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Abstract

The present study investigated a genetic underpinning of human reconciliation. Recent research has shown that people tend to inflict self-punishment as part of a repertoire of reparative acts. Since empathy generally facilitates reparative acts, we hypothesized that there exists an association between an empathy-related genetic variation, a single nucleotide polymorphism (SNP) in the oxytocin receptor (*OXTR*) gene (rs53576 A vs. G), and the tendency toward self-punishment. Participants played a modified version of the dictator game, in which they made an unfair allocation unintentionally. They then had the opportunity to punish themselves by reducing some portion of their monetary reward. The results showed that the participants with the GA or GG genotype, compared to the participants with the AA genotype, were more likely to engage in self-punishment after making the unfair allocation unintentionally. This effect was not mediated by self-critical feelings (guilt and shame) associated with the unfair allocation. The present study suggests that the *OXTR* polymorphism is associated with a human reconciliatory tendency.

Keywords: self-punishment, oxytocin receptor gene, empathy, single nucleotide polymorphism

Oxytocin Receptor Gene (*OXTR*) Polymorphism and

Self-Punishment after an Unintentional Transgression

Recent studies have reported that people inflict physical pain or economic loss on themselves when they feel a sense of guilt or shame (Bastian, Jetten, & Fasoli, 2011; Inbar, Pizzaro, Gilovich, & Ariely, 2013; Nelissen, 2012; Nelissen & Zeelenberg, 2009; Watanabe & Ohtsubo, 2012; see also Wallace & Sadalla, 1966; Wallington, 1973, for early demonstrations). At the proximate level, self-punishment has the effect of reducing one's feelings of guilt (Bastian et al., 2011; Inbar et al., 2013). At the ultimate level, self-punishment may have conciliatory functions. When one feels a sense of guilt or shame after committing an interpersonal transgression, and for some reason, he/she cannot directly apologize or compensate the victim for the damage, he/she is still able to express sincere remorse to the victim by engaging in self-punishment (Nelissen, 2012; Nelissen & Zeelenberg, 2009). In fact, victims tend to perceive sincerity in costly reparative acts (Ohtsubo & Watanabe, 2009; Ohtsubo et al., 2012). Moreover, other people besides the victim may take the self-punishment as a sign of the transgressor's willingness to comply with social norms (Tanaka & Ohtsubo, 2013).

Although the accumulated evidence suggests that self-punishment is a robust phenomenon, substantial individual differences seem to exist in the self-punishment tendency. Watanabe and Ohtsubo (2012) had their participants decide how to allocate a fixed amount of money between themselves and a partner by means of card drawing. The experiment was designed such that all participants would make an unfair allocation (i.e., giving only 20% of the endowment to the partner, while keeping the remaining 80% for oneself). After making this unintended unfair allocation, the participants had the opportunity to relinquish some of the money that they had earned in the previous allocation task. Unlike other self-punishment tasks

(e.g., one disguised as a pain tolerance task), this experimental procedure did not rely on cover stories. Therefore, the individual differences observed in this task were not attributable to factors other than the participants' proneness to self-punishment. Watanabe and Ohtsubo found that approximately half of the participants punished themselves by relinquishing some portion of their rewards. The flipside of their finding was that the remaining half of the participants did not engage in self-punishment. The factors that explain such individual differences in self-punishment tendencies remain unclear.

Recent research on human genetics has suggested that our genetic traits, such as genetic variations in the oxytocinergic system, are closely related to human sociality and prosocial behaviors (Israel et al., 2009; Poulin & Holman, 2013). It is now well known that oxytocin is a potent modulator of social and reproductive behaviors in vertebrate species (Lee, Macbeth, Pagani, & Young, 2009). Moreover, recent human genetic studies have indicated that the oxytocin receptor gene (*OXTR*) polymorphism is associated with empathy and socio-emotional sensitivity (see Meyer-Linderberg, Domes, Kirsch, & Heinrichs, 2011, for a review). It is noteworthy that empathy promotes reparative acts, such as apology-making (Howell, Turowski, & Buro, 2012), and empathy (especially perspective taking) is associated with better post-conflict relationship outcomes (Leith & Baumeister, 1998). Therefore, some variation in the oxytocinergic system might explain individual differences in conciliatory tendencies, such as the self-punishment tendency (Tabak, McCullough, Carver, Pederse , & Cuccaro, 2013).

