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ORIGINAL ARTICLE

Gender Difference of Chinese High School Students' Math Anxiety: The Effects of Self-Esteem, Test Anxiety and General Anxiety

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Abstract

The present study aimed to explore gender differences in, and the effects of, self-esteem on math anxiety. A total of 751 (450 young women) junior and senior high school students (12–18 years-old) from China were recruited and requested to report their math anxiety, self-esteem, control beliefs, test anxiety, and general anxiety. Results revealed that young women showed a higher level of math anxiety compared with young men; no gender difference was found in math performance. Further, the pathway from self-esteem to math anxiety was different for young men and young women. For young men, apart from a direct effect on math anxiety, self-esteem had an indirect effect on math anxiety as mediated by control beliefs, test anxiety, and general anxiety. For young women, self-esteem only had an indirect effect on math anxiety as mediated by test anxiety and general anxiety. Our results indicated that improving self-esteem, test anxiety and general anxiety would be helpful for students' math anxiety.

Keywords Gender · Self-esteem · Math anxiety · Mediating effect · Chinese students

Math anxiety has received considerable attention because of its negative effects on mathematical performance, meta-cognition, and career choice (Ashcraft and Krause 2007; Legg and Locker Jr 2009; Maloney and Beilock 2012). However, the persistence of potential gender differences in math anxiety remains a controversial issue. If gender differences exist, what causes them? Previous studies have suggested that gender stereotyping, report bias, and uncontrollability perception may account for gender differences in math anxiety (Goetz et al. 2013; Guimond and Roussel 2001; Zirk-Sadowski et al. 2014). Meanwhile, self-esteem is always closely associated with anxiety (Çivitci and Çivitci 2009; Harmon-Jones et al. 1997). However, known previous studies have only shown a negative correlation between self-esteem and math anxiety (Mammarella et al. 2018). As such, it remains unclear whether self-esteem is a source of gender differences in math anxiety. Therefore, in the present study we aimed to investigate gender differences in math anxiety and in the influence of self-esteem on math anxiety.

Math anxiety is a special kind of discipline anxiety, referring to stress, anxiety, and other negative emotional reactions when individuals are engaged in activities associated with math (Kennedy and Tipps 1988). An increasing number of studies have indicated that math anxiety begins in the early school years and widely exists in middle school, college, and adult life (Harari et al. 2013; Jackson and Leffingwell 1999). Experts have estimated that 93% of Americans from kindergarten through college and 50% of British adults experience varying degrees of math anxiety (Chinn 2009; Furner and Duffy 2002). A Chinese study revealed that 69% of junior school students experienced moderate and more serious math anxiety (Wang and Lu 2006). All these findings show that math anxiety is prevalent.

Math anxiety has been negatively correlated with math performance (Ashcraft and Krause 2007; Devine et al. 2012). It has been found to have a negative effect on learning attitudes (Chinn 2009), course enrollment intentions (Meece et al. 1990), working memory (Ashcraft and Krause 2007), and meta-cognition (Legg and Locker Jr 2009), all of which relate to math performance. The negative effect is not confined to school situation but also extends to normal life, including reading cash register data, making financial decisions, and choosing professions (Maloney and Beilock 2012).

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Gender Differences

The relationship between math anxiety and gender has been debated, with discourse flowing along three veins. First, a growing body of studies report that women suffer from higher levels of math anxiety compared with men, although they obtain similar levels of achievement in math relative to their male counterparts (Chinn 2009; Devine et al. 2012; Else-Quest et al. 2010). Second, some studies have shown that there are no gender differences in math anxiety (Birgin et al. 2010; Erturan and Jansen 2015; Frary and Ling 1983). Third, only one known study has reported that the level of math anxiety is higher in men than in women (Abed and Alkhateeb 2001).

Despite these mixed results, the research largely indicates that women's math anxiety is higher than men's (see a meta-analysis by Else-Quest et al. 2010). However, the reason women report higher math anxiety than men do is not clear. One view is that gender differences are the result of gender stereotypes. Gender stereotypes can be defined as beliefs about specific behaviors and characteristics of each gender (Martin et al. 1990). In most societies, math is typically viewed as a male domain, placing girls and women at a disadvantage (Plante et al. 2009). Math-related gender stereotypes have detrimental effects on women's self-perception of their math abilities (Guimond and Roussel 2001). Therefore, women may experience more math anxiety.

