

Avoidance temperament and social-evaluative threat in college students' math performance: a mediation model of math and test anxiety

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Background and Objectives: Standardized testing has become a common form of student evaluation with high stakes, and limited research exists on understanding the roles of students' personality traits and social-evaluative threat on their academic performance. This study examined the roles of avoidance temperament (i.e., fear and behavioral inhibition) and evaluative threat (i.e., fear of failure and being viewed as unintelligent) in standardized math test and course grades in college students. **Design and Methods:** Undergraduate students ($N = 184$) from a large public university were assessed on temperamental fear and behavioral inhibition. They were then given 15 minutes to complete a standardized math test. After the test, students provided data on evaluative threat and their math performance (scores on standardized college entrance exam and average grades in college math courses). **Results:** Results indicate that avoidance temperament was linked to social-evaluative threat and low standardized math test scores. Furthermore, evaluative threat mediated the influence of avoidance temperament on both types of math performance. **Conclusions:** Results have educational and clinical implications, particularly for students at risk for test anxiety and underperformance. Interventions targeting emotion regulation and stress management skills may help individuals reduce their math and test anxieties.

Keywords: avoidance temperament; behavioral inhibition system (BIS); test anxiety; social-evaluative threat; standardized testing; math anxiety

Introduction

Research on anxiety associated with standardized testing became prominent in the 1980s, and there is resurgence in test anxiety research in the twenty-first century (Stöber & Pekrun, 2004; Supovitz, 2009; William, 2010). The emphasis on Science, Technology, Engineering, and Mathematics (STEM) education in the twenty-first century has focused attention on students' proficiency in areas such as math and the use of standardized tests to document students' proficiency and progress (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Given the significance of test performances on students' future education and career pathways, many

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students experience test anxiety. Test anxiety refers to the anxiety experienced in an assessment context, such as in a standardized or a classroom exam (Putwain, 2008). Generally, test anxiety has negative impact on test performance, and research indicates that students high on test anxiety performed at a level equivalent to a full year behind, whereas students low on test anxiety performed at a level equivalent to a full year ahead in school district averages in math and reading (Hill & Sarason, 1966; Paris, Lowton, Turner, & Roth, 1991).

Although research has established that test anxiety predicts poor test performance (Sarason, 1984), the underlying mechanisms of how test-takers' characteristics influence their test performance is not well understood. The purpose of this study was to examine the roles of avoidance temperament and evaluative threat in two types of math performance (standardized math test scores and math course grades) in college students. Specifically, a mediation model was proposed and tested with evaluative threat as the mediating mechanism by which avoidance temperament influences performances in the standardized testing and class settings.

Fear and behavioral inhibition (avoidance temperament)

Temperament is a subdomain of personality, referring to stable individual differences or traits in emotional, attentional, and behavioral inclinations toward acting and reacting (Derryberry & Rothbart, 1997; Evans & Rothbart, 2007; Goldsmith et al., 1987). The temperament dimension of fearfulness may have debilitating effects on test performance, because individuals with such traits are prone to experiencing fear and distress. Fear is an emotion elicited by perceived threat or impending danger (Plutchik, 1980; Ekman & Friesen, 1971; see Russell, 1994) and serves the function of active avoidance of perceived danger (McNaughton & Corr, 2004; Rothbart & Bates, 2006). Fearfulness is associated with self-oriented or inward focus of attention and personal distress (Liew et al., 2011). The behavioral inhibition system (BIS) is one of the systems in Gray's temperament model (1991), and BIS sensitivity predicts anxiety and distress to threat or impending punishment (Heponiemi, Keltikangas-Jarvinen, Puttonen, & Ravaja, 2003).