Of particular relevance to the present study was the guanine to adenine (G/A) single nucleotide polymorphism (SNP) in the third intron of *OXTR* (dbSNP number rs53576), as previous studies suggested that the G allele is associated with higher empathic accuracy (Rodrigues, Saslow, Garcia, John, & Keltner, 2009). Consistent with this finding, among the

Chinese Han population, AA homozygotes at this locus were found to be associated with a higher risk of autism than GA or GG individuals (Wu et al., 2005). Moreover, mothers with the GG genotype expressed greater maternal sensitivity to their children than the GA or AA mothers (Bakermans-Kranenburg & van IJzendoorn, 2008; Riem, Pieper, Out, Bakermans-Kranenburg, & van IJzendoorn, 2011).

In Watanabe and Ohtsubo's (2012) self-punishment experiment, during informal debriefing sessions, some participants who had not engaged in self-punishment spontaneously commented that they had seen no reason to give up their money. Such a cold response might have been due to insensitivity to the partner's hurt feelings (i.e., a lack of empathy). If this is the case, the AA genotype of the *OXTR* polymorphism (rs53576), which is linked to a relatively low level of socio-emotional sensitivity, might explain the cold response of those participants. Accordingly, we hypothesized that the G allele at rs53576 would facilitate self-punishment. In order to test this hypothesis, the present study combined genotyping and Watanabe and Ohtsubo's self-punishment experiment.

Method

Participants

Participants were 119 undergraduates at a large Japanese university (46 males, 53 females; for procedural failure, the sex and age of another 20 participants were not recorded; M_{AGE} = 19.01 years, SD = 0.93). They responded to an e-mail advertisement that was sent to a university-wide participant pool. The advertisement emphasized the monetary rewards: the participants would earn 500 Japanese yen (JPY) as the show-up fee (≈ 5 US dollars), and they would have a chance to earn an extra amount of money. The genotype was unidentifiable for two participants, and one male participant suspected that the study involved deception. Therefore, we

omitted these three participants from the data analyses.

Procedure

Participants engaged in the experimental task in a separate booth. It was explained to them that they would each play a game with another participant. The rules of the game were as follows: One participant of each pair would be assigned to the role of the allocator, and he/she would draw a card from a box. The card would indicate how to distribute 1,000 JPY between the two participants. All participants were assigned to the role of the allocator. The participants then drew a card. The experimental setting was designed such that all participants would draw a card indicating one of three unfair allocation schemes: (self, partner) = (900 JPY, 100 JPY), (800 JPY, 200 JPY), and (700 JPY, 300 JPY). Most of the participants (n = 97) drew the card indicating (800, 200), while 11 participants drew (900, 100) and eight participants drew (700, 300). The variation in the cards was introduced so as to prevent a rumor from spreading across potential participants about the deceptive procedure (i.e., the all cards carry the 800/200 allocation). Despite the minor variation in the unfair allocation schemes, all participants made an unfair allocation unintentionally.

After drawing one card as described above, the participants were asked to fill out a questionnaire containing the State Shame and Guilt Scale (SSGS; Tangney & Dearing, 2002). SSGS consists of 15 items that are divided into three categories, each designed to measure state shame, guilt, and pride, respectively. We adopted SSGS because previous studies implicated guilt, and possibly shame, as a proximate emotional cause of self-punishment (e.g., Inbar et al., 2013; Nelissen, 2012; Watanabe & Ohtsubo, 2012).

The participants were then given a chance to reduce their own monetary reward. The instructions on the questionnaire read as follows: “If you are discontent with the allocation you

just made, you can reduce your monetary reward." The instructions emphasized that the amount of money deducted from the participant's reward would not be transferred to the partner, and the partner would not be informed of whether the participant had reduced his/her monetary reward. Therefore, self-punishment in this study was conceived as a completely private act.

Self-punishment was measured as both a dichotomous and continuous variable. Participants were first asked to indicate their willingness to reduce their reward (i.e., "yes" or "no"). This was the dichotomous self-punishment measure. Those who answered "yes" to this question were asked to indicate the maximum amount of money that they were willing to abandon. The instructions were as follows: If the indicated value exceeded a fixed amount, *x*, of which the participants had not been informed in advance, their reward would be reduced by *x* JPY. If they answered "no" to the initial inquiry or the indicated value failed to reach *x*, nothing would happen. This measure was devised on the basis of the auction theory (e.g., Steiglitz, 2007) in order to facilitate the participants' honest report of their reservation price for self-punishment (i.e., the maximum cost that they were willing to incur). By not asking the participants to pay the amount they indicated, this procedure would reduce their motivation to hide their true reservation price (see also Watanabe & Ohtsubo, 2012). Those who answered "no" to the initial inquiry were assigned 0 JPY as their maximum cost to incur for self-punishment.