Another explanation for gender differences in math anxiety is self-report bias between men and women (Goetz et al. 2013). This bias occurs when participants respond in such a way as to make them look as good as possible (Donaldon and Grant-Vallone 2002). In other words, participants may be less likely to report behaviors or feelings that are considered inappropriate by other researchers and observers or society in general. Men's math ability is often considered to be better than women's. Thus, because men should experience lower math anxiety than women do, this expectation will lead men to hide their math anxiety.

Zirk-Sadowski et al. (2014) demonstrated that uncontrollability perception is the origin of math anxiety. They found that girls have a lower adaptive perception of control in math learning, which plays a mediating role in the relationship between gender and math anxiety. That is, uncontrollability perception in math may be a reason leading to gender differences in math anxiety.

Self-Esteem and Math Anxiety

According to terror management theory (TMT), the sense of death in human beings causes terror (Greenberg et al. 1990). An effective way to alleviate this terror is to establish a cultural perspective to make people feel that the world is full of meaning, they are part of the meaning of the world, and they are valuable (Greenberg et al. 1990). The source of this meaning and value is achieved through self-esteem (Greenberg et al. 1990). TMT supposes that self-esteem provides protection against anxiety (Harmon-Jones et al. 1997). Specifically, the enhancement of self-esteem can reduce the influence of anxiety on individuals. Although self-esteem is negatively associated with math anxiety (Mammarella et al. 2018), it is not clear how self-esteem affects math anxiety. Moreover, there is a gap between men's and women's self-esteem. Girls and women report lower levels of self-esteem than do boys and men (Bachman et al. 2011; Moksnes and Espnes 2012). Thus, the influence of self-esteem on math anxiety may be different for men and women.

Math Anxiety, Test Anxiety, and General Anxiety

Test anxiety is a form of self-doubt and self-depreciation with respect to behavior and psychological reactivity in test situations (Sarason and Stoops 1978). Math anxiety is a kind of test anxiety (Richardson and Woolfolk 1980). Meanwhile, general anxiety refers to overall worry about events, behaviors, and abilities (Hill et al. 2016). Moderate correlations have been observed between test anxiety and math anxiety as well as between general anxiety and math anxiety (Devine et al. 2012; Hill et al. 2016; Kazelskis et al. 2000; Mammarella et al. 2018). Therefore, math, test, and gender anxieties are considered distinct constructs (Dew and Galassi 1983; Hembree 1990).

The Present Study

The current study has three objectives. First, we aimed to explore potential differences between young men and young women in math anxiety, thereby bridging the gap in the mixed results regarding this issue. Although most of studies support that females' math anxiety is higher than males' (Chinn 2009; Else-Quest et al. 2010; Devine et al. 2012), some studies have shown that there is no gender difference in math anxiety (Birgin et al. 2010; Frary and Ling 1983; Erturan and Jansen 2015) or males' math anxiety is higher than females' (Abed and Alkhateeb 2001). Accordingly, the current study aimed to provide additional data relevant to this question.

Second, we aimed to investigate the relationship between self-esteem and math anxiety. We hypothesized that self-esteem has a direct effect on math anxiety based on the TMT and the finding that self-esteem is closely related to one's mental health, especially anxiety disorders (Çivitci and Çivitci 2009; Zeigler-Hill 2011). Moreover, self-esteem could have an influence on math anxiety through test anxiety and

general anxiety. Some studies have shown that self-esteem is negatively correlated with test anxiety (Akinleke 2013; Kurman 2014) and general anxiety (Patten 1983), which are described as closely correlated with math anxiety (Devine et al. 2012; Hines et al. 2016). However, because women usually report lower self-esteem levels than do men (Bachman et al. 2011; Moksnes and Espnes 2012), the pathway from self-esteem to math anxiety may be different for young women and for young men.

