CHAPTER 9

Understanding and Addressing Performance Anxiety

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Alex has been preparing all year for this moment. Her number two pencils are sharp; her breakfast was full of protein. For months, she has been drilling herself on math problems and new vocabulary words. Then the moment comes—it is time to open her test booklet to the first page. Just last night she wrote three practice essays, but as she rereads the prompt, her mind goes totally blank. Precious minutes are passing, yet she is helpless to write even a single word.

Today is an important business meeting for Josh. He has spent the last 2 hours wining and dining a very important client. He reaches for the check and begins to fill in the tip when he feels an all-too-familiar sense of anxious dread. What was the rule again? Move the decimal one place or two?

Danny's daughter started fourth grade 3 weeks ago. She has been working on her homework for nearly an hour when she finally carries a worksheet covered in fractions to Danny and asks plaintively, "Can you look at this?" Stuttering, Danny reaches for the paper, answering, "I don't know, I was never so good at fractions when I was your age. I'm just not a math person."

Throughout life, there are many situations in which we desire optimal performance. Unfortunately, sometimes we are unable to perform up to our potential. Performing at a lower level than one is capable of in a high-stakes situation is often referred to as "choking under pressure." This poor performance is not necessarily a result of lack of motivation, effort, or even skill—poor performance can result from anxiety about the task at hand.

In this chapter, we explore why individuals are generally less likely to succeed when anxious in academic situations. We argue that performance anxiety undermines performance by leading to negative attitudes (e.g., a lack of confidence), changing behaviors (e.g., when a student avoids doing homework or studying), and decreasing cognitive resources available for the task at hand (e.g., working memory, which is our limited-capacity memory system used to store, manipulate, and manage information). A negative feedback loop occurs, wherein performance anxiety decreases performance, and poor performance increases anxiety on subsequent tasks. We focus on a discussion of math anxiety as a common example of performance anxiety and argue that findings related to this domain-specific performance anxiety can shed light on other types of performance anxieties as well. Additionally, we explain how many of the consequences of performance anxiety are reversible and may even be preventable.

A CONCEPTUAL MODEL OF PERFORMANCE ANXIETY

Performance anxiety is broadly defined as fear and apprehension connected to completion of a specific task (e.g., a test) or even engagement with a specific domain (e.g., math). It is characterized by the anticipatory reactions that individuals engage in to manage uncertainty associated with potential future threats (Grupe & Nitschke, 2013). Although related, performance anxiety is different from generalized anxiety. *Generalized anxiety* is defined as uncontrollable worry about one's welfare (and that of one's immediate family) that interferes with daily life. By definition, generalized anxiety impacts many domains (Akiskal, 1998). Performance anxiety is different from generalized anxiety because it concerns a specific domain (e.g., math) and is focused on performance.

There are two distinct components of performance anxiety: anxious apprehension and anxious arousal (Nitschke, Heller, Imig, McDonald, & Miller, 2001). *Anxious apprehension* is the cognitive aspect of anxiety (i.e., worries), whereas *anxious arousal* is characterized by somatic tension and physiological hyperarousal (Moser, Moran, & Jendrusina, 2012). Therefore, to have a full understanding of performance anxiety, we must understand anxious apprehension and anxious arousal as related, yet separate, constructs.

Our theoretical model of the relation between performance anxiety and poor performance is outlined in Figure 9.1. In this model, performance anxiety comprises the two aforementioned components: worry and physiological arousal. Although they are separate components of performance anxiety, worry and arousal often co-occur; that is, individuals tend to be both worried and aroused when they are experiencing performance anxiety. Additionally, increased worry and arousal can result in negative attitudes, avoidance behaviors, and fewer of the resources that individuals need to perform well on a task (e.g., working memory). The deleterious effect of performance anxiety on task performance creates a negative feedback loop in which performance anxiety undermines performance through negative attitudes, avoidance behaviors, and decreased resources. Poorer performance, in turn, leads to increased performance anxiety. Thus, both performance anxiety and actual performance continue to worsen over time in a negative recursive feedback loop (e.g., Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009).

Anxious Apprehension

Worries are commonly understood to be a major component of performance anxiety. These include concerned thoughts about performance during a task and in anticipation of a task. Importantly, worries can be distracting to individuals during a task and result in hypervigilance for problems. Some worries are situational, but worries also contribute to depression and other clinical

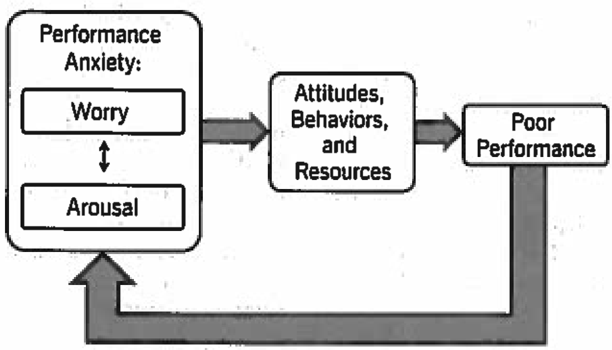

FIGURE 9.1. A conceptual model of how performance anxiety undermines task performance.

disorders (Joormann & Tran, 2009). It is therefore unsurprising that the tendency to worry in response to uncertainty may be related to maladaptive neurocognitive function and behaviors (Grupe & Nitschke, 2013).

Worries not only negatively impact performance, but they are also a distinct component of anxiety. Importantly, worries are associated with vigilance for threat in the environment. This often means that worries lead to increased attention to errors and problems. As evidence of this point, Moser and colleagues (2012) asked participants to complete the letter version of the Eriksen flanker task (Eriksen & Eriksen, 1974), in which participants are instructed to respond to the center letter (target) of a five-letter sequence and to identify whether the target letter is congruent with the rest of the letters (e.g., MMMMM) or incongruent (e.g., NNMNN). Participants are asked to work quickly, and the purpose of this task is to create a situation in which individuals make mistakes, so researchers can study what happens during incorrect responses. For example, this paradigm can be used by researchers to examine brain activity using electroencephalographic (EEG) results associated with making a mistake.

In the Moser and colleagues (2012) work, in addition to the Eriksen flanker task, participants also completed two additional measures in order to assess the two components of anxiety. Participants completed the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) to measure their tendency to worry and the Anxious Arousal subscale of the Mood and Anxiety Symptoms Questionnaire (MASQ; Watson & Clark, 1991) to measure anxious arousal. Worry was highly correlated with brain activity known to be indicative of monitoring for errors. In contrast, arousal was not associated with error monitoring. These findings support the idea that anxious worries are associated with checking for problems and errors. This makes sense because worries or negative thoughts should logically result from noticing errors and might also lead to increased vigilance or even hypervigilance for errors in the future. In comparison, anxious arousal is defined by a particular physical state, which might co-occur with but is not the same as worried thoughts.

