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ORIGINAL RESEARCH

The Relationship Between Personality and Somatic and Psychological Distress: A Comparison of Chinese and Australian Adolescents

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Abstract
The extent to which correlations between personality domains and physical and psychological health generalize cross-culturally is unclear. We compared the strength of associations between the personality domains and somatic and psychological distress in Chinese (N = 2069) and a genetically informative sample of Australian (N = 2936) adolescents. We also examined the genetic and environmental etiology between personality, somatic and psychological distress in an Australian sample of 390 monozygotic twins and 698 dizygotic twins. In both populations, personality was assessed using the Junior Eysenck Personality Questionnaire. Somatic and psychological distress was assessed using the Somatic and Psychological Health Report. We found significant cultural differences in the relationship between adolescents' personality traits and somatic and psychological distress. Extraversion was positively associated with somatic distress in the Chinese but not in Australian adolescents. In the Australian twins, genetic covariation between neuroticism and somatic and psychological distress was stronger compared to the genetic associations between either psychoticism or extraversion with psychological distress.

Keywords Australian · Chinese · Personality, somatic and psychological distress

Introduction

Beginning with early proto-psychological theories based on humors, humans have long posited relationships between personality and health and ill health (Eysenck 1965). Today, the Eysenck's Personality Questionnaire (EPQ) (Eysenck 1947) and Costa and McRae's Five-Factor Model (FFM) (Costa and McRae 1985) are the most investigated models of personality, and a number of reports have consistently shown significant associations between either the EPQ and FFM domains with indices of health including maladaptive behaviors and psychological disorders (Brikmanis et al. 2017; Brummett et al. 2007; Butkovic et al. 2017; Samek et al. 2017; Yaakobi et al. 2017).

High levels of neuroticism have been linked to social anxiety (Kendler et al. 2006), depression (Kotov et al. 2010), and somatisation (Costa and McCrae 1987). Low extraversion has been found to be related to anxiety and depression (Kendler et al. 2006). Finally, EPQ psychoticism correlates with depression (Lolas et al. 1991). Overall, these studies suggest that high levels of psychoticism and neuroticism are associated with greater levels of psychological distress whereas high extraversion is associated with less distress.

Biometrical genetic and now recent molecular studies have demonstrated that the EPQ personality domains are heritable (Docherty et al. 2016; Luciano et al. 2018; McGue and Bouchard 1998). Biometrical genetic and molecular studies have also revealed that covariation between the major personality domains such neuroticism and internalizing symptoms can be explained by common genetic risks (Boomsma et al. 2000; Hettema et al. 2006). However, much less is known about the genetic covariance between other personality domains such as extraversion and psychoticism and internalizing symptoms.

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Disorders such as anxiety and depression are important health conditions in their own right, but also act as mediating variables for the relationship between personality and physical health. The General Health Questionnaire (GHQ) is one example of an instrument originally designed to measure overall physical health that was found to usefully measure current levels of anxiety symptoms as well as predict risk of anxiety or depressive disorders. In the present study, we use the Somatic and Psychological Health Report (SPHERE) instrument that was derived from the GHQ, as well as incorporating additional items measuring symptoms of chronic fatigue, neurasthenia, and somatisation.

Another limitation is that most research examining covariance between personality and internalizing symptoms has relied heavily on European ancestral samples. While the measurement of personality domains is largely invariant across multiple ethnic groups including Han Chinese (Barrett and Eysenck 1984; Lynn and Martin 1995; McCrae et al. 2005), only a few reports have examined cross-cultural invariance with respect to the relationships between the domains of personality and mental health. Regarding aspect of cross-ethnic similarity, personality predictors of happiness and mental health reveal consistent covariance patterns in Britain, Chinese (Hong Kong) and Japanese samples, with personality explaining approximately 20% of common variance (Furnham and Cheng 1999). In terms of differences, Schmitt et al. (2007) identified mean differences in personality between Chinese and Australian subjects. Australian subjects score higher on EPQ extraversion and lower on neuroticism compared to Chinese (Schmitt et al. 2007). British subjects reported higher levels of happiness, mental health and extraversion (Furnham and Cheng 1999). Zhong et al. (2008) also found that the association between social anxiety and EPQ neuroticism is mediated by shame in Chinese, but not American subjects.

