AMERICAN PSYCHOLOGICAL ASSOCIATION

Journal of Educational Psychology

ISSN: 0022-0663

2022, Vol. 114, No. 2, 393–407
https://doi.org/10.1037/edu0000550

Math Anxiety, Self-Centeredness, and Dispositional Mindfulness

Amir David[1], Orly Rubinsten[2, 3], and Aviva Berkovich-Ohana[1, 3, 4, 5]

[1] Department of Learning and Instructional Sciences, Faculty of Education, University of Haifa
[2] Department of Learning Disabilities, Faculty of Education, University of Haifa
[3] Edmond Safra Brain Research Center, University of Haifa
[4] Department of Counseling and Human Development, Faculty of Education, University of Haifa
[5] The Integrated Brain and Behavior Research Center, University of Haifa

Math anxiety has received increasing focus in recent years, yet the causes for developing math-anxiety remain unclear. Whereas previous research focused on physiological/environmental causes, we examine the link between math-anxiety, dispositional mindfulness, and self-centeredness (operationalized as self-prioritization and decentering). The experiment was performed by 81 participants, and included the original perceptual shape-matching task, measuring the self-prioritization effect, and our novel perceptual number/equation-matching tasks, developed to examine self-prioritization under math-anxiety activation. We also measured math-anxiety, dispositional mindfulness, and decentering (self-reports). We showed that (a) math anxiety was significantly and negatively correlated with dispositional mindfulness and decentering (though there was no correlation between self-prioritization and dispositional mindfulness); (b) self-prioritization was reduced among high math anxiety participants under math-anxiety activation only in the number-matching task (main finding); and (c) decentering was significantly correlated with self-prioritization in the number-matching task, stemming from the low math anxiety group. Our study is the first to indicate a link between math-anxiety, dispositional mindfulness, and self-centeredness. Discussing the main findings, we suggest three interpretations: (a) Negative mood induction may reduce self-prioritization by turning attention to internal states rather than to the stimuli; (b) math-anxiety activation may reduce emotional valence, which in turn reduces the advantage of self-processing; and (c) disruption of self-prioritization by induced negative mood can be due to a breakdown of the integrated-self (previously conceptualized as a high degree of connectedness between the cognitive/affective/motivational/behavioral systems).

Educational Impact and Implications Statement

This study links math anxiety to *decentering*, which is the ability to create distance from the inner experience and disidentify with it. It adds a crucial psychological dimension to math learning, emphasizing the way one interprets and internalizes math situations, particularly failures in math, in relation to one's self-awareness. The current study introduces a novel perspective for examining and understanding math anxiety, relating its origin to maladaptive self-awareness, and shows that such maladaptive self-awareness is related to one's dispositional level of mindfulness.

Keywords: math anxiety, dispositional mindfulness, self-centeredness, self-prioritization, decentering

Supplemental materials: https://doi.org/10.1037/edu0000550.supp

Mathematical skills are essential for productive functioning in our progressively more complex, technological society (for review see Hart & Ganley, 2019; Mammarella et al., 2019). Yet, many people encounter apprehension and fear when dealing with numerical information, a condition termed math anxiety (Richardson & Suinn, 1972). For instance, the Organization for Economic Cooperation and Development (OECD) reported the prevalence of math anxiety to be as high as 33% in 15-year-old students (PISA, 2013). Math anxiety is characterized by an excessive and sometimes unreasonable fear of numerical related activities (e.g., math homework, comparing loan options), as well as fear of situations wherein the individual is concerned about possible negative evaluation (e.g., by teachers or classmates) of one's numerical performance (e.g., during

This article was published Online First November 15, 2021.
Amir David https://orcid.org/0000-0002-9741-4415
Orly Rubinsten https://orcid.org/0000-0003-3342-9308
Aviva Berkovich-Ohana https://orcid.org/0000-0003-2549-0168
This research was funded by the Bial Foundation, Grant 45069 to Aviva Berkovich-Ohana. Additionally, this project was supported by Grant FQXi-RFP-CPW-2004 from the Foundational Questions Institute and Fetzer Franklin Fund, a donor advised fund of Silicon Valley Community Foundation to Aviva Berkovich-Ohana.
Correspondence concerning this article should be addressed to Aviva Berkovich-Ohana, Department of Learning and Instructional Sciences, Faculty of Education, University of Haifa, 199 Aba Khoushy Avenue, Mount Carmel, Haifa, 3498838, Israel. Email: avivabo@edu.haifa.ac.il

math exams; Richardson & Suinn, 1972). Thus, in terms of numerical and academic achievements, math anxiety is negatively linked to math performance (Chang & Beilock, 2016; Hembree, 1990; Ma, 1999), and math anxious individuals show lower performance on numerical tasks (Beilock et al., 2010; Choe et al., 2019; Maloney & Beilock, 2012; Passolunghi et al., 2020; Rolison et al., 2020; Schmitz et al., 2019) and poor cognitive abilities in mathematics (Rubinsten et al., 2012; Rubinsten & Tannock, 2010).

There is increasing evidence that math anxiety has detrimental effects on the health, social, and economic trajectory of one's life course. For example, math anxiety has been associated with increased health costs (Duncan et al., 2007; Parsons & Bynner, 2005; Reyna et al., 2009; Rolison et al., 2020; Woloshin et al., 2001), low socioeconomic status (Ritchie & Bates, 2013), and mortgage default (Gerardi et al., 2013). In Western society, poor numeracy is seen as a greater handicap than poor literacy (Estrada et al., 2004; Rivera-Batiz, 1992). Quantitative reasoning is necessary in science and technology as well as in a range of educational setups (Hart & Ganley, 2019; Núñez-Peña et al., 2013; Rolison et al., 2020), such as school examinations and people's financial decisions (for review, see Dowker et al., 2016; Maloney & Beilock, 2012; and Ramirez et al., 2018). Thus, in the long run, math-anxious individuals are less likely to have math-related careers (science, technology, or engineering; see Hembree, 1990; Ma & Xu, 2004; Maloney & Beilock, 2012).

Although some interventions attempting to reduce or prevent math anxiety were found to be successful, it is still not clear how to deal successfully with math anxiety. Treatments we can mention include expressive writing ("writing out" the negative affect and worry), one-on-one math tutoring programs; noninvasive brain stimulation, such as transcranial electrical stimulation (Dowker et al., 2016), and a few mindfulness-based interventions (MBIs; Brunyé et al., 2013; Samuel & Warner, 2019), which are detailed later. Against this background, math anxiety has received increasing focus in recent years, and yet the causes for developing math anxiety remain unclear (Ashcraft, 2002; Baloğlu & Koçak, 2006; Ramirez et al., 2018). Models explaining math anxiety classically suggest several causes, including genetic factors (Wang et al., 2014), poor math skills (Ma & Xu, 2004), socioenvironmental factors such as anxiety conveyed by teachers who are themselves anxious about mathematics (Beilock et al., 2010; Kelly & Tomhave, 1985), early negative experiences with teachers (Jackson & Leffingwell, 1999), exposure to gender stereotypes (Jackson & Leffingwell, 1999; Johns et al., 2005), and intergenerational transmission (Maloney et al., 2015).

In alignment with such physiological and environmental causal explanations, most of the research on math anxiety has focused on cognitive (working memory, attention), environmental (environmental factors such as gender, classroom and teacher influence), and physiological aspects (Chang & Beilock, 2016; Dowker et al., 2016; Ramirez et al., 2018). In addition, few studies focused on the emotional aspects of math anxiety, mostly studying general anxiety and low self-confidence. For instance, it was shown that anxious participants typically rush through tasks (Ashcraft & Krause, 2007) and thus show faster and less carefully examined responses (which do not result from hampered working memory resources; see Morsanyi et al., 2014b). Additionally, math anxious individuals demonstrate reduced confidence in their performance (Jain & Dowson, 2009; Morsanyi et al., 2014a) and thus tend to select easy and low-rewarding math problems over hard and high-rewarding problems (Choe et al., 2019; Schmitz et al., 2019). Together with the shorter time they spend on math problems (Morsanyi et al., 2014a), this tendency is expected to hinder their corrective actions. It could be, for example, that math anxious individuals rush through math problems (Ashcraft & Krause, 2007; Morsanyi et al., 2014a) simply because they do not trust their ability to solve them, and thus they do not expect that investing more time would improve their performance.

In contrast to the above reviewed research on math anxiety, the current study tries to tackle math anxiety and its origins among learners from a novel perspective, one that tests the correlational role of inner psychological traits. Our study builds on a recent psychological model (Ramirez et al., 2018), which suggests that math anxiety stems from personal differences in interpreting life events, especially stressful situations in educational environments. Ramirez et al. (2018) claim that although socioenvironmental elements outline the risk factors in which math anxiety can develop more easily, this does not explain why certain students develop math anxiety whereas others do not, under the same circumstances. According to this interpretation, students who utilize maladaptive appraisal of math learning experiences or of poor math outcomes will be more likely to develop math anxiety, as opposed to student who appraise the same situation differently, acknowledging the difficulty of learning this subject matter or not adopting a self-narrative toward their adequacy or inadequacy to learn math.

Aligned with the psychological theory of math anxiety, we hypothesized that maladaptive appraisal of math learning experiences, which was suggested as a main cause for math anxiety, is connected to maladaptive self-centeredness and dispositional mindfulness. These concepts stem from solid theoretical conceptualizations that have rapidly gained support in the last decade and are detailed in the following text.

Self-Centeredness, Well-Being, and Mindfulness: Theoretical Links and Empirical Evidence

An increasing number of publications in philosophy, psychology, and neuroscience have investigated the experience of the self. The concept of the self is highly ambiguous, and includes different aspects, thus it may be best constructed as a multidimensional construct that includes somatosensory, agentive, narrative, and social components (Gallagher, 2000, 2011, 2013; Strawson, 2000). In an attempt to enable a fruitful dialogue between philosophy of mind and cognitive neuroscience, the notion of self has been grossly divided into two important concepts (Gallagher, 2000; Zahavi & Gallagher, 2008): the *narrative self* (i.e., a conceptual, autobiographical identity with continuity across time) and the *minimal self* (i.e., a momentary, perceptual, and embodied self). The two notions of self-constitution find confirmation in cognitive neuroscience, largely related to different brain regions and networks (Berkovich-Ohana & Glicksohn, 2014; Christoff et al., 2011; Legrand & Ruby, 2009). Here, we focus on aspects of the narrative self, which has been broadly discussed in clinical and social psychology and is typically related to one's inner representations or schemas of oneself, sometimes in relation to the world and others (Deci & Ryan, 2000; Mischel & Shoda, 1995).

