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The Relationship Between MAOA Gene Polymorphism and Test Anxiety

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In a sample of 569 Chinese high school students, the present findings indicated that students with the 4-repeat genotype showed a higher level of test anxiety. Furthermore, the prediction of academic performance on test anxiety was stronger among students with the 3-repeat genotype than those with the 4-repeat genotype. The present findings suggest that mono-amine-oxidase type A gene polymorphism is significantly related to test anxiety.

■ **Keywords:** MAOA, test anxiety, Chinese, adolescents, academic performance

During adolescence, many students suffer from anxiety disorders (Neil & Christensen, 2009). In previous research, researchers have proposed that too little serotonin (5-HT) in the brain leads to anxiety (Dayan & Huys, 2008). The mono-amine-oxidase type A (MAOA) gene encodes the MAOA enzyme that can render serotonin inactive by metabolizing it (Caspi et al., 2002). Previous research has identified a functional polymorphism of the MAOA gene (2-repeats, 3-repeats, 3.5-repeats, 4-repeats, and 5-repeats) according to a 30-bp insertion or deletion (Caspi et al., 2002). Researchers have found that the 4-repeat allele is associated with higher MAOA activity than the 3-repeat allele (Jonsson et al., 2000). In empirical research, extremely limited evidence indicated that the MAOA gene polymorphism was related to generalized anxiety disorders (Tadic et al., 2003). However, until now we have known little about how the MAOA gene polymorphism contributes to test anxiety. Therefore, the first objective of the present study was to explore the relationship between the MAOA gene polymorphism and test anxiety. It was expected that the 4-repeat allele would be related to a higher level of test anxiety.

Moreover, several studies have linked students' academic performance to their trait test anxiety (Chamorro-Premuzic & Furnham, 2003; Pintrich & DeGroot, 1990). In these studies, trait test anxiety was found to be weakly or moderately related to academic performance (Chamorro-Premuzic & Furnham, 2003; Pintrich & DeGroot, 1990), which suggests that some variables may moderate the relationship between academic performance and test anxiety. In the present study, the second objective was to examine the moderating effects of the MAOA gene polymorphism on the relationship between academic performance and test anxiety. It was expected that the MAOA gene polymorphism would moderate the relationship between academic performance and test anxiety. In previous research, some studies have suggested that academic-related emotions should be measured in domain-specific ways (Goetz et al., 2006). Hence, the present study focused on students' trait test anxiety in the subject of mathematics. We chose mathematics because most students said that mathematics was the most anxiety-inducing subject in their curriculum (Macher et al., 2012).

Methods

Participants and Procedure

Participants were recruited from six Chinese high schools located in an urban city (Nanjing). There were 569 Grade 10 students (269 girls) who provided their agreement to participate in the present study. Their mean age was 16.7 years ($SD = 0.6$, range 15.8–17.6). Students' test anxiety was measured at the beginning of both Grade 10 and Grade 12 during classroom time. The interval between tests was nearly 25 months. We also collected students' mathematical scores at Grade 10 from school records. Ethical approval was granted from our institution and informed consent was obtained from the participants and one of their parents.

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TABLE 1
Descriptive Data and Intercorrelations Between Academic Performance and Test Anxiety

Variables	1	2	3
1. Test anxiety (Grade 10)			
2. Test anxiety (Grade 12)	0.53**		
3. Academic performance (Grade 10)	-0.10*	-0.13**	
4. Gender	0.18**	0.08*	-0.17**
Mean	2.94	3.16	0.13
SD	0.76	0.54	0.93

Note: $N = 569$.
*$p < .05$, **$p < .01$.
Girls were coded as 1 and boys were coded as 2.

TABLE 2
Genotype Distributions for the MAOA-Upstream Variable Number of Tandem Repeats (uVNTR) Polymorphism

Gender	Genotypes	*N*
Boys	3-repeat	153
	4-repeat	123
	3-repeat	123
Girls	4-repeat	40
	3/4-repeat	128
	4/5-repeat	1
	2/4-repeat	1

Measures

Test anxiety. Test anxiety was assessed with a 5-item scale in Chinese (e.g., 'A mathematical test always makes me feel anxious'). A 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) was used. The average score of the 5-point scale was computed. In the present study, the internal consistency reliability of the scale was excellent ($\alpha = 0.90$).