To our knowledge, no study has compared the strength of the relationship between personality and somatic and psychological health between mainland Han and Australian adolescents. Here, we seek to address this issue and hypothesize that (1) EPQ psychoticism and neuroticism are positively related to adolescents' somatic and psychological distress; (2) Extraversion is negatively related to adolescents' somatic and psychological distress; and (4) the strength of associations will be invariant across the samples.

Methods

Participants and procedure

Data consist of Australian and Chinese subjects. The Australian sample consisted N = 2936 (54% female) young adult twins and siblings from the Brisbane Longitudinal Twin Study (Gillespie et al. 2013; Wright and Martin 2004) who were interviewed at age 14 years (mean = 14.2, SD = 3.3) as part of an ongoing longitudinal study of melanocytic nevi and cognition. The clinical protocols of these studies have been described in detail elsewhere (Evans et al. 2001; Gillespie et al. 2013; Wright and Martin 2004). Briefly, twins were enlisted by contacting the principals of primary schools in the greater Brisbane area, media appeals and by word of mouth. Twins were tested as closely as possible to their fourteenth birthday. The zygosity of the Australian sample is shown in Table 1.

The Chinese sample consisted N = 2069 (52% female) adolescents interviewed during grade 7 (mean age = 14.4 years, SD = 1.6) as part of a large, longitudinal study of adolescent stress and mental health in Jiangsu Province, China. Subjects completed a voluntary, online survey during class time. Given China's Family Planning Policy (aka One Child Policy) beginning in 1979, the sample consisted entirely of singletons.

Ethical approval

Written informed consent was obtained from all participants and a parent or guardian. The study was approved by the Human Research Ethics Committee of the Queensland Institute of Medical Research. For the Chinese sample, informed consent was obtained from students and one of their parents.

Measures

Personality traits

Subjects were asked to complete the full 81 item (74 item Chinese version) Junior Eysenck Personality Questionnaire (JEPQ) (Eysenck 1972) which assesses the dimensions: Psychoticism (P) (17 items), Extraversion (E) (24 items/20 items Chinese version) and Neuroticism (N) (20 items/18 items Chinese version). In addition, the questionnaire contained the 20-item Lie (L) scale which is a measure of social desirability. The JEPQ was scored on a three-point scale [Yes / Don't know / No] with "Don't know" responses recorded as missing. The reliability and validity of JEPQ have been well established in Australian (Hopper et al. 1992) and Chinese

Table 1 The zygosity distribution of the Australian sample

Zygosity	Female	Male
Monozygotic twins	215 pairs	175 pairs
Dizygotic twins	210 pairs	176 pairs
Opposite sex pair twins	312 individuals	312 individuals
Sibling	419 individuals	341 individuals

(Li and Scott 1989) samples. Here, we examined 67 items that were directly matched from translation (See Table 2). As shown in Table 3, measures of internal consistency were acceptable and comparable across samples.

The imputation option in PRELIS 2.20 (Jöreskog and Sörbom 1998) was used to impute missing values using sex and the full number items within each personality dimension. The same procedure was repeated at each wave. This approach substitutes values for the missing values from other cases with similar response patterns and no missing values in the matching variables from other cases, provided that the variance in the values from the other cases is acceptable (Jöreskog and Sörbom 1998). In order to avoid the possibility of artifactual inflation of twin correlations, imputation was carried out on an individual basis ignoring the paired structure of the data. Raw cumulative scores were then calculated for each personality dimension across age and sex.

Somatic and psychological distress

Somatic and psychological distress were measured using the Somatic and Psychological HEalth REport (SPHERE) (Hansell et al. 2012; Hickie et al. 2001).

Two subscales (somatic distress and psychological distress) of the SPHERE were used in the present study. The subscale for somatic distress consisted of 6 items (e.g., muscle pain after activity?) and the subscale for psychological distress also included 6 items (e.g., Feeling nervous or tense?). The psychological distress subscale assesses psychological health and the somatic distress subscale assesses physical symptoms and fatigue. Participants indicated if they had been troubled by symptoms over the past few weeks. Three response choices were used but recoded as: sometimes/never (coded as zero), often (coded as 1) and most of the time (coded as 1). A sum score was computed for each subscale (Hansell et al. 2012). This questionnaire has been widely used and the reliability and validity of the SPHERE have been well established in both Australian (Hansell et al. 2012; Rietschel et al. 2014) and Chinese subjects (Shi et al. 2017). As shown in Table 3, measures of internal consistency were acceptable and comparable across samples.

