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# Gender differences in the relationship between attentional bias to threat and social anxiety in adolescents ☆

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ABSTRACT

In the current study, gender differences in the relationship between attentional bias to threat and social anxiety were tested in 10- to 16-year-olds. Emotional faces were used as the experiment material, and a modified dot probe task was used to measure attentional bias. The level of social anxiety, depression, and loneliness were also measured via the Social Anxiety Scale for Children, Children's Depression Inventory, and Children's Loneliness Scale. Results indicated that males' attentional bias to threat was significantly, positively correlated with their social anxiety, yet no correlation was found for females. For adolescents, the gender differences in the relationship between attentional bias to threat and social anxiety was notable.



## 1. Introduction

Social anxiety disorder, or social phobia, is the most common anxiety disorder, with a lifetime prevalence of 12.1% (Beidel & Turner, 2007; Kessler et al., 2005; Rosenberg, Ledley, & Heimberg, 2010). Social anxiety can severely weaken social functioning, and trigger sleep disorders, depression, mood disorders, and suicidal ideation and other psychological disorders (Buckner, Bernert, Cromer, Joiner, & Schmidt, 2008a; Buckner, Eggleston, & Schmidt, 2006; Buckner et al., 2008b; Kessler, Stang, Wittchen, Stein, & Walters, 1999). Adolescents suffer more social pressure and intense emotional experiences, which makes them more prone to social anxiety (Casey et al., 2010). According to a survey, about 7% of adolescents were vexed at social anxiety (Chavira, Stein, Bailey, & Stein, 2004). Social anxiety weakened social and academic functioning in adolescents, as well as decreased their quality of life and put them at risk for the development of other mental disorders in adulthood (Brozovich & Heimberg, 2008; Mychailyszyn, Méndez, & Kendall, 2010; Woodward & Fergusson, 2001).

Attentional bias to threat-relevant information is an important factor that is known to trigger social anxiety experiences (Mogg, Philippot, & Bradley, 2004; Schultz & Heimberg, 2008). Specifically, researchers believe that those with social anxiety are more inclined to be attracted to threat-relevant information (Hofmann, 2007; Mogg & Bradley, 2002; Rapee & Heimberg, 1997). For instance, Mogg and Bradley (2002) used the modified dot probe task with 100 20-year-olds and reported that individuals with high social anxiety showed attentional alerting to threat-relevant information. Some researchers have suggested that it is difficult for individuals with social anxiety to disengage their attention from negative social cues, which is a consequence of their attentional bias to threat-relevant information (Amir, Elias, Klumpp, & Przeworski, 2003; Cisler & Olatunji, 2010; Moriya & Tanno, 2011; Yiend & Mathews, 2001). For instance, Amir et al. (2003) used the space clues task with a sample of 18 patients with social anxiety disorder and 20 without social anxiety disorder. They reported that cue dependency to threat-relevant information of patients with social anxiety disorder was significantly higher than the non-clinical participants; however, no significant differences were observed between the two groups for the neutral and positive stimulus cues. Moreover, Buckner, Maner, and Schmidt (2010) examined eye movement in 46 non-clinical individuals and identified that individuals with high social anxiety had difficulty disengaging their attention from negative social cues.

Few studies have examined gender differences in this relationship. Some evidence has indicated that variations in emotion vulnerability and emotional processing exist between men and

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women, where recognition and processing of emotional stimuli may differ between males and females (Collignon et al., 2010; Flores-Gutiérrez et al., 2009; Li, Yuan, & Lin, 2008b; Mak, Hu, Zhang, Xiao, & Lee, 2009; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008). Therefore, it seems that the onset and development of social anxiety may differ for males and females. Furthermore, neuroscience research suggests that individuals may process emotions through low-road and high-road when receiving threatening signals (Ledoux, 1995, 2003). Importantly, males have low-road *superiority*, while females possess high-road (Morris, Öhman, & Dolan, 1999). Low-road *superiority* refers to individuals who tend to respond directly after accepting relevant-threat information. high-road superiority refers to deep processing combined with the internal environment after encountering relevant-threat information (Ledoux, 1995). Thus, in the face of relevant-threat emotional stimuli, men will quickly experience social anxiety, while women may not immediately feel socially anxious since this process is regulated by internal factors such as mood and self-evaluation. Therefore, we assumed that males' attentional bias when encountering relevant-threat emotional stimuli would be positively associated with social anxiety; however, we did not expect the same correlation to emerge for females.