Although measures of knowledge or intelligence are associated with test performance, trait measures also predict a moderate percentage of the variance in academic or test performance (Cacioppo, Petty, Feinstein, & Jarvis, 1996; Chamorro-Premuzic & Furnham, 2003; Komarraju, Karau, Schmeck, 2009; Poropat, 2009; Rindermann & Neubauer, 2001). For example, Komarraju et al. (2009) found that personality traits of conscientiousness, neuroticism, agreeableness, and openness predicted self-reported grade point averages above and beyond measures of academic motivation in college students. Studies on academic performance have examined variables similar to temperamental fear and behavioral inhibition (De Raad & Schouwenburg, 1996; Hagopian & Ollendick, 1994; McNaughton & Corr, 2004; Thompson, Naccarato, Parker, & Moskowitz, 2001), but studies have not examined evaluative threat as mediating the link between avoidance temperament and test performance.

Adult temperament constructs and the lexical Big Five model of personality map on well to one another, with fear loading on the negative affect temperament factor which corresponds to the neuroticism personality factor for the Big Five (Evans & Rothbart, 2007). Of particular relevance is a 3-year longitudinal study on university students that found those who scored high on neuroticism performed worse on their exams every year (Chamorro-Premuzic & Furnham, 2003). Research also indicates that behavioral inhibition system (BIS) is highly related to neuroticism (Smits & Boeck, 2006), partly

because both tap negative emotionality (Carver & White, 1994; Larsen & Ketelaar, 1991). Elliot and Thrash (2002) defined *avoidance temperament* as a general neurobiological sensitivity to present or imagined negative stimuli that is accompanied by perceptual vigilance, negative affect, and/or behavioral inhibition or withdrawal. Avoidance temperament consists of traits such as negative emotionality, neuroticism, and BIS (Elliot & Thrash, 2010). Consistent with such a conceptualization, we view temperamental fear and behavioral inhibition (henceforth, termed avoidance temperament for brevity) as important traits to focus on for testing situations. In the present study, we hypothesize that temperamental fear and behavioral inhibition would be positively related to one another, and both traits would be negatively related to indices of math performance.

Evaluative threat and performance

Threat appraisal refers to individual's perception of danger or harm to the physical or social self (Lazarus & Folkman, 1984) and must be evaluated based on both emotional valence (e.g., feeling of threat) and goal relevance (e.g., importance or relevance to self). *Social-evaluative threat* (henceforth, termed evaluative threat for brevity) is defined as the perception or feeling of threat to the social self in conditions when an important or relevant aspect of the self-identity is, or could be, negatively evaluated by others (Dickerson, Gruenewald, & Kemeny, 2004). For college students, a relevant part of their identity stems from being viewed as academically competent. Thus, fear of failure and fear of being viewed as unintelligent are indices of social-evaluative threat (Dickerson & Kemeny, 2004). In the present study, we hypothesize that evaluative threat would be negatively related to indices of math performance because evaluative stress or anxiety impairs learning and performance (Eysenck, Derakshan, Santos, & Calvo, 2007; Hancock, 2001; Zeidner, 2007; Zeidner & Mathews, 2005).

Mediation model of test anxiety

Avoidance temperament may predispose individuals to perceive and react to an evaluative situation as ego-threatening and taxing. In situations where one's level of knowledge or competence is being evaluated, evaluative threat often impairs cognitive control or executive functions (Eysenck & Calvo, 1992; Eysenck et al., 2007). As described earlier, avoidance temperament maps onto neuroticism and is highly related to negative emotionality (Carver & White, 1994; Evans & Rothbart, 2007; Larsen & Ketelaar, 1991). Thus, avoidance temperament would likely predispose individuals to view the testing situation as threatening and elicit fear of failure (Steele, 1997; Watson & Clark, 1984). Further, we test evaluative threat as a mediating mechanism by which avoidance temperament transmits influence on two types of math performance (standardized math test score and math course grade) because math performance involves task and situation specific evaluation of the self rather than more trait-like constructs that are distal from performance (Barrick, Stewart, & Piotrowski, 2002; Chen, Gully, Whiteman, & Kilcullen, 2000; Kanfer & Heggestad, 1997).