Anxious Arousal

There is evidence that not only is arousal is a component of performance anxiety, but also that anxious arousal is distinct from anxious apprehension. Everyday events such as test-taking, social interactions, or calculating a tip can cause an increase in physical arousal, such as a state of increased heart rate and blood pressure (Seery, 2013). In certain situations, physiological arousal (i.e., increased blood flow, heart rate) can be beneficial. But sometimes, physiological arousal is instead viewed as a threat, which undermines task performance. Jamieson, Mendes, and Nock (2013) use the example of a skier looking down a steep, icy slope to highlight the contrast between arousal being interpreted positively or negatively. Experienced skiers might interpret a pounding heart rate as a sign that they are excited and have the skills necessary to succeed, whereas a novice might interpret a pounding heart rate as a sign that the hill is too difficult, inciting panic. In both cases, however, the skier experiences similar increases in physiological arousal. What we know about performance anxiety would lead us to hypothesize that a skier with performance anxiety would be more likely to view arousal negatively, which can undermine performance.

There is evidence that anxious arousal is generally implicated in worse task performance. A research study showed that when participants were given a practice graduate school entrance exam in a laboratory setting, the higher their physiological arousal (as indicated by salivary alpha amylase), the worse their performance (Jamieson, Mendes, Blackstock, & Schmader, 2010). (An additional condition, in which participants were trained to reappraise their arousal, is discussed in greater detail later in the chapter.) Although this finding shows that anxious arousal might negatively impact performance for most people in high-pressure contexts, it may be that individuals high in performance anxiety respond this same way, even in low-pressure situations.

Mattarella-Micke, Mateo, Kozak, Foster, and Beilock (2011) demonstrated this by studying high- and low-math-anxious participants' performance and physiological reactivity during a math task. For participants high in math anxiety, higher levels of physiological arousal, which was assessed by measuring the stress hormone cortisol, were associated with worse task performance. For participants low in math anxiety, higher levels of physiological arousal were associated with improved task performance. Thus, the effect of physiological arousal depended on individuals' level of performance anxiety, which demonstrates that individuals' interpretation of their physiological arousal can moderate the effects of arousal on performance. This is a topic that we discuss in more detail in the intervention and treatment section of this chapter.

Is Poor Performance the Result or Cause of Performance Anxiety?

Before delving deeper into the mechanisms underlying performance anxiety, it is important to discuss whether the relationship between performance anxiety and poor performance is solely due to performance-anxious individuals lacking ability in a specific domain. Although we know performance anxiety can emerge in early childhood and is linked to decreased performance in subjects such as math (Ramirez, Gunderson, Levine, & Beilock, 2013), its developmental origins are only now beginning to be explored. One hypothesis is that performance anxiety is synonymous with low ability in a domain; that is, performance anxiety is entirely caused by (and is nothing more than) another way to measure lack of ability. A second hypothesis is that performance anxiety plays a causal role in poor performance, independent of an individual's ability level. Thus, performance anxiety is viewed as a factor that can affect individuals with high and low levels of ability. A third, competing reciprocal relationship hypothesis is that performance anxiety leads to lower performance and engagement in a domain or task, which in turn results in lower ability and higher performance anxiety over time. Given that psychological interventions (e.g., Park, Ramirez, & Beilock, 2014), which do not increase ability, can help performance-anxious individuals perform close to the level of less performance-anxious individuals, the evidence seems to favor the idea that performance anxiety is not *simply* a proxy for a lack of ability in a domain or task; that is, there is a psychological component to performance, and performance anxiety can undermine how well individuals perform, regardless of their ability (Beilock & Maloney, 2015; Geary, 2014).

Further evidence that performance anxiety is not the same as a lack of ability comes from the work of Lyons and Beilock (2012), who focused on math anxiety (i.e., fear and apprehension about performing poorly in math) as a type of performance anxiety. Specifically, they found that some math-anxious individuals are able to perform at high levels despite their math anxiety. Participants performed a mental arithmetic task in which they identified whether an arithmetic problem had been correctly solved. They also completed a difficulty matched word-verification task in which they had to decide whether a letter string, if reversed, spelled an actual English word. All of this was done while having their brain activity recorded in a magnetic resonance imaging (MRI) scanner. Overall, high- and low-math-anxious participants scored identically on the word tasks, but the high-math-anxious participants generally scored worse than low-math-anxious individuals on the math tasks. Most interestingly, Lyons and Beilock also found that not all high-math-anxious participants showed identical neural patterns. Before each type of problem, participants were given a visual cue that indicated whether the next problem would be a math or a word trial, allowing researchers to distinguish the neural activity associated with the anticipation of doing math from that of actually doing the math. The more that high-math-anxious individuals showed activation of a frontoparietal network when anticipating math problems, including the inferior frontal junction (IFJ), the inferior parietal lobule (IPL), and the left anterior inferior frontal gyrus (IFGa), the better they performed. These regions are known to help coordinate cognitive control and motivational resources, and can indicate positive reappraisals of stress. These findings, in terms of the brain activation patterns, suggest that some performance-anxious individuals may be reappraising the situation more positively than their peers before they begin the task and that this reappraisal leads to better performance. All in all, because the different brain activation patterns of high-math-anxious participants are thought to represent something about how individuals view the task and not something about their innate ability—further evidence that suggests performance anxiety has a causal role in performance. Of course, none of the previously mentioned evidence rules out the possibility that some individuals are anxious because they start out low in ability, or the possibility that there might be a reciprocal relationship between performance anxiety and poor performance. However, it does suggest that performance anxiety is not solely due to low ability.

Summary

Performance anxiety is characterized by the anxiety experienced in the immediate context of the performance setting (e.g., a testing situation), the anticipation of having to perform a task, and even fear about future evaluation. Performance anxiety includes physiological arousal and negative cognitions or worries and may lead to negative attitudes, avoidance behaviors, decreased resources, and performance deficits (Ashcraft & Krause, 2007; Hopko, McNeil, Zvolensky, & Eifert, 2002). Moreover, experimental evidence supports performance anxiety as being a causal factor in poor performance. While there are many types of performance anxiety, we explore one specific form, math anxiety, as an exemplar of how performance anxiety works. Although math anxiety is just an example of performance anxiety within one domain, we argue that the mechanisms of math anxiety generalize to other types of performance anxiety, such as test anxiety or sports anxiety. In addition, we argue that performance anxieties are domain-specific. Thus, an individual's level of math anxiety should predict his or her math performance, but not necessarily performance in other domains, such as sports.

ONE EXAMPLE OF A DOMAIN-SPECIFIC PERFORMANCE ANXIETY: MATH ANXIETY

The fear and terror experienced by Josh in the opening anecdote while calculating a tip, is an example of the negative emotions math-anxious individuals may feel when faced with everyday math tasks. *Math anxiety* is a domain-specific performance anxiety defined by the fear and apprehension experienced by an individual when placed in a situation wherein math must be performed (Hembree, 1990). Consistent with our theoretical model of performance anxiety, these fears and negative emotions utilize cognitive resources that might otherwise be focused on math-related tasks and have deleterious effects on performance. Math anxiety also affects behavior, especially by leading individuals to avoid math whenever possible. For example, math-anxious individuals tend to avoid math classes. Furthermore, they perform worse in the math classes they do take than do less-math-anxious individuals (Ashcraft, 2002; Hembree, 1990; Ma, 1999). One study even showed that some of the same areas of the brain that are activated in response to pain become active for math-anxious individuals in anticipation of a math task (Lyons & Beilock, 2012). Thus, it is not surprising that math-anxious individuals often avoid college majors requiring math and eventually avoid math-related careers (Chipman, Krantz, & Silver, 1992).

