The association between romantic relationship status and 5-HT1A gene in young adults

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What factors determine whether or not a young adult will fall in love? Sociological surveys and psychological studies have shown that non-genetic factors, such as socioeconomic status, external appearance, and personality attributes, are crucial components in romantic relationship formation. Here we demonstrate that genetic variants also contribute to romantic relationship formation. As love-related behaviors are associated with serotonin levels in the brain, this study investigated to what extent a polymorphism (C-1019G, rs6295) of *5-HT1A* gene is related to relationship status in 579 Chinese Han people. We found that 50.4% of individuals with the CC genotype and 39.0% with CG/GG genotype were in romantic relationship. Logistic regression analysis indicated that the C-1019G polymorphism was significantly associated with the odds of being single both before and after controlling for socioeconomic status, external appearance, religious beliefs, parenting style, and depressive symptoms. These findings provide, for the first time, direct evidence for the genetic contribution to romantic relationship formation.

In the 1980's, student romantic relationships were prohibited in Chinese universities. Nowadays such restrictions are long gone, yet many students (as many in American or European schools) stay single. What factors determine whether a young adult falls in love? Sociological surveys show that an individual's demographics and personal attributes, such as socioeconomic status and external appearance, partly determine dating opportunities[1]. Psychological research shows that personality traits, such as secure attachment orientation and optimism, are also crucial in romantic relationship formation[2,3]. Here we demonstrate that genetic variants also contribute to the formation of romantic relationships.

Love-related behaviors, such as pair bonding and affective affiliation, are shown to be associated with the serotonin levels in the brain[4–9]. In non-human animals, decreasing serotonin levels via 5-HT1A receptor agonists diminishes female sexual receptivity and induces aggression towards male mates[6,8]. The G allele of the C-1019G (rs6295) polymorphism, which leads to higher expression of *5-HT1A* gene, is related to decreased comfort with close relationships[9]. Thus it is possible that this *5-HT1A* gene polymorphism is related to the likelihood of a young adult being in a relationship. This possibility was tested on 579 Chinese undergraduate students.

Results

Given that the distribution of genotypes and the percentages of individuals in a relationship did not differ between male and females ($p > .20$, see *Supplementary Materials* Table S4), the following analyses were collapsed over gender. As Table 1 shows, we found that 50.4% of individuals with the CC genotype and 39.0% CG/GG genotype were in a relationship. We combined CG and GG genotypes into one group due to the rare frequency of GG (5.7%) and because the likelihood for being single was extremely similar between the two genotypes. The CG/GG genotype was significantly associated with an increased likelihood of being single as compared with the CC genotype, odds ratio = 1.59, 95% CI = [1.13, 2.24]. The chi-square test also showed a significant difference in the distribution of the genotype and relationship status, $\chi^2 = 7.139$, $p = .008$.

To make sure that the effect of genotype on relationship status survived even when we partialed out non-genetic factors such as the contributions of socioeconomic status, external appearance, religious beliefs, parenting style, and depression, we collected data concerning parents' levels of education, parents' occupation, household income, average monthly expenditure, height, body mass index (BMI), religious beliefs, perceived mother's and

Table 1 | The effect of C-1019G (rs6295) polymorphism on the distribution of romantic relationship status

|	Genotype frequency			
	CC	CG	GG	Total
In a relationship	182 (50.4%)	72 (38.9%)	13 (39.4%)	267 (46.1%)
Single	179 (49.6%)	113 (61.1%)	20 (60.6%)	312 (53.9%)

Note. N = number of individuals being in a relationship (single). The percentages were computed by dividing the number of individuals in a relationship (single) with the number of individuals having a particular genotype.

father's parenting styles, and depressive symptoms, and entered them as control variables into the logistic regression (see *Supplementary Materials*). The logistic model which included both genotype and control variables as predictors was more effective in predicting relationship status than the model which included only control variables, as revealed by the likelihood ratio test, $\chi^2 = 6.314$, $df = 1$, $p = .012$. The former model revealed a significant association between the C-1019G polymorphism and relationship status, $B = .450$, $SE = .180$, $df = 1$, Wald's $\chi^2 = 6.249$, $p = .012$, odds ratio = 1.569. The Nagelkerke R^2 change index showed that 1.4% of the variance in the log odds of being single could be explained by the C-1019G polymorphism. To sensibly interpret the odds ratios of the polymorphism, we also examined whether the genotype interacted with the predictors that were significant in the logistic model[10]. No significant interactions were observed, all $ps > .20$.