Table 2 Details of matching item numbers of the JEPQ between Australian and Chinese variables

Sample	Total	Psychoticism	Extraversion	Neuroticism	Social desirability
Australian	81	17	24	20	20
Chinese	74	17	20	18	19
Matched	67	13	20	18	16

Zygosity

Zygosity in the same sex Australian twin pairs was diagnosed by typing 9 highly polymorphic DNA microsatellite markers (AmpFLSTRR Profiler PlusT, Applied Biosystems, Foster City, CA) and three blood groups (ABO, MNS, Rh). The probability of dizygosity, given concordance for all markers in our panel, was $< 10–4$. In 50 twin pairs where DNA was not available, zygosity was judged by similarity of appearance.

Statistical methods

Phenotypic associations and cross-cultural comparisons

Full Information Maximum Likelihood (FIML) polychoric correlations were calculated in the Mx software program (Neale and Cardon 1992). All pairwise correlations were adjusted for the effects of sex on the item thresholds. Next, FIML multi-group structural equation modelling was used to compare the strengths of association between the personality traits, somatic, psychological health scores between the Australian and Chinese samples. For each personality domains, somatic and psychological distress score, all pairwise correlations were allowed to vary across samples. A model which constrained all pairwise correlations to be equal across samples was then fitted. The unconstrained and constrained models were then compared using a likelihood ratio Chi square test.

Twin modeling

Standard biometrical genetic model-fitting methods were applied (Neale and Cardon 1992) to the Australian monozygotic (MZ) and dizygotic (DZ) twin data to decompose the sources of variance within and between traits. In univariate analyses, the total variance in each of the observed personality, somatic and psychological

Table 3 Reliabilities of the Subscales

Sample	Somatic distress	Psychological distress	Psychoticism	Extraversion	Neuroticism	Social desirability
Australian	0.74	0.77	0.64	0.78	0.83	0.74
Chinese	0.81	0.88	0.66	0.79	0.89	0.69

distress traits was decomposed into additive (A genetic variance, plus shared (C) and unique (E) environmental variance. Because MZ twins are genetically identical, correlations for the additive genetic effects between MZ twins is set to 1.0. For DZ twins, the correlations for additive 0.5. An important assumption of the biometrical model is that shared environmental effects correlate equally in MZ and DZ twin pairs. Because non-shared environmental effects are by definition uncorrelated, E necessarily includes measurement error, and short-term fluctuations.

For each variable, the goodness-of-fit of the full ACE model was compared to that of AE, CE and E submodels using likelihood-ratio chi-squared tests. Best-fitting models were chosen on the basis of parsimony, i.e. non-significant changes in the Chi square and the smallest number of parameters. To this end, the Akaike's Information Criterion (AIC) was calculated for each model, and the model with the lowest value of this index was chosen as the best fitting.

Results

Phenotypic associations and cross-cultural comparisons

Descriptive data of the two samples including means and standard deviations are shown in Table 4. The correlations of the variables are illustrated in Table 5. In the Chinese sample, except for extraversion, sex was significantly correlated with all traits, while age was only significantly correlated with psychological distress ($r = 0.08$) and social desirability ($r = -0.05$). In the Australian sample, sex was significantly correlated with somatic distress, psychoticism, neuroticism, and social desirability, but not psychological distress and extraversion.

