Fa [illegible] (La

a e de ce f e be ee e a e a a d e- ce f e f e a e (C a d e a., 1997; B a d Re e, 2012), a ea e e e f e f- e e a c ed e e a c ce f e. Rece e a f d f e de ae a ca a ea be ee e f-c a a d e a c a e f-c a a e a f ed e de e de ce/ de e de ce e ed d a f e a c e a e e e ffe (J a e a., 2014; Wa e a., 2015). M e e, e f-c a d a e e a c e a e e de e d a c a c c c a e e e ce (J a e a., 2014) a d e ce ed e ea be ee he e a d a e (Wa e a., 2015). T e c e f d b ade de a d f e ea be ee e f-c a a d e a b a e e c ec be ee e c e c e f ca c e e f-c a a d e a c a ed b e e e c a e . T OXTR 53576 a e be a a/d a e a (R d e a., 2009) a d e a c e a e e (L e a., 2015) b a de a e e ea be ee d ffe e c ca a (e. e f-c a a d e a) a de e e ca ab .

I e e, e e ac be ee e de e de ce a d OXTR 53576 a e de a e b a e e a ed e (e. e a, a da a a d STG). T d ffe e f e f d f ece a e a ed e e ac be ee e de e de ce a d 5-HTTLPR d a e f- efe e a a (Ma e a., 2014c). I d , / (/) / (/) a- a f e 5-HTTLPR e e ca ed d ef ec f e a a b e f e e f a d e e. I a f d a / b / e e ed f ca a ca be ee e f- c a a d ac b a e e a ed b c e a d affec e ce e c a e MPFC, b a e a dd e f a c e, TPJ, a a d ca d ef ec e a a b e f e e f a d e. T e ef e, e e ac be ee c a e a a d e e a a e e a ac e de- ca c e de f e ca b a e . H e e, e a c e a ed d b a a f e ce c b a e a e ce be e effec f e e × c e e a .

T e e de ec ed c a a d e a ed -e e e e–c e e ac be a a/ c ca e- de ce b e a c - d c e a c c a a be ee d ffe e e e (K e a., 2010a,b, 2011; I e a., 2014; K a a a e a., 2014). T , e e, a ed e e- a be ee e e a d c e d d a e e f e a e c a b e d ed a c a a d ffe e de e. Rec a c a f e a e c a e e e e e e c , a a e, e e , ec. a e - e ce d d a d ffe e ce c a e a . Ba ed e e f e de a c a ed c a , a bee e ed a e G a e e f OXTR 53576 c fe e a ced e - c a c a ed A/A e a d a bee ed e a d d a ca e e d ffe e a - ce b e e a e e d ffe e a d e e e be a d ffe e c e (K e a., 2010a, 2011; K a d Sa a , 2014). O e a e c e b - a a f e a e de c be ee d d a a d e de e de ce a d a e be ee e a a d e- de e de ce G/G ea e A/A ca e . M e e, e ea e ce b c a G/G ca e e ed b e a - ea ed be a a/ c ca e de c a d b a ac a d e e a e e e c a a e be a .

H d e de a d e e–c e e ac e a b a f e e ec e f e e–c e c e (B d a d R c e , 1985; R c e e a., 2010)? T ece de a e e ea ed a a d a ed b e c ec c a e c e e d d a ca e a e e f 5-HTTLPR a d e d d a ca e G a e e f OXTR 53576 (C a a d B , 2010; L a d Ha , 2014). I e e , b e (Ma e a., 2014c) a d c e f d a e C e e a e f a e e f e e c (.e. e a e e f 5-HTTLPR a d e G a e e f OXTR 53576) e b a ac e c ed a c a a (.e. e de e de ce) c - a ed e a f e a . O e be acc a , de e a d c ea e be , e a a a be e e e d a c a a e a d a e a e a a d ed e a ca be ee b a ac a d c a a (e. e de e de ce). A e a e , e a e f d a G/G ca e f OXTR 53576 d a ed e e a ee N A e ca e G/G a e e ca e c e e a- f e a (K e a., 2010a), be a G/G a a f OXTR 53576 e e e c a a e / de e de f f e e c a a . T e , e e , be e ed f e e ea c .

T e e a bee c ea e de ce f e e × c e e ac be a a e de c . Be de a G a d A a a f OXTR 53576 e b ed d c e e e a e f e e a a d e a ee . A e ca a d K ea (K e a., 2010a, 2011), a ece a e ea ed a c a d ffe e ce a de e de ca e a be ee e e b a d a ed e USA a d Ea A a a e ea e f ca e f ec f c a e e a d a e ece e e (.e. DRD4; K a a a e a., 2014). H e e , e ec a f c e × b a e ac a ed a e e effec f e e × c e e ac be a a e de c e a de d (H de e a., 2015). B c a e e c d ffe - e ce be a a e de c ac c a , e ea c e ca ca f e he e ed e e × c e e ac be a - a e de c ed a ed b a c a a a f e de e a ec a . I add , a ac c f ed - e a d ffe e ce e e e d ffe e ce de a d e a c ca be ee c a a a e e a ed. T , e e a ca f c ec f c c a e a e ac b a ac ed a a c a a b c e e a c f d . T e a ac de e ed d , .e. e a e e e × c e e ac b be a a e de c a d b a ac e a ed e a e ca be a d d a f e a e c e, a a ca f f e e ea c f ec e e f c a e ce ce.

W a a e e ca f f d f de a d e effec f c a b a ac a d be a ? G e a a a a ad a f c affec b a ac b c b - c ece e b a , f d f e de e de ce × OXTR e ac e a e a a- a a ad a f c a a e ac d d a ' c a e a d a e b a ac be a . A e e a bee e ea c e a e e effec f c × c a- e a e ac e a , ece e ea c deed e ed a c × e de e de ce e ac b a ac a d be a . L e a. (2013) f d a c aceb ea e ed ced e e a ac a ca e f- ef ec e - a a a d c effec a e c e a ed a ea e f e de e de ce f e f-c a (L e a., 2013). Pf d a e a. (2014) a e ed a a a a ad a a f c a e a ed e a e affec e e ac a d e

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SUPPLEMENTARY DATA

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Conflict of Interest

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