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The Influence of Math Anxiety, Math Performance, Worry, and Test Anxiety on the Iowa Gambling Task and Balloon Analogue Risk Task

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Abstract

Multiple studies have shown that performance on behavioral decision-making tasks, such as the Iowa Gambling Task (IGT) and Balloon Analogue Risk Task (BART), is influenced by external factors, such as mood. However, the research regarding the influence of worry is mixed, and no research has examined the effect of math or test anxiety on these tasks. The present study investigated the effects of anxiety (including math anxiety) and math performance on the IGT and BART in a sample of 137 undergraduate students. Math performance and worry were not correlated with performance on the IGT, and no variables were correlated with BART performance. Linear regressions indicated math anxiety, physiological anxiety, social concerns/stress, and test anxiety significantly predicted disadvantageous selections on the IGT during the transition from decision making under ambiguity to decision making under risk. Implications for clinical evaluation of decision making are discussed.

Keywords

math anxiety, math, worry, test anxiety, decision making, Iowa Gambling Task, Balloon Analogue Risk Task

Decision making, at its most basic level, involves a choice between two or more options. In the clinical realm, decision making has often been assessed with behavioral decision-making tasks such as the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994). Although these tasks have been shown to differentiate between patient populations and healthy controls (see Buelow & Suhr, 2009, for review), questions remain regarding other factors, such as personality characteristics and subclinical levels of anxiety, that can influence performance on this task. The present study sought to examine the potential influence of different types of anxiety and math performance on behavioral decision-making task performance.

The Iowa Gambling Task and Balloon Analogue Risk Task

The IGT (Bechara et al., 1994) has been adapted for use in both clinical and research settings. Although originally designed to examine real-world decision-making deficits among individuals with ventromedial prefrontal cortex damage, its use has been expanded to various clinical applications (see Buelow & Suhr, 2009, for review). Participants are told to maximize profit by making selections from one of the four decks of cards over the course of 100 trials (Bechara et al., 1994). Decks A and B are "disadvantageous" and Decks C and D "advantageous" due to their long-term outcomes. Continued selections from Decks A and B are deemed risky decision making (Bechara, 2008; Bechara et al., 1994).

On the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), a second common behavioral decision-making task, participants earn money by pumping up balloons; however, balloons pop if they are pumped up too much. No explicit information is given about the probability a balloon will pop on a given trial, but one of the early balloons pops quickly to show participants that this outcome can occur (Lejuez et al., 2002). Higher pumps per balloon is considered risky decision making on this task (Lejuez et al., 2002).

Anxiety and Decision Making

Anxiety comes in multiple forms, including physiological anxiety, worry, test anxiety, and math anxiety. It has been theorized anxiety, and worry in particular, impairs

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functioning by interfering with attentional resources (Bishop, Duncan, Brett, & Lawrence, 2004; Eysenck, Derakshan, Santos, & Calvo, 2007). Individuals may ruminate on select pieces of information, losing sight of the overall context of a decision. Yet other researchers put forth that anxiety can increase vigilance to signs of danger (Mathews & MacLeod, 1986), leading to risk-averse decisions (Hartley & Phelps, 2012; Paulus, Rogalsky, Simmons, Feinstein, & Stein, 2003). Subclinical levels of anxiety may be more adaptive (Borkovec & Roemer, 1995), but greater anxiety could lead to impaired decision making and other cognitive abilities (Wittchen, Carter, Pfister, Montgomery, & Kessler, 2000; Worthy, Byrne, & Fields, 2014). Although the precise mechanism remains unclear, anxiety likely exerts an influence on the decision-making process.

To date, research regarding the influence of anxiety on decision-making task performance—the IGT, BART, and other tasks—has been mixed. Previous research with the IGT has shown anxious individuals select more advantageously (Mueller, Nguyen, Ray, & Borkovec, 2010; Werner, Duschek, & Schandry, 2009), more disadvantageously (de Visser et al., 2010; Miu, Heilman, & Houser, 2008; Pajkossy, Dezso, & Paprika, 2009), or select no differently than those without anxiety (Castro e Couto et al., 2012; Drost, Spinhoven, Kruijt, & van der Does, 2014; Kirsch & Windmann, 2009). These data were mixed regardless of the particular subtype of anxiety: subclinical worry (Drost et al., 2014; Kirsch & Windmann, 2009; Pajkossy et al., 2009), Generalized Anxiety Disorder (Castro e Couto et al., 2012; Mueller et al., 2010), or trait anxiety (de Visser et al., 2010; Miu et al., 2008; Werner et al., 2009). Only one study has examined the influence of anxiety on the BART, indicating participants were more risk averse (i.e., fewer pumps per balloon) as a function of social and trait anxiety as well as worry (Maner et al., 2007). Taken together, the impact of several types of anxiety is inconsistent at best across different behavioral decision-making tasks, and additional information is needed to determine the relationship between worry, one type of anxiety that has been previously studied, and decision making. The ruminative components of worry could act as a cognitive distractor, utilizing vital working memory and other cognitive resources needed to make an advantageous decision. In addition, examination of other subtypes of anxiety could help tease apart the relationship between anxiety and behavioral decision-making task performance.

Test Anxiety, Math Anxiety, and Decision Making

Test anxiety, of which math anxiety is a specific form, may affect the decision-making process. Test anxiety occurs in general testing or evaluative situations (Hembree, 1988), with high levels negatively affecting performance across a variety of tasks including neuropsychological tests (Chapell et al., 2005; Musch & Broder, 1999; Ng & Lee, 2015; Sarason, 1984; Seipp, 1991; Thames et al., 2015). Test anxiety can also negatively affect decision making, in that individuals with test anxiety sought out increasing amounts of redundant information prior to making a decision (Nichols-Hoppe & Beach, 1990). Although test anxiety has not been examined with behavioral decision-making tasks to date, it could be expected to have negative effects similar to those seen on other tasks.