Third, the current study aimed to investigate whether self-esteem affects math anxiety through control beliefs, defined as perceived control or the sense of control (Lachman et al. 2011). Control beliefs have the same meaning as the locus of control, referring to perceived control over self-related events (Chorpita and Barlow 1998). However, we employ the term *control beliefs* to emphasize the broader coverage of perceived control. As claimed by Rothbaum et al. (1982), people attempt to gain control by bringing not only the environment into line with their wishes (emphasized by the locus of control) but also themselves into line with environmental forces. Self-esteem is highly associated with internal locus of control (Saadat et al. 2012; Theofilou 2012), but the direction between self-esteem and locus of control remains not very clear. Recently, Furnham and Cheng (2016) found that self-esteem at 10-years-old is an important predictor of locus of control at 16-years-old, with a reciprocal cycle between the two. Children with higher self-esteem are more likely to initiate activities they can control, and the success they acquire from these activities will increase their self-esteem.

Lack of control is closely related to anxiety and anxiety disorders (Moulding and Kyrios 2006; Weems et al. 2007). Chorpita and Barlow (1998) pointed out that the experience of uncontrollable events could produce uncontrollable beliefs, referring to a perception about events are not within one's control, which would lead to increased anxiety when faced in the future with similar uncontrollable events. Math anxiety is thought to be related to earlier negative math experiences (Bekdemir 2010). Therefore, we assume that failure in math causes individuals to lose control with math, leading to math anxiety. Zirk-Sadowski et al. (2014) reported that gender differences in perceived controllability causes gender differences in math anxiety. In the present study, we investigate not only the effect of control beliefs on gender differences but also the relationship between control beliefs and self-esteem in young men and young women. We hypothesized that self-esteem will affect math anxiety through control beliefs.

In our study, control beliefs were divided into primary and secondary controls (Rothbaum et al. 1982). *Primary control* is defined as individuals' attempts to change the world to fit their own needs*; secondary control* is defined as individuals' attempts to change themselves to fit in with the world. Xin and Chi (2008) further divided primary control into direct and indirect control, and secondary control into cognitive and emotional control. Direct control refers to the manner through which individuals deal with things or problems through their own striving; indirect control refers to controlling the external environment through finding help from people who have the ability to change the environment. Cognitive control is defined as seeking the positive meaning of things through reasonable cognitive interpretation; emotional control is defined as accepting the reality at the emotional level (Xin and Chi 2008).

In exploring gender differences in math anxiety and the effects of self-esteem on math anxiety, we formulated three hypotheses. (a) There are gender differences in math anxiety, with young women's math anxiety being higher than young men's. (b) Self-esteem can affect math anxiety through test anxiety and general anxiety. (c) Self-esteem can affect math anxiety through control beliefs.

Method

Participants

A total of 990 middle school students were recruited from two public middle schools in Chongqing, China. A total of 239 students were excluded from the investigation; they did not complete the questionnaires or they answered the questionnaire in the same repeated value. Finally, 751 students (450, 60%, young women) were included in the current analyses. Among the participants, 144 students were in Grade 7 (M_{age} = 12.63, SD = .55), 164 students in Grade 8 (M_{age} = 13.59, SD = 1.00), 193 students in Grade 10 (M_{age} = 15.77, SD = .63), and 250 students in Grade 11 (M_{age} = 16.75, SD = .58). The average age for young women (M = 15.23, SD = 1.75) was higher than young men's (M = 14.69, SD = 1.79), $t(1, 747) = -4.08$, $p < .001$. .xxx.

Procedure and Measures

Questionnaires, including self-esteem, math anxiety, test anxiety and general anxiety, were translated into Chinese for the investigation. All of the questionnaires were completed in students' classrooms in a 45-min session administered by teachers. Participants were asked to report their age and gender; they then completed the questionnaire's measures in the order listed in the following. All of the students received a pen for their participation.

Self-Esteem

Self-esteem was measured by Rosenberg's Self-Esteem Scale (SES; Rosenberg 1965). The questionnaire contained 10 items (e.g., "I hold a positive attitude to myself") and used a 4-point rating scale from 1 (*disagree strongly*) to 4 (*agree strongly*).

Higher summed scores indicated higher self-esteem. In this study, Cronbach's alpha was .81, similar to that in another study (α = .82; Zhao et al. 2013).

