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Effort(Less) Exam Preparation: Math Anxiety Predicts the Avoidance of Effortful Study Strategies

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Previous research suggests that math anxiety, or feelings of apprehension about math, leads individuals to engage in math avoidance behaviors that negatively impact their future math performance. However, much of the research on this topic explores global avoidance behaviors in situations where math can be avoided entirely rather than more localized avoidance behaviors that occur within a mathematics context. Since the option to completely avoid math is not common in most formal education systems, we investigated how and if math avoidance behaviors manifest for math-anxious high school students enrolled in math courses. Given previous research highlighting the utility of effortful study strategies as well as recent findings identifying a relation between math anxiety and the avoidance of math-related effort, we hypothesized that math anxiety would be associated with decreased planned engagement of effortful study strategies by students and that such effort avoidance would result in worse performance on a high-stakes mathematics exam. We found ($N = 190$) that the majority of students ranked problem-solving as the most effortful study strategy and that math anxiety was associated with less planned engagement with effortful problem-solving during studying. Moreover, the avoidance of effortful problem-solving engagement partially mediated the association between math anxiety and exam performance, marking it as a potential target for intervention.

Keywords: math anxiety, math avoidance, math performance, exam preparation, study strategies

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Math anxiety, or feelings of tension and apprehension about math, is a problem that affects students around the globe (Barroso et al., 2021; Foley et al., 2017). Students who experience math anxiety score lower on standardized math examinations compared to their less anxious peers, even in countries that are considered “high achieving” in the subject (Foley et al., 2017; Organization for Economic Cooperation and Development, 2013b). Given the significant role math skills play in the global labor market (Organization for Economic Cooperation and Development, 2013a; Watt et al., 2017), it is important to understand how and why math anxiety relates to students' ability to achieve their full potential in mathematics.

Many theories have been proposed to explain how math anxiety influences math learning and performance (for a review, see Ramirez et al., 2018). Although the most prominent theory posits that math anxiety limits the availability of working memory resources needed for problem-solving in the moment (Ashcraft & Kirk, 2001; Beilock et al., 2017; Ramirez et al., 2016), another hypothesis suggests that math-anxious students perform worse in math over time because they are math avoidant—the *math avoidance hypothesis* (Hembree, 1990; Richardson & Suinn, 1972). These avoidance behaviors are thought to limit students' exposure to math concepts, negatively impacting future math outcomes (Carey et al., 2015; Ramirez et al., 2018). However, there is little data exploring how, why, and when math-anxious students actually

engage in math avoidance behavior. Gaining a full understanding of these behaviors can provide additional insight into the math anxiety-performance relation as well as identify potential ways to intervene.

The most commonly cited data in support of the math avoidance hypothesis found that math-anxious students are less likely to enroll in optional math courses (Ashcraft & Kirk, 2001; Hembree, 1990; LeFevre et al., 1992). These data focus on the presence of math avoidance behaviors in situations where math can be avoided completely. However, in most Westernized school systems, students are required to take math courses and therefore cannot avoid math completely in the ways typically cited by the literature. This begs the question of whether and how math avoidance behaviors manifest for students within the context of a math course. If math anxiety does lead to math avoidance for students enrolled in math classes, what does this avoidance look like, and how does it relate to students' course performance?

Findings from recent research provide some initial insight about how math avoidance behaviors manifest in mathematical situations. In one study, math-anxious seventh-grade students were rated by their teachers as having lower in-class attention compared to their less anxious peers, with lowered attention indirectly influencing students' achievement gains (Geary et al., 2021). Additionally, previous research on math anxiety reveals a link between math anxiety and a reduction in mathematical processing (Ashcraft & Faust, 1994; Pizzie & Kraemer, 2017), decreases in cognitive reflection (Maloney & Retanal, 2020; Morsanyi et al., 2014), and activation of the neural "pain network" when anticipating math engagement (Lyons & Beilock, 2012). Together, these studies suggest a link between math anxiety and the avoidance of math engagement, providing critical information about how math avoidance behaviors might manifest for students within math courses.