The participants were then asked to fill out a post-task questionnaire including several questions regarding the self-punishment task. One item, the *partner anger* item, asked participants to estimate how angry their partner was about the allocation. This was considered as a proxy measure of the participants' awareness of the partner's hurt feelings. The other item, the *belief in apology norm* item, asked participants to rate how strongly they believed that social norms would compel them to offer an apology, given the unfair allocation that they had just

made unintentionally. This item was included to measure a belief that could facilitate self-punishment independently of empathy.

After filling out the post-task questionnaire, the participants were given absorbent cotton with rubbing ethanol, an ordinary nail clipper, and a small tube. They were instructed to first apply the ethanol to their nails, clip and chop up them, and put the small pieces of their nails into the tube. After the nail samples were collected, all participants received thorough debriefing about the experiment. They were then paid the monetary reward.

This study was approved by the institutional review board at the first author's institute. Portion of the participants took part in a personality assessment session approximately two months earlier than this experiment. Those participants' self-punishment data were combined with the earlier session data and used in a different research project (Tanaka, Yagi, Komiya, Mifune, & Ohtsubo, 2014).

Genotyping

Genomic DNA was extracted from the participants' nail samples by using ISOHAIR kits (NIPPON GENE CO., LTD, Tokyo, Japan). The SNP marker for rs53576 was genotyped using TaqMan® SNP Genotyping Assays (Applied Biosystems, Foster City, CA), which were functionally tested by Applied Biosystems and available on demand. All polymerase chain reactions (PCR) and allelic discrimination reactions were performed on the StepOne Plus™ Real-Time PCR System (Applied Biosystems).

Results

Genotype Distribution

The ethnicity of all participants was considered to be Japanese according to their names and fluency in Japanese. The A allele, rather than the G allele, is the most common allele among

East Asian populations (Kim et al., 2010, 2011; Wu et al., 2005). Consistent with the previous studies involving Asian samples, in the present study, the A allele was more common than the G allele (46 AA, 56 GA, and 14 GG). The genotype distribution did not significantly deviate from the Hardy-Weinberg equilibrium, $\chi^2(1) = .24$, *ns*. Moreover, the relative frequency of AA individuals (.39) was similar to the frequencies observed in Korean and Chinese studies (.42 in Kim et al., 2010; .41 in Wu et al., 2005). We divided the participants into the AA group and the GA/GG group because only 14 GG individuals were involved in the present study.

Self-punishment and *OXTR*

As stated in the method section, we did not record the sex of 20 participants. However, there were no significant sex differences in self-punishment tendencies: the proportions of the self-punishers were .50 (18/36) and .41 (17/41) among the males and females, respectively; the sex difference was not significant by Fisher's exact test. The amount of the cost that the participants had been willing to incur did not significantly differ between the males and females, either: $t(95.54) = .04$, *ns*, by a Welch test with the square-root transformed continuous self-punishment as the dependent variable. In addition, there was no significant association between sex and the *OXTR* genotype frequency, $p = .53$ by Fisher's exact test. Therefore, in the subsequent analyses, we did not include sex in the independent variables.

We first analyzed the dichotomous measure of self-punishment. Supporting the hypothesis, there were significantly more self-punishers in the GG/GA group (.53 = 37/70) than in the AA group (.37 = 17/46), $p = .022$ by Fisher's exact test. We then analyzed the continuous measure of self-punishment. The mean amount of self-punishment was greater in the GG/GA group (145.79 JPY, *SD* = 163.89) than in the AA group (74.80 JPY, *SD* = 140.59). As the scores were positively skewed (Figure 1), the data were square-root transformed and submitted to a

Welch test. The difference was significant, $t(105.5) = 2.67$, $p = .009$, $d = .50$. We also confirmed the significance of this difference by a non-parametric test, Mann-Whitney's *U* test, $p = .012$.

The present study included three types of unfair allocation: (Self, Partner) = (900, 100), (800, 200), and (700, 300). The present study also included the measures of state guilt and state shame (i.e., SSGS). The state guilt and state shame scores were separately computed (Cronbach's $\alpha = .81$ and .78, respectively). However, because these two scores were highly correlated with each other ($r = .80$), they were averaged and used as a single *compunction* score (cf. Giner-Sorolla, Piazza, & Espinosa, 2011), which was not significantly correlated with the *OXTR* genotype grouping, point-biserial $r(114) = .13$, *ns* (GG/GA was assigned 1, and AA was assigned 0, see also Table 1 for the correlation matrix of these variables). We tested whether *OXTR* genotype would still predict self-punishment after controlling for these potentially confounding variables. As shown in Table 2, a logistic regression (Model D1) revealed that *OXTR* genotype significantly predicted dichotomous self-punishment, and a multiple regression analysis (Model C1) revealed that *OXTR* genotype significantly predicted continuous self-punishment. These results suggest that the effect of *OXTR* genotype on self-punishment was robust and was not mediated by self-critical emotions, such as guilt or shame.