Present study

The main purpose of the present study was to examine the joint influences of trait variables (avoidance temperament) and state variables (evaluative threat) on college

students' math performance (standardized test scores and course grades). We also test a mediation model where the influences of avoidance temperament on scores of standardized math test and college math course are mediated by evaluative threat (e.g., fear of failure). Specifically, we hypothesize that avoidance temperament predicts evaluative threat in testing situations, which then predicts poor math performance in the standardized testing and college math course settings.

Method

Participants

Undergraduate students ($N = 184$; $M = 18.55$ years, $SD = .83$) from a Tier-1 (research-intensive) large public university located in Southwestern USA took part in the study for partial course credit, with majority as females (71.2%). Majority of participants were first-year students ($n = 135$; 73.4%). Ethnically, 144 students were White/Caucasian (78.3%), 24 were Hispanic (13%), 5 were Asian-American (2.7%), 5 were African-American (2.7%), and 6 students were considered Other (3.3%).

Procedure and measures

Data collection protocols were approved by the university Institutional Review Board (IRB). Participants were brought into a classroom in groups of approximately 20 and asked to sit with one seat apart from others. After informed consent procedures, participants completed trait measures that assessed temperamental fear and behavioral inhibition (BIS). Participants were then informed that, as part of an effort to develop new evaluation tests, they would be taking a standardized math test. Participants were given a maximum of 15 minutes to complete the test, and were told that they could not turn the test in early. The time limit of 15 minutes was selected so that participants had ample (at least 2 minutes per test item) and exactly the same amount of time to complete the test. After completing the test, participants reported on how they felt about the test. Participants also provided information on their scores from their standardized college entrance exam in math and the average grades they received from college math courses.

Avoidance temperament

The measure of temperamental fear consists of seven items (e.g., "I become easily frightened"; subscale $\alpha = .60$) from the Adult Temperament Questionnaire (ATQ) – Short Form (Evans & Rothbart, 2007) that were rated on a 5-point scale. Avoidance was assessed using 5 items ("I worry about making mistakes") from the BIS scale (The BIS/BAS Scales; Carver & White, 1994). The BIS scale consists of seven items, but two items ("I have very few fears compared to my friends" and "Even if something bad is about to happen to me, I rarely experience fear or nervousness") were excluded due to low reliability with other items for this sample (5-item BIS scale $\alpha = .78$). Measures of behavioral inhibition and temperamental fear were positively correlated, $r(184) = .47$, $p = .001$, and scores were standardized and averaged to compute a composite for avoidance temperament ($\alpha = .70$ for 12 items).

Evaluative threat

Participants reported on the degree to which they felt “threatened by the test” and that they “will fail the test” on a 7-point scale ($\alpha = .72$), and a score for evaluative threat was computed by averaging responses on the two items.

Indices of math performance

The standardized math test consisted of seven items taken from past SAT Reasoning Test exams given to high school students for college entrance (College Board, 2009). At the top of the test, the same information that is provided on SAT exams was given (e.g., all numbers are real numbers and basic formulae) and no items required the use of a calculator. Participants were told they had 15 minutes to complete the test, and tests were collected after 15 minutes. Participants also were asked to recall and report the percentile score (below 25th percentile, 25th–49th percentile, 50th percentile, 51st–75th percentile, and above 75th percentile) they received on the math portion of their standardized college entrance exam (i.e., SAT and/or ACT). Participants’ seven-item math test score and their self-reported percentile score were correlated, $r(179) = .20$, $p = .006$, and were standardized and averaged to compute a composite for standardized math test score. In addition, participants provided information on the average grade they received in their college math courses ($A = 4$, $B = 3$, $C = 2$, D or *lower* = 1).

Results

Descriptive statistics

Based on guidelines described by West, Finch, and Curran (1995), all variables were normally distributed with no significant skewness or kurtosis. Descriptive statistics and the zero-order correlations of study variables are presented in Table 1. Consistent with hypotheses, avoidance temperament and evaluative threat were positively correlated with each other. In addition, avoidance temperament and evaluative threat were both negatively correlated with standardized math test scores. However, only evaluative threat (not avoidance temperament) was negatively correlated with college math course grades. And standardized math test scores and college math course grades were unrelated to one another.