In the current study, we explored whether math avoidance occurs within the context of a mathematics classroom by focusing on how it may manifest as the avoidance of effort for math-anxious students. We were especially interested in whether math-anxious students avoid effortful study strategies when preparing for an exam. This idea of a math anxiety-math effort avoidance link is based on findings from our recent work, which shows that math anxiety is associated with the prioritization of solving easy math problems over harder ones, even in situations where harder problems are associated with a higher reward and when problem difficulty is adapted to the ability of the participant (Choe et al., 2019).

Furthermore, we hypothesized that the avoidance of effortful exam study strategies would be associated with worse exam performance. This idea is grounded in research findings that highlight the critical role that self-regulated use of study strategies plays in student performance (Dunlosky et al., 2013; Pintrich & De Groot, 1990). Specifically, this research suggests that student engagement with effortful or "desirably difficult" study strategies reliably enhances learning and performance (Bjork et al., 2013; Carpenter et al., 2020). Additionally, high- and low-achieving students have been found to differ in how they engage with various study strategies, and these differences have been linked to differential performance outcomes (DiFrancesca et al., 2016.; Proctor et al., 2006; Yip, 2007). Given these findings, it seems plausible to predict that gaps in performance between more- and less-math-anxious students may be, in part, the result of differential studying behaviors. If math-anxious students avoid effortful study strategies

that are effective in advancing math proficiency, they may have lower exam performance and exacerbate their difficulties with math.

Therefore, in the current study, we examined the relation between math anxiety and math avoidance by assessing the study strategies and exam scores of students enrolled in a math course. We hypothesized that math anxiety would be associated with planned effort avoidance during exam preparation, as measured both by the quantity (i.e., planned study time allocation) and quality (i.e., planned prioritization of difficulty) of students' engagement with effortful study strategies. We also predicted that students' planned engagement with effortful study strategies would, at least, partially mediate the association between math anxiety and their performance on a math exam.

Method

Participants

Two hundred sixty students enrolled in Advanced Placement (AP) Calculus AB at a public, Midwestern high school were invited to complete our survey. The AP Program is run by the College Board and enables high school students to take a variety of college-level courses. At the conclusion of each course, students can complete an AP exam, with many colleges awarding students with qualifying AP exam scores college credit or the opportunity to skip intro-level courses in the subject. The AP Calculus AB exam is 3 hr long and covers the concepts, methods, and applications of differential and integral calculus.

Parents were sent a letter informing them of the study and how they could opt out of sharing their student's data with researchers. Students were similarly allowed to opt out of sharing their data with researchers. All procedures were completed in accordance with the guidelines of the University of Chicago Institutional Review Board. We report results from 190 students who completed the survey (~75% response rate) and did not opt out of sharing data with researchers (six students or parents opted out of sharing their data). We note that this sample only includes students who did not opt out of taking the AP exam at the end of the course. Our sample was 49% female, 70% White, 13% Latino, 10% African American, 6% Asian, 1% Native American, and 1% mixed race.

Our decision to recruit students taking AP Calculus was based on the rationale that all enrolled students would prepare for and take the same standardized exam, which would allow us to have the same reliable outcome measure for all participants. We also chose students taking AP Calculus because the course is both selective and rigorous; students who sign up for the course are therefore likely to be highly motivated and somewhat similar in math ability. Additionally, since previous research has found that the negative consequences of math anxiety are weaker for students with high math motivation (Wang et al., 2015), we reasoned that the AP class context likely serves as a conservative test of our hypothesis. This is because students who self-select into AP Calculus and opt in to taking the AP exam are likely to have higher math motivation than those who choose not to take AP Calculus or who take the course and opt out of the exam and thus should show a weaker association between math anxiety and the avoidance of effortful study behavior than students not taking AP Calculus.

Thus, any trends of avoidance behavior found for students taking AP Calculus and who opt to take the AP exam should hold for students within a standard, nonoptional math course.

Measures

Math Anxiety

Math anxiety was measured using the shortened Math Anxiety Rating Scale (Alexander & Martray, 1989), which is a shortened version of the 98-item Math Anxiety Rating Scale (Richardson & Suinn, 1972). Students responded to 25 questions about how anxious they would feel in different math-related situations (e.g., “signing up for a math course,” “studying for a math test”) on a 5-point Likert scale ranging from 1 (*not at all*) to 5 (*very much*). All analyses were conducted on the average of the 25 items for each student.