To test this hypothesis, we selected adolescents aged 10–16 years as the subjects. We used the Chinese version of the Children's Social Anxiety Scale to examine level of social anxiety, as well as an modified dot probe task to measure attentional bias to relevant-threat information. The dot probe task is the most widely used paradigm in the field of attentional bias (MacLeod & Holmes, 2012). In addition, we chose emotional face pictures as the stimuli, which is consistent with stimuli during social situations; therefore, this procedure is ecologically valid. Moreover, in order to examine the influence of depression and loneliness on the results, we also administered the Chinese version of the Children's Depression Inventory and the Children's Loneliness Scale to measure subjects' depression and loneliness.

## 2. Material and methods

### 2.1. Participants

All participants were in grades fourth to sixth in a primary school in Gansu province. We distributed 125 copies of the following questionnaires: the Children's Social Anxiety Scale, the Children's Depression Inventory and the Children's Loneliness Scale, a total of 109 valid questionnaires were received. Ninety-two children volunteered and took part in the study; these participants had their guardians sign the informed consent forms. All participants were of Han nationality and were 10- to 16-years-old, with normal vision and corrected visual acuity. All subjects were right-handed and had no history of color blindness, neurological problems, or psychotherapy. The experimental protocol was approved by the Northwest Normal University Psychological Experiment Ethics Committee.

### 2.2. Measures

#### 2.2.1. Social Anxiety Scale for Children

The Social Anxiety Scale for Children (SASC) was used herein. This scale was developed by La Greca, Dandes, Wick, Shaw, and Stone (1988) and contains 10 items rated on a 3-point scale (0 = never; 1 = sometimes; 2 = always). Children's anxiety was assessed on a scale of "0" to "20", with higher scores indicating more severe social anxiety. Two dimensions were included in the scale: negative evaluation (items 1, 2, 5, 6, 8, and 10) and social avoidance and vexation (items 3, 4, 7, and 9). The verified Chinese version of the Social Anxiety Scale for Children has reported sound reliability and validity (Li, Su, & Jin, 2006).

#### 2.2.2. The Children's Depression Inventory

The Children's Depression Inventory (CDI) was used herein and contained 27 items rated from 0 to 2 points (Saylor, Finch, Spirito, & Bennett, 1984). Scores ranged from 0 to 54, and higher scores indicate higher levels of depression. The Chinese version of the Children's Depression Inventory yields indices of good reliability and validity (Wu, Lu, Tan, & Yao, 2010).

#### 2.2.3. The Children's Loneliness Scale

The Children's Loneliness Scale (CLS) was used to measure subjects' loneliness (Asher, Hymel, & Renshaw, 1984). Twenty-four items on the scale can be used to assess loneliness in children from the third to sixth grade. Sixteen items measure students' loneliness, social adaptability, and adaptation; in addition, ten items assess solitude and six items measure a lack of loneliness. Eight items were added about extracurricular activities and personal preferences in order to encourage candid and relaxed responses. The items are rated on a scale from 1 to 5 (1 = always; 2 = often; 3 = sometimes; 4 = very little; five = no). Ten items expressing solitude were reverse scored (3, 6, 9, 12, 14, 17, 18, 20, 21, 24), the total score ranged from 16 to 80 points, with higher scores indicating greater loneliness. The Chinese version of the Children's Loneliness Scale (CLS) has been validated and demonstrated good reliability and validity (Gao & Chen, 2011).