The realization of more adaptive psychological functioning of the self is suggested to be a cornerstone of well-being (Dambrun & Ricard, 2011; Hadash et al., 2016; Hanley et al., 2017, 2020). Specifically, the relationship between the mode of psychological functioning of the self and well-being is laid out by the theory of self-based psychological functioning (Dambrun & Ricard, 2011), which has recently gained empirical support (Dambrun, 2016, 2017; Dambrun et al., 2019; Hanley et al., 2017, 2020). According to this theory,

> the perception of a structured self, which takes the form of a permanent, independent, and solid entity leads to self-centered psychological functioning, and this seems to be a significant source of both affliction and fluctuating happiness. Contrary to this, a selfless psychological functioning emerges when perception of the self is flexible (i.e., a dynamic network of transitory relations), and this seems to be a source of authentic-durable happiness.

Thus, at one pole of the self-configuration continuum, there is self-centeredness, experienced as sharply defined, solid, and independent. At the opposite pole, selflessness is experienced as more flexible (arising from dynamic, interactive processes) and fundamentally interconnected (Dambrun & Ricard, 2011).

The psychological mode of self-centeredness, which is characterized by preoccupation with the self (Dambrun & Ricard, 2011), has been suggested to drive intolerance of unpleasant emotion, experiential avoidance, and reactivity to internal experience, anxiety, and depression (Bernstein et al., 2015; Dambrun & Ricard, 2011). In contrast to this stable, highly judgmental, evaluative self, which is related to a strong need for self-validation, an integrative yet flexible and nonevaluative self has been considered a more adaptive form of self, which can contribute to interconnectedness with others and to decreased preoccupation with the self (Dambrun & Ricard, 2011). According to self-determination theory (Deci & Ryan, 2000), the adaptive self-schema (or self- concept), which is the basis for self-determined action, is created when the self is gradually elaborated and refined throughout integrating processes. In such processes, the self-schema comprises a set of "flexible, unified regulatory processes, values, and structures, that allow people to engage volitionally in activities" (p. 248). Neff (2003) suggested a related paradigm within the framework of self-compassion—a kind, nonevaluative perspective on the self and emphasis on its interconnected components, which enhances a positive yet flexible and adaptive perspective on the self and can counter maladaptive self-centeredness and its undesirable consequences. Under this theoretical framework, we set out to test the relationship between self-centeredness and math anxiety. Our assumption was based on ample literature showing a strong link between math anxiety and math avoidance (Carey et al., 2016; Choe et al., 2019; Hembree, 1990). Considering research showing a connection between self-centeredness and intolerance to unpleasant emotions, experiential avoidance, and anxiety, we can base our hypothesis on solid theory.

Importantly, there is a strong link between mindfulness, both as a practice and as a disposition, and psychological functioning of the self. *Mindfulness* is a way of purposefully paying attention to present moment experiences with no judgment or elaboration (Bishop et al., 2004; Brown & Ryan, 2003; Kabat-Zinn, 2003). Mindfulness meditation, a nonsectarian Western development of the Buddhist Theravada Vipassana meditation, is rapidly spreading as a secular practice worldwide, with millions practicing daily in the United States alone and with growing presence in scientific publications (Davidson & Kaszniak, 2015). Emerging research shows that mindfulness meditation generally exerts beneficial effects on one's physical and mental health, including heightened attention and emotion regulation (Tang et al., 2015), increased immune function (Black & Slavich, 2016), and possibly offsetting age-related cognitive decline (Gard et al., 2014). Although mindfulness can be characterized as a trained skill, it is also thought to be a dispositional capacity, and as such it varies between individuals due to the propensity or willingness to devote attention to the present moment (Brown & Ryan, 2003).

Notably, one of the proposed key mechanisms for achieving the effects of mindfulness is reducing identification with a rigid self-concept through enhanced meta-awareness (Dambrun & Ricard, 2011; Hart, 1987; Olendzki, 2003). This, in turn, creates a shift in the experience of the self and its proposed underlying neural activity (Berkovich-Ohana et al., 2020; Dahl et al., 2015; Hölzel et al., 2011; Tang et al., 2015; Vago & David, 2012). Disidentification with such a static self-concept results in the freedom to experience a more genuine way of being. Through enhanced meta-awareness (making awareness itself an object of attention), mindfulness (both as meditation and as a disposition) is thought to facilitate a detachment from identification with the self as a static entity and a tendency to identify with the phenomenon of "experiencing" oneself is thought to emerge. Specifically, enhancing mindfulness is related with enhancing the regulation of attention and meta-awareness, which in turn down-regulates the automatic process of absorption in the contents of consciousness (experiential-fusion), as well as deconstructing maladaptive self-schema by utilizing self-inquiry to foster flexibility and insights into self-related psychological processes (Dahl et al., 2015).

The Current Study

Based on the theory previously laid out connecting dispositional mindfulness, self-centeredness, and well-being, this study is the first to attest to the links between math anxiety, dispositional mindfulness, and self-centeredness. There is no research to date connecting these variables, and even research on the relationship between mindfulness training and math anxiety is scarce (Brunyé et al., 2013; Samuel & Warner, 2019). To fill these gaps, we set out to test the link between these variables, as subsequently elaborated.

Notably, we operationalize self-centeredness by measuring decentering using self-reports, as well as implicit self-prioritization using cognitive behavioral tasks. Decentering is a shift in perspective to the self-experience, described as "the ability to step outside of one's immediate experience, thereby changing the very nature of that experience" (Safran & Segal, 1996, p. 117). Decentering involves taking a nonjudgmental and accepting stance regarding thoughts and feelings (Fresco et al., 2007) and reflects the metacognitive awareness that one's thoughts and experiences are in essence no more than mental events that can be observed without requiring response or reaction from oneself (Bernstein et al., 2015; Grabovac et al., 2011; Shapiro et al., 2006). Decentering has been suggested to contribute to emotion regulation, and has been linked to reduced anxiety and depression (Hayes-Skelton et al., 2015; Teasdale et al., 2002) and enhanced mental health

(Ashcraft & Moore, 2009; Hayes et al., 2002; Salmon et al., 2009). Importantly for our study, decentering is considered an important working mechanism of dispositional mindfulness (Gecht et al., 2014; Hayes-Skelton & Graham, 2013).

The concept of the self is rather abstract and difficult to measure. Thus, multimethod assessments, including self-reports and measures assessing the actual behavior, are recommended in order to reach a more complete understanding of phenomena related to the experience of the self (Nyklíček, 2020). Hence, in addition to measuring decentering using self-reports, we added to the study a behavioral measure. An implicit way of tackling self-centeredness is by measuring self-prioritization effects, which "serve as a proxy for the otherwise difficult to measure and abstract concept of the self" (Sui & Humphreys, 2017, p. 2). Self-prioritization, or self-bias, is people's tendency to favor information regarding themselves over information regarding others. These biases appear in perception, memory, and attention, and are used by researchers to shed light on the nature of the self. The research measuring these biases is vast and includes evidence in memory, face-recognition, and even simple perceptual matching tasks through objective measures (which we will use in this study; Sui & Humphreys, 2017). There is some evidence linking mindfulness practice to self-prioritization, showing that among long-term practitioners there are reduced electrophysiological responses of self-versus-other in the face recognition task (Trautwein et al., 2016).

In the current study, we developed a unique implicit behavioral task aimed at testing the association between activated math anxiety and self-prioritization. To this end, we modified the well-known perceptual shape-matching task (Sui et al., 2012), in which self-prioritization is measured as the difference between reaction time (RT) and self-matching versus stranger-matching shapes. Instead, we created a novel perceptual number-matching task, where self-prioritization is measured as the difference between RT and self-matching versus stranger-matching numbers (these numbers are either single digits or simple equations, to manipulate the math difficulty level and thus raise the math anxiety level among math-anxious individuals). We hypothesized that a change would be found in self-prioritization in the perceptual number-matching task for the high math anxiety (HMA) individuals compared with low math anxiety (LMA) individuals. This hypothesis is based on previous findings which showed a disruption of self-prioritization under negative mood induction, using negative statements along with negative/neutral music (Sui et al., 2016). The researchers found that self-prioritization was reduced under negative mood, compared with neutral conditions. Hence, we expected to find a similar disruption in self-prioritization when numbers (and even more so equations) would replace the shapes for the high math-anxious individuals compared with low math-anxious individuals.

To summarize, here we examined the possible relationship between math anxiety, dispositional mindfulness, and self-centeredness (including self-reports of decentering, as well as behavioral measures of self-prioritization). Specifically, the research questions and hypotheses were as follows:

1. What is the relationship between math anxiety, dispositional mindfulness, and decentering? We hypothesized that math anxiety would be negatively correlated with dispositional mindfulness and decentering.

2. What is the relationship between math anxiety and self-prioritization? We hypothesized that under math anxiety activation, self-prioritization would be reduced in HMA compared with LMA individuals (i.e., the tendency to prioritize the self would be disrupted among HMA under math activation).

3. What is the relationship between self-prioritization and dispositional mindfulness? We hypothesized a negative correlation between these variables.

4. Considering that decentering and self-prioritization capture two different aspects of self-centeredness, what is the relationship between the two variables in the context of math anxiety? We hypothesized that under stress (e.g., math anxiety activation), decentering would be negatively correlated with self-prioritization (i.e., individuals better able to decenter would show normal/heightened self-prioritization).

Method

Participants

Eighty-one participants took part in the experiment (*M* age = 33.14, *SD* = 11.40; 53 women). Forty-six of them were students from the University of Haifa, recruited to this study in exchange for academic credits. The rest were individuals from the general population, without prior knowledge concerning their level of math anxiety, recruited from outside the university as volunteers based on acquaintance with the first author. Eight participants underwent the experiment before adding the number-macthing and equation-matching tasks to the study, and thus their data is partial. All participants were recruited with no prior knowledge of their math anxiety level.

Procedure

Upon arrival, participants were introduced to the lab, seated in front of a computer in a small private experimental chamber, and asked to fill out a demographic questionnaire, as well as to sign a consent form. Following that, they performed a battery of tasks/self-reports in the following order: the original perceptual shape-matching task (Sui et al., 2012) in order to study self-prioritization in nonmath-anxiety activated conditions, several questionnaires (listed below), and the perceptual number-matching task, modified to examine performance in the perceptual matching task under math anxiety activation. The entire lab procedure lasted one hour. The study was approved by the Institutional Review Board Ethics Committee of the Faculty of Education at the University of Haifa.