Test Anxiety

Sarason's Test Anxiety Scale (TAS; Sarason 1978) was used to measure test anxiety. The questionnaire contained 37 items, and participants indicate whether they believe the items apply to them by answering true (coded 1) or false (coded 0) (e.g., "If I were to take an intelligence test, I would worry a great deal before taking it"). Responses were summed so that higher scores indicated greater test anxiety. The internal consistency reliability in our study was .83, similar to that of Devine et al. (2012, α = .86).

Math Anxiety

The Abbreviated Math Anxiety Scale (AMAS; Hopko et al. 2003) was used to measure levels of math anxiety. The AMAS is the shortest known, valid math anxiety scale with only nine items, but it has been shown to be as effective as the longer Math Anxiety Rating Scale (MARS; Hopko et al. 2003) (Cronbach's α = .90; two-week test-retest reliability: r = .85; convergent validity of AMAS and MARSR, r = .85). Items in this scale (e.g., "Thinking about an upcoming math test one day before") had response options from 1 (*not anxious at all*) to 5 (*very anxious*). Higher summed scores indicated greater math anxiety (α = .85).

Control Beliefs

The Chinese revision (Xin and Chi 2008) of Primary-Secondary Control Scale (PSCS; Chang et al. 1997) was used to measure control beliefs. The scale contained 30 items that deal with primary and secondary controls. The primary control subscale included direct control (e.g., "I try to find a way to change the situation") and indirect control (e.g., "I look for help from those who have the ability to change the situation"), whereas the secondary control sub-scale included cognitive control (e.g., "I try to see some good aspects of what happened") and emotional control (e.g., "I accept everything that happened"). The questionnaire used a 5-point scale from 1 (*disagree strongly*) to 5 (*agree strongly*). We used the overall score for control beliefs by summing across all items so that higher scores indicate beliefs in greater control. The alpha of .91 for our study is similar to that in another study (α = .89; Chi 2013).

General Anxiety

The Revised Children's Manifest Anxiety Scale (RCMAS): What I Think and Feel (Reynolds and Richmond 1978; α = .83) was translated into Chinese to measure general anxiety. The scale had 28 items (e.g., "It is hard for me to fall asleep at night"), to which the participants responded true (coded 1) or false (coded 0) accordingly. Higher summed scores indicate higher general anxiety. The internal consistency reliability in our study was .88.

Mathematics Performance

Final math scores in the previous semester were used to assess math performance. Generally, the final math test contains the same test content within school and grade, and math scores are judged by teachers according to standard answers. The total math score is 120 in junior high school and 150 in senior high school. Because participants were from different schools and grades, we transformed the final grades to z-scores within school and grade to enable further analysis.

Results

Preliminary Analyses

First, we conducted a t-test to explore possible gender differences in junior and senior high school participants. The results showed that young women's math anxiety was higher than young men's in both junior (M_{women} = 22.27, SD = 7.54; M_{men} = 17.88, SD = 6.94), $t(1, 306) = 5.43$, $p < .001$, $d = .62$, and senior (M_{women} = 23.12, SD = 6.12; M_{men} = 20.35, SD = 6.87), $t(1, 441) = 4.05$, $p < .001$, $d = .43$, high school. The size of both differences was medium using Cohen's (1988) criteria for effect sizes. Second, bivariate correlations of all variables were calculated. Means, standard deviations, and bivariate correlations are reported in Table 1. Overall, young women scored higher in math anxiety, $t(1, 747) = 5.73$, $p < .001$, $d = .57$, and lower in self-esteem, $t(1, 747) = 4.05$, $p < .001$, $d = .31$, compared with young men. However, no gender differences were found on control beliefs, $F(1, 747) = .22$, $p = .640$, $\eta_p^2 = .000$, test anxiety, $F(1, 747) = 3.17$, $p = .076$, $\eta_p^2 = .004$, general anxiety, $F(1, 747) = 2.15$, $p = .143$, $\eta_p^2 = .003$, and mathematics performance, $F(1, 747) = .18$, $p = .675$, $\eta_p^2 = .000$, controlling for the gender difference in age.