Explaining the Relation between Math Anxiety and Poor Math Performance

Several mechanisms have been hypothesized to explain the relation between math anxiety and poor performance. Following our theoretical model, we posit that attitudes, behaviors, and reduced resources (e.g., working memory) act as key mechanisms. However, there is also evidence that a lack of basic number skills may contribute to math anxiety, resulting in a reciprocal relationship: Poor numerical skills result in math anxiety, which reduces cognitive resources, leading students to avoid situations involving math and, as a result, limiting students' opportunities to learn and master new math skills.

Research shows that high-math-anxious individuals struggle with both simple and complex math concepts and skills. In terms of the former, in one study, college-age participants were asked to identify the number of squares on a screen, ranging from one to nine. No differences between high- and low-math-anxious individuals were found when one to four squares were presented, but when presented with five or more squares, the high-math-anxious individuals were slower and less accurate at identifying the number of squares than low-math-anxious individuals (Maloney, Risko, Ansari, & Fugelsang, 2010). In another study, high-math-anxious individuals were found to exhibit a larger numerical distance effect, or were slower to judge numbers that were numerically closer together (e.g., 4 and 5 compared with 4 and 8), than were low-math-anxious individuals. This suggests that high-math-anxious individuals have less precise representations of numbers than do their low-math-anxious peers (Maloney, Ansari, & Fugelsang, 2011). Thus, one potential reason why math anxiety is related to poor math performance is that anxiety makes it more difficult to think about numbers at a basic level, which makes doing complex math problems more difficult, more anxiety-provoking, and unpleasant (Maloney & Beilock, 2012). Though experimental research rules out the possibility that math anxiety is due only to innate numerical deficits (e.g., Park et al., 2014), having poor basic number skills may lead to math anxiety, which in turn leads to worse math performance.

Another potential explanation for why math anxiety might undermine math performance is that it takes up or depletes limited cognitive resources, specifically, working memory. Similar mechanisms have been hypothesized for many types of performance anxiety (e.g., Schmader & Johns, 2003). When faced with performing math tasks, math-anxious individuals experience worries and fears, which might then compromise cognitive resources, particularly working memory. Working memory is often described as a limited-capacity system that stores, computes, and manipulates information (Baddeley, 2000; Engle, 2002; Miyake & Shah, 1999). Therefore, how we use our working memory has implications for performance. Although working memory is limited by default, it is important to recognize that there are substantial individual differences in working memory, even at different stages in development (e.g., Ramirez et al., 2013).

Performance anxieties (e.g., math anxiety, test anxiety, and other domain-specific anxieties) are hypothesized to impact working memory because anxious thoughts (e.g., "I'll never be able to do this!") may occupy the working memory resources available in that moment. Therefore, when math-anxious individuals are doing math problems, they are actually engaging in a dual task—solving the task at hand and thinking about their fears. Support for this hypothesis comes from two main types of studies: (1) studies that examine the effects of performance anxiety on tasks that are either demanding or not, in terms of working memory, and (2) studies that examine the effects of performance anxiety on individuals with higher and lower levels of working memory. The first type of study would support reduced working memory availability as a mechanism underlying performance anxiety, if performance anxiety were associated with poor performance only on highly demanding working memory tasks. The second type of study would support reduced working memory availability as a mechanism underlying performance anxiety if performance anxiety were only associated with worse performance in individuals with naturally high levels of working memory. The idea here is that individuals with low levels of working memory would not be affected by reduced working memory because they start off with such low levels that they tend not rely on working memory resources for optimal performance. On the other hand, individuals with higher levels of working memory tend to use working memory resources during performance tasks, so if their working memory is reduced due to performance anxiety, then these individuals are likely to underperform.

As an example of the first type of study, Ashcraft and Kirk (2001) asked high- and low-math-anxious participants to solve high-demand and low-demand working memory problems. On questions that were not demanding of working memory resources, both the high- and low-math-anxious groups performed similarly, but on problems that were more demanding on working memory resources, high-math-anxious participants performed significantly worse than at baseline. In fact, the drop in performance for high-math-anxious individuals was far larger than that for the low-math-anxious participants. One way to interpret these findings is that when high-math-anxious individuals are doing math, their working memory capacity is reduced because of their nervous thoughts, at least as compared to that of low-math-anxious individuals. Therefore, when considering tasks that place a high demand on working memory, individuals with high math anxiety (e.g., Alex, in the case anecdotes at the beginning of this chapter) may be disadvantaged.

These findings show that math anxiety undermines performance on high-demand working memory tasks, but another way to examine this question is to test whether individual differences in working memory play a role in the effects of math anxiety. Specifically, do individual differences in working memory capacity impact the relation between math anxiety and math performance? One study examined this in first- and second-grade children and showed that there was a clear negative relation between math anxiety and math achievement for children with high-capacity working memory (Ramirez et al., 2013). However, no such relationship existed for children with low-capacity working memory. The authors suggested that individuals with higher working memory capacities prefer to use and rely on strategies that require more working memory. Thus, when high-math-anxious children are faced with the negative thoughts associated with math anxiety, their working memory capacity is disturbed, leaving them unable to use their preferred high-capacity working memory requirement strategies. This finding—that those with the highest working memory capacity are most impacted by math anxiety—is especially troubling because these children are more likely to avoid math and math-related careers, despite their clear potential.

Math anxiety has also been found to be negatively associated with the use of more advanced problem-solving strategies, which undermines performance, because advanced strategies are associated with better math achievement. Advanced strategies might rely on working memory resources, so if math anxiety reduces available working memory, then it might block the ability of anxious individuals to utilize these useful ways of solving math problems. Following up on their previous study, Ramirez, Chang, Maloney, Levine, and Beilock (2016) investigated how math anxiety and individual differences in working memory predicted advanced strategy use in math tasks. Consistent with other studies, the negative effects of math anxiety were limited to individuals with high-capacity working memory. Moreover, math anxiety affected strategy use in children with high-capacity working memory. High-math-anxious children with higher levels of working memory were less likely to use advanced memory-based strategies to solve math problems. In contrast, children with low-capacity working memory showed no effect of math anxiety on strategy use. The authors suggest two possibilities for why higher levels of math anxiety were associated with reduced use of advanced strategies among children with higher capacity working memory. One possibility is that these children with high-capacity working memory initially use advanced strategies, but their math anxiety interferes with these strategies, and they come to rely less on these strategies since they are no longer effective. Another possibility is that the math anxiety actually fundamentally alters children's behavior; thus, high-math-anxious children with high-capacity working memory never attempt to use the advanced memory-based strategies. In either case, there is a strong body of work to support the hypothesis that one route through which math anxiety relates to poor math performance is by occupying or depleting working memory resources.