Math anxiety can be thought of as a type of performance-based anxiety (Hopko, McNeil, Zvolensky, & Eifert, 2001), with associated increases in physiological arousal and negative, distracting thought processes (Ashcraft & Kirk, 2001; Levine, 1995; Richardson & Suinn, 1972). Although related (r = .3-.5), test anxiety and math anxiety are distinct constructs (Devine, Fawcett, Szucs, & Dowker, 2012; Dew & Galassi, 1983; Hembree, 1990). High levels of math anxiety can negatively affect performance on math (Ashcraft & Faust, 1994; Ashcraft & Kirk, 2001; Hembree, 1990; Hopko, Mahadevan, Bare, & Hunt, 2003; Hopko, McNeil, Lejuez, et al., 2003; Rydell, Van Loo, & Boucher, 2014) and nonmath tasks (Buelow & Frakey, 2013; Cassaday & Johnson, 2002; Hopko, Crittendon, Grant, & Wilson, 2005; Ikeda, Iwanaga, & Seiwa, 1996; Ma, 1999; Markham & Darke, 1991; Miller & Bichsel, 2004). Math anxiety can also affect buying decisions (Jones, Childers, & Jiang, 2012), and decrease cognitive reflection (Morsanyi, Busdraghi, & Primi, 2014). Math anxiety and low math performance have both been linked with difficulties with risk perception and increased risky decision making (Brand, Schiebener, Pertl, & Delazer, 2014; Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin, 2008; Reyna, Nelson, Han, & Dieckmann, 2009; Rydell et al., 2014). Taken together, math anxiety has a robust effect on math performance and other cognitive abilities.

The Present Study

To date, no research has investigated the potential influence of math anxiety, math performance, or test anxiety on the IGT and BART. Advantageous decision making on the IGT requires learning and utilization of probabilities associated with each deck (e.g., learning Deck A results in losses on 50% of trials; Bechara, 2008). To learn these probabilities, individuals must utilize individual trial feedback. Low math performance may increase difficulty identifying and utilizing probabilities on subsequent trials. This process could also be affected as a function of math anxiety or worry, both of which can disrupt working memory resources (Ashcraft, 2002; Bishop et al., 2004; Eysenck & Calvo, 1992; Eysenck et al., 2007). Working memory has been linked to performance on the IGT in some studies (see Toplak, Sorge, Benoit, West, & Stanovich, 2010, for review), and it is likely these resources are needed for successful probability learning. Math anxiety decreases cognitive reflection (Morsanyi et al., 2014), which could also affect the ability to process win/loss information. Although originally intended to assess affective decision making, more and more researchers are finding that learning does occur on the IGT (Dunn, Dalgleish, & Lawrence, 2006; Guillaume et al., 2009; Maia & McClelland, 2004; Schiebener, Zamarian, Delazer, & Brand, 2011), and this process could be disrupted by different forms of anxiety. This same learning does not occur on the BART, as the probability the balloon will pop on a given trial is random and unknown to the participant. Thus, anxiety may affect this task differently than the IGT. Personality characteristics, such as avoidance temperament, influence the presence of math anxiety, and in turn math performance (Liew, Lench, Kao, Yeh, & Kwok, 2014). It is then possible that those experiencing anxiety are predisposed to math anxiety, indicating the need to examine the influence of different types of anxiety on decision making.

The present study sought to examine the influence of math performance and different types of anxiety, including worry, test anxiety, and math anxiety, on performance on the IGT and BART. Gender was included as a covariate as inconsistent relationships have been shown with math anxiety (Ashcraft & Faust, 1994; Betz, 1978; Devine et al., 2012; Hembree, 1990; Ma & Xu, 2004; Tapia, 2004), math performance (Devine et al., 2012; Scafidi & Bui, 2010), test anxiety (Akanbi, 2013; Putwain & Daly, 2014), and decision making (van den Bos, Homberg, & de Visser, 2013). Several hypotheses and study aims were addressed. First, it was hypothesized that math anxiety would be significantly related to performance on behavioral decision-making tasks, specifically due to the need to determine probabilities associated with decisions on the IGT. Next, we examined the utility of math anxiety, test anxiety, worry, and math performance to predict decision making on the IGT and BART. Worry was examined in an attempt to clarify the inconsistent previous research, and math performance was examined to extend the previous research showing math performance affects decision making to common behavioral decision-making tasks.

Method

Participants

Participants were 137 undergraduate students, ages 18 to 32 years (M = 19.07, SD = 1.74), who were enrolled in psychology courses in which course credit was given for participation in research studies. There were 55 males and participants were primarily Caucasian (78%).

Measures

Iowa Gambling Task. Participants completed the standard computerized version of the IGT available through PAR, Inc. (Bechara, 2008). Individuals started with a loan of $2,000, and were tasked with maximizing profit over the course of 100 trials. Participants selected a card from one of four decks: Decks A and B yielded an average profit of $100 per selection, whereas Decks C and D yielded an average profit of $50 per selection. But, after 10 selections from Decks A and B ("disadvantageous" decks), participants have incurred a net loss of $250. After 10 selections from Decks C and D ("advantageous" decks), participants have instead incurred a net gain of $250 (Bechara et al., 1994). Analyzing performance on the task by total selections misses important distinctions in how decision-making changes as the task progresses. During the initial trials, participants do not know much about the relative risks and benefits of each deck, and thus these decisions have been termed decision making under ambiguity (Brand, Recknor, Grabenhorst, & Bechara, 2007). The final 60 (Brand et al., 2007) or 40 (Ko et al., 2010; Noel, Bechara, Dan, Hanak, & Verbanck, 2007) trials are instead considered decision making under risk, as participants have gained enough experience with the decks to learn their relative risks and benefits. Continued selections from the disadvantageous decks during these latter trials is considered decision making under risk. To examine the influence of anxiety and math performance on both decision making under ambiguity and decision making under risk, the present study analyzed performance by the number of advantageous minus disadvantageous selections by five, 20-card blocks of trials.

Balloon Analogue Risk Task. The BART was created to assess real-world risk-taking behavior in adolescents and adults (Lejuez et al., 2002). On this computerized task, participants saw 30 balloons, one at a time, and were asked to pump up the balloon to earn money. Each pump earns five cents. The balloons pop if they are pumped up too much, and any money earned on that balloon is lost. Participants must stop pumping before the balloon pops and bank the money, as any money banked cannot then be lost on subsequent balloons. The explosion point for each balloon ranges from 1 to 128 pumps (Lejuez et al., 2002). Risk taking is rewarded on this task through increased money earned; however, on each balloon there reaches a point where each additional pump brings increasing risk yet diminishing rewards. Risk taking on this task is then defined as higher numbers of pumps per balloon. For the present study, the average number of pumps per balloon, adjusted for only the unexploded balloons (as if the balloon popped it is unclear how far the participant was willing to go on that trial), was used as the dependent variable.