Research Tools

Questionnaires

The math anxiety level was assessed using the Math Anxiety Rating Scale (MARS; Suinn & Winston, 2003), a 30-item inventory composed of brief descriptions of behavioral situations (e.g., "having someone watch you as you total up a column of figures").

The MARS-R is a shorter version of the MARS, which is 98-item scale. The level of anxiety for each item is rated on a 5-point Likert scale ranging from 1 (*not at all anxious*) to 5 (*very much anxious*).

Trait mindfulness was assessed using the Five Facet Mindfulness Questionnaire–Short Form (FFMQ-SF; Bohlmeijer et al., 2011). This is a 24-item questionnaire extracted from the five facets of the FFMQ (Baer et al., 2006), which measures five facets of mindfulness: observing (e.g., "I pay attention to physical experiences, such as the wind in my hair or the sun on my face"), describing (e.g., "I'm good at finding words to describe my feelings"), acting with awareness (e.g., "It seems I am 'running on automatic' without much awareness of what I'm doing"), nonjudging (e.g., "I make judgements about whether my thoughts are good or bad"), and nonreacting (e.g., "When I have distressing thoughts or images, I don't let myself be carried away by them"). Participants were asked to rate the degree to which each statement is true for them, on a 5-point Likert-type scale ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*).

Decentering was assessed using the Experiences Questionnaire–Decentering factor (EQ-D; Fresco et al., 2007), an 11-item self-report inventory (e.g., "I can actually see that I am not my thoughts"). Items are rated on a 7-point Likert scale ranging from 1 (*never*) to 7 (*all the time*).

Self-Prioritization Tasks

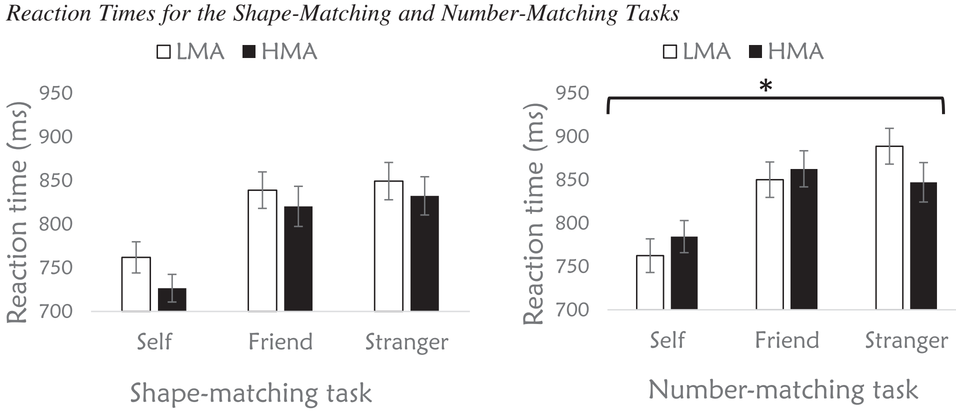
In this first task, three geometric shapes (triangle, square, and circle, each 3.80 × 3.80) were assigned to labels representing you, friend, or stranger (each 3.60 × 1.60, written in Hebrew)" to " In this first task, three geometric shapes (a triangle, square, and circle, each 3.80 × 3.80) were labeled "you," "friend," or "stranger" (each 3.60 × 1.60, written in Hebrew). Further, a slide was displayed for 100 ms in each trial with a random pair of geometric shapes and labels; the participant was instructed to decide whether the displayed pair was a matched or nonmatched pair, according to the labeled items displayed in the beginning of the task, and to press the correct button indicating a matched/nonmatched pair, accordingly. The assignment of the shapes to the different labels was counterbalanced across participants and sessions. After the instruction to associate shape with label, participants were given a short training session containing twelve trials and subsequently performed the task in four blocks, each block containing sixty trials. We decided to shorten the length of the task in comparison to the original (Sui et al., 2012), from six to four blocks, because the task would be too long after adding the other tasks in the battery. The choice of four blocks was based on three things: (a) Sui and colleagues (2016) published other articles with less than six blocks, for example, with three blocks; (b) we ran a pilot study on nine participants, which showed no significant differences in performance (RT and accuracy) between two, three, four, five, and six blocks (for details, see the online supplemental material, Part A); and (c) we did identify a trend (not significant) of reduced accuracy when performing less than four blocks (see Figure 1 and Part A of the online supplemental material). Hence, we conclude that the shortening of the original task did not reduce the task's reliability.

At the end of each block, a frame was displayed informing the participants of their overall accuracy in the block. Each trial began with a fixation point for 500 ms (.8° × .8°), after which a shape was displayed above a white central fixation cross, and a label was displayed above it for 100 ms. Immediately after that, a blank frame was presented for 1,300 ms. Participants were expected to judge whether the pair presented matched or mismatched by pressing one of the two response buttons as quickly and accurately as possible. Feedback (correct or incorrect) was immediately presented on the screen for 500 ms.

Perceptual Number-Matching Task

This task differs from the perceptual shape-matching task by replacing the three shapes with three one-digit numbers (*5*, *7*, *9*). This was based on a previous report (Rubinsten et al. (2015), which showed that the very act of showing numbers, and not necessarily math equations, can be a stimulus that is cognitively or affectively linked with threatening and negative valence among high math-anxious individuals, which

Figure 1
Reaction Times for the Shape-Matching and Number-Matching Tasks



Note. Reaction time (RT; $M \pm SEM$) as a function of the three conditions (Self, Friend, and Stranger) for the two groups (LMA – low math anxiety; HMA – high math anxiety) for the shape-matching (left) and number-matching (right) tasks.
* $p < .05$.

leads to an attentional bias toward the emotionally negative information. Thus, the one-digit numbers were intended to activate math anxiety among math-anxious participants. Apart from the change from shapes to numbers, the procedure in each trial was identical to the perceptual-matching shape task. The assignment of the numbers to the different labels was counterbalanced across participants and sessions. Because the perceptual equation-matching followed the number-matching task, the participants completed two blocks in this task, containing 60 trials each.

Perceptual Equation-Matching Task

This task, continuing the previous task, was designed to examine changes in self-prioritization under elevated math anxiety among math-anxious participants. In this task, the three one-digit numbers (*5*, *7*, *9*) were replaced by simple addition or subtraction equations representing the same numbers (e.g., *5* was replaced by 3 + 2 or 9 – 2, and *7* was replaced by 9 – 2 or 5 + 2). For each number there were seven different equations (e.g., *9* was represented by the following equations: 7 + 2; 4 + 5; 6 + 3; 8 + 1; 10 – 1; 12 – 3; 14 – 5). The assignment of the numbers resulting from the equations and the labels (self, friend, stranger) was identical to the previous task. Participants were expected to implement two operations in each trial: first to solve the equation presented and then to judge whether the resulting number matched or mismatched the label presented. Because this task was utterly novel, we could not rely on previous research in deciding the accurate time intervals required to implement these two operations in each trial.

Each trial began with a fixation point for 500 ms (.8° × .8°), after which an equation was displayed above a white central fixation cross, and a label was displayed above it for 500 ms (instead of 100 ms in the two previous tasks). Immediately after that, a blank frame was presented for 2,500 ms (instead of 1,300 ms in the two previous tasks). The participants completed two blocks in this task, containing sixty trials each.

Statistical Analyses

For testing correlations between the various scales and measures, we used Pearson correlations, correcting for multiple comparisons using the Holm-Bonferroni method (Sedgwick, 2012). For testing the self-prioritization effect in all three perceptual matching tasks, we analyzed them separately. Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall. For the RTs, we used a one-way analysis of variance (ANOVA) for each of them, testing within-subject differences for shape/number/equation. This was first performed for all conditions together, and then separately for matched and nonmatched pairs. For accuracy, we used the measure of d', following Sui et al. (2012). The measure of d' is used in signal detection theory, providing a separation between the means of the signal and the noise distributions. Specifically, we calculated d' as the subtraction of the z transforms of hits and correct rejections.

For testing the interaction between math anxiety and self-prioritization in each perceptual task, we used Pearson correlation, as well as group division. We sorted participants into two groups of HMA and low LMA, based on group median score, according to the methods of previous studies, because the literature does not set a clear threshold for HMA levels (Beilock & DeCaro, 2007; Brunyé et al., 2013; Ramirez et al., 2016; Rubinsten et al., 2015). We then performed a two-way repeated measures ANOVA, with the between-subjects factor being math anxiety (LMA vs. HMA) and the within-subject factor being shape/number/equation.

Results

Correlations Among Math Anxiety, Dispositional Mindfulness, and Decentering

All the questionnaires used in this study showed high reliability, compatible with the literature (see Table 1). To answer the first research question, we tested the correlations between math anxiety, dispositional mindfulness, and decentering. Pearson correlation analyses yielded a negative significant correlation between math anxiety and dispositional mindfulness ($r = -.245$, $n = 81$, $p < .05$) and a significant negative correlation between math anxiety and decentering ($r = -.307$, $n = 81$, $p < .01$), showing that individuals exhibiting LMA report high levels of dispositional mindfulness and decentering compared with individuals exhibiting

Table 1
Means and Standard Deviations, Minimum and Maximum Scores and Skewness and Kurtosis Values With Standard Errors, and Reliablities With Cronbach's Alphas for Each Questionnaire in the Current Study and in the Literature

Variable	*M* (*SD*)	Minimum	Maximum	Skewness (*SE*)	Kurtosis (*SE*)	Reliability (α)	Questionnaire's reliability in the literature
Math anxiety	2.34 (0.75)	1.00	3.87	.396 (.269)	−.732 (.532)	.96	.96 (Suinn & Winston, 2003)
Dispositional mindfulness (five facets)	3.52 (0.55)	1.00	4.87	.601 (.269)	.351 (.532)	.80 (actaware), .75 (observe), .77 (nonjudge), .77 (nonreact), .84 (describe)	.86 (actaware), .78 (observe), .86 (nonjudge), .73 (nonreact), .91 (describe) (Bohlmeijer et al., 2011)
Decentering	4.31 (0.80)	2.13	4.53	.173 (.269)	.673 (.532)	.86	.83 (Fresco et al., 2007)

HMA. The results remain significant negative correlation following Holm–Bonferroni corrections for multiple comparisons.