SOCIAL FACTORS IN PERFORMANCE ANXIETY

Social Pressure and Stereotypes as Sources of Performance Anxiety

It is important to acknowledge that the source of performance anxiety is sometimes social in nature. For example, math-anxious adults often attribute their math anxiety to public embarrassment connected to math (e.g., often directly from math teachers) (Ashcraft, 2002). This is supported by a meta-analytic review of the research on social-evaluative threat, or the fear of being judged negatively by others, which has been shown to be a highly potent psychological stressor across a range of studies (Dickerson & Kemeny, 2004). Social pressure may take many forms, including pressure from higher status individuals, cultural norms that promote pressure in certain situations, and the pressure of letting down a team or group.

Although any situation can be made into a high-pressure context by, for example, adding a judgmental audience during a performance task or raising the stakes of the task by adding monetary incentives or penalties (e.g., Ramirez & Beilock, 2011), one frequently studied type of social pressure concerns stereotypes about groups of people. Stereotypes are ubiquitous in society, and some stereotypes focus on the performance of one group relative to other groups. *Stereotype threat* refers to a phenomenon whereby individuals perform below their ability when a relevant negative stereotype to the individual is made salient in a performance situation, thereby inducing performance anxiety (Steele & Aronson, 1995). For example, researchers observed a decrease in women's math performance when the stereotype "women are bad at math" was made salient (Spencer, Steel, & Quinn, 1999). Unfortunately, even minor acts, such as being asked to circle one's gender in a test booklet before a test, can activate previously established stereotypes (McQueen & Klein, 2006).

But why would stereotypes disrupt performance? The resulting poor performance is believed to be a result of the fear of confirming the negative social stereotype (e.g., a woman in a high-stakes testing situation might worry that she will confirm the stereotype that women are bad at math). Although stereotype threat is often discussed with regard to underrepresented gender and racial-minority groups, theoretically, it might affect anyone for whom a negative stereotype exists. Furthermore, research has shown that one reason why stereotype threat undermines performance is because it depletes working memory resources, similar to the mechanism by which other types of performance anxiety, such as math anxiety, affect performance (Schmader & Johns, 2003).

Person-to-Person Transmission of Performance Anxiety: Examples from Math and Test Anxiety

Not only can performance anxiety be impacted by social factors, such as social evaluation and cultural stereotypes, but an individual's performance anxiety can also influence others around him or her. For example, researchers investigated the impact of female elementary school teachers' math anxiety on their first- and second-grade students (Beilock, Gunderson, Ramirez, & Levine, 2010). Because of the stereotypes about women in math, and because female students might be more likely to identify with female teachers, one hypothesis is that young girls might be particularly likely to be influenced by their female teachers' attitudes about math. At the beginning of the school year, there was no relation between a teacher's math anxiety and her students' math achievement. However, at the end of the school year, results showed that female students in high-math-anxious teachers' classrooms learned less math over the course of the school year than female students in low-math-anxious teachers' classrooms. These students were also more likely to endorse the stereotype "boys are good at math, and girls are good at reading." In contrast, for male students, there was no relation between boys' stereotype endorsement, math achievement, and their teachers' math anxiety levels.

Given that high-math-anxious elementary school teachers can influence children's math performance and stereotype endorsement, even though they only are with children for 180 days, parents stand to make an even greater impact. Parents have varying levels of math anxiety, and this could affect their children's math performance. In one study, researchers examined parents' math anxiety in combination with how often they interacted with their first- and second-grade children about math, specifically, how frequently they helped their children with their math homework, a relatively ubiquitous part of the elementary school experience. When parents who were high in math anxiety helped their children with math homework, their children learned less over the course of the school year than did children of high-math-anxious parents who did not receive help from parents with their math homework (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Simply put, children of high-math-anxious parents actually performed worse when their parents helped them with math homework than did children with low-math-anxious parents, which suggests that the interactions of these math-anxious parents with their children were negative. Furthermore, children's poor performance was associated with higher levels of math anxiety. Thus, one route through which parents' math anxiety might increase their children's math anxiety is by undermining their math performance.

A similar pattern of results has also been found in other countries; therefore, the relation between parents' math anxiety and their children's math achievement is not unique to the North American context. One study in India examined the role of parents' math anxiety and attitudes in shaping their 10- to 15-year-old children's math anxiety and achievement (Soni & Kumari, 2015). Parents' math anxiety was found to be a significant positive predictor of children's math anxiety and children's math attitudes, such that parents with higher levels of math anxiety tended to have children with higher levels of math anxiety. In fact, there was a remarkably high association between parents' math anxiety and children's math anxiety, suggesting that parents might have an important and strong influence on their children's performance anxiety. In addition, children's math anxiety and math attitudes were negatively associated with their math achievement.

Taken together, these studies on the relations between teachers' and parents' math attitudes and children's math attitudes help shed light on a social-developmental model in which adults' math anxiety acts as precursor to children's math anxiety, math attitudes, and math performance. A better understanding of the connections between adults' and children's math anxiety, attitudes, and achievement will allow researchers specifically to target interventions that disrupt this relationship. We can look to research on another type of performance anxiety, test anxiety (i.e., fear and apprehension about performing well on tests), to add to our knowledge of how specific types of performance anxiety (i.e., math or test anxiety) might develop.

Sarason (1960) proposed that children develop test anxiety when they fail to meet their parents' overly high expectations and when parents react critically in an evaluative setting, which makes children sensitive to adult reactions. Adams and Sarason (1963) tested part of this hypothesis using the Test Anxiety Scale, the Need for Achievement Scale, the Lack of Protection Scale of the Autobiographical Survey, and Bendig's (1956) brief version of Taylor's Manifest Anxiety Scale. The authors found a positive correlation for female students and their mothers on all four scales. Additionally, anxiety scores of both boys and girls were more related to their mothers' anxiety levels than to their fathers' anxiety levels.

Similar effects have been shown when examining how much children fear failure, which concerns performance anxiety in general. Elliot and Thrash (2004) found that parents with higher levels of fear of failure had children with higher levels of fear of failure, which suggests that parents might be transmitting these attitudes to their children. The association between mothers' fear of failure and their children's fear of failure was mediated by love withdrawal, which was measured by asking children about how each of their parents would respond to the children's mistakes or perceived failures (e.g., "He or she would avoid looking at me when I disappointed him or her"). Children with higher levels of fear of failure were also more likely to adopt avoidance goals in the academic domain (i.e., goals to avoid performing poorly relative to others in school), which are associated with worse task performance.

Finally, once a child's performance anxiety is high, parents might be crucial factors in maintaining those high levels of anxiety. For example, in one study, the parents of high- and low-test-anxious students worked on a problem-solving task with their children. Parents of high-anxious children provided less support, rejected children's attempts for attention, and were less likely to provide reinforcement following success than did parents of low-anxious students (Hermans, ter Laak, & Maes, 1972). Thus, not only might adults be one cause of performance anxiety, but they also may play a role in the persistence and growth of these attitudes over time.

INTERVENTIONS AND TREATMENTS FOR PERFORMANCE ANXIETY

Given evidence showing that a psychological factor (i.e., performance anxiety) has a significant impact on task performance, psychologists can play a pivotal role in creating theory-driven interventions to address the problems caused by performance anxiety. Many of the techniques developed by psychologists focus on the anxiety instead of the task; that is, an intervention may work by helping to reduce an individual's worries and arousal, not by training him or her to be more skillful at the task. Because these types of interventions target underlying social and cognitive processes of anxiety, these interventions are relevant for a wide range of performance anxiety, rather than being specific only to math anxiety, for example. However, we do not want to suggest that skills and ability do not matter. It is clear that both anxiety and ability play important roles in task performance (Beilock & Maloney, 2015).