Math Anxiety Rating Scale–Revised. The Math Anxiety Rating Scale–Revised (MARS-R; Plake & Parker, 1982) is a 24-item revision of the original 98-item MARS (Richardson & Suinn, 1972). Participants viewed a series of statements regarding math (e.g., buying a math textbook, being told how to interpret probability statements), and responded on a 5-point Likert-type scale as to how anxious the described activity makes them feel (0 *not at all*, 4 *very much*). Higher summed scores indicated higher levels of math anxiety. The MARS-R correlates strongly with the original MARS (r = .97; Plake & Parker, 1982). Internal consistency was high in our sample (α = .95).

Adult Manifest Anxiety Scale. The present study utilized the college student version of the Adult Manifest Anxiety Scale (AMAS; Reynolds, Richmond, & Lowe, 2003). Participants responded to 49 items across four subscales: physiological anxiety, social concerns/stress, test anxiety, and worry/oversensitivity. Although not the primary focus of the present study, physiological anxiety and social concerns/stress were included in the analyses to more fully assess the influence of different types of anxiety on decision making. The fifth subscale (lie) is a validity index, and was not included in the present investigation. Participants responded with a yes/no scale, and a total summed score is calculated for each subscale. Higher scores indicated higher levels of worry, physiological anxiety, social concerns/stress, or test anxiety. Construct validity has been shown through correlations with other measures of anxiety, and test–retest reliability is moderate to high (Lowe, Peyton, & Reynolds, 2007; Reynolds et al., 2003). Internal consistency was high in our sample (α = .83-.84 across subscales).

Wide Range Achievement Test. The math computation subtest from the Wide Range Achievement Test–IV (WRAT-IV-m) was utilized to assess basic written math skills (Wilkinson & Robertson, 2006). Participants completed a series of 40 math problems that ranged from simple arithmetic to division by fractions. Total scores were calculated by summing the total number of correct answers. Internal consistency was high across different age groups in the normative sample (α = .83-.95; Wilkinson & Robertson, 2006).

Procedure

The present study was approved by the university's institutional review board. All participants provided informed consent and were debriefed at the end of the study. Participants in the present study were compiled from other studies assessing predictors of performance on decision-making tasks. In these other studies, participants completed measures of mood and personality characteristics, as well as behavioral decision-making tasks. All questionnaires were administered in a random order prior to administration of the decision-making tasks, which were presented in a counterbalanced order. Participants were included in the present analyses if they did not report a diagnosis of Attention-Deficit/Hyperactivity Disorder or other psychiatric concern, and completed the IGT, BART, MARS-R, AMAS, and WRAT-IV-m.

Table 1. Ranges, Means (*M*), and Standard Deviations (*SD*) of Study Variables.

Variable	Range	*M* (*SD*)
MARS-R	1 to 96	37.53 (19.32)
AMAS-w	0 to 12	7.48 (3.40)
AMAS-p	0 to 8	2.99 (2.46)
AMAS-t	0 to 15	8.13 (3.92)
AMAS-s	0 to 7	2.60 (1.95)
WRAT-IV-m	25 to 52	39.42 (5.50)
IGT 1	−20 to 20	−2.75 (6.10)
IGT 2	−18 to 20	0.67 (6.62)
IGT 3	−20 to 20	0.58 (7.84)
IGT 4	−20 to 20	0.38 (8.65)
IGT 5	−20 to 20	0.64 (9.03)
BART	0 to 62.27	26.55 (12.25)

Note. MARS-R = Math Anxiety Rating Scale–Revised; AMAS = Adult Manifest Anxiety Scale, College version: worry (w), physiological anxiety (p), test anxiety (t), and social concerns/stress (s) subscale scores; WRAT-IV-m = Wide Range Achievement Test–IV, math computation subtest; IGT = Iowa Gambling Task, advantageous minus disadvantageous selections per 20-card blocks of trials; BART = Balloon Analogue Risk Task, average number of adjusted pumps per balloon.

Data Analysis

To assess the first study hypothesis, correlations were calculated between the IGT, BART, MARS-R, AMAS subscales, and WRAT-IV-m. To assess the second aim (the utility of different anxieties and math performance to predict decision making), linear regressions were conducted on the IGT and BART outcome variables. Only those variables that were significantly correlated with the outcome variables were included in the regression analyses.

Results

Means and standard deviations for the study variables are presented in Table 1. Significant correlations were found between math anxiety, worry, physiological anxiety, social concerns/stress, and test anxiety (see Table 2). In addition, math anxiety, gender, physiological anxiety, social concerns/stress, and test anxiety were correlated with performance on the IGT but not BART. Higher levels of math anxiety on the MARS-R were associated with riskier (less advantageous) performance on Blocks 2 to 5 (Trials 21-100) of the IGT. Higher levels of test anxiety on the AMAS were associated with riskier performance on Block 4 (Trials 61-80) of the IGT only. Higher levels of physiological anxiety were associated with riskier performance on Block 2 (Trials 21-40) of the IGT only. Higher levels of social concerns/stress were associated with riskier performance on Block 5 (Trials 81-100) of the IGT only. Males selected more advantageously than females on Blocks 2 to 4 (Trials 21-80) of the IGT. No relationship was seen between math performance or any of the anxiety variables and performance on the BART.

Table 2. Correlation Matrix.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Gender	—	−.133	−.271***	−.222**	−.245**	−.138	.184*	.087	.242**	.186*	.175*	.143	.048
2. MARS-R		—	.302***	.277***	.323***	.240**	−.162	−.130	−.199*	−.225**	−.173*	−.185*	−.054
3. AMAS-w			—	.603***	.617***	.512***	.026	−.059	−.084	−.033	−.068	−.121	.058
4. AMAS-p				—	.576***	.532***	.040	−.073	−.231**	−.093	−.156	−.116	−.122
5. AMAS-t					—	.416***	−.105	−.031	−.027	−.100	−.182*	−.130	−.027
6. AMAS-s						—	.120	−.003	.026	−.082	−.128	−.181*	−.061
7. WRAT-IV-m							—	.117	.054	.146	.087	.109	.037
8. IGT 1								—	.244**	.305***	−.009	.134	−.064
9. IGT 2									—	.573***	.364***	.347***	.183*
10. IGT 3										—	.583***	.555***	.062
11. IGT 4											—	.515***	.052
12. IGT 5												—	−.063
13. BART													—

Note. MARS-R = Math Anxiety Rating Scale–Revised; AMAS = Adult Manifest Anxiety Scale, College version: worry (w), physiological anxiety (p), test anxiety (t), and social concerns/stress (s) subscale scores; WRAT-IV-m = Wide Range Achievement Test-IV, math computation subtest; IGT = Iowa Gambling Task, advantageous minus disadvantageous selections per 20-card blocks of trials; BART = Balloon Analogue Risk Task, average number of adjusted pumps per balloon. Gender coded 1 = female, 2 = male.
*$p \le .05$. **$p \le .01$. ***$p \le .001$.