Math Anxiety and Self-Prioritization

The Novel Number and Equation-Matching Task Show Self-Prioritization Effects

We first analyzed all the self-prioritization tasks over all the participants together, to confirm Sui et al. (2012) results showing greater prioritization in favor of the self versus stranger. In the perceptual shape-matching task, one female participant was excluded due to missing data. Another participant was excluded from further analyses due to outlier results (>2 *SD*) of fast RTs and low accuracy. In the equation-matching task, two participants did not complete the experiment due to personal reasons and therefore their data is missing.

For the RTs, in the perceptual shape-matching task, a one-way repeated measures ANOVA with the within-subjects factor being the shape category (self, friend, stranger) showed a significant effect in favor of Self < Friend < Stranger, $F(2, 156) = 26.84$, $p < .001$, $\eta^2 = .26$, as previously reported by Sui et al. (2012). In the perceptual number-matching task, the same ANOVA with the within-subjects factor being the number category (self, friend, stranger) yielded a significant difference for the number category, $F(2, 140) = 24.80$, $p < .001$, $\eta^2 = .26$, with faster responses to self-association and an almost identical RT to friend and stranger. Finally, the same ANOVA yielded a significant effect for the equation-matching task, $F(2, 136) = 15.826$, $p < .001$, $\eta^2 = .19$, with faster responses to self-association and almost an identical RT to friend and stranger. We proceeded with the same RT analyses separately for matched and nonmatched pairs. In the matched condition, the same analysis yielded a significant effect for the shape-matching task, $F(2, 156) = 31.93$, $p < .001$, $\eta^2 = .29$, as well as for the number-matching task, $F(2, 140) = 31.29$, $p < .001$, $\eta^2 = .31$. and for the equation-matching task, $F(2, 136) = 25.78$, $p < .001$, $\eta^2 = .275$. In contrast, there was no significant effect for the nonmatched pairs in all three tasks ($p = .26$ in the shape-matching task, $p = .40$ in the number-matching task, and $p = .40$ in the equation-matching task).

For accuracy, a one-way repeated measures ANOVA with the within-subjects factor being the shape category showed a significant effect with a larger d' for self-association than other in the shape-matching tasks, $F(2, 154) = 10.27$, $p < .001$, $\eta^2 = .12$.The same analysis yielded the same results for number category in the number-matching task, $F(2, 140) = 12.66$, $p < .001$, $\eta^2 = .15$, and in the equation-matching task, though it was weaker than in the previous tasks, $F(2, 138) = 4.828$, $p < .05$, $\eta^2 = .065$. These results replicate and extend Sui et al. (2012) findings, showing faster and more accurate responses with increasing proximity to self-association (self < friend <stranger) and indicating a clear self-prioritization effect, whether the self is associated with a shape, number, or equation (see Table 2).

As can be inferred from Table 2, the mean RT in the equation-matching task (1,206 ms) is longer than in the number-matching task (867 ms) and the shape-matching task (837 ms), due to experimental allocation of longer intervals in this task. Aligned with that, the mean accuracy is generally higher in the equation-matching task (.83) than in the number-matching task (.77) and the shape-matching task (.79).

Self-Prioritization Under Math Anxiety Activation

To answer the second research question, we first conducted a Pearson correlation between math anxiety and performance in self-prioritization tasks. To this end, we first followed Sui et al. (2013), by creating a single measure named *behavioral response efficiency*, which is the Self – Stranger difference in RT/accuracy (note that the stronger the self-prioritization, the higher the behavioral response efficiency). Examining the relationship between behavioral response efficiency and math anxiety yielded no significant correlations for the perceptual shape-matching task, nor for the number-matching or equation-matching tasks ($r = -.150$, $n = 79$, $p = .187$; $r = -.035$, $n = 72$, $p = .768$; and $r = -.112$, $n = 69$, $p = .361$, respectively).

Because Sui et al. (2016) found disruption in self-prioritization only in RT (but not in accuracy) under conditions of negative statements/music, we then tested the correlation for RT only. We created a single RT measure of Self – Stranger and conducted a Pearson correlation separately for each perceptual-matching task. There was no significant correlation between math anxiety and the single RT measure for the shape-matching task ($r = -.130$, $n = 79$, $p = .255$) or the equation-matching task ($r = -.068$, $n = 69$, $p = .576$). As opposed to these tasks, the correlation between math anxiety and single RT measure in number-matching task did show a borderline significance, for a negative correlation coeficient of medium-low size ($r = -.209$, $n = 72$, $p = .078$). A robust regression

Table 2

Means and Standard Deviations (in Parentheses) of Reaction Time (RT) and Accuracy (Proportion Correct) for Self, Friend, and Stranger in the Matched and Nonmatched Condition for Each Task

	RT (ms)			Accuracy		
Condition	Shape-matching	Number-matching	Equation-matching	Shape-matching	Number-matching	Equation-matching
Matched						
Self	744 (107)	770 (111)	1,111 (198)	0.83 (0.17)	0.86 (0.16)	0.85 (0.16)
Friend	829 (137)	855 (123)	1,217 (207)	0.75 (0.18)	0.81 (0.20)	0.81 (0.16)
Stranger	840 (135)	864 (129)	1,211 (199)	0.73 (0.20)	0.74 (0.19)	0.82 (0.17)
Nonmatched						
Self	865 (118)	894 (125)	1,225 (202)	0.75 (0.16)	0.72 (0.21)	0.81 (0.16)
Friend	874 (117)	905 (124)	1,227 (210)	0.74 (0.16)	0.74 (0.20)	0.80 (0.17)
Stranger	869 (118)	899 (136)	1,247 (237)	0.74 (0.17)	0.74 (0.18)	0.79 (0.17)

analyses did not yield different findings. Because we uncovered negative correlations between math anxiety and performance in self-prioritization tasks with a borderline significance in the number-matching task only, we proceeded to analyze group differencs, using the median split for the math anxiety variable. The division into the group of HMA or LMA was based on the group median score in the MARS-R questionnaire, as done in previous studies in the field of math anxiety (Beilock & DeCaro, 2007; Brunyé et al., 2013; Ramirez et al., 2016; Rubinsten et al., 2015). The cut-off threshold for inclusion was a score below (for LMA group) or above (for HMA group) 2.20, which was the group's median. Importantly, there were no significant differences, other than math anxiety level, between the HMA and LMA groups (see Table 3).

Next, we compared the two math anxiety groups (LMA vs. HMA) and examined differnces in self-prioritization between the two groups separately for the perceptual shape-matching task (no math anxiety activation, or the "neutral state"), the perceptual number-matching task (under math anxiety activation). To this end, we first tested the shape-matching task results, using a two-way repeated measures ANOVA with the between-subjects factor being math anxiety (LMA $n = 40$ vs. HMA $n = 39$). As expected, there was no significant interaction effect of Shape Category × Math Anxiety Group for the matched condition, neither in RT ($p = .73$; see Figure 1) or in accuracy ($p = .58$). These results indicate no apparent difference between the two groups in the shape-matching association task, when self, friend, stranger are associated with shapes.

Importantly, these results changed significantly when self, friend, stranger were associated with numbers. In RT, the two-way repeated measures ANOVA with the between-subjects factor being math anxiety (LMA $n = 34$ vs. HMA $n = 37$) resulted in a significant interaction effect between Math Anxiety Group × Number Category in the matched condition, $F(2, 138) = 3.54$, $p < .05$, $\eta^2 = .05$, see Figure 1. In accuracy, results yielded a borderline significant interaction effect between number category and math anxiety group, $F(2, 138) = 2.78$, $p = .067$, but no significant interaction effect for d' ($p = .17$).

In order to highlight the change in self-prioritization between LMA and HMA, when self-processing is under math anxiety activation (perceptual number-matching task) compared with the neutral state (perceptual shape-matching task), we created a new variable we refer to as ΔRT. We subtracted the RT of Stranger – Self, and then compared the ΔRT of LMA and HMA for the shape-matching and number-matching tasks. A two-way repeated measures ANOVA with the within-subject factor being task category (shape vs. number) and the between-subjects factor being math anxiety (LMA vs. HMA) for ΔRT showed a significant interaction effect for the Math Anxiety Group × Task Category, $F(1, 69) = 6.01$, $p < .05$, $\eta^2 = .08$. Figure 2 shows that ΔRT self-stranger in matched pairs is reduced from the perceptual shape-matching task to the perceptual number-matching task only for the HMA group, whereas the opposite is true for the LMA group.

Table 3
Study Variables by Group

Variable	LMA *M* (*SD*) or *n*	HMA *M* (*SD*) or *n*
Age	33.5 (10.3)	32.7 (12.5)
Dispositional mindfulness	3.65 (0.473)	3.45 (0.46)
Decentering	4.46 (0.78)	4.15 (0.81)
Female	27	31
Male	14	8

Note. LMA = low math anxiety; HMA = high math anxiety.

Because data analyses showed a significant interaction effect in RT between the LMA and HMA groups in number category (perceptual number-matching task) but not in shape category (perceptual shape-matching task), we performed a three-way repeated measures ANOVA for RT in the matched condition. The ANOVA included two within-subjects factors: association category (Self, Friend, Stranger) and task category (shape-matching vs. number-matching) and the between-subjects factor of math anxiety (LMA vs. HMA). Results yielded a significant interaction effect between task, association category, and math anxiety group, $F(2, 138) = 3.37$, $p < .05$, $\eta^2 = .05$. To conclude, results show that self-prioritization is distrupted among HMA, but only when math anxiety is activated (i.e., only in the perceptual number-matching task).

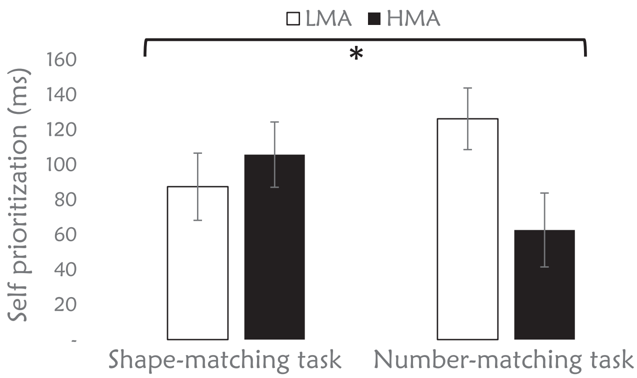
We then continued to analyze the perceptual equation-matching task, expecting similar results as in the number-matching task, because the equation-matching task is an extention of the number-matching task with elevated activation of math anxiety. However, to our surprise, the results did not yield similar results. In RT, the two-way repeated measures ANOVA with the between-subjects factor of math anxiety (LMA $n = 33$ vs. HMA $n = 36$) resulted in a a nonsignificant interaction effect between Math Anxiety Group × Number Category in the matched condition ($p = .40$). In accuracy, the results once again yielded a nonsignificant interaction effect between the number category and the math anxiety group ($p = .86$), and a nonsignificant interaction effect in d' ($p = .985$). In sum, the results did not yield a significant interaction effect between the LMA and HMA groups, neither for RT nor for accuracy.