Correlation analyses showed similar results for young men and young women with respect to math anxiety; it was negatively associated with self-esteem, control beliefs, and math performance. Meanwhile, math anxiety was positively related with test anxiety and general anxiety. Despite these similar results, some different correlations were found for young men and young women. For instance, grade and age were positively associated with math anxiety for young men but not for young women. Besides, age was negatively related to control beliefs and test anxiety for young men but not for

Table 1 Descriptive statistics and correlations among study variables

	Young men	Young women	Correlationss							
Variables	*M* (*SD*)	*M* (*SD*)	1	2	3	4	5	6	7	8
1. Grade	8.92 (1.58)	9.59 (1.51)	–	.941***	.159**	−.141*	−.177**	.149*	.067	−.092
2. Age	14.69 (1.79)	15.23 (1.75)	.903***	–	.160**	−.124*	−.134*	.166**	.077	−.073
3. Math anxiety	$19.01\ (7.01)_a$	$22.88\ (6.61)_b$	.055	.064	–	−.374***	−.267***	.368***	.353***	−.338***
4. Self-esteem	$29.46\ (4.83)_a$	$28.06\ (4.27)_b$	.051	.058	−.166***	–	.337***	−.416***	−.412***	.085
5. Control beliefs	$111.36\ (17.83)_a$	$110.30\ (15.25)_a$	−.084	−.055	−.111*	.207***	–	−.182**	−.219***	.122*
6. Test anxiety	$16.49\ (6.44)_a$	$17.44\ (6.50)_a$	−.039	−.033	.422***	−.394***	−.102*	–	.561***	−.056
7. General anxiety	$11.62\ (6.52_{)a}$	$12.34\ (6.28)_a$	−.065	−.049	.345***	−.437***	−.112*	.629***	–	−.063
8. Math performance	$-.01\ (.97)_a$	$.02\ (.96)_a$	.034	.007	−.211***	.029	−.034	−.113*	−.065	–

Means for young men and young women with different subscripts across a row are significantly different at $p < .001$. Correlations for young men are reported above the diagonal; correlations for young women are reported below the diagonal

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

young women. Control beliefs were positively related with young men's math performance but not young women's. Conversely, test anxiety was negatively related with young women's math performance but not with young men's.

Structural Equation Modeling

SEM analysis was conducted separately for young men and young women using AMOS 17.0. The indices used to evaluate the fit of the model were CFI, TFI, and RMSEA (Schreiber et al. 2006). The tested model for young men was found acceptable (see Fig. 1), χ^2 (6) = 16.58, $p = .011$, RMSEA = .077, TLI = .914, CFI = .965. To examine the mediation effect further, 5000 bootstrap samples and the 95% bias-corrected confidence intervals were calculated, with significance indicated by confidence intervals that do not span zero. Results indicated that the mediation effects were statistically significant for control beliefs, 95% CI [−.079, −.003], test anxiety, 95% CI [−.124, −.018], and general anxiety, 95% CI [−.110. -.013]. However, the effect of self-esteem on math anxiety remained significant, 95% CI [−.280. -.061]. Therefore, the relationship between self-esteem and math anxiety was mediated by control belief, test anxiety, and general anxiety.

The tested model for young women was also acceptable (see Fig. 2), $\chi^2(6) = 7.86$, $p = .25$, RMSEA = .026, TLI = .990, CFI = .996. The mediating effects were significant for test anxiety, 95% CI [−.193, −.088], and for general anxiety, 95% CI [−.119, −.016], but not significant for control beliefs,