Academic performance. Students' mathematical scores were evaluated by city-wide standardized tests. Similar to other studies (Liu & Lu, 2011), we standardized students' mathematical scores in each high school. This method has been widely used by researchers to assess Chinese students' academic performance (Liu & Lu, 2011).

DNA collection and genotyping. Genomic DNA was extracted from cheek cells. Polymerase chain reaction (PCR) was performed to amplify the DNA fragment. The primer sequences, temperature, time, and cycles of the PCR program were set according to the conditions used in previous studies (Caspi et al., 2002). The length of PCR products was separated by using a 2% agarose gel electrophoresis.

Results

Descriptive data (mean values and standard deviations) and intercorrelations of test anxiety and academic performance are listed in Table 1. Path analysis was used to examine the longitudinal relationship between academic performance and test anxiety. Students' test anxiety at Grade 10, mathematical scores at Grade 10, and gender were treated as predictors of their test anxiety at Grade 12. Statistics were performed with SPSS16.0 and AMOS 7.0. The results indicated that students' mathematical performance ($\beta = -0.08$, $p < .05$) and test anxiety at Grade 10 ($\beta = 0.52$, $p < .01$) significantly predicted their test anxiety at Grade 12. Moreover, students' mathematical performance at Grade 10 was negatively correlated with their test anxiety at Grade 10 (correlation coefficient = -0.07, $p < .01$. Boys had higher mathematical performance ($t = 4.17$, $df = 567$, $p < .01$) and lower anxiety scores (at Grade 10, $t = -4.04$, $df = 567$, $p < .01$; at Grade 12, $t = -2.01$, $df = 567$, $p < .05$) than girls.

Furthermore, Table 2 shows the distribution of students' genotypes. When we tested Hardy–Weinberg equilibrium for females' MAOA genotypes, we combined girls with the 2/4-repeat genotype and the 4/5-repeat genotype with girls who carry the 3/4-repeat genotype. The results showed that females' MAOA genotypes were in Hardy–Weinberg equilibrium ($\chi^2 = 0.52$, $df = 1$, ns). As the MAOA gene is on the X chromosome, the phenomenon of gene suppression for girls can happen. Hence, the next analysis only included boys with the 3-repeat genotype and the 4-repeat genotype and girls with the 3/3-repeat genotype and the 4/4-repeat genotype. We combined the boys with the 3-repeat genotype and the girls with the 3/3-repeat genotype into one group (group 1) and combined the boys with the 4-repeat genotype and girls with the 4/4-repeat genotype into another group (group 2). Figure 1 shows the mean values and standard errors of students' test anxiety scores at Grade 12 in the two groups.

In this study, ANOVA was used to analyze the effects of the MAOA gene polymorphism on test anxiety at Grade 12 across the two groups. During analysis, we controlled for students' gender and academic performance at Grade 10, and their test anxiety at Grade 10. The results showed that the main effects of the MAOA gene polymorphism on test anxiety at Grade 12 were significant, $F(1, 434) = 5.45$, $p < .05$, $\chi^2 = 0.01$. Students in group 2 showed a higher level of test anxiety than students in group 1. Next, multi-group comparison was used to examine the moderating effects of the MAOA gene polymorphism on the relationship between academic performance and test anxiety by using AMOS 7.0. We compared unconstrained models in which parameters were freely estimated with constrained models in which the relationships between academic performance and test anxiety at Grade 12 were forced to be equal between groups 1 and 2. The results indicated that there were significant differences in the strength of the relationship between academic performance and test anxiety across students with two different kinds of alleles ($\Delta\chi^2 = 3.68$, $df = 3$, $p < .05$). The results revealed that the prediction of academic performance on test anxiety was only significant among students in group 1 ($\beta = -0.16$, $p < .01$).