Correlations Among Self-Prioritization, Dispositional Mindfulness, and Decentering

To answer the third and fourth research questions, we assessed the relationship between self-prioritization and dispositional mindfulness as well as decentering in the three perceptual-matching tasks. To this end, we examined the relationship between behavioral response efficiency and dispositional mindfulness, by conducting Pearson's correlation analyses separately for each perceptual-matching task, yielded no significant correlations: neither for the perceptual shape-matching task ($r = -.084$, $n = 79$, $p = .46$) or for the perceptual number-matching task ($r = -.136$, $n = 72$, $p = .26$) or for the perceptual equation-matching task ($r = -.106$, $n = 69$, $p = .39$).

As for the question concerning the relationship between decentering and self-prioritization, Pearson's correlation analyses yielded a significant negative correlation between behavioral response efficiency and decentering ($r = -.248$, $n = 72$, $p < .05$) only in the perceptual number-matching task. The meaning of this negative correlation is that the higher the ability to decenter, the lower the behavioral efficiency response and thus the stronger the self-prioritization. As for the other task, the same analysis yielded no significant correlation, neither for the perceptual shape-matching task ($r = -.114$, $n = 80$, $p = .315$) or for the perceptual equation-matching task ($r = -.024$, $n = 69$, $p = .842$). Hence, the increase in behavioral response efficiency for the self is associated with enhanced decentering, but only in the number-matching task (i.e., when self-prioritization is disrupted among the HMA group).

Figure 2
Self Prioritization for the Shape-Matching and Number-Matching Tasks



Note. Self prioritization (ΔRT Stranger–Self, in ms; $M \pm SEM$) for the two groups (LMA – low math anxiety; HMA – high math anxiety) for the shape-matching (left) and number-matching (right) tasks.
* $p < .05$.

Looking closer at the significant correlation between behavioral response efficiency and decentering in the perceptual number-matching task and testing the same in the two groups of HMA and LMA separately, we found that the LMA was driving the total group results ($r = -.475$, $n = 35$, $p < .01$), whereas there was no such significant correlation in the HMA group ($r = -.012$, $n = 37$, $p = .944$). Because a significant correlation was found only in the LMA group, we ended by performing a linear regression analysis only among the LMA, to examine whether decentering predicts behavioral response efficiency. The linear regression was found to be significant, $F(1, 34) = 9.59$, $p < .01$, $\eta^2 = .225$). Hence, decentering can predict the behavioral response efficiency of self-prioritization under math anxiety activation, but only in the LMA group.

Discussion

Our study is the first to indicate a link between math anxiety, dispositional mindfulness, and self-centeredness (operationalized here as decentering and self-prioritization). Our first hypothesis was that math anxiety would be significantly and negatively correlated with dispositional mindfulness and decentering. This hypothesis was fully supported by our findings, as math anxiety was found to be significantly negatively correlated with both dispositional mindfulness and decentering. To the best of our knowledge, there is no research linking math anxiety and dispositional mindfulness, albeit two previous studies examined the effect of MBIs on math anxiety. In one study, the researchers examined the influence of a combined intervention of mindfulness and growth mindset on math anxiety. It was found that an intervention consisting of a 1-min deep breathing exercise and recitation of positive affirmations about math at the beginning of each class in a statistics course effectively reduced math anxiety in 20 students, compared with a control group that took the same course with no intervention (Samuel & Warner, 2019). In another study, mindfulness teaching was limited to one-time listening to a 15-min audio tape. Here, the researchers examined the influence of four brief interventions, three behavioral (focused and unfocused breathing exercises, worry exercise), and one nutritional (L-theanine tea) on math performance (not math anxiety). This study showed that focused breathing exercise significantly improved math performance compared with the other interventions (Brunyé et al., 2013). Our results revealed that the higher the level of dispositional mindfulness, the lower the level of math anxiety. This is compatible with studies showing a negative relationship between general anxiety and dispositional mindfulness (Tomlinson et al., 2018). The beneficial effects of high dispositional mindfulness on various psychological factors was previously shown by ample studies, including higher levels of self-esteem and lower levels of social anxiety (Rasmussen & Pidgeon, 2011) and lower levels of depression and anxiety (Bränström et al., 2011). In addition, dispositional mindfulness was shown to moderate the relationship between neuroticism and depressive symptoms (Barnhofer et al., 2011).

We also found a negative correlation between math anxiety and decentering. This is compatible with the previously reported negative correlation between general anxiety and decentering (Hayes-Skelton et al., 2015). In addition, decentering was found to mediate improvements in general anxiety following MBI (Hoge et al., 2015) and shown to be a partial mediator of the relationship between dispositional mindfulness and depressive symptoms, anxiety symptoms, and alcohol related problems (Pearson et al., 2015). Decentering is perceived as the ability to shift one's perspective from the inner experience, constructed by three metacognitive processes such as meta-awareness (awareness of subjective experience), disidentification from the internal experience (instead of "I am afraid," one may note "a feeling of fear"), and reduced reactivity to thought content (Bernstein et al., 2015). Based on our findings, it may be suggested that individuals with higher levels of decentering can interpret math-learning events in a way that shifts the perspective from the self (e.g., "I experienced a failure in solving math" instead of "I am a failure in solving math"). Such disidentified adaptive interpretations can help reduce math anxiety. By contrast, reduced decentering leads to possible identification and reaction to external maladaptive interpretations, and hence it can be linked to internalization of these interpretations and enhance math anxiety. Our results are compatible with the interpretation account (Ramirez et al., 2018), which suggests that the reason one will develop (or not develop) math anxiety lies in one's adaptive or maladaptive, interpretation of math-learning situations.

The second research question focused on the relationship between math anxiety and self-prioritization, hypothesizing that under math anxiety activation, self-prioritization would be reduced in HMA compared with LMA individuals. This was partially supported by our findings for RTs, but not for accuracy: self-prioritization was reduced among HMA under math anxiety activation in the number-matching task but not in the equation-matching task. Importantly, there was no significant difference in self-prioritization between LMA and HMA when the labels were matched to shapes (a condition we considered the 'neutral state'), indicating that there is no inherent difference in self-prioritization between the two groups. However, there was a significant group difference when participants were asked to match numbers to labels, which we considered the *math anxiety activated state*. For math-anxious individuals, the activation of math anxiety led to a reduction in self-stranger bias on RTs (though this did not hold for d'). Our findings are in line with Sui et al. (2016) findings showing that the drop in mood across participants (through reading negative statements) led to a disruption of the self-prioritization effect (i.e., self-stranger bias) on RTs but not on *d′*. Following Sui et al. (2016), the disruption found for RTs but not for accuracy might reflect changes in memory but not in perception. This account is congruent with findings showing that math anxiety compromises the functioning of working memory (Ashcraft & Krause, 2007). In contrast to our expectation, the equation-matching task did not yield similar results concerning disruption of self-prioritization among HMA. We suggest two explanations for failing to find such an effect. The first explanation concerns the design of the task and the time intervals given for presentation of the equation-label pairs (500 ms vs. 100 ms in the previous tasks) and the time interval given to participants to judge and reply whether the pair presented matched or mismatched (2,500 ms vs. 1,300 ms in the previous tasks). Analyzing the RT results over all participants from all three tasks, showed that the mean RT in the equation-matching task was higher compared with the other tasks by approximately 350 ms (the mean RTs of the shape-matching and number-matching tasks were almost identical). This can also be seen in the mean accuracy in this task, which was higher than the two former tasks. This implies that a shorter time interval of 1,650 ms for an answer would probably suffice and possibly create the self-prioritization effect in this task.

The second explanation is that the perceptual equation-matching task required that participants to perform two different cognitive operations in each trial, which required divided attention: solving an equation, and judging whether the stimuli presented are matched. Sui and Humphreys (2017) argued that divided attention may disrupt elaborative encoding of self-referential stimuli and reducing self-prioritization. For example, research has shown that the own-name effect decreases when stimuli are presented outside the focus of attention, such as in the experiment where the presence of a participant's own face can disrupt a primary task (e.g., judging which arm of a cross is longer) when the self-face appears as a background distractor (Sui & Humphreys, 2017). In light of this, we can argue that self-prioritization was disrupted in the equation-matching task not only for the math-anxious individuals, who were under math anxiety activation, but also for the low math-anxious individuals, due to the divided attention the task required. That is, the participant's attention was drawn into solving math equations and thus attention for the self-related stimulus was disrupted. Instead of the usual case (as in the shape-matching task and the number-matching task) in which the presence of self-related stimuli improved performance, in this task the self-related items interfered with the main target of attention (which was solving math equations). The divided attention interpretation was reviewed thoroughly by Sui and Humphreys (2017), but only future studies can examine a shorter time allocated for reactions in the perceptual equation-matching task, thus adjudicating between these two explanations offered in the preceding text.

We now turn to explaining the disruption of self-prioritization among HMA under math anxiety activation, suggesting three interpretations of our findings. First, Sui et al. (2016) suggested that the prioritization effect occurs by enhanced perception and memory from efficient allocation of attention to external stimuli associated with the self. Induction of a negative mood may reduce self-prioritization by turning attention to internal states rather than external states. In other words, it may be that activation of math anxiety turns attention to internal states (preoccupied by the anxiety itself) rather than to the stimuli. In alignment with this interpretation, Ashcraft and Krause (2007) examined the relationship between math anxiety and math performance, showing that math anxiety compromises the functioning of working memory. They claim that math anxiety works like a dual task setting: preoccupation with anxiety functions as a resource-demanding secondary task. A second possible explanation of the disruption of the self-prioritization effect is that self-associations generate a positive emotional response, which enhances the processing of perceptual self-matching items (Ma & Han, 2010; Sui et al., 2016). Following this interpretation, the effect of math anxiety activation may reduce emotional valence, which in turn reduces the advantage of self-processing over stranger. We further suggest a third explanation. Recently, Verplanken and Sui (2019) offered an account referring to a psychological concept designated the integrated self. They suggested that the strength of self-prioritization observed in perceptual matching tasks may be considered a proxy for cognitive self-integration. Self-integration is a high degree of connectedness between cognitive, affective, motivational, and behavioral systems (Kuhl et al., 2015). Consistent with this, they claim that the disruption of self-prioritization by an induced negative mood can be due to a breakdown of the integrated self (i.e., the intrinsic association between self and positive emotions; Verplanken & Sui, 2019). On this basis, we suggest that only for math-anxious individuals, once math anxiety is activated, is there a breakdown of the integrated self and thus the ability to prioritize the self is compromised (as in the perceptual number-matching task).