We next compared the strength of the associations between the personality domains, somatic and psychological distress between the Australian and Chinese subjects. As shown in Table 6, the results revealed that there were significant differences in the relationships between distress and personality traits. The associations between psychoticism

Table 4 Descriptive data of variables in both Australian and Chinese samples

Sample	Variable	Boys			Girls		
		Mean	SD	N	Mean	SD	N
Chinese	Somatic distress	1.94	2.60	998	2.31	2.57	1071
	Psychological distress	1.32	2.43	998	1.46	2.40	1071
	Psychoticism	2.34	2.28	998	1.79	1.69	1071
	Extraversion	12.12	4.38	998	12.00	3.91	1071
	Neuroticism	6.77	5.12	998	7.63	4.94	1071
	Social desirability	9.95	3.01	998	10.54	3.07	1071
Australian	Somatic distress	2.81	2.43	1355	2.63	2.43	1581
	Psychological distress	1.52	1.97	1355	1.67	2.23	1581
	Psychoticism	2.76	2.14	1355	1.50	1.57	1581
	Extraversion	15.80	3.43	1355	15.76	3.35	1581
	Neuroticism	8.38	4.34	1355	9.19	4.31	1581
	Social desirability	5.72	3.08	1355	7.13	3.22	1581

Table 5 The correlations of personality traits and somatic and psychological health across Australian and Chinese sample

China/Australia	1	2	3	4	5	6	7	8
1.Somatic distress		0.55**	0.19**	−0.03	0.35**	−0.12**	0.04*	0.02
2. Psychological distress	0.68**		0.14**	−0.12**	0.43**	−0.06**	−0.02	0.09**
3. Psychoticism	0.23**	0.28**		0.11**	0.28**	−0.49**	0.33**	0.03
4. Extraversion	−0.05*	−0.13**	0.04		−0.12**	−0.12**	0.01	0.08**
5.Neuroticism	0.50**	0.56**	0.40**	0.04		−0.22**	−0.09**	0.12**
6. Social desirability	−0.23**	−0.27**	−0.41**	0.20**	−0.33**		−0.22**	−0.16**
7. Sex	−0.09**	−0.05*	0.13**	0.03	−0.09**	−0.09**		−0.05*
8. Age	0.04	0.08**	0.01	−0.00	0.01	−0.05*	0.11**	

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

Table 6 A comparison of the effect size (betas) between distress and personality in Australian and Chinese samples

Variable		Model statistics			
		−2LL	df	ΔX^2	Significance
Somatic distress	EQ psychoticism	12067.5	4990	2.4	–
	EQ extraversion	12069.3	4990	4.3	*
	EQ neuroticism	12075.6	4990	10.6	**
	EQ social desirability	12071.7	4990	6.6	*
Psychological distress	EQ psychoticism	10940.8	4990	0.0	–
	EQ extraversion	10949.2	4990	8.4	**
	EQ neuroticism	10946.1	4990	5.3	*
	EQ social desirability	10954.7	4990	13.9	**

– not significant

*p < .05, **p < .01

and somatic and psychological distress could be constrained equal across samples, the associations between neuroticism and somatic and psychological distress were significantly stronger among the Chinese adolescents. Results also indicated that there were significant cross-cultural differences in the associations between psychoticism and somatic distress. Similarly, neuroticism in the Chinese sample correlated more highly with the somatic and psychological distress scales. The Box and Whisker plots were also used to demonstrate the relationship between EPQ scores and somatic and psychological distress (Fig. 1). The plots indicated that somatic distress was linearly related to neuroticism in both countries, while psychological distress seemed to be more quadratic, and for the latter the differences between countries for the high neuroticism group (15–20) was significant. Social desirability was associated with decreased reports of distress in the Chinese sample and the inter-country differences were significant. Increasing E was also associated with reduced distress in the Chinese sample.

Twin modeling

In the multivariate analysis, which combined psychoticism, extraversion, neuroticism, somatic and psychological distress, familial aggregation could be entirely explained by additive genetic risk factors, with no evidence of shared environment variance / covariance (ACE vs. AE: change in $x^2 = 26.86$, change in df = 21, $p = .17$). Additive genetic correlations based on the best fitting AE models between each of the personality domains, somatic and psychological distress in the Australian sample are shown in Table 7. The highest genetic correlation observed was between somatic distress and psychological distress ($r_g = 0.78$). Extraversion exhibited a higher genetic correlation with distress than did psychoticism. The distress-neuroticism genetic correlations were again lower. A similar pattern was seen for the environmental correlations, but with lower magnitudes (for somatic and psychological distress $r_e = 0.4$).