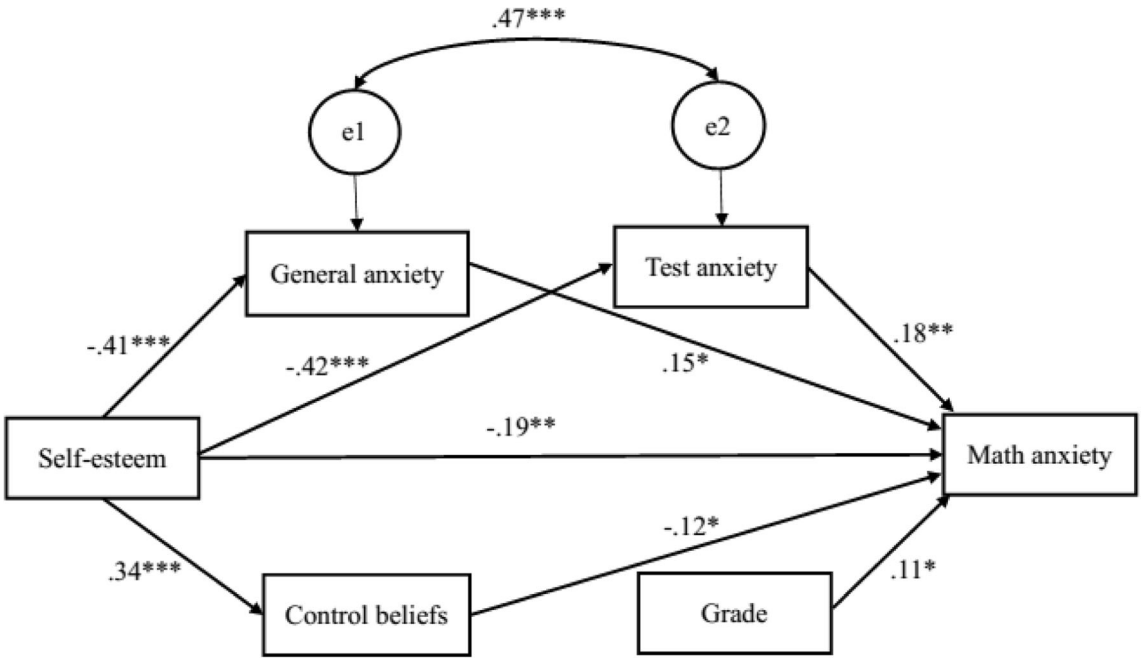

Fig. 1 Path model of the relationship between self-esteem and math anxiety for young men. *$p < .05$. ** $p < .01$. *** $p < .001$

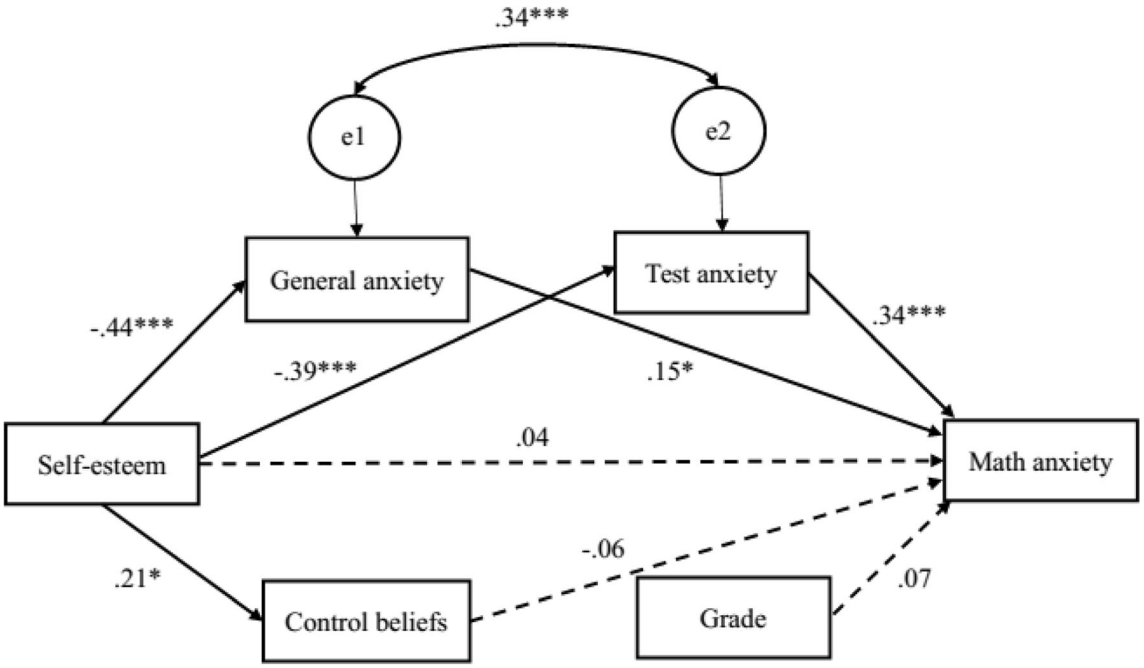

Fig. 2 Path model of the relationship between self-esteem and math anxiety for young women. *$p < .05$. ** $p < .01$. *** $p < .001$