Table 1. Zero-order correlations for all analysis variables.

Scale		1	2	3	4	5
1.	Gender	—				
2.	Avoidance temperament	.31**	—			
3.	Evaluative threat	.16	.23**	—		
4.	Standardized math test scores	-.02	-.19*	-.42**	—	
5.	College math course grades	.04	.02	-.47**	.02	—
	Mean	1.71	.00	2.61	.00	2.92
	SD	.45	.85	1.40	.78	.91

Note: For coding of gender, males = 1 and females = 2.

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

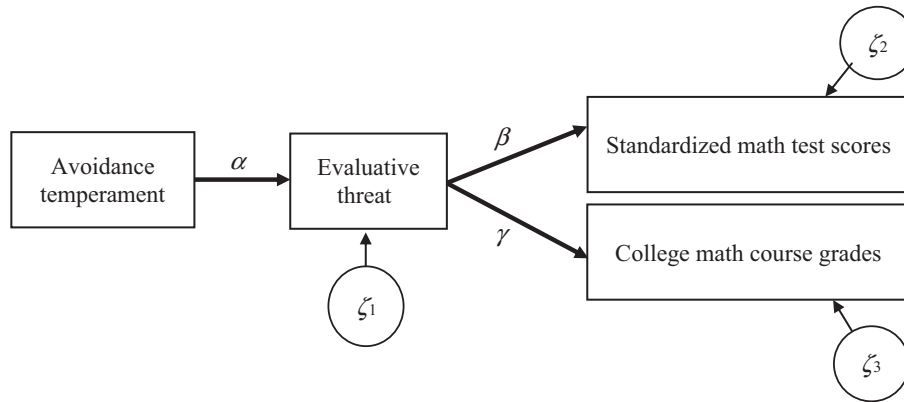


Figure 1. Hypothesized mediation model.

Structural equation model and tests of mediation

The hypothesized mediation model is presented in Figure 1. The three arrows (α , β , and γ) indicate the mediation effect where avoidance temperament was hypothesized to predict evaluative threat (path α), which in turn predicted low standardized math test score (path β) and low college math course grade (path γ), respectively. Potential gender differences were accounted for by including gender as a covariate predicting all the variables in the hypothesized model. The model was analyzed by using Mplus version 6.11 (Muthén & Muthén, 1998–2010) with full information maximum likelihood (FIML) estimation, which allowed estimating the model with the full sample. The two mediation effects (i.e., $\alpha\beta$ and $\alpha\gamma$) were examined by using the bootstrap method with the computation of the 95% confidence intervals. The estimation of these bootstrap 95% confidence intervals is available in Mplus.

The overall model chi-square test and the model fit indexes for the mediational models were: $\chi^2_{(3, N=184)} = 6.72$ ($p = .081$), CFI = .94, RMSEA = .08, and SRMR = .04, respectively, indicating that the hypothesized model adequately fit the data. Model results with all standardized path coefficients are presented in Table 2. The coefficient of gender on avoidance temperament was significant, indicating that females ($M = .17$, $SD = .80$) reported significantly higher levels of avoidance temperament than males ($M = -.41$, $SD = .84$). In addition, as shown in Figure 1, even after accounting for gender effects, avoidance temperament predicted evaluative threat ($\hat{\alpha} = .19$, $p = .023$), which in turn, predicted both low standardized math test scores ($\hat{\beta} = -.37$, $p = .001$) and low college math course grades ($\hat{\gamma} = -.46$, $p = .001$), respectively. Both the mediated effect estimates, $\hat{\alpha}\hat{\beta}$ and $\hat{\alpha}\hat{\gamma}$, were statistically significant given that the corresponding bootstrap 95% confidence intervals did not include zero (i.e., $\hat{\alpha}\hat{\beta} = -.07$, 95% CI = $[-.163, -.008]$; $\hat{\alpha}\hat{\gamma} = -.10$, 95% CI = $[-.217, -.019]$, respectively) so that evaluative threat mediated the relations between avoidance temperament and both indices of math performance. Model results indicate that even after controlling for the participants' gender, participants who reported higher level of avoidance temperament were more likely to report experiencing evaluative threat to math tests. Furthermore, the experience of evaluative threat to math tests then predicted low standardized math test scores and low college math course grades.