Partial correlations were also calculated to determine the relationship between math anxiety and decision making, after controlling for the effects of gender, worry, test anxiety, physiological anxiety, social concerns/stress, and math performance. Math anxiety showed a small but significant partial correlation with IGT Block 2, $r(129) = −.188$, $p = .033$, and Block 3, $r(129) = −.187$, $p = .033$.

For the linear regression analyses, gender, physiological anxiety, test anxiety, and social concerns/stress were included in Step 1. Math anxiety was then entered in Step 2. As math performance and worry were not correlated with the IGT, they were not included as predictors in the remaining regressions. In addition, regression analyses were only conducted for the IGT variables, as no anxiety or math performance variables were correlated with the BART. Each analysis was examined for problems with multicollinearity with the variance inflation factor, but none of the analyses revealed significant problems (largest variance inflation factor = 1.80).

Across linear regression analyses, math anxiety emerged as a significant predictor of performance on the IGT (see Table 3). Specifically, MARS-R scores were significant negative predictors of performance on the IGT in Blocks 2 and 3, with higher math anxiety predicting riskier (less advantageous) selections on the middle trials (Trials 21-60). Gender significantly predicted performance on the IGT in Block 2 (males selected more advantageously than females). More disadvantageous selections on Block 2 were associated with higher levels of physiological anxiety but lower levels of test anxiety and social concerns/stress. No predictors were significant during Block 1 (ps > .16), Block 4 (ps > .14), or Block 5 (ps > .12).

Discussion

The present study sought to examine the potential influences of math performance and different types of anxiety—math anxiety, test anxiety, worry, physiological anxiety, and social concerns/stress—on behavioral decision-making task performance utilizing the IGT and BART. It was hypothesized that math anxiety would be related to performance on the IGT and BART. Consistent with this hypothesis, high levels of math anxiety were correlated with riskier selections on Blocks 2 to 5 (Trials 21-100) of the IGT. This negative correlation held for Blocks 2 to 3 when partial correlations were instead examined. Of the remaining variables examined, males selected more advantageously than females on Blocks 2 to 4, and high test anxiety was associated with riskier decision making on Block 4. In addition, riskier decision making was associated with higher physiological anxiety on Block 2 and higher social concerns/stress on Block 5. It appears that math anxiety exerts an independent influence on decision making during the transition from decision making under ambiguity to decision making under risk (Brand et al., 2007). However, math anxiety was not related to performance on the BART, nor were any of the other study variables. This is the first study to examine a potential relationship between math anxiety and behavioral decision-making tasks frequently utilized by clinical psychologists and neuropsychologists, with initial evidence suggesting that the presence of a relationship between these factors depends on the particular decision-making task utilized.

The second study aim was to assess whether different types of anxiety or math performance predicted performance on the IGT and BART. As math performance and

Table 3. Summary of Regressions Between Gender, Anxieties, and Decision Making.

Criterion	Step	Predictors	*F*	*p*	ΔR^2	*B*	*p*
IGT Block 1	1		0.425	.790	.013		
		Gender				.078	.388
		AMAS-p				−.094	.419
		AMAS-t				.022	.841
		AMAS-s				.048	.642
	2		0.732	.601	.027		
		Gender				.072	.424
		MARS-R				−.129	.165
		AMAS-p				−.082	.477
		AMAS-t				.050	.649
		AMAS-s				.060	.561
IGT Block 2	1		5.438	.000	.141		
		Gender				.224	.008
		AMAS-p				−.377	.001
		AMAS-t				.166	.102
		AMAS-s				.188	.054
	2		5.440	.000	.172		
		Gender				.216	.010
		MARS-R				−.187	.030
		AMAS-p				−.360	.001
		AMAS-t				.208	.042
		AMAS-s				.205	.033
IGT Block 3	1		1.355	.253	.039		
		Gender				.170	.057
		AMAS-p				−.017	.883
		AMAS-t				−.034	.754
		AMAS-s				−.036	.728
	2		2.144	.064	.076		
		Gender				.160	.068
		MARS-R				−.203	.025
		AMAS-p				.001	.990
		AMAS-t				.011	.915
		AMAS-s				−.016	.871
IGT Block 4	1		1.912	.112	.055		
		Gender				.133	.131
		AMAS-p				−.042	.711
		AMAS-t				−.107	.313
		AMAS-s				−.043	.674
	2		1.850	.108	.066		
		Gender				.128	.147
		MARS-R				−.113	.213
		AMAS-p				−.032	.779
		AMAS-t				−.082	.446
		AMAS-s				−.032	.752
IGT Block 5	1		1.685	.157	.049		
		Gender				.115	.195
		AMAS-p				.020	.860
		AMAS-t				−.048	.649
		AMAS-s				−.156	.128
	2		1.842	.109	.066		
		Gender				.108	.220
		MARS-R				−.140	.124
		AMAS-p				.032	.774
		AMAS-t				−.018	.871
		AMAS-s				−.143	.162

Note. MARS-R = Math Anxiety Rating Scale–Revised; AMAS = Adult Manifest Anxiety Scale, College version: physiological anxiety (p), social concerns/stress (s), and test anxiety (t) subscale scores; IGT = Iowa Gambling Task, advantageous minus disadvantageous selections per 20-card blocks of trials. Gender coded 1 = female, 2 = male.

worry were not correlated with either task, they were not included in the linear regressions. We found high levels of math anxiety predicted more disadvantageous, or riskier, selections on Blocks 2 to 3 of the IGT. Gender also predicted selections on Block 2, in that males selected more advantageously than females. Test anxiety, physiological anxiety, and social concerns/stress also emerged as significant predictors of performance on the IGT on Block 2. As no variables were correlated with performance on the BART, no linear regressions were conducted. Our results, taken together, are consistent with some previous research suggesting worry was not associated with IGT performance (Drost et al., 2014; Kirsch & Windmann, 2009); however, they are inconsistent with previous research suggesting worry can lead to risk averse behavior on the BART (Maner et al., 2007). Although math performance has not been previously studied with the IGT or BART, the present nonsignificant correlations between this variable and the decision-making tasks are inconsistent with research showing the negative effects of low math performance on cognitive and neuropsychological task performance (Gigerenzer et al., 2008; Reyna et al., 2009; Schiebener et al., 2011). In addition, the results of linear regressions suggested high levels of test anxiety were associated with more advantageous decision making on Block 2 of the IGT, during the transition from decision making under ambiguity to decision making under risk. By contrast, previous research has indicated test anxiety is typically associated with decreases in task performance (Ng & Lee, 2015; Thames et al., 2015). It is possible that individuals with high test anxiety (or high social concerns/stress) paid attention to signals of punishment/losses, leading to improved performance earlier on the IGT. The present results are the first to examine the potential relationship between math performance and behavioral decision making, indicating that any relationship may be tenuous at best. A specific form of anxiety—math anxiety—predicted IGT performance rather than a more general type of anxiety—worry.