Study Strategies

Students were asked about how they planned to study for the AP Calculus AB exam using questionnaire items modeled after those used in other study strategy and avoidance behavior questionnaires (Midgley et al., 2000; Pintrich et al., 1991). Our questionnaire included three measures that were critical to our research question on effortful study strategy use; these three measures are described in greater detail below.

Rank Ordering of Study Strategies by Effort. To identify the study strategies that students viewed as requiring the most effort, we asked the following question:

When preparing for your AP exam for this class, which study strategies do you think would require the most work? Rank the following strategies from *the one you think would require the most work* (1) to *the one you think would require the least amount of work* (6).

Students then rank ordered the following set of study strategies: reading textbook section(s) for the first time, rereading textbook section(s), reviewing homework solutions, solving practice problems, reading examples of solved problems, and reviewing notes.

Allocation of Study Time Across Various Strategies. To measure the quantity of students’ engagement with effortful study strategies, we asked them to report how they would allocate their study time across various study strategies with the following question:

When preparing for your AP exam for this class, what percentage of your study time would you spend doing the following activities: (a) reading textbook sections for the first time, (b) rereading textbook section(s), (c) reviewing homework solutions, (d) solving practice problems, (e) reading examples of solved problems, (f) reviewing your notes?

Students reported their allocations using a sliding bar to indicate the percentage of study time they planned to allocate to each strategy. Students’ total study time allocation was constrained to equal 100% across the six options.

Prioritization of Difficulty During Strategy Use. To measure the quality of students’ engagement with effortful study strategies, we asked students to report how they would prioritize difficulty when solving practice problems with the following

question: “When studying for the AP exam for this class, how much do you think you would prioritize (or spend time on) solving easier practice problems in comparison to solving harder practice problems?” Students reported their answers on a scale from 1 to 7, with 1 corresponding to prioritizing easier problems and 7 corresponding to prioritizing harder problems. Our decision to view engagement with problem-solving as a measure of studying quality is grounded in the “desirable difficulty” literature, which suggests that student engagement with effortful study strategies reliably enhances learning and performance (Bjork et al., 2013). While we agree that overly difficult problems would not benefit students who would be “laboring in vain” (Bae et al., 2020), our aim for this questionnaire item was to have students reflect on their use of “easy” and “hard” practice problems in relation to their own ability (i.e., “easy and hard for me”) rather than more objectively (i.e., “easy and hard problems based on course/state standards”).

AP Exam Scores

All students in this study took the same standardized AP exam at the end of the school year to assess their knowledge of calculus. Scores for AP exams are given on a scale from 1 to 5, with 5 being the best possible score and scores of 3 and above typically counting as qualification for college credit (College Board, 2019).

PSAT Math Scores

Students’ scores on the math portion of the Preliminary SAT (PSAT) were also collected from school administrative records for this study as a measure of student prior achievement. The PSAT is a standardized test administered by the College Board in the United States and has been shown to predict students’ AP Calculus exam scores in previous research ($r = .507$; Ewing et al., 2006). Scores for the math subsection of the PSAT exam are given on a scale from 160 to 760.

Procedure

Students completed the questionnaire measures during their calculus class at school. Teachers were trained to administer the questionnaires during normal class time, 2 weeks before the scheduled AP Calculus AB exam date.

Results

Descriptive Statistics

Zero-order correlations between all study variables are reported in Table S1 in the online supplemental materials. We followed up on significant correlations that were pertinent to our research questions by fitting linear mixed-effects models to our data. These models included random effects to account for the hierarchical structure of our data, where students were nested within classes that were nested within teachers. We report the results of those analyses in the remainder of this section.

Math anxiety scores ranged from 1 to 5 out of a possible score of 5 ($M = 2.3$, $SD = .7$). Student math PSAT scores ranged from 420 to 760 ($M = 610.22$, $SD = 71.11$). AP Calculus exam scores ranged from 1 to 5 ($M = 3.0$, $SD = 1.3$). This mean exam score reflects the national average for the AP Calculus AB exam for the

year that the study was conducted ($M = 2.9$, $SD = 1.4$; College Board, 2018).

Isolating Effort: Which Study Strategy Did Students View as Most Effortful?