#### 2.2.4. The dot probe task

From the Chinese Affective Picture System we chose pictures of happy, neutral and disgust faces of fourteen people as the stimuli (Bai, Ma, Huang, & Luo, 2005). The proportion of male and female pictures was evenly distributed (50%). Six pairs displayed happy (arousal, $M = 7.2$, $SD = 0.1$) and disgust ($M = 7.2$, $SD = 0.5$) faces; the remaining 16 pictures were neutral faces ($M = 5.2$, $SD = 0.1$). We adopted Photoshop 7.01 simplified Chinese edition to process the face picture into 10.8 cm × 12.7 cm with same brightness (black and white).

Participants completed the questionnaires in a quiet and spacious classroom with the help of a research assistant. The questionnaires were pencil-and-paper tests; three of the questionnaires were randomly presented to the participants. At the end of 14.7 ($SD = 1.14$) days, we measured the participants' attentional bias to threat-relevant information using the modified dot probe task developed by Macleod (MacLeod, Mathews, & Tata, 1986). All participants entered the 15-$m^2$ laboratory that was appropriately lighted, and were seated in a comfortable chair; their hand was lightly placed on the mouse. The instructions were then repeated and subjects completed a practice task by clicking the "Q" key. After the presentation of the emotion faces, participants were required to discriminate the letters that appeared as quickly and accurately as possible. Each trial began with a 500 ms fixation point that was presented centrally on a black background. It was followed by a randomized blank screen presented within 400–800 ms. Two emotional face stimuli of the same person remained on the screen for 500 ms. After the face stimulus disappeared, a blank screen was presented randomly between 400 and 800 ms. Probe point ("E" or "F") randomly appeared where one of the face stimuli was located. We asked participants to discriminate the type of probe points by clicking the left ("E") or right ("F") mouse button. The offset of the probe point for the next trial began after one second. Two neutral face stimuli of the same person were presented during the practice task, and were repeated twice. Thus, there were eight people and 16 (2 repetition × 8 person) trials in all. If accuracy was lower than 90%, subjects returned to the practice session. Each participant had three practice opportunities, or

he/she would have to quit. If accuracy reached 90%, the test phase began. During the test, every happy-disgust face stimuli of the same people were presented. The probe point "E" and "F" was presented by an identical probability, so did the probability of happy-disgust face stimulus. The stimuli were repeated four times in every condition, so six people had 96 (2 "E" or "F" × 2 position × 4 repetition × 6 person) trials in total. All trials were randomly assigned to four groups and each group had 24 trials. The participants had a rest between blocks; when they felt adequately rested, they continued training by clicking "Q" key. The whole session lasted about 15 min. The face stimuli were presented on a 17-inch display with 1440 × 900 resolution, with a black background and white instructions. Participants sat 60 cm from the monitor at a 3° angle. The probe stimulus was 1.5 cm tall and 2 cm wide, and was centered horizontally on the screen. Face pictures were centered horizontally 11.5 cm from the left edge of the screen and 2.5 cm from the top of the screen. There was a 1 cm gap between the bottom of the top image and the top of the bottom image.

## 3. Results

### 3.1. Data reduction

Data were processed with SPSS 19.0. The following subjects were removed due to their responses during the dot probe task: 2 subjects whose response time was less than 200 ms or more than 2000 ms, since that accounted for more than 50% of the trial; 3 subjects whose accuracy was lower than 65%; 2 subjects whose accuracy after the happy face was lower than 85%; 2 subjects who did not pass the practice task and quit during the experiment; and 1 subject whose data was incomplete because of power loss. Thus, 82 subjects' data were used, and the loss rate was 12.2%. Trials with errors, and response time of 200 ms or less, or 3000 ms or more, were excluded form the analyses. The variable attentional bias score was used to describe the level of the participants' attentional bias to the negative information. It was defined as the discrepancy between the time cost to discriminate the type of those probes presented in the vicinity of the positive pictures and that of the negative pictures (Li, Tan, Qian, & Liu, 2008a).