Partner Anger, Apology Norms, and *OXTR*

Consistent with the previous studies indicating that the G allele was associated with empathy, the participants' perception of their partner's anger (i.e., a proxy measure of the participants' sensitivity to their partner's hurt feelings) was significantly correlated with *OXTR* grouping, point-biserial $r(114) = .18$, $p = .049$ (Table 1). However, perceived partner anger was not significantly correlated with either dichotomous self-punishment, point-biserial $r(114) = –.05$, *ns*, or continuous self-punishment, $r(114) = –.02$, *ns* (Table 1). Perhaps a more direct measure of

the partner's hurt feelings would have served as a better predictor of self-punishment.

As expected, the participants' belief in apology norms predicted both dichotomous self-punishment, point-biserial $r(114) = .29$, $p = .001$, and continuous self-punishment, $r(114) = .29$, $p = .001$ (Table 1). Nonetheless, belief in apology norm was not significantly correlated with *OXTR* grouping, $r(114) = .14$, *ns* (Table 1). In addition, as shown in Table 2, when the effect of belief in apology was statistically controlled for, the effect of *OXTR* genotype grouping was marginally significant for the dichotomous self-punishment (Model D2: $\beta = .40$, $p = .065$), and significant for the continuous self-punishment (Model C2: $\beta = .20$, $p = .028$). These results suggest that the effect of *OXTR* polymorphism on self-punishment was not *cognitively* mediated by the participants' beliefs.

Discussion

The present study showed that an SNP on *OXTR* (rs53576) was associated with a tendency toward self-punishment. The G allele on this SNP region, which has been found to be related to greater empathy, facilitated self-punishment after a commission of an unintentional transgression toward a stranger. Those who were high in empathy might have automatically attended to their partner's hurt feelings and attempted to punish themselves. However, this interpretation is not consistent with the observed result that perceived partner anger (i.e., a proxy measure of empathy) did not mediate the relation between *OXTR* grouping and self-punishment.

There is an alternative explanation for the observed correlation between the rs53576 variation and self-punishment. Chen et al. (2011) revealed that the G allele on rs53576 was also associated with sensitivity to social rewards. Therefore, the GG/GA individuals may be more sensitive social learners. As apologies are particularly encouraged after transgressions in Japan (e.g., Hamilton & Hagiwara, 1992; Itoi, Ohbuchi, & Fukuno, 1996; Maddux, Kim, Okumura, &

Brett, 2011), the GG/GA individuals might have internalized the norm of expressing apology and remorse more so than the AA individuals. However, the present results were not consistent with this social learning explanation, too. The social learning explanation predicts that those who have the G allele more highly internalize the apology norm than those who do not have the allele. Nevertheless, the G allele was not correlated with belief in the existence of apology norms. Admittedly, this is not conclusive counterevidence against the social learning explanation. A more critical prediction from the social learning hypothesis is associated with gene–culture interactions (Kim et al., 2010, 2011). That is, the association between the G allele and the self-punishment tendency may disappear in different cultures, where apologies and reparative acts are not particularly encouraged. Therefore, experiments involving cross-cultural comparisons appear promising.

Limitations of the present study include such inconclusiveness regarding the underlying mechanism that bridges the G allele on rs53576 and self-punishment. In addition, the sample size of this study was small compared to other genetic polymorphism studies. Therefore, the mediation analyses might have suffered particularly low statistical power. It is also important to note that the functionality of this SNP (rs53576) is currently unknown. Further studies including direct measures of empathy and a larger sample size, in addition to cross-cultural comparisons, should contribute to the state of knowledge of the functionality of this SNP.

The present study showed the relation between an SNP on *OXTR* (rs53576) and self-punishment. In a conceptually similar study, however, Tabak et al. (2013) failed to find significant correlation between the rs53576 variation and forgiveness, while they found significant correlation between different SNPs on *OXTR* (rs9840864, rs2268494) and forgiveness. Further research that attempts to resolve the inconsistency between this study and Tabak et al.'s

study should be informative because it is known that empathy promotes not only reparative acts (Howell et al., 2012) but also victims' forgiveness (McCullough, Worthington, & Rachal, 1997). Expanding the scope of the research by including other polymorphisms and different operationalization of reconciliatory tendency seems to be of theoretical and practical importance. We hope that this line of research will ultimately provide a full picture of the genetic underpinnings of reconciliation processes.