Discussion

The present study contributes to the literature in two important ways. First, we directly compared the strength of the relationship between adolescents' personality traits and their somatic and psychological distress by using two samples from Australia and China. To our knowledge, the present study is the first empirical study that has examined the cross-cultural difference in this relationship. The other contribution is that the Australian twin sample enabled us to examine the genetic correlations between personality and somatic and psychological health during adolescence which is the peak age of onset for all of the major adult psychiatric phenotypes (Hansell et al. 2012).

We first note that the Australian adolescents scored higher on extraversion, psychoticism and neuroticism than their Chinese counterparts, with the exception of psychoticism in girls. This is in keeping with studies suggesting extraversion is regarded less favorably in Chinese society (e.g.,Chen et al. 1995). In Western countries, extraversion and neuroticism have increased steadily with each birth cohort (Twenge 2001), though no specific Australian data are available on this point. These secular changes imply that culture can have sizeable effects on personality, but do not specify the size of the correlation between personality and health measures.

In this study, we first hypothesized that psychoticism and neuroticism were positively and extraversion was negatively related to adolescents' somatic and psychological distress. The significant association between Neuroticism and adolescent somatic and psychological distress in both samples is consistent with previous studies (Grandi et al. 2011; Noteboom et al. 2016). Furthermore, our results found that psychoticism was related to Australian adolescents' somatic and psychological distress, which is in line with previous Western findings (Compton et al. 2008; Garcia-Torres et al. 2016). However, in the present study, we found that psychoticism was not significantly related to Chinese adolescents' somatic distress. Our findings suggest