The present findings, taken together, suggest that high levels of math anxiety can negatively affect cognitive processes other than those specifically tied to overt math processes. Even on tasks in which math components are not directly indicated to the participant, the potential need to rely on math processes, such as mental calculation of probabilities, could interfere with performance. It is possible that math anxiety acts like other forms of anxiety, impairing cognitive functioning by interfering with attentional resources when it is activated (Ashcraft & Kirk, 2001; Bishop et al., 2004; Eysenck et al., 2007; Levine, 1995; Richardson & Suinn, 1972). It is possible that math anxiety affected participants' interest in engaging in cognitive reflection (Morsanyi et al., 2014), as to learn to do well on the IGT, participants must process the feedback given on each trial to create a conceptualization of the risks and benefits of selections from each deck. Math anxiety may, then, delay the transition from decision making under ambiguity to decision making under risk, potentially due to decreased ability to learn from feedback. Our results expand those of other research indicating the deleterious effects of math anxiety on other math (Ashcraft & Faust, 1994; Ashcraft & Kirk, 2001; Hembree, 1990; Rydell et al., 2014) and nonmath (Buelow & Frakey, 2013; Hopko et al., 2005; Ikeda et al., 1996; Markham & Darke, 1991; Miller & Bichsel, 2004) tasks. In addition, the present results expand previous findings that math anxiety can affect decision making and risk perception (Jones et al., 2012; Rydell et al., 2014), but fail to replicate findings that math performance and numerical abilities predict risky decision making (Gigerenzer et al., 2008; Reyna et al., 2009; Schiebener et al., 2011). Although participants may have had adequate math resources to learn the relative risks and benefits associated with each deck, math anxiety may have created an unwillingness to or otherwise impeded their ability to utilize these resources. Thus, math anxiety and not math performance predicted risky decision making on the IGT.

It is unclear why significant results were found for the IGT but not the BART. Previous research has been inconsistent in terms of significant (Skeel, Neudecker, Pilarski, & Pytlak, 2007) and nonsignificant (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Buelow & Blaine, 2015; Lejuez et al., 2003) relationships between these tasks, so it could be that math anxiety only affects particular decision-making processes. Performance on the IGT has been compared with performance on other measures of executive functions, but a recent review indicated significant results in only five of 21 studies assessing measures of inhibition, set-shifting, working memory, and general intelligence (Toplak et al., 2010). To perform well on the IGT, individuals must mentally keep track of the pattern of wins/losses associated with each deck and integrate this information into a heuristic for each deck. This process likely benefits from intact working memory, attentional control, and self-regulation resources, which may be otherwise distracted by the presence of math-anxious thoughts. Even in someone with high math ability, math anxiety could impair resources needed to access and apply these math skills to the IGT. Participants have to inhibit an inclination to pick decks with high immediate rewards in favor of decks with lower immediate gains but long-term payoffs. In addition, several recent studies have shown learning occurs over the course of the IGT (Dunn et al., 2006; Guillaume et al., 2009; Maia & McClelland, 2004; Schiebener et al., 2011). On the BART, however, there is no advantageous strategy or cost/benefit ratio to learn. The balloon could pop on any trial, and participants can only rely on information about the number of pumps and money that could be lost to make the decision to stop pumping the balloon. No differences are seen on average pumps per balloon across three, 10-balloon blocks of trials

(Aklin et al., 2005; Buelow & Blaine, 2015; Lejuez, Aklin, Bornovalova, & Moolchan, 2005). It is possible that the lack of findings on the BART in the present study could be due to the executive processes and learning occurring on the IGT (where math anxiety could disrupt cognitive processes) versus the more risk-taking behaviors—independent of learning an advantageous strategy—on the BART.

The present results, when coupled with additional future research studies, may have implications for clinical assessment of decision making with math anxious individuals. The present results provide the first evidence that math anxiety is related to performance on the IGT, which to date is the only behavioral decision-making task developed for use in clinical assessment settings. Previous research has shown that high levels of math anxiety are associated with lower scores on Wechsler Adult Intelligence Scale–IV Arithmetic compared with Digit Span subtests (Buelow & Frakey, 2013), indicating math anxiety can lead to an underestimate of working memory abilities when a standard assessment instrument is utilized. It is then possible that high math anxiety levels could underestimate true decision-making abilities when the IGT, and only the IGT, is utilized. However, before recommending a change in the approach to assessing decision making among individuals with math anxiety, additional research is needed to further assess the direct effect of math anxiety on decision making, and to determine if elements of the IGT in particular "trigger" math anxiety during the task. The present findings should also be expanded to examine the potential influence of math anxiety on other commonly used behavioral decision-making tasks, such as the Columbia Card Task (Figner, Mackinlay, Wilkening, & Weber, 2009; Figner & Voelki, 2004) and Game of Dice Task (Brand et al., 2005). Multiple measures of any construct, decision making, or otherwise, should be utilized to ensure that impaired cognition is not determined based on one impaired performance on one task, pointing toward the need for additional clinical decision-making instruments to supplement the IGT.

Limitations

The present study has several limitations that could have affected outcomes. First, we utilized a sample of college students who were not presenting for evaluation of clinical complaints. It is possible that their performance may have differed from the typical assessment patient, and current enrollment in math courses may have affected their levels of math anxiety. The present participants scored lower (M = 37.53) than the initial validation sample (M = 59.84; Plake & Parker, 1982) on the MARS-R, so it is important to follow up on the present study with individuals reporting higher levels of math anxiety. Performance on the WRAT-IV was the only indication of math performance level, as participants were not asked to provide a listing of math courses taken and their grades. To more fully understand if math performance affects the IGT and BART, it would be important to follow up with more formal assessments of math performance and ability. Since the present participants were undergraduate students, we relied on self-reported levels of different anxieties using questionnaires. In addition, participants with diagnosed clinical disorders were removed from analysis. It is possible that the present results might be different if individuals with anxiety disorders, as diagnosed by a clinician, completed the study. Utilizing a clinical sample in future research would allow for greater understanding of whether level of anxiety/worry symptoms affects performance on decision-making tasks in different ways.