### 3.2. Descriptive statistics

Upon examination, there were no significant differences in age, years of education, depression, loneliness, social anxiety, accuracy, and attentional bias score (See Table 1).

### 3.3. Regression analyses to social anxiety

The correlation between attentional bias and social anxiety for participants was non-significant. Males and females were separated in the analysis. Males' attentional bias scores were significantly associated with social anxiety; however, there was no significant correlation for females (See Table 2).

**Table 1**
Gender differences in statistics.

| | Male ($n$ = 42) | | Female ($n$ = 40) | | $t$ | $p$ |
|---|---|---|---|---|---|---|
| | $M$ | $SD$ | $M$ | $SD$ | | |
| Ages | 11.79 | 1.22 | 11.90 | 1.60 | −0.365 | 0.716 |
| Education years | 5.05 | 0.73 | 5.20 | 0.79 | −0.907 | 0.367 |
| Depression | 27.62 | 4.00 | 27.05 | 4.26 | 0.624 | 0.535 |
| Loneliness | 35.93 | 7.65 | 36.18 | 10.06 | −0.125 | 0.901 |
| Social anxiety | 7.10 | 2.78 | 7.63 | 2.76 | −0.865 | 0.390 |
| Accuracy | 0.736 | 0.017 | 0.739 | 0.018 | −0.806 | 0.633 |

Next, a hierarchical multiple regression was conducted and the male subjects data were analyzed. Ages, education years, depression, loneliness, and accuracy were entered as control variables on the first step. Attentional bias was entered on the second step. The results indicated that the attentional bias scores of male subjects predicted their social anxiety after controlling for ages, education years, depression, loneliness, and accuracy (See Table 3).

## 4. Discussion

The present research targeted adolescents aged 10–16 years. Their attentional bias towards threatening stimuli and their social anxieties was examined. The results indicated that males' attentional bias towards threatening stimuli was positively related to their social anxiety; however, the same was not true for females. Importantly, depression and loneliness was controlled for herein.

We believe that the findings reported in this study may represent gender differences in emotional processing. The amygdala is the key organizational component of the cranial nerve where individual fears are produced and processed (Furmark et al., 2002; Tillfors, Furmark, Marteinsdottir, & Fredrikson, 2002; Öhman, 2005). For instance, Ledoux (1995) believes there may be two kinds of mechanisms for amygdalar functioning in emotional processing. Specifically, one is a low-road process, where the stimulating signals are sent by the hypothalamus to the amygdala, which induces a fear response. Without advanced processing, this process has the characteristics of a quick reaction, and is important for survival. The other process is high-road. This process occurs when stimulation messages are transmitted simultaneously to the thalamus and the amygdala, the anterior cingulate, and the ventromedial prefrontal cortex structure; then, these stimulation signals are processed and produce an accurate emotional response. The two roads are separate from each other, and occur simultaneously. Recent research conducted by Morris (1999) found that the right side of the amygdala is mainly responsible for the low-road and the left one for the high-road. Moreover, Cahill et al. (2001) explored whether there are gender differences in emotional processing by the amygdala in a study using PET scans. In this study, participants viewed clips containing negative stimuli and male participants' right amygdala was activated and the left side was not. However, the results of the women were the opposite to those of the males. Furthermore, Canli, Desmond, Zhao, and Gabrieli (2002) found the same result using fMRI technique. Thus, it appears that during emotion induction and processing, men use the right side of the amygdala and women use the left side.

