Dopamine beta-hydroxylase gene modulates individuals empathic ability

Pingyuan Gong,[1,2] Jinting Liu,[1] She Li,[2] and Xiaolin Zhou[1,3,4]

[1]Center for Brain and Cognitive Sciences and Department of Psychology, Peking University, Beijing 100871, [2]Laboratory of Medical Molecular Biology, Henan University of Science and Technology, Luoyang 471003, China, [3]Key Laboratory of Machine Perception (Ministry of Education) and [4]PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing 100871, China

Dopamine beta-hydroxylase (DBH), an enzyme that converts dopamine to norepinephrine, has broad influences on social functions. In this study, we examined to what extent two polymorphisms (1021C/T and a 19 bp insertion/deletion) in DBH gene modulate individuals empathic perception and response, which were measured, respectively, by reading the mind in the eyes test and the empathic concern subscale of interpersonal reactivity index. Results showed that polymorphism at 1021C/T, but not the 19 bp insertion/deletion, accounts for 2.3% variance of empathic perception and 1.4% variance of empathic response. Individuals with the CC genotype, which is associated with higher DBH activity, manifested greater empathic ability than those with CT/TT genotypes. These findings demonstrate the importance ofDBH 1021C/T as a genetic basis of empathy and in predicting individual differences in social and affective processing.

Keywords: dopamine beta-hydroxylase; DBH; 1021C/T; polymorphism; empathy

INTRODUCTION

Empathy, the ability to understand and experience the mental state of another person, is fundamental for living in social groups and caring for others. It is composed of two major components, cognitive empathy and affective empathy, both of which can be further divided into a variety of subskills and systems, such as empathic perception (the ability to perceive and identify another person's internal state) and empathic response (the ability to share other persons' feelings)

activity (CC of −1021C/T, II of the 19 bp insertion/deletion), would have higher empathic abilities or tendency than individuals with the genotypes leading to lower DBH activity (CT or TT of −1021C/T, ID or DD of the 19 bp insertion/deletion). Moreover, as −1021C/T accounts for a majority of variation in DBH activity (Zabetian *et al*, 2001), it is possible that the genetic variations in −1021C/T could account for more individual differences in empathic perception and response than the variations in the 19 bp insertion/deletion. To measure participants' empathic perception, we used the reading the mind in the eyes test (RMET; Baron-Cohen *et al*, 2001) in which participants recognized or inferred others' emotional states by using visual cues from eye regions. This task has been shown to have high validity in measuring the individual's ability of inferring others' internal emotional state (Baron-Cohen *et al*, 2001; Vellante *et al*, 2012) and it has been widely used in previous studies to link empathic perception with individuals' genetic polymorphisms or hormone levels (Domes *et al*, 2007; Rodrigues

P¼0.023, partial η^2¼0.016, with females performed better than males (60% 11% vs 57% 12%). Importantly, the main effect of genotype was also significant, F(1, 318)¼8.975, P¼0.003 and partial η^2¼0.027. This effect of genotype remained to be significant when the seven excluded participants were included, F(1, 325)¼5.824, P¼0.016 and partial η^2¼0.018. Individuals with CC genotype (60% 11%) performed significantly better than individuals with CT/TT genotypes (56% 12%). The interaction between gender and genotype was not significant, F(1, 318)¼1.445, P¼0.230 and partial η^2¼0.005. Regression analysis with 1021C/T polymorphism (0¼CT/TT, 1¼CC) as a single predictor of RMET indicated that this polymorphism accounted for a significant proportion of the variance in RMET, F(1, 320)¼7.460, P¼0.007, β¼0.151, R^2¼0.023 and adjusted R^2¼0.020. This result continues to hold after controlling for gender (step 1, entering gender with 0¼male and 1¼female; step 2, entering both gender and 1021C/T polymorphism) F(1, 319) change¼7.765, P¼0.006, β¼0.153 and R^2 change¼0.023. For the 19 bp insertion/deletion, however, a 2 (gender: male vs female) 3 (genotype: II vs ID vs DD) ANOVA found no significant RMET score difference between individuals with II (58% 12%), ID (59% 11%) and DD (59% 10%) genotypes, F(2, 303)¼0.078, P¼0.925, partial η^2¼0.001, nor the interaction between gender and genotype, F(2, 303)¼0.752, P¼0.472 and partial η^2¼0.005.

Empathic response

We used the total score on the IRI empathic concern subscale to measure participants' empathic responses. For 1021C/T, a 2 (gender: male vs female) 2 (genotype: CC vs CT/TT) ANOVA showed no main effect of gender, F(1, 325)¼2.275, P¼0.132, partial η^2¼0.007, but a main effect of genotype, F(1, 325)¼4.895, P¼0.028 and partial η^2¼0.015. Individuals with CC genotype (21.1 3.5) showed greater empathic response to others' misfortune than those with CT/TT genotypes (20p77.5 783.1 (partial)]TJ ( )TjT0A on ureeTj 57-27, main

emergency situations, I feel apprehensive and ill at ease') assess emotional self-control rather than the tendency to share others' feelings (Baron-Cohen and Wheelwright, 2004). The null effect on perspective taking and fantasy was inconsistent with the significant effect on RMET, possibly because these tasks measure different aspects of cognitive empathy, as outlined previously. For the 19 bp insertion/deletion, no effect of genotype was found on the combined affective or cognitive subscales.

DISCUSSION

In this population-based study, we found that 1021C/T, but not the 19 bp insertion/deletion, of *DBH* gene modulates individuals' em-

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