95% CI [−.039, .006]. Moreover, the direct effect of self-esteem on math anxiety was not significant, 95% CI [−.055, .141]. That is, the relationship between self-esteem and math anxiety was mediated by test anxiety and general anxiety, but self-esteem and math anxiety were not directly related.

Discussion

In the present study we aimed to assess and determine the origin of gender differences in math anxiety. The findings showed that young women's math anxiety was higher than young men's. For young men, self-esteem had a direct effect on math anxiety, and it had indirect effects on math anxiety through control beliefs, test anxiety, and general anxiety. For young women, self-esteem only affected math anxiety through test anxiety and general anxiety, but not directly.

Our study showed that women's math anxiety is higher than men's, which is consistent with many previous studies (Chinn 2009; Else-Quest et al. 2010). However, other studies have reported contradicting results (Abed and Alkhateeb 2001; Birgin et al. 2010; Erturan and Jansen 2015; Frary and Ling 1983). There are two possible reasons to explain the different results. First, it is expected that the gender gap in math anxiety would be broadened with grade and become more obvious during high school (Else-Quest et al. 2010). Gender differences in this respect most likely emerge in middle school (Ashcraft and Moore 2009). The current participants were secondary school students, whereas those in extant studies were mainly elementary school students (Erturan and Jansen 2015). Second, sample bias is a factor to be considered. For example, the participants in the research by Abed and Alkhateeb (2001) were Emirati. In Arab culture, women with higher math scores are given more respect, and as such, women are motivated to spend more time on math (Alkhateeb 2010). As a result, women outperform men in mathematics achievements, which leads men to feel more anxious. Meanwhile, another study investigated university students from non-technical majors who did not care whether they obtained good mathematics grades or not; therefore, no gender differences were found in math anxiety (Frary and Ling 1983).

The present study also observed a significant gender difference in self-esteem. It is claimed that self-esteem is a cultural construction derived from the culture as well as others and thus integrated into an individualized worldview by each person (Pyszczynski et al. 2004). Many unfavorable factors from society and family contribute to women's low self-esteem, such as gender stereotypes, interactions with peer or teachers, cultural emphasis on women's physical appearance, or differential athletic participation (Kling et al. 1999). In Chinese tradition, most parents have a deep-rooted preference for sons than for daughters. They hold that sons will provide support for parents and continue the family line. In contrast, daughters will join another family after marriage. In addition, the social roles of men and women in China are different. Men are typically orientated to be independent, strong, and to provide for their whole family, whereas women are generally conditioned to be dependent, gentle, and responsible for family trifles and the care of children. These factors may lead to women's low self-esteem.

One important finding in our study is that self-esteem has both a direct and indirect influence on math anxiety for young

men, but only an indirect influence for young women. As such, self-esteem appears to be closely related with young men's math anxiety rather than young women's. In terror management theory, self-esteem is defensive and provides a shield against anxiety (Harmon-Jones et al. 1997). Therefore, self-esteem should have a direct effect on anxiety, regardless of math, test, or general anxiety. The current study confirmed that self-esteem has a direct effect on test and general anxiety for both young men and young women. However, an exception is that self-esteem has a direct effect on math anxiety for young men but not for young women. Such a finding may be associated with gender stereotypes. Mathematics is thought to be a field in which men rather than women are superior. Affected by such a social stereotype, young women may have lower expectations in math compared with young men.

Further, as we mentioned, a couple of factors in Chinese tradition lead to women's low self-esteem. As a result, in our study young women's self-esteem could not provide a shield against math anxiety, and there is no obvious specific association between their self-esteem and math anxiety. Young women's math anxiety seems to be a generalization of general anxiety and test anxiety. Therefore, our findings showed that self-esteem did not have an effect on math anxiety but had an indirect effect mediated by general anxiety and test anxiety. In contrast, for young men, math anxiety is a specific form of anxiety different from general and test anxiety. Therefore, self-esteem had a direct influence on math anxiety. However, young men's math anxiety is also closely associated with general and test anxiety, as revealed by our finding that self-esteem had an indirect effect on math anxiety mediated by general anxiety and test anxiety.