To put performance anxiety interventions in the context of our conceptual model (see Figure 9.2), the interventions we discuss target at least one of the two components of performance anxiety: worry and arousal. Interventions may work by reducing these aspects of anxiety, thereby buffering individuals from negative effects. Interventions may also work by changing how worries and arousal are connected to performance, thereby disrupting the negative link between performance anxiety and the resources needed to do well on tasks. For example, if an intervention reduces worries, then performance anxiety should have a smaller negative effect on working memory, which means that more working memory is available for the task, and performance should be improved. Importantly, this can then disrupt the negative recursive cycle that develops when poor performance leads to increased performance anxiety and subsequent even poorer performance. Table 9.1 provides an overview of a set of interventions that have been found to be successful in combating the negative effects of performance anxiety. As mentioned previously, the majority of these interventions are likely applicable for treatment of performance anxiety in a wide variety of domains. Different types of performance anxiety may manifest themselves in widely different ways, but the underlying processes are similar.

As an overview, we discuss three types of performance anxiety interventions in this chapter: exposure; mindset: anxiety-focused; and mindset: self-focused. Exposure interventions involve positive experiences in the anxiety-provoking domain. The two types of mindset interventions involve changing individuals' ways of thinking, or mindsets, about either the anxiety they are feeling (anxiety-focused) or the way they are thinking about themselves in the situation (self-focused). All three types of interventions have been shown to be promising for

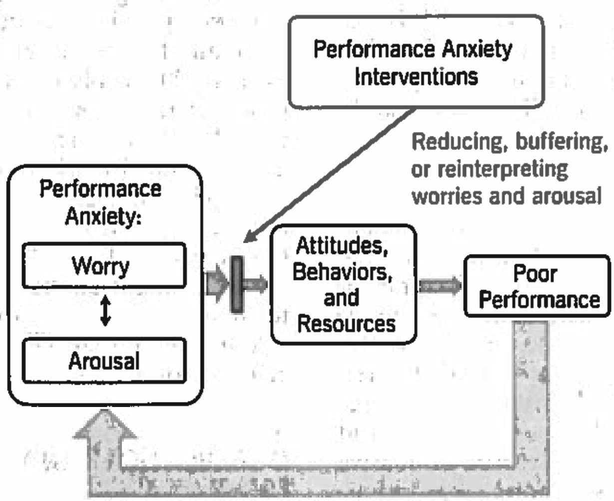

FIGURE 9.2. Interventions can disrupt the negative cycle between performance anxiety and performance.

TABLE 9.1. Performance Anxiety Interventions

Focus	Intervention	Representative study	Brief description
Exposure	Encouraging positive experiences in the threatening domain	Berkowitz et al. (2015)	This intervention works by providing scripted, positive interactions within the anxiety-provoking domain.
Exposure	Practice under pressure	Oudejans and Pijpers (2009)	Practicing under pressure can help to prevent underperformance in future high-stakes events.
Mindset: Anxiety-focused	Anxiety reappraisal	Johns, Inzlicht, and Schmader (2008)	This intervention focuses on reinterpreting anxious thoughts as helpful for task performance (e.g., worries can help you pay attention during a test).
Mindset: Anxiety-focused	Arousal reappraisal	Jamieson et al. (2010)	This intervention asks individuals to reinterpret the arousal that comes with anxious situations as helpful for task performance (e.g., a faster heart rate means increased energy).
Mindset: Anxiety-focused	Expressive writing	Ramirez and Beilock (2011)	This brief writing intervention consists of writing about and off-loading worries before a stressful situation.
Mindset: Anxiety-focused	Labeling the worries	Johns, Schmader, and Martens (2005)	This intervention involves explicitly focusing attention on the existence of a threatening stereotype and acknowledging that it is only a stereotype.
Mindset: Anxiety-focused	Mindfulness	Mrazek et al. (2013)	This intervention involves regularly practicing mindfulness mediation and learning to focus on different aspects of thoughts and sensations.
Mindset: Anxiety-focused	Reattribution of uncertainty	Wilson and Linville (1982)	This intervention focuses on teaching individuals to view ambiguous cues, such as a low grade on a test, as common to everyone and as temporary in nature.
Mindset: Self-focused	Perspective broadening	Critcher and Dunning (2015)	This intervention asks individuals to think about multiple aspects of their identities in order to decrease their focus on the threatening domain or task.
Mindset: Self-focused	Self-affirmation	Cohen et al. (2009)	This brief writing exercise increases individuals' self-integrity by asking them to write about important interests and activities.

reducing the negative effects of performance anxiety (though more research is needed) and are described in more detail below.

Exposure Interventions

One of the most intuitive methods for reducing the impact of performance anxiety on performance is exposure interventions. One example of exposure interventions involves having individuals practice in the anxiety-provoking domain. However, practice alone is not enough to overcome performance anxiety. Individuals need to practice under pressure to see a reduced impact of performance anxiety. As evidence for this, in one study, expert basketball players and dart throwers practiced with or without induced performance pressure for 5 weeks. Only those participants who practiced under pressure showed an improvement in performance during a high-pressure posttest (Oudejans & Pijpers, 2009).

Performance anxiety can affect others beyond the individual with performance anxiety. For example, children of parents who are anxious about math perform worse in math than children with less-math-anxious parents (Maloney et al., 2015; Soni & Kumari, 2015). One way to lessen the impact of parents' math anxiety on their children's math performance is to provide parents with scripted ways to talk about math with their children in order to create more positive math interactions in the home. One recent study involved providing parents of elementary school-age children with access to either an iPad math app (intervention condition) or a reading app (control condition). The math app provided a nightly word problem; that is, a written script with problems and solutions for parents' use to engage in math discussions and increase positive math talk in the home. Being assigned to the intervention condition improved the academic performance of children of high-math-anxious parents. In fact, the achievement gap between children of high- and low-math-anxious parents was greatly diminished. Therefore, providing a scripted way for families to have positive math interactions offered a way to block the negative effects of parents' math anxiety on their children's math performance. The app may give parents, especially high-math-anxious parents, more (and better) ways to talk to their children about math not only during app usage but also in other everyday interactions (Berkowitz et al., 2015).

Mindset

Anxiety-Focused Interventions

Exposure interventions are an intuitive and straightforward strategy for managing performance anxiety; however, other, less intuitive strategies involve helping individuals to think about the performance anxiety or themselves in different ways in order to allow them to perform well even when anxious. These psychological-based mindset interventions often involve giving individuals new information and teaching them to change how they think about a task or themselves, which can occur in an intervention as brief as reading a paragraph before taking a test or completing a short writing exercise at the beginning of a school year (Wilson, 2011). Mindset interventions can focus directly on how to think about the anxiety (anxiety-focused) or they can focus on how individuals view themselves in situations in which anxiety might occur (self-focused).