Table 2. Standardized parameter estimates for the study ($N = 184$).

	Estimates (SE)		Z value
<i>Path coefficient</i>			
Gender-> Avoidance temperament	.31 (.07)	***	4.43
Gender-> Evaluative threat	.07 (.09)		.78
Gender-> Standardized math test score	.02 (.07)		.29
Gender-> College math course grade	.08 (.08)		1.00
<i>Direct effect</i>			
α	.19 (.09)	*	2.11
β	-.37 (.08)	***	-4.63
γ	-.46 (.11)	***	-4.18
Indirect effect [†] ($\alpha\beta$)	-.07	95% CI = [-0.16, -0.01], Reject H_0	
Indirect effect [†] ($\alpha\gamma$)	-.10	95% CI = [-0.22, -0.02], Reject H_0	
<i>Model fit</i>			
Chi-square (df)	6.72 (3)	$p = .081$	
CFI	.94		
RMSEA	.08		
SRMR	.04		

CI = confidence interval. H_0 : The null hypothesis of the indirect effect which was set to be equal to zero.

* $p < .05$, *** $p < .001$. [†]Based on the unstandardized coefficients; the standard errors of $\alpha\beta$ and $\alpha\gamma$ were not estimated due to the use of the bootstrap methods.

Discussion

To our knowledge, this is the first study to demonstrate evaluative threat as a mediating mechanism in the linkage between avoidance temperament and math performance. Findings have implications for managing test or math anxiety and for preventing underperformance.

Relations among avoidance temperament, evaluative threat, and performance

Consistent with the view that the constructs of trait and state anxiety are positively associated with one another (Ashcraft, 2002; Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez, 2010; Watson & Clark, 1984), our measures of avoidance temperament and evaluative threat were positively correlated with one another. Also consistent with previous literature that suggests gender-specific risks for high fearfulness (Cote, Tremblay, Nagin, Zoccolillo, & Vitaro, 2002), the females in our sample reported higher levels of avoidance temperament than males. Yet, no gender differences were found in all other measures. Our finding is consistent with those from Devine, Fawcett, Szucs, and Dowker (2012) who found that females had higher levels of math and text anxiety, but no gender differences were found on math performance. In past research, when gender differences in math anxiety are found, they tend to be small (Ashcraft, 2002; Hyde et al., 2008). In regards to relations among major variables, avoidance temperament and evaluative threat were both associated with low standardized math test scores. But low math course grades were associated with evaluative threat and not avoidance temperament. In addition, standardized math test scores were unrelated to college math course grades. Thus, evaluative threat appears to hinder not only performance in testing

situations but also in courses. Because avoidance temperament is a more distal predictor of math performance than state variables such as evaluative threat (Barrick et al., 2002; Chen et al., 2000; Kanfer & Heggstad, 1997), the relation between avoidance temperament and college math course grades would be weak. Importantly, course grades are not always dependent only on exam scores, but some percentage of grades often depends on nonexam evaluation indicators such as homework assignments.

Mediation model of test anxiety: trait and state anxiety on performance

Data confirmed that evaluative threat was one mediating mechanism by which avoidance temperament influenced standardized math test scores and college math course grades. Findings are consistent with the view that individuals with greater temperamental fear and BIS sensitivity are predisposed to distress in evaluative situations (Heponiemi et al., 2003; Lilley & Cobham, 2005) which would lead them to more readily experience evaluative threat during testing. In turn, evaluative threat has a debilitating effect on test scores and on course grades.