As for the third research question, concerning the relationship between self-prioritization and dispositional mindfulness, our finding rejected any negative correlation, in contrast to our hypothesis. As dispositional mindfulness was significantly and positively correlated with decentering, we deduce that decentering and self-prioritization capture two different qualities of self-centeredness. Whereas the first is intertwined with mindful awareness, the second seems to rely on other mechanisms.

The fourth research question concerned the relationship between decentering and self-prioritization, in the context of math anxiety. We hypothesized that under math anxiety activation, decentering would be negatively correlated with self-prioritization. Our findings supported this hypothesis, by showing that decentering is significantly correlated with self-prioritization (measured through behavioral response efficiency) in the number-matching task. We further found that this correlation was stemming from the LMA group. Thus, we can infer that in situations where self-prioritization is prone to disruption (i.e., in the number-matching task, where self-prioritization was disrupted only in the HMA group but not in the LMA group), the ability to decenter had an important role in maintaining self-prioritization. We did not find such a relationship between decentering and the behavioral efficiency response in situations where there was no disruption of self-prioritization (i.e., in the shape-matching and in the equation-matching tasks). Thus, the ability to decenter does not contribute in neutral states, where self-prioritization is not disrupted, as self-prioritization is a common tendency for all, regardless of their ability to decenter (or their dispositional mindfulness level, regarding the third hypothesis). In other words, it is possible that the ability to shift one's perspective from the inner experience (i.e., decentering) can help shift attention from the inner experience in math-anxious states, and thus helps maintain the self-referencing ability. Finally, based on the correlations uncovered between decentering and self-prioritization, we can carefully suggest that one's level of decentering is related to one's ability to prevent or avoid a breakdown of the integrated self.

Theoretical and Practical Implications

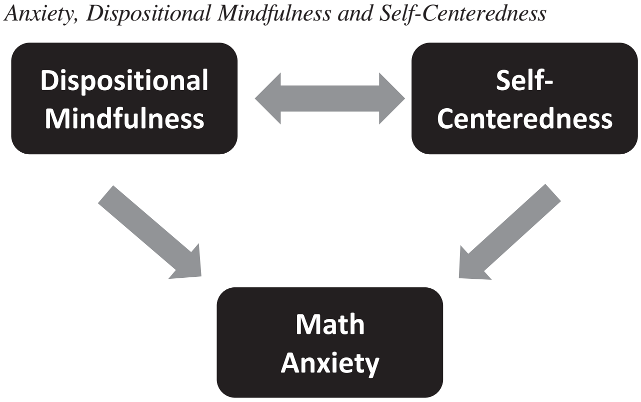
As a theoretical implication of this article, we suggest here a novel conceptual and schematic framework for understanding math anxiety, self-centeredness, and dispositional mindfulness (see Figure 3). According to this theoretical model, lower math anxiety is related to elevated dispositional mindfulness as well as reduced maladaptive self-centeredness, which might be measured by reduced decentering and elevated self-prioritization. Our findings indicate that self-prioritization is disrupted in math activation, a disruption that decentering is correlated with (though dispositional mindfulness is not). Thus, whereas the causal connection between self-prioritization and math anxiety is unclear, we can suggest that decentering has an important role in reducing the disruption of self-prioritization when math anxiety is activated (an assumption derived from our finding, in which decentering predicts the self-prioritization under math anxiety activation, but only in the LMA group). In sum, our study offers a new theoretical framework to understand and investigate math anxiety.

On a practical level, we offer here a novel and useful way to measure math anxiety through changes in performance in the perceptual number-matching task. Up until now, measures for math anxiety were restricted to self-reports. If validated in future studies, the perceptual number-matching task can function as an implicit, third-person perspective measure for math anxiety.

We suggest several future practical implications for our study. First, future longitudinal studies should examine the effects of MBIs on math anxiety, especially among young learners, with an emphasis on preliminary and high schools, as mindfulness interventions effects on math anxiety have scarcely been studied (Samuel & Warner, 2019), and thus far only on college students. Moreover, the few MBIs on math anxiety so far have focused on short breathing exercise. Mindfulness training can be a much deeper practice than "learning to relax" (as declared in a headline of one article on MBI on math anxiety; Brunyé et al., 2013). It can enhance nonjudgmental, nonreactive awareness and thus enhance the ability to decenter among practitioners. In fact, it has the potential to reduce self-centeredness. Thus, we recommend examining in future studies whether MBIs affect self-prioritization under math anxiety activation, as in the perceptual number-matching task, as well as examining a better designed perceptual equation-matching task in light of the recommendations presented in this article. Second, future longitudinal studies should examine if and how decentering mediates the benefits of MBIs for math anxiety. Such a design would enable studying causality, not just correlations, between these constructs. Third, the effect of MBIs on math learning, not only math anxiety, should be studied: in alignment with research showing that MBIs in schools show numerous benefits, such as improving cognitive performance and resilience to stress (Zenner et al., 2014), we propose it can also benefit math learning, by reducing math anxiety.

Figure 3

A Proposed Schematic Model for the Relationship Between Math Anxiety, Dispositional Mindfulness and Self-Centeredness



Limitations

The main limitation of the present correlational study is that we cannot infer causality from our findings. As we are unable to demonstrate temporal precedence, the vital question of causality (between dispositional mindfulness, decentering, self-prioritization, and math anxiety) cannot be answered here. The causality question is crucial, not only from a scientific perspective but also from a clinical perspective. If decentering or dispositional mindfulness are causally involved in the development of math anxiety, then therapeutic interventions should aim to elevate these abilities, which can be cultivated through MBIs, in order to prevent or reduce the individual's level of math anxiety.

It should also be noted that participants in this study were divided into LMA versus HMA groups using a median split. Albeit this was previously used by several other studies in the field of math anxiety (Beilock & DeCaro, 2007; Brunyé et al., 2013; Ramirez et al., 2015; Rubinsten et al., 2015), we acknowledge that the median split to dichotomize the scores may not be the optimal method of assessing high or low groups of participants (Waller & Meehl, 1998), especially because such an approach warrants a much higher group size, to enable using only the highest and lowest quartiles. Furthermore, whereas there was a negative correlation between the two variables, the correlation significance (p value) was marginal, due to the small group size (all other things being equal, the larger the sample, the more likely an obtained correlation would reach an acceptable level of statistical significance; Akoglu, 2018). Hence, future studies should be conducted with a larger group size, to enable both a significant correlation, as well as using a quartile split.

Finally, we wish to address the discrepancy between the findings referring to the interaction between math anxiety and the number-matching versus the equation-matching tasks. Our initial hypothesis was that the interaction effect found between math anxiety and self-prioritization in the number-matching task will yield the same, if not a stronger effect, in the equation-matching task because math anxiety is amplified when an individual is required to compute equations. Unfortunately, the findings did not show the expected effect. We provided in the discussion several feasible explanations for this failure to show such a significant interaction. Importantly, this requires us to interpret the interaction between math anxiety and self-prioritization carefully, underscoring the need for future studies to replicate this novel finding.

Conclusions

This study explores a novel and intricate relationship between math anxiety and self-centeredness, and we hope that it will inspire more research in this innovative direction. The novelty of this study lies in showing a relationship between math anxiety, dispositional mindfulness, and self-centeredness through the measure of decentering and self-prioritization effects. The present study offers a novel perspective for examining math anxiety and its possible origins. To explain our results, we make use of the innovative conceptualization of self-integration, suggesting that under stress experienced by HMA individuals, there is a breakdown of self-integration, seen as reduced self-prioritization. Dispositional mindfulness and decentering might be seen as qualities reducing self-centeredness and contributing to self-integration.

Our study introduces a novel and fresh perspective for examining and understanding math anxiety, presenting an approach that emphasizes psychological functioning of the self as the possible mechanism underlying math anxiety. Moreover, our study presents a novel method for examining and connecting between math anxiety and self-centeredness, such as perceptual matching tasks, including the novel task introduced in this article. By understanding the important relationship between math anxiety and self-centeredness, we hope that this study will add a crucial dimension of psychoeducation to teaching and learning math, giving weight not just to the didactics of math teachings, math argumentations, math exercises, and so on, but also to how one interprets and internalizes math situations, especially failures in math learning. Thus, we believe, exemplar math lessons should also include paying attention to awareness to the self and maintaining self-integration, in order to succeed in learning math.

References

Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*, *18*(3), 91–93. https://doi.org/10.1016/j.tjem.2018.08.001

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review*, *14*(2), 243–248. https://doi.org/10.3758/BF03194059

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment*, *27*(3), 197–205. https://doi.org/10.1177/0734282908330580

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment*, *13*(1), 27–45.