Thus, this functional deviation may be stimulated from sex differences in physiological functioning. By using seed-PLS analyses, Kilpatrick, Zald, Pardo, and Cahill (2006) found that the right amygdala of male subjects had wider functional connections that were mainly concentrated in the sensorimot or cortex, striatum, and pulvinar areas. These areas tend to be in response to external environment and process external stimuli rapidly and directly. On the other hand, the females' left amygdala had wider functional connections than the males' primarily in the subgenual cortex and hypothalamus areas; importantly, these areas are associated with introversion and combine with the internal factors to process stimuli. Thus, these studies indicate that sex differences in processing stimuli exist at the physiological level; in other words, males activate their right amygdale more, which has "low-road" advantages, while the females activate their left amygdale more, which has "high-road" advantages. In conclusion, males' tendency towards social anxiety may be due to the way they directly process threatening stimuli, whereas females' processing of stimuli is done via inner factors, which does not lead to social anxiety. Indeed, this line of previous research supports this conclusion.

**Table 2**
Correlations between attentional bias and social anxiety.

| | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Male | 1 Ages | | | | | | |
| | 2 Education years | .641*** | | | | | |
| | 3 Depression | −.107 | −.110 | | | | |
| | 4 Loneliness | .205 | .057 | .385** | | | |
| | 5 Social anxiety | −.173 | −.134 | .406** | .569*** | | |
| | 6 Accuracy | .345* | .400** | −.059 | .082 | .038 | |
| | 7 Attentional bias | −.120 | −.243 | .131 | .129 | .467** | −.039 |
| Female | 1 Ages | | | | | | |
| | 2 Education years | .564*** | | | | | |
| | 3 Depression | .035 | −.033 | | | | |
| | 4 Loneliness | −.018 | −.092 | .241 | | | |
| | 5 Social anxiety | −.288 | −.235 | −.005 | .514** | | |
| | 6 Accuracy | −.006 | −.077 | −.016 | −.158 | −.180 | |
| | 7 Attentional bias | .256 | .230 | −.029 | −.003 | −.038 | .184 |

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 3**
Results of the hierarchical multiple regression analyses.

| Step | Variables | Predicting social anxiety betas |
|---|---|---|
| 1 | Ages | −0.521 |
| | Education years | −0.006 |
| | Depression | 0.015 |
| | Loneliness | 0.17*** |
| | Accuracy | 1.513 |
| | Multiple $R^2$ | 0.354*** |
| 2 | Attentional bias | 0.008* |
| | Multiple $R^2$ | 0.385*** |
| | $\Delta R^2$ | 0.031*** |

* $p < 0.05$.
*** $p < 0.001$.

In sum, the findings of the present research provide a novel perspective of the effect of attentional bias on social anxiety. Moreover, this study also provides a new direction in the understanding the gender differences in the onset and development of social anxiety. Recent studies have indicated that attentional bias training may help to alleviate individual social anxiety (Amir, Weber, Beard, Bomyea, & Taylor, 2008; de Voogd, Wiers, Prins, & Salemink, 2014; Schmidt, Richey, Buckner, & Timpano, 2009). However, some studies have failed to consider gender differences and have yielded mixed results (Bunnell, Beidel, & Mesa, 2013; Julian, Beard, Schmidt, Powers, & Smits, 2012; Kruijt, Putman, & Van der Does, 2013; McNally, Enock, Tsai, & Tousian, 2013).

The current research does have some limitations. First, in accordance with methods described in literature (Amir et al., 2008; de Voogd et al., 2014; Kruijt et al., 2013), we excluded 10 subjects (attrition rate is 12.2%), which might skew the results. On the other hand, the performance of some children was too poor to be included. Future study should develop easier paradigms for children, and therefore reduce the attrition rate. Second, our study targeted adolescents aged 10–16 years within a small sample, which is limited to draw conclusions on relation between individual attentional bias towards threatening stimuli and social anxiety. Moreover, there are studies suggesting that age, years of education and sample size might have some effects on this relation (Hakamata et al., 2010; Hallion & Ruscio, 2011), which reminds us to be cautious in extending conclusions. Future studies can enlarge the sample size and age range to find more general conclusions or relations between attentional bias towards threatening stimuli and social anxiety.

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