Given previous research highlighting the utility of effortful study strategies and recent findings linking math anxiety to the avoidance of math-related effort, we first assessed which study strategies students perceived as most effortful by asking them to rank a set of study strategies on the amount of effort they require (with lower numbers indicating strategies that were perceived to require more work). In ranked order from most to least work, students listed solving practice problems as most effortful ($M = 1.9$, $SD = 1.3$), followed by reading textbook section(s) for the first time ($M = 2.9$, $SD = 1.8$), rereading textbook section(s) ($M = 3.7$, $SD = 1.6$), reviewing homework solutions ($M = 4.0$, $SD = 1.2$), reading examples of solved problems ($M = 4.2$, $SD = 1.4$), and reviewing notes ($M = 4.3$, $SD = 1.6$). Over half of students (57%) ranked solving practice problems as the most effortful study strategy, and nearly three quarters (73%) ranked solving practice problems as the most or the second most effortful strategy. We also explored relations between math anxiety and individual strategy rankings to determine whether rankings differed across math anxiety. Following up on significant and marginally significant correlations from Table S1 with linear mixed models, we found that math anxiety was marginally associated with ranking solving practice problems as more effortful, $\beta = -.15$, $t = -1.98$, $SE = .08$, $p = .050$, and with ranking rereading the textbook as less effortful, $\beta = .17$, $t = 2.22$, $SE = .08$, $p = .028$. Thus, although students generally viewed solving practice problems as the most effortful strategy, math-anxious students were marginally more likely to endorse practice problems as effortful. Additionally, math-anxious students were more likely to view rereading the textbook as less effortful. Given the limited variability in the strategy ranked by students as being most effortful, additional analyses exploring individual differences in student perceptions of the most effortful strategy were not conducted. Further, we note that while 190 students completed the other two measures in this study (as discussed in later sections), only 175 students completed this measure of ranking study strategy effort.

Overall, these findings identify solving practice problems as the study strategy students perceive to be the most effortful. Thus, given our original hypothesis that math anxiety would be associated with the avoidance of effortful study strategies, we can predict more specifically that math anxiety will be negatively associated with the quantity and quality of students' engagement with solving practice problems during study. We explore this idea in the remaining sections.

Assessing Quantity: Does Math Anxiety Relate to Study Time Allocation Across Strategies?

To measure the association between math anxiety and students' engagement with effortful study strategies, we asked students to report how they would allocate their study time across six study strategies (see "Method"). On average, students planned to spend 39% ($SD = 21.7$) of their time solving practice problems, 21% ($SD = 18.1$) of their time reviewing notes, 15% ($SD = 12.9$) of their

time reviewing homework solutions, 15% ($SD = 13.2$) of their time reading examples of solved problems, 6% ($SD = 11.4$) of their time rereading textbook section(s), and 5% ($SD = 10.7$) of their time reading textbook section(s) for the first time. To determine whether math anxiety predicted students' study time allocation, we then fit multiple linear mixed-effects models to our data that accounted for the hierarchical structure of our data. Here, as an extra robustness check to rule out the potential confound of math ability, we included students' PSAT math scores as a covariate. We note that the results of these analyses (and those below that also include this covariate) are similar when not including this covariate in the analysis. We found that math anxiety was negatively related to the proportion of total study time students planned to devote to solving practice problems, $\beta = -.23$, $t = -3.23$, $SE = .07$, $p < .001$.¹ Math anxiety also was positively related to the proportion of total study time students planned to devote to reading the textbook for the first time, $\beta = .21$, $t = 2.81$, $SE = .08$, $p < .005$, and marginally positively related to the proportion of total study time students planned to devote to reviewing homework solutions, $\beta = .14$, $t = 1.98$, $SE = .08$, $p = .05$. Students with greater math anxiety therefore reported allocating less of their study time to solving practice problems and more of their study time to reading the textbook for the first time and reviewing homework solutions compared to their less anxious peers. Figure 1 depicts how more- and less-math-anxious students planned to allocate their study time, with math anxiety divided by a median split (median split was used here solely for illustrative purposes; all analyses were conducted using the full continuous measure of math anxiety). These results support our hypothesis that math-anxious students avoid engaging with effortful study strategies, specifically solving practice problems, when preparing for a math exam.