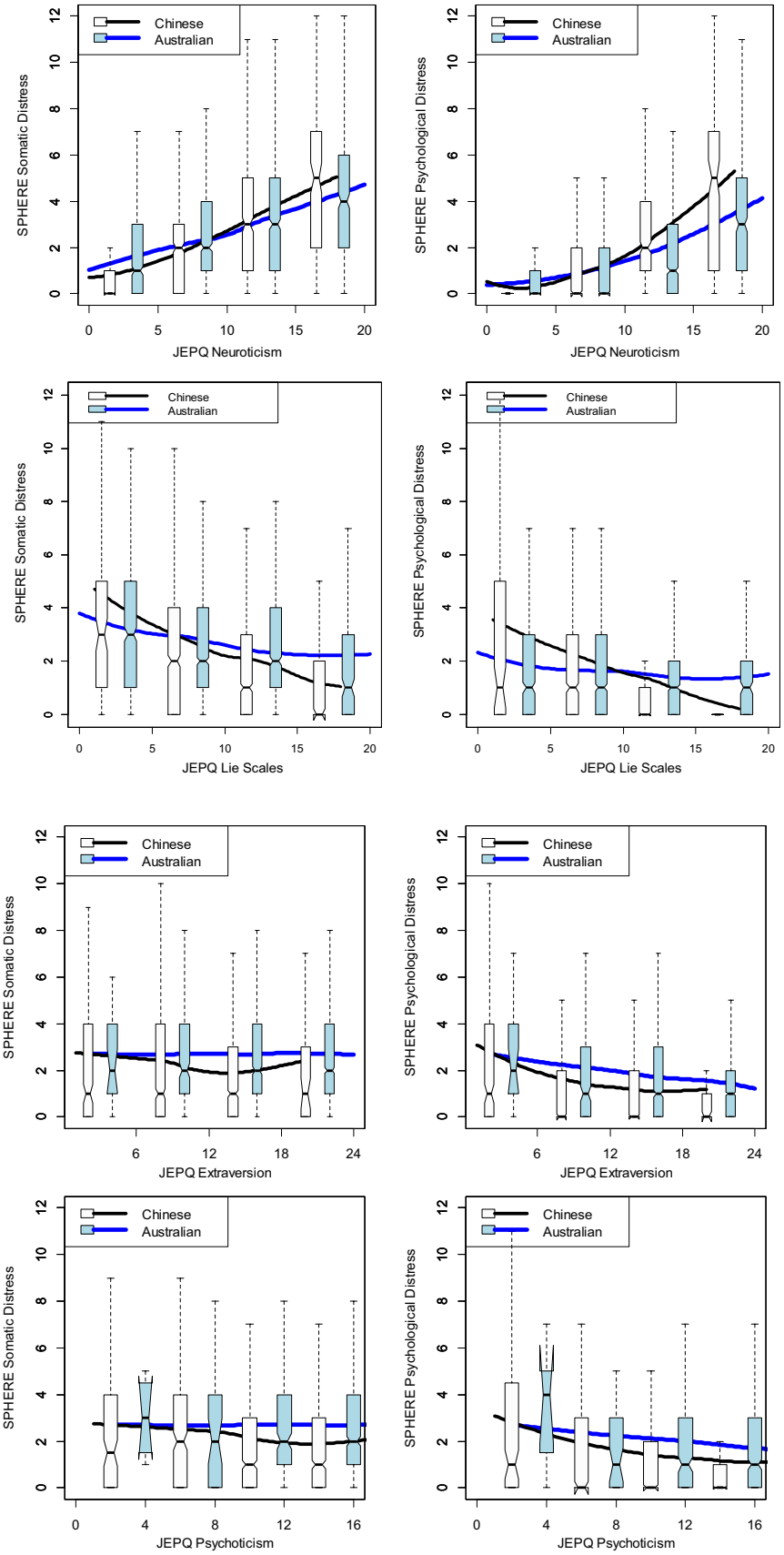

Fig. 1 Box and Whisker plot fitted local regressions for the quartiles of EPQ scores with somatic and psychological distress

Table 7 The latent correlations from AE model between personality traits and psychological distress and somatic distress

r_a/r_e	1	2	3	4	5	6
1.Somatic distress		0.40	0.10	0.10	0.23	0.07
2. Psychological distress	0.78		0.10	0.10	0.25	0.09
3. Psychoticism	0.32	0.24		0.10	0.32	0.29
4. Extraversion	0.05	0.17	0.13		0.16	0.17
5. Neuroticism	0.51	0.65	0.34	0.09		0.06
6. Social desirability	0.15	0.08	0.65	0.29	0.16	

r_a genetic correlation

r_e environmental correlation

the relationship between psychoticism and somatic distress is inconsistent across Caucasian and Chinese adolescents. In previous research, some studies found that extraversion was negatively related to mental disorders (Furnham and Cheng 1999). We confirm this finding, but found it more pronounced in the Chinese setting. As noted above, it has been suggested that extraversion is frowned upon in Chinese society, in which case we might expect higher degrees of distress in individuals who are genetically unable to sufficiently reduce the expression of this trait. Our findings suggest that there are cultural differences in the relationship between adolescents' personality traits and their somatic and psychological distress. However, with the exception of neuroticism, the cross-cultural differences in the correlations between two personality scales (extraversion and psychoticism) and two health variables (somatic distress and psychological distress) seem quite small.

By using a twin sample, we also examined the genetic correlations between personality traits and adolescents' somatic and psychological health. In previous research, some studies showed that there was genetic covariation between neuroticism and somatic and psychological distress (Hettema et al. 2006; Vassend et al. 2012). In this study, our findings suggest that the strength of the genetic covariation between neuroticism and somatic and psychological distress was stronger than the genetic covariation between the other two personality traits (psychoticism and extraversion) and somatic and psychological distress.

Limitations and further directions

Although this study adds to the literature in some important ways, it is important to recognize its limitations. First, the measures of somatic distress and psychological distress were self-report. Addition measures based on parental or teacher observations could be incorporated in further research. Second, the present study relied on a cross-sectional design. Longitudinal designs could allow us to compare the trajectories of adolescents' somatic and psychological health within and between ethnic groups, and examine the effects of personality traits on these trajectories. Third, the Chinese data are not genetically informative. It is unclear to what extent the genetic etiology observed in the Australian twin sample generalizes to Chinese.

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Compliance with Ethical Standards

Conflict of Interest Yangyang Liu, Nathan A. Gillespie, Lin Ye, Gu Zhu, David L. Duffy, Nicholas G. Martin declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Human and Animal Rights The procedures used in the present study were in accordance with the ethical standards of the responsible committee on human experimentation (Nanjing university).

Informed Consent Informed consent was obtained from all participants and parents prior to testing.

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