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Table 1

Descriptive Statistics and the Correlation Matrix of Variables of Interests

		Mean (Proportion of 1)	*SD*	2	3	4	5	6	7
1	OXTR (AA = 0, GG/GA=1)	(.60)	0.49	.22*	.24*	.14	.13	.18*	.14
2	Dichotomous Self-Punishment (Not punished = 0, Punished = 1)	(.44)	0.50		.95***	.03	.36***	–.05	.29***
3	Continuous Self-Punishment†	117.64	158.32			.06	.42***	–.02	.29***
4	Allocation to the Self (700, 800, or 900)	802.59	40.56				.08	.02	.01
5	Compunction (scale range = 1 to 5)	1.95	0.73					.21*	.41***
6	Partner Anger (scale range = 1 to 5)	3.75	0.82						.26**
7	Belief in Apology Norms (scale range = 1 to 5)	3.57	1.25						

Notes. †The mean score (*SD*) was computed based on untransformed scores. The correlation coefficients were computed after square-root transformation.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 2

Regression Analyses Predicting Self-punishment from OXTR Genotype Group, Allocation Schemes That Participants Chose, and Compunction

	Dichotomous Self-punishment (not punished = 0, punished = 1)						Continuous Self-punishment (Square-root transformed)					
	Model D1			Model D2			Model C1			Model C2		
	β	SE	*p*	β	SE	*p*	β	SE	*p*	β	SE	*p*
OXTR (GG/GA=1)	.42	.21	.047	.40	.21	.065	.18	.08	.033	.17	.09	.046
Allocation to the Self	–.07	.21	*ns*	–.05	.20	*ns*	–.00	.09	*ns*	.00	.08	*ns*
Compunction	.83	.24	< .001	.68	.25	.007	.39	.08	< .001	.34	.09	< .001
Belief in Apology Norms				.39	.24	*ns*				.12	.09	*ns*

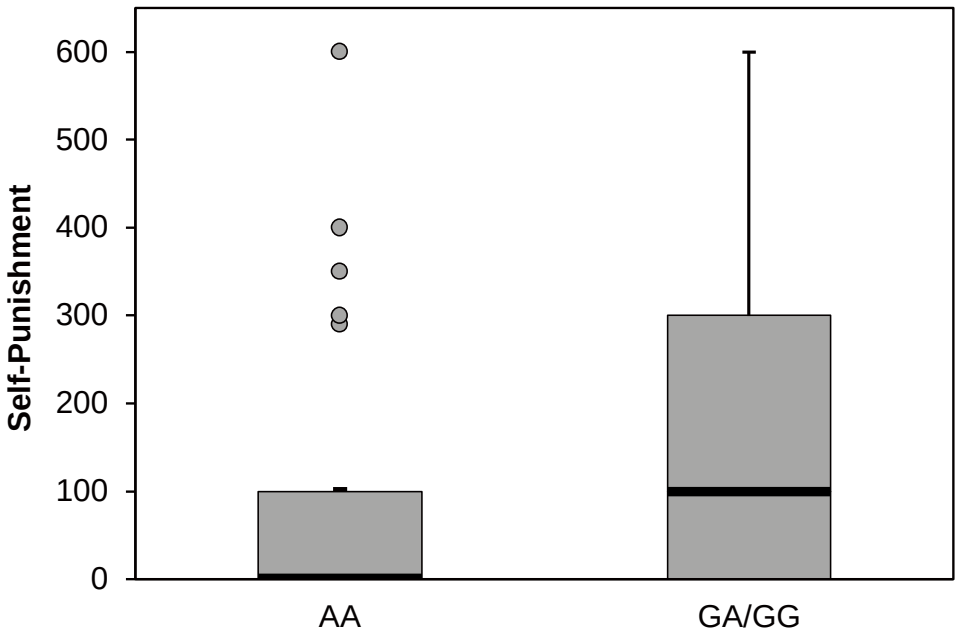

Figure 1. Boxplot of the maximum monetary punishment that the participants were willing to inflict on themselves as a function of genotype grouping. The boxplot was drawn following the standard rule: Each horizontal line represents the location of the median; each rectangle covers the middle 50% of the data; each whisker was extended to the adjacent value; and each

circle indicates an outlier.