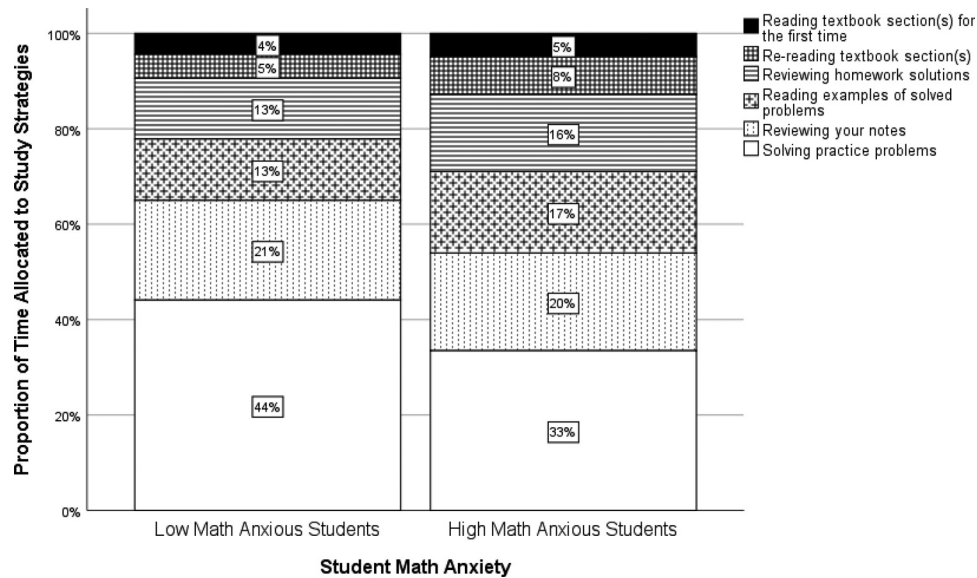
Assessing Quality: Does Math Anxiety Relate to the Prioritization of Difficulty During Studying?

To measure the association between math anxiety and the quality of students' engagement with effortful study strategies, we asked students to report how they would prioritize difficulty when solving practice problems on a scale from 1 to 7, with 1 corresponding to prioritizing easier problems and 7 corresponding to prioritizing harder problems. After fitting a linear mixed-effects model to our data that again controlled for students' math PSAT scores and accounted for the hierarchical structure of our data, we found that math-anxious students were less likely to prioritize harder practice problems compared to their less anxious peers, $\beta = -.22$, $t = -2.99$, $SE = .07$, $p = .003$.² These results support our hypothesis that math-anxious students avoid engaging with effortful study strategies by deprioritizing difficult problem-solving when studying.

¹ PSAT score was not a significant predictor of the proportion of total study time students planned to devote to solving practice problems in this model, $\beta = .11$, $t = 1.50$, $SE = .07$, $p = .13$.

² PSAT score was not a significant predictor of difficulty prioritization in this model, $\beta = -.06$, $t = -0.87$, $SE = .07$, $p = .38$.

Figure 1
Proportion of Time Less- and More-Math-Anxious Students Planned to Allocate to Various Study Strategies



Note. For illustrative purposes, math anxiety was divided into low and high levels using a median split (all analyses use the continuous measure of math anxiety).

Mediation: The Indirect Association Between Math Anxiety and Math Performance Through Problem Solving Quantity and Quality

To test whether effortful study strategy engagement mediates the relation between math anxiety and math performance, we conducted both individual and multiple mediator analyses using practice problem quantity and practice problem quality as our mediator variables. We report zero-order correlations as well as the results of our multiple mediator analysis here, but note that a significant indirect effect was found in the individual mediator analyses for problem-solving quantity and quality (more details on the individual mediator analyses are included in the online supplemental materials). Results with all standardized regression coefficients for the multiple mediator analysis are presented in Figure 2.

Math-anxious students received lower AP exam scores than their less anxious peers, $r(188) = -.27, p < .001, 95\% \text{ CI} [-.40, -.14]$. Students who planned to allocate a higher proportion of their study time to solving practice problems (problem solving quantity) also had higher exam scores, $r(188) = .35, p < .001, 95\% \text{ CI} [.22, .47]$, and prioritized solving more difficult practice problems (problem quality), $r(188) = .22, p = .002, 95\% \text{ CI} [.08, .35]$. Practice problem quantity and quality were also positively correlated with one another, $r(188) = .21, p = .003, 95\% \text{ CI} [.07, .35]$.