Conclusions

The present study provides evidence that math anxiety exerts a unique influence on some behavioral decision-making tasks (IGT). Test anxiety, physiological anxiety, and social concerns/stress also contributed to the prediction of performance on the IGT during Block 2, whereas no correlations were found with worry or math performance. Additionally, math anxiety appears to alter the transition from decision making under ambiguity to decision making under risk on the IGT, which can negatively affect overall performance on the task. None of the study variables were related to performance on the BART; however, only the IGT has been put forth as a clinical instrument to assess decision-making processes. If math anxiety does not affect performance on the BART to the extent it does on the IGT, then, with additional research into the relationship between math anxiety and behavioral decision-making task performance, the BART may emerge as a better measure of decision-making processes—independent of math anxiety influence—than the IGT. The same holds true for individuals with high levels of social concerns/stress, physiological anxiety, and test anxiety. Future research should continue to assess the relationship between a broader range of math anxiety levels, as well as other anxieties (including worry, test anxiety, physiological anxiety, and social concerns/stress) on the IGT, BART, and other decision-making tasks such as the Columbia Card Task and Game of Dice Task.

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References

Akanbi, S. T. (2013). Comparisons of test anxiety level of senior secondary school students across gender, year of study, school type and parental educational background. *IFE Psychologia*, *21*, 40-54.

Aklin, W. M., Lejuez, C. W., Zvolensky, M. J., Kahler, C. W., & Gwadz, M. (2005). Evaluation of behavioral measures of risk taking propensity with inner city adolescents. *Behavior Research and Therapy*, *43*, 215-228. doi:10.1016/j.brat.2003.12.007

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*, 181-185. doi:10.1111/1467-8721.00196

Ashcraft, M. H., & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion*, *8*, 97-125. doi:10.1080/02699939408408931

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, *130*, 224-237. doi:10.1037/0096-3445.130.2.224

Bechara, A. (2008). *Iowa Gambling Task: Professional manual*. Lutz, FL: Psychological Assessment Resources.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*, 7-15. doi:10.1016/0010-0277(94)90018-3

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology*, *25*, 441-448. doi:10.1037/0022-0167.25.5.441

Bishop, S. J., Duncan, J., Brett, M., & Lawrence, A. (2004). Prefrontal cortical function and anxiety: Controlling attention to threat-related stimuli. *Nature Neuroscience*, *7*, 184-188. doi:10.1038/nn1173

Borkovec, T. D., & Roemer, L. (1995). Perceived functions of worry among generalized anxiety disorder subjects: Distraction from more emotionally distressing topics. *Journal of Behavior Therapy and Experimental Psychiatry*, *26*, 25-30. doi:10.1016/0005-7916(94)00064-S

Brand, M., Fujiwara, E., Borsutzky, S., Kalbe, E., Kessler, J., & Markowitsch, H. J. (2005). Decision-making deficits of Korsakoff patients in a new gambling task with explicit rules: Associations with executive functions. *Neuropsychology*, *19*, 267-277. doi:10.1037/0894-4105.19.3.267

Brand, M., Recknor, E. C., Grabenhorst, F., & Bechara, A. (2007). Decisions under ambiguity and decisions under risk: Correlations with executive functions and comparisons of two different gambling tasks with implicit and explicit rules. *Journal of Clinical and Experimental Neuropsychology*, *29*, 86-99. doi:10.1080/13803390500507196

Brand, M., Schiebener, J., Pertl, M-T., & Delazer, M. (2014). Know the risk, take the win: How executive functions and probability processing influence advantageous decision making under risk conditions. *Journal of Clinical and Experimental Neuropsychology*, *36*, 914-929. doi:10.1080/13803395.2014.955783

Buelow, M. T., & Blaine, A. L. (2015). The assessment of risky decision making: A factor analysis of performance on the Iowa Gambling Task, Balloon Analogue Risk Task, and Columbia Card Task. *Psychological Assessment*, *27*, 777-785. doi:10.1037/a0038622

Buelow, M. T., & Frakey, L. L. (2013). Math anxiety differentially affects WAIS-IV arithmetic performance in undergraduates. *Archives of Clinical Neuropsychology*, *28*, 356-362. doi:10.1093/arclin/act006

Buelow, M. T., & Suhr, J. A. (2009). Construct validity of the Iowa Gambling Task. *Neuropsychology Review*, *19*, 102-114. doi:10.1007/s11065-009-9083-4

Cassaday, J. C., & Johnson, R. E. (2002). Cognitive test anxiety and academic performance. *Contemporary Educational Psychology*, *27*, 270-295. doi:10.1006/ceps.2001.1094

Castro e Couto, T., Neves, F. S., Machado, M. C. L., Vasconcelos, A. G., Correa, H., & Malloy-Diniz, L. F. (2012). Assessment of impulsivity in bipolar disorder (BD) in comorbidity with generalized anxiety disorder (GAD): Revisiting the hypothesis of protective effect. *Clinical Neuropsychiatry*, *9*, 102-106.

Chapell, M. S., Blanding, Z. B., Silverstein, M. E., Takahashi, M., Newman, B., & McCann, N. (2005). Test anxiety and academic performance in undergraduate and graduate students. *Journal of Educational Psychology*, *97*, 268-274. doi:10.1037/0022-0663.97.2.268

de Visser, L., van der Knaap, L. J., van de Loo, A. J. A. E., van der Weerd, C. M. M., Ohl, F., & van den Bos, R. (2010). Trait anxiety affects decision-making differently in healthy men and women: Towards gender-specific endophenotypes of anxiety. *Neuropsychologia*, *48*, 1598-1606. doi:10.1016/j.neuropsychologia.2010.01.027

Devine, A., Fawcett, K., Szucs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and Brain Functions*, *8*, 33. doi:10.1186/1744-9081-8-33

Dew, K. H., & Galassi, J. P. (1983). Mathematics anxiety: Some basic issues. *Journal of Counseling Psychology*, *30*, 443-446. doi:10.1037/0022-0167.30.3.443

Drost, J., Spinhoven, P., Kruijt, A. W., & van der Does, W. (2014). The influence of worry and avoidance on the Iowa Gambling Task. *Journal of Behavior Therapy and Experimental Psychiatry*, *45*, 74-80. doi:10.1016/j.jbtep.2013.08.001

Dunn, B. D., Dalgleish, T., & Lawrence, A. D. (2006). The somatic marker hypothesis: A critical evaluation. *Neuroscience and Biobehavioral Reviews*, *30*, 239-271. doi:10.1016/j.neubiorev.2005.07.001

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition and Emotion*, *6*, 409-434. doi:10.1080/02699939208409696

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, *7*, 336-353. doi:10.1037/1528-3542.7.2.336

Figner, B., Mackinlay, R. J., Wilkening, F., & Weber, E. U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35*, 709-730. doi:10.1037/a0014983

Figner, B., & Voelki, N. (2004). Risky decision making in a computer card game: An information integration experiment. *Polish Psychological Bulletin*, *35*, 135-139.