One type of mindset intervention focuses on reappraisal. Reappraisal interventions can work by reframing anxiety in general or by targeting one specific component of anxiety, such as arousal or worries. To demonstrate the effectiveness of reappraisal, one study examined how reappraisal might help participants when they were experiencing performance anxiety because of stereotype threat, which is the fear of being judged because of negative stereotypes about one's group, such as the stereotype about women being worse at math than men (Johns, Inzlicht, & Schmader, 2008). The authors hypothesized that the performance deficit associated with stereotype threat could be reduced (or eliminated) when individuals' performance anxiety was reframed more positively. Specifically, when participants were told that anxiety could help, rather than harm, performance on a math task (e.g., by increasing their attention during the task), subsequent performance improved compared to that of the control group. Importantly, the reappraisal manipulation did not reduce self-reported anxiety; instead, it helped participants turn the anxiety into a positive for task performance.

Some other treatments try to curtail the negative impacts of performance anxiety by reappraising or reframing just the arousal component of anxiety. In one study, students completed a practice version of an upcoming high-stakes test (Jamieson et al., 2010). Before the test, half of the participants (the reappraisal condition) were informed that the physical arousal that they would feel (e.g., sweaty palms and a fast heartrate) is actually helpful for test performance (e.g., because it indicates that their bodies are energizing them for the task). Participants in the control condition were given no additional information. The participants in the reappraisal group who were told that arousal was positive outperformed participants in the control group on the practice test. This change in mindset, or the way in which students thought about physiological arousal before a test, seemed to persist, as the students in the reappraisal group also had better performance on the actual test, outside of the lab, several months later, which suggests that teaching individuals about this reappraisal mindset once could have long-lasting effects. These effects were later confirmed and replicated in a study showing the positive effects of the arousal reappraisal intervention on test performance for remedial math students in community college (Jamieson, Peters, Greenwood, & Altose, 2016). A related study indicated that arousal reappraisal interventions can also have positive effects on physiological stress responses, such as improved immune functioning (John-Henderson, Rheinschmidt, & Mendoza-Denton, 2015).

A different way of reframing an anxiety-provoking task is to educate individuals explicitly about and label the source of the worries. Johns, Schmader, and Martens (2005) did this by teaching women about the concept of stereotype threat in the math domain. Specifically, researchers told participants in a stereotype threat awareness condition the definition of stereotype threat (i.e., that *stereotype threat* is defined as worrying that if you are a woman and perform poorly in math, then you will confirm the negative stereotype that women are worse at math than men, and that stereotype threat has been shown to undermine performance). The hypothesis was that the stereotype threat awareness condition could reduce the amount of performance anxiety experienced by participants by giving them a known external source for the pressure (i.e., stereotype threat). Put another way, making participants aware of stereotype threat could give them a ready-made excuse for underperformance, which might alleviate the performance anxiety that they would experience (Brown & Josephs, 1999). Both men and women were asked to complete math problems, described either as a "problem-solving task" (control group) or as a "math test" (so-called to induce the pressure associated with stereotype threat, the stereotype threat group). One additional group was informed that the task was a math test (stereotype induction), but participants in this group were also given information defining stereotype threat, and they were informed that stereotype threat might make women feel more anxious (stereotype-threat-aware group). Women in the stereotype-threat-aware group performed identically to men; in the unaware-stereotype-threat condition, women performed significantly worse than men. In other words, simply labeling and explaining the effects of stereotype threat to women enabled them to perform better. As mentioned previously, this is hypothesized to be because they could attribute the worries and arousal associated with performance anxiety to stereotype threat rather than attributing it to a high degree of pressure to succeed, consequently inoculating them against stereotype threat. A more recent study found comparable results with high school students using a similar intervention (Moè, 2012).

A third way of reframing anxiety focuses on the attributions individuals make about ambiguous situations. *Attributions* are the reasons or causes individuals give to events, and much research has been conducted on how attributions can affect performance. Importantly, attributions can either be stable or unstable. For example, if individuals believe that their performance is due to an immutable ability they were either born with or without (stable), then when they perform poorly at that task, they are likely to interpret that poor performance as a signal that they should quit the task because they have low ability levels that cannot be changed. Conversely, if individuals believe that their performance is due to effort or another malleable factor (unstable), then even when they perform poorly, they should persist on a task because low task performance only indicates a lack of effort, which can be increased (Dweck, 1986).

Intervention work has shown that teaching students that perceived failure in school is due to unstable causes can help them react better when they feel anxious about their performance. For example, Wilson and Linville (1982) recruited a sample of first-year college students who were anxious about their performance in college. Students in an intervention condition were taught that poor performance during their first year of college was common and generally became less of a problem over time for students, which was done to teach students in the intervention condition to make unstable attributions about performance. As compared to a control group, students in the intervention group had a higher grade-point average (GPA) and were less likely to drop out of college. More recent studies have replicated these findings with groups of students who suffer from performance anxiety due to their race (Walton & Cohen, 2011), socioeconomic status (Yeager et al., 2016), and the transition to middle school (Rozek, Pyne, Hanselman, Feldman, & Borman, 2016). Thus, reframing individuals' attributions about perceived failure is another way to help mitigate the effects of performance anxiety.

Instead of reframing the meaning of performance anxiety, other types of mindset interventions focus on reducing worries during the task. One method for reducing worries involves mindfulness meditation techniques. In one study, participants were given a 2-week mindfulness training course designed to lessen anxiety and the associated mind wandering or distraction (e.g., thinking about worries), especially during assessments (Mrazek, Franklin, Philips, Baird, & Schooler, 2013). At the end of the training, participants showed improved performance on the Graduate Record Exam (GRE) Reading Comprehension subtest, as well as increased working memory capacity, which is consistent with the idea that this intervention might work to reduce the negative effects of performance anxiety by targeting the worry component of anxiety. Additionally, participants who completed the training reported the reduced occurrence of distracting thoughts during assessments. This work suggests that training underlying cognitive processes (e.g., mindfulness) can prevent the cycle of negative ruminations that leads to a drain on cognitive resources, which are necessary for performance. Relatedly, a randomized trial of mindfulness Kindness Curriculum in preschool classrooms showed further support for the positive effects of mindfulness interventions in educational settings in a much younger age group (Flook, Goldberg, Pinger, & Davidson, 2015).

Instead of training for 2 weeks, another option for targeting the cognitive worry component of anxiety is to do a specific activity directly before the task to regulate anxious thoughts. Across several studies, Ramirez and Beilock (2011) demonstrated that expressive writing (i.e., writing about one's thoughts and feelings about an upcoming task or event) can alleviate the negative impact of test anxiety on exam performance. This intervention is theorized to work by off-loading worries, which should then reduce the number of intrusive thoughts that are experienced while one is anxious. In one of the studies, on the day of the final exam in ninth-grade science courses, the researchers asked half of the students either to think about a topic not on the exam (control condition) or to write about their thoughts and feelings regarding the upcoming exam (expressive writing condition) for 10 minutes. Students given the opportunity to write about their worries had higher overall scores than those students who were in the control condition. However, the most striking finding was that students with the highest reported levels of test anxiety benefited the most from expressive writing. In fact, the expressive writing exercise was able to close the achievement gap between students high and low in test anxiety.