In the current study we also found that self-esteem could affect math anxiety through control beliefs for male students. Generally, people with high self-esteem have a greater potential for control (Fish and Karabenick 1971). When facing a challenging job, a person with higher self-esteem will view it as a deserved opportunity that can be controlled and yield benefits, whereas a person with lower self-esteem is more likely to view it as an undeserved opportunity or a chance to fail (Judge and Bono 2001). Therefore, when facing math-related tasks, young men may be more likely to have a sense of control owing to their high self-esteem. High self-esteem is associated with positive adaptability, whereas low self-esteem is related to maladaptive responses, such as anxiety and depression (Boden et al. 2008; Bos et al. 2010).

Meanwhile, grade was positively associated with men's math anxiety but not women's. It may be that men experience increased parental pressure from junior to senior high school, particularly in math performance. Parental pressure reportedly contributes to the increasing math anxiety (Chen 2012). In China, parents place great importance on their children's academic performance as a means to achieve family glory (Chen 2012), with academic performance in the college entrance examination seen as culmination. Therefore, most parents begin to place great importance on math performance in senior high school. However, math becomes abstract in senior high school, which may increases men's learning difficulty. Thus, men score high in math anxiety beginning in senior high school. In contrast, there is no significant correlation between grade and math anxiety for women. It is likely that young women always keep a higher math anxiety from junior to senior high school. As we mentioned, mathematics is commonly thought to be a field in which men rather than women excel. Therefore, young women continuously work hard in math because they do not want to disappoint their parents (Else-Quest et al. 2010), and their math anxiety does not vary from junior to senior high school.

Practice Implications

The current study suggests that improving test anxiety and general anxiety is a valid approach to alleviate students' math anxiety. Various approaches have been used to alleviate test anxiety, including the behavioral method, cognitive method, cognitive-behavioral method, study and test-taking skills, and biofeedback technology (Embse et al. 2013). To intervene in test anxiety and general anxiety, the most important aspect is to understand anxiety and self-regulated learning. Future interventions may combine cognitive, behavioral, and biofeedback technology.

Our study also suggests that directly improving self-esteem is a valid approach to alleviate young men's math anxiety. The development of self-esteem is affected by individuals' environment, including social circle, family, and school. Because it is hard to change the environment in a short time, the more valid approach may be to change one's mind. For example, cognitive-behavioral therapy can be used to help students identify and modify their false thoughts, whereas narrative therapy can be used to help students formulate new self-concepts of themselves (Chadwick et al. 2014). In addition, a self-esteem focused curriculum can be provided for students in school.

Limitations and Future Research Directions

Our study has a number of limitations. First, all our measures are self-reported, and as such, the answers may be tainted by report bias, which is attributed to social desirability, although we promised anonymity to participants. Future studies can be conducted using biological instruments and brain imaging technology, which can provide more indexes to increase the validity of the measurement of math anxiety. Second, the control beliefs in our study were not math-related, which may explain why our findings are different from those in Zirk-Sadowski et al. (2014). Although the current work indicates that control beliefs had an important influence on math

anxiety for young men, future studies can investigate whether math-related control beliefs have a more important influence on math anxiety.

Conclusions

The current study supports the view that young women have higher math anxiety than do young men. Moreover, self-esteem is an important source of gender difference in math anxiety. However, self-esteem had both direct and indirect effects on math anxiety for young men, whereas it only had an indirect effect for young women, mediated by test anxiety and general anxiety. Young women's math anxiety may be a generalization of general anxiety and test anxiety. In contrast, math anxiety appears to be a specific form of anxiety for young men.

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Compliance with Ethical Standards

Conflict of Interest Fang Xie and Ziqiang Xin contributed equally to this paper, as Ziqiang Xin gave suggestion to this paper's revision as well as the language proofreading. There is no other conflict exists.

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards.

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