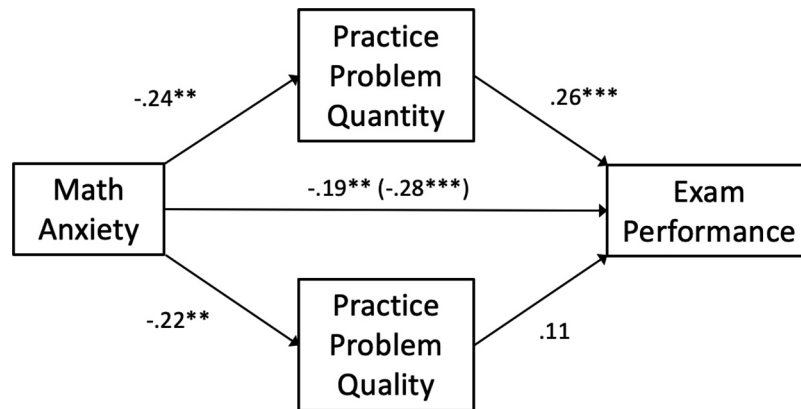
We used procedures delineated by Preacher and Hayes (2008) to assess the indirect effects of math anxiety on exam performance through problem-solving quantity and quality together. Simple linear regressions were used in the mediation, and PSAT score was included in all pathways as a covariate. Standardized indirect

effects were computed for each of 5,000 bootstrapped samples. The bootstrapped standardized indirect effect in this multiple mediator model was $-.09, 95\% \text{ CI} [-.15, -.03]$. These findings are consistent with our hypothesis that engagement with effortful study strategies mediates the association between math anxiety and exam performance. When examining each mediator individually within this dual mediator model, we found a significant indirect effect of math anxiety on exam performance through practice problem quantity, $\beta = -.06, 95\% \text{ CI} [-.11, -.01]$, but not practice problem quality, $\beta = -.03, 95\% \text{ CI} [-.07, .01]$. Finally, there was a diminished but still statistically significant direct effect of math anxiety on exam score with these two mediators in the model, $\beta = -.19, 95\% \text{ CI} [-.33, -.05]$, suggesting that avoidance of effortful engagement during studying accounted for part but not all of the association between math anxiety and exam performance. Consistent with this idea, using the coefficients from this statistical model, we can estimate that if solving math problems is just as effective for students regardless of math anxiety, the achievement gap between more- and less-math-anxious students could potentially decrease by 31% (i.e., the proportion mediated from our model) if students with greater math anxiety engaged with practice problems as much as their less anxious peers. However, future research will need to assess whether these assumptions hold with real-world intervention studies, which we cover in more detail in the next section.

Discussion

Previous studies have investigated the math avoidance hypothesis by examining student course enrollment and college major selection, finding that math-anxious students avoid elective math courses and math-heavy college majors (Ashcraft & Kirk, 2001;

Figure 2
Mediation Model Showing Association Between Math Anxiety, Practice Problem Quantity, Practice Problem Quality, and Exam Performance



Note. Pathway coefficients are standardized beta weights to allow for a consistent metric for comparisons across variables. PSAT score was included in all pathways as a covariate. (Mediation analyses used simple linear regression and not mixed models reported in the “Results” section. Individual mediation models can be found in the online supplemental materials.)

** $p < .01$. *** $p < .001$.

Hembree, 1990; LeFevre et al., 1992). Here, we expand this line of research by testing whether and how the tendency to avoid math manifests for students in situations where math cannot be completely avoided, such as within a mathematics course. We were particularly interested in whether math-anxious students would make different choices when deciding how to study for a mathematics exam.

The results from our study show that even when math-anxious students are enrolled in a challenging math course, they still avoid effortful math by planning to allocate smaller proportions of their study time to effortful strategies like problem-solving and larger proportions to less-effortful study strategies like reading the textbook and reviewing homework solutions. Math-anxious students also planned to prioritize solving problems perceived to be easier over those perceived to be harder during exam preparation. Additionally, our mediation analysis suggests that this pattern of effortful math avoidance during exam preparation contributed to the poor exam performance of math-anxious students.