This same idea—that expressive writing dampens the impact of performance anxiety—has been shown to lessen the impact of math anxiety as well (Park et al., 2014). For high-math-anxious participants, engaging in an expressive writing exercise before completing math problems resulted in improved performance on those math problems. This positive effect of expressive writing narrowed the performance gap between high- and low-math-anxious individuals. A third study showed similar positive effects of expressive writing on Medical College Admission Test (MCAT) and Law School Admission Test (LSAT) scores, and also on participants' depressive symptoms before the exams (Frattaroli, Thomas, & Lyubomirsky, 2011).

Self-Focused Interventions

Although changing how individuals think about anxiety can be helpful for reducing the negative effects of performance anxiety, another type of mindset intervention focuses on how individuals think about themselves in situations that create high performance anxiety. The hypothesis is that when in a high-performance-anxiety situation, such as a math test for a high-math-anxious individual, attention becomes narrowed and focused on the anxiety-provoking task or stimuli to the exclusion of everything else. That is, threats, like performance anxiety, constrict the working self-concept, or what is salient in individuals' minds, to focus on threatened self-aspects (Critcher & Dunning, 2015). For example, when individuals are worried about their academic performance, they put more of their attention on that particular domain (i.e., academics), even though remembering that they care about other domains or that they are good in other areas of life might reduce their anxiety levels.

Critcher and Dunning (2015) found that helping individuals to broaden their perspective in high-performance-anxiety situations could help reduce the negative effects of performance anxiety. First, performance pressure was manipulated for participants. Then, all participants completed a task in which they were asked to think and write about various aspects of their identity. Before beginning that task, participants in the perspective-broadening condition were asked to think about the actions, talents, characteristics, and tasks that define who they are as a person because this was hypothesized to remind them about non-threatened aspects of their identities. Supporting this hypothesis, participants in the perspective-broadening condition were more able to identify multiple aspects of their self-concepts than participants in the control condition. They also responded in a less anxious manner (e.g., less defensively) on the task at hand. Alternatively, participants who were not given the opportunity to engage in a perspective-broadening writing activity displayed a constricted self-concept, which is indicative of anxiety, and responded more defensively during the task. Performance anxiety alone (without the opportunity for perspective-broadening writing) left participants unable to recognize their own full potential and instead left them distracted and focused mainly on feeling threatened. These results demonstrate the potential for low-cost interventions to combat performance anxiety through engagement in perspective-broadening writing activities before high-performance-anxiety tasks.

With a related self-focused intervention, Cohen, Garcia, Purdie-Vaughns, Apfel, and Brzustoski (2009) have done groundbreaking work to reduce racial achievement gaps by using an intervention called self-affirmation to buffer minority students from the negative effects of performance anxiety (for a review of self-affirmation studies, see Hanselman, Rozek, Grigg, & Borman, 2016). In a study with middle school students, those students assigned to the intervention group completed brief, structured writing assignments designed to allow them to affirm important values (e.g., liking sports or caring about their families). Control group students wrote about values that were important to other people. Students only completed a few of these writing exercises over the course of the school year, but results showed that intervention group students potentially susceptible to stereotype threat had higher grades for up to 2 years after the intervention took place. The authors suggest that an initial boost in performance disrupted the negative recursive cycle between performance anxiety and poor performance, placing students on a new and positive performance trajectory. As further support of these findings, another study showed positive effects of self-affirmation on physiological stress responses directly by randomly assigning some participants to a self-affirmation condition and others to a control writing condition before having them engage in a high-pressure publicly evaluated speech (Creswell et al., 2005). Participants in the self-affirmation condition showed smaller physiological stress responses (i.e., cortisol responses) than participants in the control condition, suggesting that self-focused interventions such as self-affirmation may improve performance by dampening the physiological stress response.

CONCLUSION

Performance anxiety has myriad and long-reaching effects. It can impact academic performance, social interactions, and even life decisions, such as college major and career choices. The roots and mechanisms of performance anxiety are complex and multifaceted, but research across different domains of performance anxiety (e.g., math anxiety and test anxiety) can be used to provide a clearer picture of how performance anxiety develops and works in general. Research points to multiple mechanisms, including negative attitudes (e.g., negative affect), specific behaviors (e.g., avoidance), and decreased resources (e.g., working memory impairment). Although more research is needed to understand better how performance anxiety develops, current findings suggest an important role for both social evaluation and relevant adults (e.g., parents, teachers) during childhood.

Current research is also developing both treatments and preventive measures, including interventions that focus on exposure, on anxiety itself, and on changing the way people think about themselves in situations that evoke performance anxiety. Performance anxiety treatment studies point to the benefit of decreasing working memory load through tasks such as expressive writing and mindfulness mediation. Preventive measures have also proven helpful. For instance, providing positive scripts for anxious adults to use when working with children can help reduce the transmission of performance anxiety to young children, which could stop performance anxiety before it develops. In summary, performance anxiety is an important factor to take into account in promoting optimal task performance and developing competence in a domain over time.

REFERENCES

Adams, E. B., & Sarason, I. G. (1963). Relation between anxiety in children and their parents. *Child Development, 34*, 237–246.

Akiskal, H. S. (1998). Toward a definition of generalized anxiety disorder as an anxious temperament type. *Acta Psychiatrica Scandinavica Supplementum, 393*(98), 66–73.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181–185.

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*(2), 224–237.

Ashcraft, M. H., & Krause, J. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin and Review, 14*, 243–248.

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417–423.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences USA, 107*(5), 1860–1863.

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 4–12.

Bendig, A. W. (1956). The development of a short form of the Manifest Anxiety Scale. *Journal of Consulting Psychology, 20*(5), 384.

Berkowitz, T., Schaeffer, M. W., Maloney, E. A., Peterson, L., Gregor, C., Levine, S. C., et al. (2015). Math at home adds up to achievement in school. *Science, 350*, 196–198.

Brown, R. P., & Josephs, R. A. (1999). A burden of proof: Stereotype relevance and gender differences in math performance. *Journal of Personality and Social Psychology, 76*(2), 246–257.

Chipman, S. F., Krantz, D. H., & Silver, R. (1992). Mathematics anxiety and science careers among able college women. *Psychological Science, 3*(5), 292–295.

Cohen, G. L., Garcia, J., Purdie-Vaughns, V., Apfel, N., & Brzustoski, P. (2009). Recursive processes in self-affirmation: Intervening to close the minority achievement gap. *Science, 324*, 400–403.

Creswell, J. D., Welch, W. T., Taylor, S. E., Sherman, D. K., Gruenewald, T. L., & Mann, T. (2005). Affirmation of personal values buffers neuroendocrine and psychological stress responses. *Psychological Science, 16*(11), 846–851.

Critcher, C. R., & Dunning, D. (2015). Self-affirmations provide a broader perspective on self-threat. *Personality and Social Psychology Bulletin, 41*(1), 3–18.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355–391.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41*(10), 1040–1048.

Elliot, A. J., & Thrash, T. M. (2004). The intergenerational transmission of fear of failure. *Personality and Social Psychology Bulletin, 30*(8), 957–971.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*(1), 19–23.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception and Psychophysics, 16*(1), 143–149.