Heponiemi et al. (2003) proposed two mechanisms by which temperamental fear and BIS sensitivity might increase individuals' vulnerability to stress. First, temperamental fear and BIS sensitivity may predispose individuals to maladaptive coping or noncoping (Watson & Clark, 1984). Second, temperamental fear and BIS sensitivity may hinder individuals' attention and information processing (Derryberry & Reed, 1994). Therefore, avoidance temperament may predispose individuals to experience evaluative threat via affective and cognitive or attention mechanisms (Elliot & Thrash, 2010). According to Carver and Sheier's Model of Self-regulation (1981), continuous states of self-focused attention trigger chronic comparisons of current behavior or performance with a criterion or standard that often compromise performance. Furthermore, fearfulness (as a temperamental trait) is linked to inward focus of attention and personal distress (Liew et al., 2011). Thus, it is likely that low trait-anxious individuals are able focus their attention on completing the math test rather than worrying about threat-related stimulus (Eysenck et al., 2007). In contrast, high trait-anxious individuals are likely to employ a hypervigilant cognitive mode and allocate attentional resources to threat-related stimulus (also see Egloff & Hock, 2001). This is consistent with studies confirming that math anxiety is associated with reduced working memory capacity (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Miller & Bichsel, 2004; Ramirez, Gunderson, Levine, & Beilock, 2013).

Limitations and future directions

The present study contributes to better understanding of the process by which avoidance temperament and evaluative threat may influence performance. Importantly, research findings need to be interpreted in light of study limitations. Although our mediation model of test anxiety was derived from theory and supported by previous research, causal conclusions cannot be confirmed from cross-sectional data. Also, we tested our model using observed rather than latent variables. Use of latent variables can help account for the measurement errors and reduce the risk of attenuation in the estimated effects (due to measurement error) but increases the number of unknown parameters to be estimated. Based on the commonly used 1:10 rule of thumb (i.e., a ratio of 1 parameter to 10

observations; Bentler, 1995), the latent variable model would require a significantly larger number of observations than what we had ($N = 184$) to obtain stable estimates. Hence, we decided to use observed rather than latent variables for our analyses. Furthermore, our sample was largely female and Caucasian. Thus, it is important to replicate our study findings using latent variable models with larger and diverse samples in future studies. Importantly, there is no evidence to suggest that study results will differ based on gender and past research generally have found small or no gender differences in math anxiety (Ashcraft, 2002). All data were collected using self-report methodology with the exception of performance on the seven-item math test. For self-reported measures of test scores, some participants may have inflated their scores due to social desirability bias or may have inaccuracies in their recall of their scores from high school. Nonetheless, systematic relations or patterns were found between self-reported measures. It is important to note that our measure of evaluative threat was taken after the math test, primarily due to methodological constraints. Without the use of physiological or behavioral measures, it is difficult to assess test-takers' evaluative threat during the test without disrupting performance of the task at hand (i.e., test taking). Future studies could overcome this methodological challenge by inclusion of behavioral or physiological measures, including video-recording participants to observe and code for emotions and behaviors that indicate anxiety and vigilance or attentional bias.

Implications and conclusions

Consistent with work conducted by Gray (1991), Larsen and Diener (1992), and Heponiemi et al. (2003), our findings support the view that individuals with high fear and high BIS (avoidance) sensitivity are prone to experience emotional distress in stressful or high-stakes situations which would then impair their performance. Previous research indicates that individual differences in abilities for self-regulation predict lower levels of emotional or personal distress and internalizing problems (Baumeister, Gailliot, DeWall, & Oaten, 2006; Eisenberg, Spinrad, & Eggum, 2011; Liew et al., 2011; Saklofske, Austin, Mastoras, Beaton, & Osborne, 2012). Furthermore, interventions targeting self-regulation (Domitrovich, Cortes, & Greenberg, 2007) as well as test and math anxiety (Maloney & Beilock, 2012; Weems et al., 2010) have been found to be effective in helping individuals manage or reduce their anxieties including test or math anxiety. By offering support to students who suffer from test anxiety, their performance would be optimized through empowering them with emotion regulation and stress management skills.

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