Baloğlu, M., & Koçak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences*, *40*(7), 1325–1335. https://doi.org/10.1016/j.paid.2005.10.009

Barnhofer, T., Duggan, D. S., & Griffith, J. W. (2011). Dispositional mindfulness moderates the relation between neuroticism and depressive symptoms. *Personality and Individual Differences*, *51*(8), 958–962. https://doi.org/10.1016/j.paid.2011.07.032

Beilock, S. L., & DeCaro, M. S. (2007). From poor performance to success under stress: working memory, strategy selection, and mathematical problem solving under pressure. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(6), 983–998. https://doi.org/10.1037/0278-7393.33.6.983

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 of the United States of America*, *107*(5), 1860–1863. https://doi.org/10.1073/pnas.0910967107

Berkovich-Ohana, A., Dor-Ziderman, Y., Trautwein, F. M., Schweitzer, Y., Nave, O., Fulder, S., & Ataria, Y. (2020). The hitchhiker's guide to neurophenomenology—The case of studying self boundaries with meditators. *Frontiers in Psychology*, *11*, Article 1680. https://doi.org/10.3389/fpsyg.2020.01680

Berkovich-Ohana, A., & Glicksohn, J. (2014). The consciousness state space (CSS)—A unifying model for consciousness and self. *Frontiers in Psychology*, *5*, Article 341. https://doi.org/10.3389/fpsyg.2014.00341

Bernstein, A., Hadash, Y., Lichtash, Y., Tanay, G., Shepherd, K., & Fresco, D. M. (2015). Decentering and related constructs. *Perspectives on Psychological Science*, *10*(5), 599–617. https://doi.org/10.1177/1745691615594577

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice*, *11*(3), 230–241. https://doi.org/10.1093/clipsy.bph077

Black, D. S., & Slavich, G. M. (2016). Mindfulness meditation and the immune system: A systematic review of randomized controlled trials. *Annals of the New York Academy of Sciences*, *1373*(1), 13–24. https://doi.org/10.1111/nyas.12998

Bohlmeijer, E., ten Klooster, P. M., Fledderus, M., Veehof, M., & Baer, R. (2011). Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. *Assessment*, *18*(3), 308–320. https://doi.org/10.1177/1073191111408231

Bränström, R., Duncan, L. G., & Moskowitz, J. T. (2011). The association between dispositional mindfulness, psychological well-being, and perceived health in a Swedish population-based sample. *British Journal of Health Psychology*, *16*(2), 300–316. https://doi.org/10.1348/135910710X501683

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Brunyé, T. T., Mahoney, C. R., Giles, G. E., Rapp, D. N., Taylor, H. A., & Kanarek, R. B. (2013). Learning to relax: Evaluating four brief interventions for overcoming the negative emotions accompanying math anxiety. *Learning and Individual Differences*, *27*, 1–7. https://doi.org/10.1016/j.lindif.2013.06.008

Carey, E., Hill, F., Devine, A., & Szücs, D. (2016). The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in Psychology*, *6*, Article 1987. https://doi.org/10.3389/fpsyg.2015.01987

Chang, H., & Beilock, S. L. (2016). The math anxiety-math performance link and its relation to individual and environmental factors: A review of current behavioral and psychophysiological research. *Current Opinion in Behavioral Sciences*, *10*, 33–38. https://doi.org/10.1016/j.cobeha.2016.04.011

Choe, K. W., Jenifer, J. B., Rozek, C. S., Berman, M. G., & Beilock, S. L. (2019). Calculated avoidance: Math anxiety predicts math avoidance in effort-based decision-making. *Science Advances*, *5*, Article eaay1062. https://doi.org/10.1126/sciadv.aay1062

Christoff, K., Cosmelli, D., Legrand, D., & Thompson, E. (2011). Specifying the self for cognitive neuroscience. *Trends in Cognitive Sciences*, *15*(3), 104–112. https://doi.org/10.1016/j.tics.2011.01.001

Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences*, *19*(9), 515–523. https://doi.org/10.1016/j.tics.2015.07.001

Dambrun, M. (2016). When the dissolution of perceived body boundaries elicits happiness: The effect of selflessness induced by a body scan meditation. *Consciousness and Cognition*, *46*, 89–98. https://doi.org/10.1016/j.concog.2016.09.013

Dambrun, M. (2017). Self-centeredness and selflessness: Happiness correlates and mediating psychological processes. *PeerJ*, *5*, e3306. https://doi.org/10.7717/peerj.3306

Dambrun, M., Berniard, A., Didelot, T., Chaulet, M., Droit-Volet, S., Corman, M., Juneau, C., & Martinon, L. M. (2019). Unified consciousness and the effect of body scan meditation on happiness: Alteration of inner-body experience and feeling of harmony as central processes. *Mindfulness*, *10*(8), 1530–1544. https://doi.org/10.1007/s12671-019-01104-y

Dambrun, M., & Ricard, M. (2011). Self-centeredness and selflessness: A theory of self-based psychological functioning and its consequences for happiness. *Review of General Psychology*, *15*(2), 138–157. https://doi.org/10.1037/a0023059

Davidson, R. J., & Kaszniak, A. W. (2015). Conceptual and methodological issues in research on mindfulness and meditation. *American Psychologist*, *70*(7), 581–592. https://doi.org/10.1037/a0039512

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology*, *7*, Article 508. https://doi.org/10.3389/fpsyg.2016.00508

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428

Estrada, C. A., Martin-Hryniewicz, M., Collins, C., Byrd, J. C., & Peek, B. T. (2004). Literacy and numeracy skills and anticoagulation control. *The American Journal of the Medical Sciences*, *328*(2), 88–93. https://doi.org/10.1097/00000441-200408000-00004

Fresco, D. M., Moore, M. T., van Dulmen, M. H. M., Segal, Z. V., Ma, S. H., Teasdale, J. D., & Williams, J. M. G. (2007). Initial psychometric properties of the Experiences Questionnaire: Validation of a self-report measure of decentering. *Behavior Therapy*, *38*(3), 234–246. https://doi.org/10.1016/j.beth.2006.08.003

Gallagher, S. (2000). Philosophical conceptions of the self: Implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14–21. https://doi.org/10.1016/S1364-6613(99)01417-5

Gallagher, S. (2013). A pattern theory of self. *Frontiers in Human Neuroscience*, *7*, Article 44. https://doi.org/10.3389/fnhum.2013.00443

Gallagher, S. (Ed.). (2011). *The Oxford handbook of the self*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199548019.001.0001

Gard, T., Hölzel, B. K., & Lazar, S. W. (2014). The potential effects of meditation on age-related cognitive decline: A systematic review. *Annals of the New York Academy of Sciences*, *1307*, 89–103. https://doi.org/10.1111/nyas.12348

Gecht, J., Kessel, R., Forkmann, T., Gauggel, S., Drueke, B., Scherer, A., & Mainz, V. (2014). A mediation model of mindfulness and decentering: Sequential psychological constructs or one and the same? *BMC Psychology*, *2*(1), Article 18. https://doi.org/10.1186/2050-7283-2-18

Gerardi, K., Goette, L., & Meier, S. (2013). Numerical ability predicts mortgage default. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(28), 11267–11271. https://doi.org/10.1073/pnas.1220568110

Grabovac, A. D., Lau, M. A., & Willett, B. R. (2011). Mechanisms of mindfulness: A Buddhist psychological model. *Mindfulness*, *2*(3), 154–166. https://doi.org/10.1007/s12671-011-0054-5

Hadash, Y., Plonsker, R., Vago, D. R., & Bernstein, A. (2016). Experiential self-referential and selfless processing in mindfulness and mental health: Conceptual model and implicit measurement methodology. *Psychological Assessment*, *28*(7), 856–869. https://doi.org/10.1037/pas0000300

Hanley, A. W., Baker, A. K., & Garland, E. L. (2017). Self-interest may not be entirely in the interest of the self: Association between selflessness, dispositional mindfulness and psychological well-being. *Personality and Individual Differences*, *117*, 166–171. https://doi.org/10.1016/j.paid.2017.05.045

Hanley, A. W., Dambrun, M., & Garland, E. L. (2020). Effects of mindfulness meditation on self-transcendent states: Perceived body boundaries and spatial frames of reference *Mindfulness*, *11*(5), 1194–1203. https://doi.org/10.1007/s12671-020-01330-9

Hart, W. (1987). *The art of living: Vipassana meditation as taught by SN Goenka*. Harper & Row.

Hart, S. A., & Ganley, C. M. (2019). The nature of math anxiety in adults: Prevalence and correlates. *Journal of Numerical Cognition*, *5*(2), 122–139. https://doi.org/10.5964/jnc.v5i2.195

Hayes, S. C., Strosahl, K., & Wilson, K. D. (2002). Acceptance and commitment therapy, an experiential approach to behavior change. *Journal of Applied Behavior Analysis*, *35*(3), 323–336.

Hayes-Skelton, S. A., Calloway, A., Roemer, L., & Orsillo, S. M. (2015). Decentering as a potential common mechanism across two therapies for generalized anxiety disorder. *Journal of Consulting and Clinical Psychology*, *83*(2), 395–404. https://doi.org/10.1037/a0038305

Hayes-Skelton, S., & Graham, J. (2013). Decentering as a common link among mindfulness, cognitive reappraisal, and social anxiety. *Behavioural and Cognitive Psychotherapy*, *41*(3), 317–328. https://doi.org/10.1017/S1352465812000902

Hembree, R. (1990). The nature, effects, and relief of aathematics anxiety. *Journal for Research in Mathematics Education*, *21*(1), 33–46. https://doi.org/10.2307/749455

Hoge, E. A., Bui, E., Goetter, E., Robinaugh, D. J., Ojserkis, R. A., Fresco, D. M., & Simon, N. M. (2015). Change in decentering mediates improvement in anxiety in mindfulness-based stress reduction for generalized anxiety disorder. *Cognitive Therapy and Research*, *39*(2), 228–235. https://doi.org/10.1007/s10608-014-9646-4

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science*, *6*(6), 537–559. https://doi.org/10.1177/1745691611419671

Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *The Mathematics Teacher*, *92*(7), 583–586. https://doi.org/10.5951/MT.92.7.0583

Jain, S., & Dowson, M. (2009). Mathematics anxiety as a function of multidimensional self-regulation and self-efficacy. *Contemporary Educational Psychology*, *34*(3), 240–249. https://doi.org/10.1016/j.cedpsych.2009.05.004

Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle. *Psychological Science*, *16*(3), 175–179. https://doi.org/10.1111/j.0956-7976.2005.00799.x

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, *10*, 144–156. https://doi.org/10.1093/clipsy.bpg016

Kelly, W. P., & Tomhave, W. K. (1985). A study of math anxiety/math avoidance in preservice elementary teachers. *The Arithmetic Teacher*, *32*(5), 51–53. https://doi.org/10.5951/AT.32.5.0051

Kuhl, J., Quirin, M., & Koole, S. L. (2015). Being someone: The integrated self as a neuropsychological system. *Social and Personality Psychology Compass*, *9*(3), 115–132. https://doi.org/10.1111/spc3.12162

Legrand, D., & Ruby, P. (2009). What is self-specific? Theoretical investigation and critical review of neuroimaging results. *Psychological Review*, *116*(2), 252–282. https://doi.org/10.1037/a0014172

Mammarella, I. C., Caviola, S., & Dowker, A. (Eds.). (2019). *Mathematics anxiety: What is known, and what is still missing*. Routledge.