Gigerenzer, G., Gaissmaier, W., Kurz-Milcke, E., Schwartz, L. M., & Woloshin, S. (2008). Helping doctors and patients make sense of health statistics. *Psychological Science in the Public Interest*, *8*, 53-96. doi:10.1111/j.1539-6053.2008.00033.x

Guillaume, S., Jollant, F., Jaussent, I., Lawrence, N., Malafosse, A., & Courtet, P. (2009). Somatic markers and explicit knowledge are both involved in decision-making. *Neuropsychologia*, *47*, 2120-2124. doi:10.1016/j.neuropsychologia.2009.04.003

Hartley, C. A., & Phelps, E. A. (2012). Anxiety and decision-making. *Biological Psychiatry*, *72*, 113-118.

Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Research*, *58*, 47-77. doi:10.3102/00346543058001047

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal of Research in Mathematics Education*, *21*, 33-46. doi:10.2307/749455

Hopko, D. R., Crittendon, J. A., Grant, E., & Wilson, S. A. (2005). The impact of anxiety on performance IQ. *Anxiety, Stress, & Coping*, *18*, 17-35. doi:10.1080/10615800412336436

Hopko, D. R., McNeil, D. W., Lejuez, C. W., Ashcraft, M. H., Eifert, G. H., & Riel, J. (2003). The effects of anxious responding on mental arithmetic and lexical decision task performance. *Anxiety Disorders*, *17*, 647-665. doi:10.1016/S0887-6185(02)00240-2

Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). The abbreviated math anxiety scale (AMAS): Construction, validity, and reliability. *Assessment*, *10*, 178-182. doi:10.1177/1073191103010002008

Hopko, D. R., McNeil, D. W., Zvolensky, M. J., & Eifert, G. H. (2001). The relation between anxiety and skill in performance-based anxiety disorders: A behavioral formulation of social phobia. *Behavior Therapy*, *32*, 185-207. doi:10.1016/S0005-7894(01)80052-6

Ikeda, M., Iwanaga, M., & Seiwa, H. (1996). Test anxiety and working memory system. *Perceptual & Motor Skills*, *82*, 1223-1231. doi:10.2466/pms.1996.82.3c.1223

Jones, W. J., Childers, T. L., & Jiang, Y. (2012). The shopping brain: Math anxiety modulates brain responses to buying decisions. *Biological Psychology*, *89*, 201-213. doi:10.1016/j.biopsycho.2011.10.011

Kirsch, M., & Windmann, S. (2009). The role of anxiety in decision-making. *Review of Psychology*, *16*, 19-28.

Ko, C. H., Hsiao, S., Liu, G. C., Yen, J. Y., Yang, M. J., & Yen, C. F. (2010). The characteristics of decision making, potential to take risks, and personality of college students with Internet addiction. *Psychiatry Research*, *175*, 121-125. doi:10.1016/j.psychres.2008.10.004

Lejuez, C. W., Aklin, W. M., Bornovalova, M. A., & Moolchan, E. T. (2005). Differences in risk-taking propensity across inner-city adolescent ever- and never-smokers. *Nicotine & Tobacco Research*, *7*, 71-79. doi:10.1080/14622200412331328484

Lejuez, C. W., Aklin, W. M., Jones, H. A., Richards, J. B., Strong, D. R., & Read, J. P. (2003). The balloon analogue risk task (BART) differentiates smokers and nonsmokers. *Experimental and Clinical Psychopharmacology*, *11*, 26-33. doi:10.1037/1064-1297.11.1.26

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: The balloon analogue risk task (BART). *Journal of Experimental Psychology: Applied*, *8*, 75-84. doi:10.1037/1076-898X.8.2.75

Levine, G. (1995). Closing the gender gap: Focus on mathematics anxiety. *Contemporary Education*, *67*, 42-45.

Liew, J., Lench, H. C., Kao, G., Yeh, Y., & Kwok, O. (2014). Avoidance temperament and social-evaluative threat in college students' math performance: A mediation model of math and test anxiety. *Anxiety, Stress, & Coping*, *27*, 650-661. doi:10.1080/10615806.2014.910303

Lowe, P. A., Peyton, V., & Reynolds, C. R. (2007). Test score stability and the relationship of adult manifest anxiety scale-college version scores to external variables among graduate students. *Journal of Psychoeducational Assessment*, *25*, 69-81. doi:10.1177/0734282906293698

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal of Research in Math Education*, *30*, 520-540. doi:10.2307/749772

Ma, X., & Xu, J. (2004). Determining the causal ordering between attitude toward mathematics and achievement in mathematics. *American Journal of Education*, *110*, 256-281.

Maia, T. V., & McClelland, J. L. (2004). A reexamination of the evidence for the somatic marker hypothesis: What participants really know in the Iowa Gambling Task. *Proceedings of the National Academy of Sciences*, *101*, 16075-16080. doi:10.1073/pnas.0406666101

Maner, J. K., Richey, A., Cromer, K., Mallott, M., Lejuez, C. W., & Schmidt, N. B. (2007). Dispositional anxiety and risk-avoidant decision-making. *Personality and Individual Differences*, *42*, 665-675. doi:10.1016/j.paid.2006.08.016

Markham, R., & Darke, S. (1991). The effects of anxiety on verbal and spatial task performance. *Australian Journal of Psychology*, *43*, 107-111. doi:10.1080/00049539108259108

Mathews, A., & MacLeod, C. (1986). Discrimination of threat cues without awareness in anxiety states. *Journal of Abnormal Psychology*, *95*, 131-138. doi:10.1037/0021-843X.95.2.131

Miller, H., & Bichsel, J. (2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences*, *37*, 591-606. doi:10.1016/j.paid.2003.09.029