Flook, L., Goldberg, S. B., Pinger, L., & Davidson, R. J. (2015). Promoting prosocial behavior and self-regulatory skills in preschool children through a mindfulness-based kindness curriculum. *Developmental Psychology, 51*(1), 44–51.

Frattaroli, J., Thomas, M., & Lyubomirsky, S. (2011). Opening up in the classroom: Effects of expressive writing on graduate school entrance exam performance. *Emotion, 11*(3), 691–696.

Geary, D. C. (2014). *Learning mathematics: Findings from the National (U.S.) Mathematics Panel.* Presentation at the 3rd National Conference Dyscalculia and Maths LD, Columbia, MO.

Grupe, D. W., & Nitschke, J. B. (2013). Uncertainty and anticipation in anxiety: An integrated neurobiological and psychological perspective. *Nature Reviews Neuroscience, 14*(7), 488–501.

Hanselman, P., Rozek, C. S., Grigg, J., & Borman, G. D. (2016). New evidence on self-affirmation effects and theorized sources of heterogeneity from large-scale replications. *Journal of Educational Psychology.* [Epub ahead of print]

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33–46.

Hermans, H. J., ter Laak, J. J., & Maes, P. C. (1972). Achievement motivation and fear of failure in family and school. *Developmental Psychology, 6*(3), 520–528.

Hopko, D. R., McNeil, D. W., Zvolensky, M. J., & Eifert, G. H. (2002). The relation between anxiety and skill in performance-based anxiety disorders: A behavioral formulation of social phobia. *Behavior Therapy, 32*(1), 185–207.

Jamieson, J. P., Mendes, W. B., Blackstock, E., & Schmader, T. (2010). Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE. *Journal of Experimental Social Psychology, 46*(1), 208–212.

Jamieson, J. P., Mendes, W. B., & Nock, M. K. (2013). Improving acute stress responses: The power of reappraisal. *Current Directions in Psychological Science, 22*(1), 51–56.

Jamieson, J. P., Peters, B. J., Greenwood, E. J., & Altose, A. J. (2016). Reappraising stress arousal improves performance and reduces evaluation anxiety in classroom exam situations. *Social Psychological and Personality Science, 7*(6), 579–587.

John-Henderson, N. A., Rheinschmidt, M. L., & Mendoza-Denton, R. (2015). Cytokine responses and math performance: The role of stereotype threat and anxiety reappraisals. *Journal of Experimental Social Psychology, 56*, 203–206.

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General, 137*(4), 691.

Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance. *Psychological Science, 16*(3), 175–179.

Joormann, J., & Tran, T. B. (2009). Rumination and intentional forgetting of emotional material. *Cognition and Emotion, 23*(6), 1233–1246.

Lyons, I. M., & Beilock, S. L. (2012). When math hurts: Math anxiety predicts pain network activation in anticipation of doing math. *PLoS ONE*, 7(10), e48076.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*(5), 520–540.

Maloney, E. A., Ansari, D., & Fugelsang, J. A. (2011). The effect of mathematics anxiety on the processing of numerical magnitude. *Quarterly Journal of Experimental Psychology, 64*(1), 10–16.

Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences, 16*(8), 404–406.

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science, 26*(9), 1–9.

Maloney, E. A., Risko, E. F., Ansari, D., & Fugelsang, J. (2010). Mathematics anxiety affects counting but not subitizing during visual enumeration. *Cognition, 114*(2), 293–297.

Mattarella-Micke, A., Mateo, J., Kozak, M. N., Foster, K., & Beilock, S. L. (2011). Choke or thrive?: The relation between salivary cortisol and math performance depends on individual differences in working memory and math-anxiety. *Emotion, 11*(4), 1000–1005.

McQueen, A., & Klein, W. M. (2006).

Experimental manipulations of self-affirmation: A systematic review. *Self and Identity, 5*(4), 289–354.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy, 28*(6), 487–495.

Miyake, A., & Shah, P. (1999). *Models of working memory: Mechanisms of active maintenance and executive control.* New York: Cambridge University Press.

Moè, A. (2012). Gender difference does not mean genetic difference: Externalizing improves performance in mental rotation. *Learning and Individual Differences,* 22(1), 20–24.

Moser, J. S., Moran, T. P., & Jendrusina, A. A. (2012). Parsing relationships between dimensions of anxiety and action monitoring brain potentials in female undergraduates. *Psychophysiology, 49*(1), 3–10.

Mrazek, M. D., Franklin, M. S., Phillips, D. T., Baird, B., & Schooler, J. W. (2013). Mindfulness training improves working memory capacity and GRE performance while reducing mind wandering. *Psychological Science, 24*(5), 776–781.

Nitschke, J. B., Heller, W., Imig, J. C., McDonald, R. P., & Miller, G. A. (2001). Distinguishing dimensions of anxiety and depression. *Cognitive Therapy and Research, 25*(1), 1–22.

Oudejans, R. R., & Pijpers, J. R. (2009). Training with anxiety has a positive effect on expert perceptual–motor performance under pressure. *Quarterly Journal of Experimental Psychology, 62*(8), 1631–1647.

Park, D., Ramirez, G., & Beilock, S. L. (2014). The role of expressive writing in math anxiety. *Journal of Experimental Psychology: Applied, 20*(2), 103–111.

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science, 331,* 211–213.

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: The role of problem solving strategies. *Journal of Experimental Child Psychology, 141,* 83–100.

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187–202.

Rozek, C. S., Pyne, J. R., Hanselman, P., Feldman, R. C., & Borman, G. D. (2016, January). *Reappraising adversity improves students' academic achievement, behavior, and well-being.* Poster presented at the annual meeting of the Society for Personality and Social Psychology, San Diego, CA.

Sarason, I. G. (1960). Empirical findings and theoretical problems in the use of anxiety scales. *Psychological Bulletin, 57*(5), 403–415.

Schmader, T., & Johns, M. (2003). Converging evidence that stereotype threat reduces working memory capacity. *Journal of Personality and Social Psychology, 85*(3), 440–452.

Seery, M. D. (2013). The biopsychosocial model of challenge and threat: Using the heart to measure the mind. *Social and Personality Psychology Compass, 7*(9), 637–653.

Soni, A., & Kumari, S. (2015). The role of parental math anxiety and math attitude in their children's math achievement. *International Journal of Science and Mathematics Education, 5*(4), 159–163.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology, 35*(1), 4–28.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797–811.

Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331,* 1447–1451.

Watson, D., & Clark, L. A. (1991). *The Mood and Anxiety Symptoms Questionnaire (MASQ).* Unpublished manuscript, University of Iowa, Iowa City, IA.

Wilson, T. D. (2011). *Redirect: The surprising new science of psychological change.* London: Penguin.

Wilson, T. D., & Linville, P. W. (1982). Improving the academic performance of college freshmen: Attribution therapy revisited. *Journal of Personality and Social Psychology, 42*(2), 367–376.

Yeager, D. S., Walton, G. M., Brady, S. T., Akcinar, E. N., Paunesku, D., Keane, L., et al. (2016). Teaching a lay theory before college narrows achievement gaps at scale. *Proceedings of the National Academy of Sciences, 113*(24), E3341–E3348.