To confirm the above analyses, we also derived the predicted probabilities of being single for different genotypes from the logistic regression equation, after controlling for other variables (see *Supplementary Materials* Table S5). Figure 1 shows that the predicted probability for CG/GG carriers was significantly higher than that for CC carriers, $t(572) = 12.73$, $p < .001$.

Discussion

Individuals carrying the G allele (CG/GG) of C-1019G polymorphism were more likely to be single than CC carriers. This is consistent with the finding that G allele carriers are less comfortable in close relationships with others[9]. Indeed, G allele carriers are more likely to develop neurotic personalities[11] and psychiatric disorders such as major depression[12,13] and borderline personality disorder[14]. As pessimism and neuroticism are detrimental to the formation, quality, and stability of relationships[3,15], this connection between G allele and psychological disorders might decrease carriers' dating opportunities or lead to romantic relationship failure. Given that the G allele is associated with higher expressions of 5-HT1A receptors[13], the present finding is also consistent with animal studies showing that 5-HT1A receptor agonist inhibited affiliative behaviors[6,8].
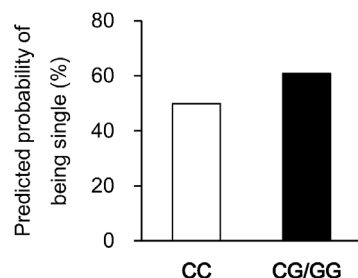
Figure 1 | Impact of the *5-HT1A* C-1019G polymorphism on the predicted probability of being single after controlling for socioeconomic status, external appearance, religious belief, parenting style, and depression. Individuals with the CG/GG genotype were more likely to be single than individuals with the CC genotype.

One should be cautious when interpreting the current finding given the following concerns. First, we examined the romantic relationship status of students in college, a time in which the participants may have strong intrinsic motivations to develop a relationship and are relatively free from family and social pressures to engage in such a relationship. Genetic influences on relationship formation can thus be revealed for this time window. One can imagine that, at least in the Chinese society, family and social pressures would force individuals to form romantic relationships as they get older making the contribution of genetic variation less easy to detect. Nevertheless, genetic variation may contribute to the intimate relationship in other ways, such as affecting attachment orientation[9], perceived marital crisis[16], and marital status[16]. It is for further studies to examine whether the polymorphism of the *5-HT1A* gene has such contributions. Second, the recruitment of participants for this study was limited to senior university students who may have unique characteristics regarding things like income, free time, the probability of encountering members of the opposite sex, etc. When these characteristics are changed, for example, for same-age blue-collar workers in factories, it is not clear whether the association between the *5-HT1A* gene and relationship status would still hold. It may be the case that under certain circumstances, the genetic contribution to romantic relationship formation could be overshadowed by other factors.

Nevertheless, our results demonstrate the importance of *5-HT1A* C-1019G in individual differences on romantic relationship formation, thereby providing evidence for the genetic contribution to complex social relationships in certain contexts.

Methods

PASW statistics 18 (formerly SPSS Statistics; http://www.spss.com.hk/statistics/) was used to analyze data. We tested 579 unrelated, unselected Chinese Han senior full-time undergraduate students (70.6% female, mean age = 24.2 ± 1.4 years) in Henan University of Science and Technology (a tier 2 university), China. Students in this university should be more representative of the general population of young adults in China than students in a top institution, say, Peking University. We identified their relationship status by asking them to answer the question "are you currently in love (romantically involved) with someone?" Hair follicle cells were collected for genotyping (see *Supplementary Materials*). Written informed consents were obtained from each participant. This study was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Psychology, Peking University.

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