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. https://doi.org/10.2307/749772

Ma, Y., & Han, S. (2010). Why we respond faster to the self than to others? An implicit positive association theory of self-advantage during implicit face recognition. *Journal of Experimental Psychology: Human Perception and Performance*, *36*(3), 619–633. https://doi.org/10.1037/a0015797

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. https://doi.org/10.1016/j.tics.2012.06.008

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), 1480–1488. https://doi.org/10.1177/0956797615592630

Ma, X., & Xu, J. (2004). Determining the causal ordering between attitude toward mathematics and achievement in mathematics. *American Journal of Education*, *110*(3), 256–280. https://doi.org/10.1086/383074

Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological eview*, *102*(2), 246–268. https://doi.org/10.1037/0033-295x.102.2.246

Morsanyi, K., Busdraghi, C., & Primi, C. (2014a). Does maths anxiety make people bad decision-makers? The link between mathematical anxiety and cognitive reflection. *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 36, pp. 1042–1047). https://escholarship.org/uc/item/7gz0j252

Morsanyi, K., Busdraghi, C., & Primi, C. (2014b). Mathematical anxiety is linked to reduced cognitive reflection: A potential road from discomfort in the mathematics classroom to susceptibility to biases. *Behavioral and Brain Functions*, *10*(1), Article 31. https://doi.org/10.1186/1744-9081-10-31

Neff, K. (2003). Self-compassion: An alternative conceptualization of a healthy attitude toward oneself. *Self and Identity*, *2*(2), 85–101.

Núñez-Peña, M. I., Suárez-Pellicioni, M., & Bono, R. (2013). Effects of math anxiety on student success in higher education. *International Journal of Educational Research*, *58*, 36–43. https://doi.org/10.1016/j.ijer.2012.12.004

Nyklíček, I. (2020). Aspects of self-awareness in meditators and meditation-naïve participants: Self-report versus task performance. *Mindfulness*, *11*(4), 1028–1037. https://doi.org/10.1007/s12671-020-01318-5

Olendzki, A. (2003). Buddhist psychology. In S. R. Segall (Ed.), *Encountering Buddhism: Western psychology and Buddhist teachings* (pp. 9–30). SUNY Press.

Parsons, S., & Bynner, J. (2005). *Does numaracy matter more?* nrdc.org.uk/wp-content/uploads/2005/01/Does-numeracy-matter-more.pdf

Passolunghi, M. C., De Vita, C., & Pellizzoni, S. (2020). Math anxiety and math achievement: The effects of emotional and math strategy training. *Developmental Science*, *23*(6), Article e12964. https://doi.org/10.1111/desc.12964

Pearson, M. R., Brown, D. B., Bravo, A. J., & Witkiewitz, K. (2015). Staying in the moment and finding purpose: The associations of trait mindfulness, decentering, and purpose in life with depressive symptoms, anxiety symptoms, and alcohol-related problems. *Mindfulness*, *6*(3), 645–653. https://doi.org/10.1007/s12671-014-0300-8

PISA. (2013). *PISA 2012 results: Ready to learn* (Vol. III). https://doi.org/10.1787/9789264201170-en

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. https://doi.org/10.1016/j.jecp.2015.07.014

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist*, *53*(3), 145–164. https://doi.org/10.1080/00461520.2018.1447384

Rasmussen, M. K., & Pidgeon, A. M. (2011). The direct and indirect benefits of dispositional mindfulness on self-esteem and social anxiety. *Anxiety, Stress, & Coping*, *24*(2), 227–233. https://doi.org/10.1080/10615806.2010.515681

Reyna, V. F., Nelson, W. L., Han, P. K., & Dieckmann, N. F. (2009). How numeracy influences risk comprehension and medical decision making. *Psychological Bulletin*, *135*(6), 943–973. https://doi.org/10.1037/a0017327

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology*, *19*(6), 551–554. https://doi.org/10.1037/h0033456

Ritchie, S. J., & Bates, T. C. (2013). Enduring links from childhood mathematics and reading achievement to adult socioeconomic status. *Psychological Science*, *24*(7), 1301–1308. https://doi.org/10.1177/0956797612466268

Rivera-Batiz, F. L. (1992). Quantitative literacy and the likelihood of employment among young adults in the United States. *Journal of Human Resources*, *27*(2), 313–328. https://doi.org/10.2307/145737

Rolison, J. J., Morsanyi, K., & Peters, E. (2020). Understanding health risk comprehension: The role of math anxiety, subjective numeracy, and objective numeracy. *Medical Decision Making*, *40*(2), 222–234. https://doi.org/10.1177/0272989X20904725

Rubinsten, O., Bialik, N., & Solar, Y. (2012). Exploring the relationship between math anxiety and gender through implicit measurement. *Frontiers in Human Neuroscience*, *6*, Article 279. https://doi.org/10.3389/fnhum.2012.00279

Rubinsten, O., Eidlin, H., Wohl, H., & Akibli, O. (2015). Attentional bias in math anxiety. *Frontiers in Psychology*, *6*, Article 1539. https://doi.org/10.3389/fpsyg.2015.01539

Rubinsten, O., & Tannock, R. (2010). Mathematics anxiety in children with developmental dyscalculia. *Behavioral and Brain Functions*, *6*, 46. https://doi.org/10.1186/1744-9081-6-46

Safran, J., & Segal, Z. V. (1996). *Interpersonal processes in cognitive therapy*. Jason Aronson.

Salmon, P. G., Santorelli, S. F., Sephton, S. E., & Kabat-Zinn, J. (2009). Intervention elements promoting adherence to mindfulness-based stress reduction (MDSR) programs in a clinical behavioral medicine setting. In S. A. Shumaker, J. K. Ockene, & K. A. Riekert (Eds.), *The handbook of health behavior change* (pp. 271–286). Springer Publishing Company.

Samuel, T. S., & Warner, J. (2019). "I can math!": Reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students. *Community College Journal of Research and Practice*, *45*(3), 205–222. https://doi.org/10.1080/10668926.2019.1666063

Schmitz, E. A., Jansen, B. R., Wiers, R. W., & Salemink, E. (2019). Do implicitly measured math–anxiety associations play a role in math behavior? *Journal of Experimental Child Psychology*, *186*, 171–188. https://doi.org/10.1016/j.jecp.2019.05.013

Sedgwick, P. (2012). Multiple significance tests: The Bonferroni correction. *BMJ*, *344*, Article e509. https://doi.org/10.1136/bmj.e509

Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of Clinical Psychology*, *62*(3), 373–386. https://doi.org/10.1002/jclp.20237

Strawson, G. (2000). The phenomenology and ontology of the self. In D. Zahavi (Ed.), *Exploring the self: Philosophical and psychopathological perspectives on self-experience* (pp. 39–54). John Benjamins.

Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience: Evidence from self-prioritization effects on perceptual matching. *Journal of Experimental Psychology: Human Perception and Performance*, *38*, 1105–1117. https://doi.org/10.1037/a0029792

Sui, J., & Humphreys, G. W. (2017). The ubiquitous self: What the properties of self-bias tell us about the self. *Annals of the New York Academy of Sciences*, *1396*(1), 222–235. https://doi.org/10.1111/nyas.13197

Suinn, R. M., & Winston, E. H. (2003). The Mathematics Anxiety Rating Scale, a brief version: Psychometric data. *Psychological Reports*, *92*(1), 167–173. https://doi.org/10.2466/pr0.2003.92.1.167

Sui, J., Ohrling, E., & Humphreys, G. W. (2016). Negative mood disrupts self- and reward-biases in perceptual matching. *Quarterly Journal of Experimental Psychology*, *69*(7), 1438–1448. https://doi.org/10.1080/17470218.2015.1122069

Sui, J., Rotshtein, P., & Humphreys, G. W. (2013). Coupling social attention to the self forms a network for personal significance. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(19), 7607–7612. https://doi.org/10.1073/pnas.1221862110

Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213–225. https://doi.org/10.1038/nrn3916

Teasdale, J. D., Moore, R. G., Hayhurst, H., Pope, M., Williams, S., & Segal, Z. V. (2002). Metacognitive awareness and prevention of relapse in depression: Empirical evidence. *Journal of Consulting and Clinical Psychology*, *70*(2), 275–287. https://doi.org/10.1037/0022-006X.70.2.275

Tomlinson, E. R., Yousaf, O., Vittersø, A. D., & Jones, L. (2018). Dispositional mindfulness and psychological health: A systematic review. *Mindfulness*, *9*(1), 23–43. https://doi.org/10.1007/s12671-017-0762-6

Trautwein, F. M., Naranjo, J. R., & Schmidt, S. (2016). Decentering the self? Reduced bias in self-vs. other-related processing in long-term practitioners of loving-kindness meditation. *Frontiers in Psychology*, *7*, Article 1785. https://doi.org/10.3389/fpsyg.2016.01785

Vago, D. R., & David, S. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, *6*, Article 296. https://doi.org/10.3389/fnhum.2012.00296

Verplanken, B., & Sui, J. (2019). Habit and identity: Behavioral, cognitive, affective, and motivational facets of an integrated self. *Frontiers in Psychology*, *10*, Article 1504. https://doi.org/10.3389/fpsyg.2019.01504

Waller, N. G., & Meehl, P. E. (1998). *Multivariate taxometric procedures: Distinguishing types from continua*. SAGE.

Wang, Z., Hart, S. A., Kovas, Y., Lukowski, S., Soden, B., Thompson, L. A., Plomin, R., McLoughlin, G., Bartlett, C. W., Lyons, I. A., & Petrill, S. A. (2014). Who is afraid of math? Two sources of genetic variance for mathematical anxiety. *Journal of Child Psychology and Psychiatry*, *55*(9), 1056–1064. https://doi.org/10.1111/jcpp.12224

Woloshin, S., Schwartz, L. M., Moncur, M., Gabriel, S., & Tosteson, A. N. (2001). Assessing values for health: Numeracy matters. *Medical Decision Making*, *21*(5), 382–390. https://doi.org/10.1177/0272989X0102100505

Zahavi, D., & Gallagher, S. (2008). *The phenomenological mind*. Routledge.

Zenner, C., Herrnleben-Kurz, S., & Walach, H. (2014). Mindfulness-based interventions in schools—A systematic review and meta-analysis. *Frontiers in Psychology*, *5*, Article 603. https://doi.org/10.3389/fpsyg.2014.00603

Received April 28, 2020
Revision received March 24, 2021
Accepted May 12, 2021 ■