Interestingly, our study also found that math anxiety was related to how effortful students perceived particular study strategies to be, with greater anxiety being associated with ranking solving practice problems as more effortful and with ranking rereading the textbook as less effortful. These findings seem to suggest that math-anxious students’ avoidance of effortful study strategies may be caused by biased perceptions of the amount of effort required for certain study behaviors. These findings connect to neuroimaging work on clinical forms of anxiety, which theorizes that anxiety is linked to cognitive biases that may influence choice behavior (Hartley & Phelps, 2012), highlighting this topic as a critical direction for future research.

Despite its robust findings, the current study is potentially limited by its prospective nature: Students were asked to report how they “planned” to study for their AP Calculus exam, which may vary from how they actually studied. Additionally, recent research

has found that students emphasize different study strategies across multiple study sessions, suggesting that the most accurate estimates of study should be based on an aggregate of multiple sessions (Janes et al., 2018). However, research also suggests that students are relatively accurate when estimating their use of ineffective but easy-to-use study strategies such as rereading text notes but overestimate their use of more effective (and potentially more effortful) strategies such as practice testing (Blasiman et al., 2017). These findings suggest that students’ actual use of effortful problem-solving as a study strategy may be even lower than reported, strengthening the importance of our findings. Furthermore, our finding that planned practice problem-solving significantly predicts exam performance, net of prior ability controls, serves as additional evidence of the validity and importance of this measure. Future research should therefore consider educational interventions that can help increase math-anxious students’ use of effortful and effective study strategies such as problem-solving to help improve their math outcomes.

To the best of our knowledge, our research is the first to identify and characterize the effort-based decision-making behavior of math-anxious students with respect to how they studied for their exams in the real-world setting of a math course. Previous research investigating local math avoidance behaviors has focused primarily on the relation between math anxiety and avoidance in the form of math disengagement/attentional deficits (Ashcraft & Faust, 1994; Geary et al., 2021; Pizzie & Kraemer, 2017). Our study extends these findings by focusing on how math anxiety relates to decision-making during active math engagement, with students making choices on how to allocate their study time. We believe that our study makes a significant contribution to the literature by highlighting how math anxiety can impact effort-based decision-making when the option to completely disengage with math (via global or attentional avoidance) is not available. Our findings show that when students are given math engagement options,

higher levels of math anxiety are associated with choosing less effortful engagement options, and that this effort-based avoidance has consequences for student performance.

Additionally, our study provides a new lens through which to explore the math anxiety-performance relationship: by investigating students' choices about their study behaviors. Previous research suggests that students are not always the best at regulating their own use of study strategies and may therefore benefit from metacognitive and self-regulation interventions that encourage them to strategically engage with beneficial study strategies (Chen et al., 2017, 2020; Culler & Holahan, 1980; Karpicke et al., 2009; Passolunghi et al., 2020; Supekar et al., 2015; Zepeda et al., 2015). It may also be useful to consider pairing performance anxiety interventions with interventions that encourage adaptive study behaviors to help math-anxious students cope with their anxiety about effortful study strategies (Jamieson et al., 2016; Rozek et al., 2019; Zepeda et al., 2020). Thus, future research should explore ways to structure supports for math-anxious students to encourage their engagement with the "desirably difficult" study strategies that they may otherwise avoid.

Context

With rising demands for science, technology, engineering, and mathematics professionals worldwide, a great focus has been put on student achievement in mathematics. Critical to student success in math is the ability to prepare for and perform on mathematics examinations. Our research findings suggest that students who experience math anxiety (i.e., feelings of fear toward math) prepare for math exams in suboptimal ways by choosing to avoid effortful study strategies during exam preparation. This effort-avoidance behavior is theorized to prevent students from practicing math in ways that are critical for their success, ultimately contributing to their underperformance in math courses. To the best of our knowledge, our research is the first to identify and characterize the effort-based decision-making behavior of math-anxious students in the real-world setting of a math course. Insights from our research can be used to develop educational interventions that regulate the study behaviors of students who experience math anxiety in an attempt to increase their performance in mathematics.

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