Miu, A. C., Heilman, R. M., & Houser, D. (2008). Anxiety impairs decision-making: Psychophysiological evidence from an Iowa Gambling Task. *Biological Psychology*, *77*, 353-358. doi:10.1016/j.biopsycho.2007.11.010

Morsanyi, K., Busdraghi, C., & Primi, C. (2014). Mathematical anxiety is linked to reduced cognitive reflection: A potential road from discomfort in the mathematics classroom to susceptibility biases. *Behavioral and Brain Functions*, *10*, 31-43. doi:10.1186/1744-9081-10-31

Mueller, E. M., Nguyen, J., Ray, W. J., & Borkovec, T. D. (2010). Future-oriented decision-making in generalized anxiety disorder is evident across different versions of the Iowa Gambling Task. *Journal of Behavioral Therapy and Experimental Psychiatry*, *41*, 165-171. doi:10.1016/j.jbtep.2009.12.002

Musch, J., & Broder, A. (1999). Test anxiety versus academic skills: A comparison of two alternative models for predicting

performance in a statistics exam. *British Journal of Educational Psychology*, *69*, 105-116. doi:10.1348/000709999157608
Ng, E., & Lee, K. (2015). Effects of trait anxiety and state anxiety on children's working memory task performance. *Learning and Individual Differences*, *40*, 141-148. doi:10.1016/j.lindif.2015.04.007
Nichols-Hoppe, K. T., & Beach, L. R. (1990). The effects of test anxiety and task variables on predecisional information search. *Journal of Research in Personality*, *24*, 163-172. doi:10.1016/0092-6566(90)90014-W
Noel, X., Bechara, A., Dan, B., Hanak, C., & Verbanck, P. (2007). Response inhibition deficit is involved in poor decision making under risk in nonamnesic individuals with alcoholism. *Neuropsychology*, *21*, 778-786. doi:10.1037/0894-4105.21.6.778
Pajkossy, P., Dezso, L., & Paprika, Z. Z. (2009). The opposite effect of trait and state anxiety on Iowa Gambling Task. *Learning & Perception*, *1*, 279-295. doi:10.1556/LP.1.2009.2.110
Paulus, M. P., Rogalsky, C., Simmons, A., Feinstein, J. S., & Stein, M. B. (2003). Increased activation in the right insula during risk-taking decision making is related to harm avoidance and neuroticism. *NeuroImage*, *19*, 1439-1448. doi:10.1016/S1053-8119(03)00251-9
Plake, B. S., & Parker, C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. *Educational and Psychological Measurement*, *42*, 551-557. doi:10.1177/001316448204200218
Putwain, D., & Daly, A. L. (2014). Test anxiety prevalence and gender differences in a sample of English secondary school students. *Educational Studies*, *40*, 554-570. doi:10.1080/03055698.2014.953914
Reyna, V. F., Nelson, W., Han, P., & Dieckmann, N. F. (2009). How numeracy influences risk comprehension and medical decision making. *Psychological Bulletin*, *135*, 943-973. doi:10.1037/a0017327
Reynolds, C. R., Richmond, B. O., & Lowe, P. A. (2003). *The Adult Manifest Anxiety Scale: Professional manual*. Los Angeles, CA: Western Psychological Services.
Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology*, *19*, 551-554. doi:10.1037/h0033456
Rydell, R. J., Van Loo, K. J., & Boucher, K. L. (2014). Stereotype threat and executive functions: Which functions mediate different threat-related outcomes? *Personality and Social Psychology Bulletin*, *40*, 377-390. doi:10.1177/0146167213513475
Sarason, I. G. (1984). Stress, anxiety, and cognitive interference: Reactions to tests. *Journal of Personality and Social Psychology*, *46*, 929-938. doi:10.1037/0022-3514.46.4.929
Scafidi, T., & Bui, K. (2010). Gender similarities in math performance from middle school through high school. *Journal of Instructional Psychology*, *37*, 252-255.
Schiebener, J., Zamarian, L., Delazer, M., & Brand, M. (2011). Executive functions, categorization of probabilities, and learning from feedback: What does really matter for decision making under explicit risk conditions? *Journal of Clinical and Experimental Neuropsychology*, *33*, 1025-1039. doi:10.1080/13803395.2011.595702
Seipp, B. (1991). Anxiety and academic performance: A meta-analysis of findings. *Anxiety Research*, *4*, 27-41. doi:10.1080/08917779108248762
Skeel, R. L., Neudecker, J., Pilarski, C., & Pytlak, K. (2007). The utility of personality variables and behaviorally-based measures in the prediction of risk-taking behavior. *Personality and Individual Differences*, *43*, 203-214. doi:10.1016/j.paid.2006.11.025
Tapia, M. (2004). The relationship of math anxiety and gender. *Academic Exchange Quarterly*, *8*, 130-134.
Thames, A. D., Panos, S. E., Arentoft, A., Byrd, D. A., Hinkin, C. H., & Arbid, N. (2015). Mild test anxiety influences neurocognitive performance among African Americans and European Americans: Identifying interfering and facilitating sources. *Cultural Diversity & Ethnic Minority Psychology*, *21*, 105-113. doi:10.1037/a0037530
Toplak, M. E., Sorge, G. B., Benoit, A., West, R. F., & Stanovich, K. E. (2010). Decision-making and cognitive abilities: A review of associations between Iowa Gambling Task performance, executive functions, and intelligence. *Clinical Psychology Review*, *30*, 562-581. doi:10.1016/j.cpr.2010.04.002
van den Bos, R., Homberg, J., & de Visser, L. (2013). A critical review of sex differences in decision-making tasks: Focus on the Iowa Gambling Task. *Behavioural Brain Research*, *238*, 95-108. doi:10.1016/j.bbr.2012.10.002
Werner, N. S., Duschek, S., & Schandry, R. (2009). Relationships between affective states and decision-making. *International Journal of Psychophysiology*, *74*, 259-265. doi:10.1016/j.ijpsycho.2009.09.010
Wilkinson, G. S., & Robertson, G. J. (2006). *Wide range achievement test-4: Professional manual*. Lutz, FL: PAR.
Wittchen, H. U., Carter, R. M., Pfister, H., Montgomery, S. A., & Kessler, R. C. (2000). Disabilities and quality of life in pure and comorbid generalized anxiety disorder and major depression in a national survey. *International Clinical Psychopharmacology*, *15*, 319-328.
Worthy, D. A., Byrne, K. A., & Fields, S. (2014). Effects of emotion on prospection during decision-making. *Frontiers in Psychology*, *5*, 591. doi:10.3389/fpsyg.2014.00591