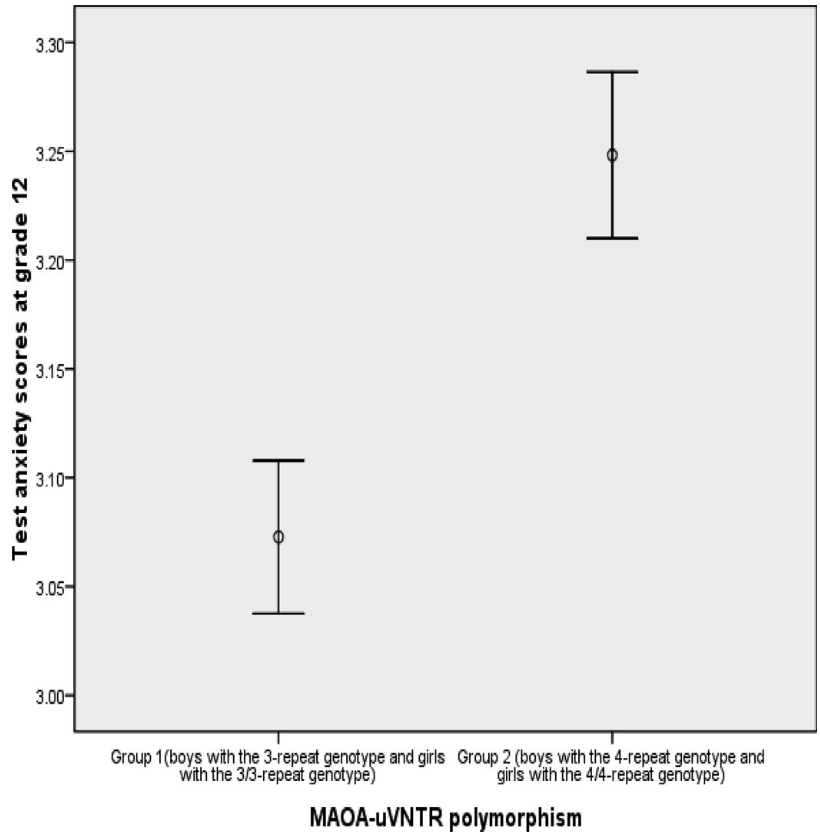

FIGURE 1

The mean values and standard errors of test anxiety scores at Grade 12 for students with different genotypes.

Discussion

The present study significantly contributed to theory in several important ways. By using a Chinese sample, the present study first investigated the direct effects of the MAOA gene polymorphism on test anxiety in the subject of mathematics. Our findings provided initial supportive evidence about the significant relationship between the MAOA gene polymorphism and test anxiety. In line with previous Western studies (Tadic et al., 2003), our data confirmed that the 4-repeat allele of the MAOA gene was related to a higher level of anxiety. In addition, as the previous studies were conducted in Western countries, our findings implied that the links between the MAOA gene polymorphism and anxiety could be generalized to Chinese adolescents.

Second, recently, researchers have become interested in investigating the interaction of gene-by-environment (G × E) on emotional outcomes (Laucht et al., 2009). To our knowledge, the present study was the first study that examines the moderating effects of gene polymorphism on the relationship between academic performance and test anxiety. Consistent with the previous studies (Chamorro-Premuzic & Furnham, 2003; Pintrich & DeGroot, 1990), we found that Chinese high school students' academic performance was weakly related to their test anxiety. Furthermore, in line with our expectations, our findings showed that the strength of the relationship between academic performance and test anxiety was stronger among students with the 3-repeat allele than those with the 4-repeat allele. Taken together, our findings suggested that the MAOA gene polymorphism was not only directly related to test anxiety but also indirectly moderates the effects of academic performance on test anxiety.

In this study there were some limitations that could be improved in further research. First, the participants were from one city in China, and further research may test the present findings by using samples from other cities. Second, the present study focused on the subject of mathematics; further studies may replicate the present findings in other academic domains. Third, the present study found that the MAOA gene polymorphism moderated the relationship between academic performance and test anxiety. Further studies may examine the moderating effects of other serotonin-related genes on this relationship.

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