The Moderating Effect of Emotional Competence on Math Anxiety and Math Performance in Elementary-School Children

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Abstract

Many studies have explored the relation between math anxiety and math performance. However, the relation between emotional control and math performance is still unclear. We seek to address this gap, focusing specifically on elementary-school children, a demographic where emotional competence is developing. We first looked at the literature then analyzed existing data to see if it agreed with literature. Specifically, we predict that emotional control moderates the relationship between math anxiety and math performance. To test our hypothesis, we looked at the moderating effect of emotional control on math anxiety and math performance. 3rd and 4th grade students were given a battery of assessments to capture their emotional control, math anxiety, and math performance. The literature revealed that high math anxiety can negatively affect math performance. The existing data partially confirmed our hypothesis.

Keywords: Math Anxiety, Emotional Control, Self-Efficacy, Math Performance

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One challenge with math learning is children's feelings of aversion towards math. Some children even develop math anxiety, which interferes with math learning. Therefore, it would be useful to consider strategies by which children can overcome these negative feelings. However, the relation between math anxiety, emotion control, and math learning are not yet well understood. In the current paper, we seek to contribute to this conversation. Specifically, we ask whether children's emotional competence moderates the relation between math anxiety and math performance. In what follows, we first review the research on math anxiety and emotional control. We then present data that was obtained with students who worked on math problems, as well as completed a math anxiety survey and an emotional-control survey.

Math Anxiety and Math Performance

Math anxiety is defined as feelings of "tension, apprehension, or fear" regarding math (Ashcraft, 2002). The existing literature has examined the relationship between math anxiety and math performance. Many of them have found a negative relationship between math anxiety, calculations and math fluency (Adams and H, 1986; Ashcraft and Moore, 2009; Cates and Rhymer, 2003; Legg and Locker, 2009; Tsui and Mazzocco, 2007; Wu, et al., 2012; Krinzinger, et al., 2009) and grades (Karimi and Venkatesan, 2009; Llabre and Suarez, 1985; Satake and Amato, 1995).

High school and university students with high math anxiety are more likely to avoid selecting elective coursework that involves math. High school students with low math anxiety are more likely to select a STEM major than students with high math anxiety (Ahmed, 2018). The effects of high math anxiety persist past school; individuals with high math anxiety tend to avoid opportunities involving math in their adult lives (Espino, et al., 2017; Hembree, 1990; Hurst & Cordes, 2017; Meece, Wigfield, & Eccles, 1990).

One major theory that explains the relationship between the math anxiety and math performance is the *processing efficiency theory*. In the *processing efficiency theory*, cognitive trouble hinders cognitive processes needed for accurate and efficient performance in a task (Eysenck & Calvo, 1992). This negative interaction is attributed to the very high usage of working memory (Ashcraft, Kirk, & Hopko, 1998; Caviola et al., 2012). Working memory is a limited capacity store that enables us to perform cognitive activities (Cowan, 2014).

The *attention control theory* is a more generalized theory which suggests that tasks can be stimulus-driven or goal-directed (Eysenck et al., 2007). Concerning math anxiety, the task becomes stimulus-driven due to "math stressors" (Barroso, et al., 2021), and the task no longer is goal-directed. Negative cognitive biases play a role in this. Negative cognitive biases, like interpreting math stimuli as dangerous can distract one's math performance and can cause them to focus on negative thoughts (Macleod & Mathews, 2012).

Overall, the findings of published work suggest that math anxiety can negatively affect math performance. Children may avoid math if they struggle to do well in the subject. Math anxiety can even influence children's future experiences in math. To what extent does emotional control relate to math performance?

Emotional Control and Math Performance

Emotional intelligence, or control, is a term used for the ability to adequately reason with and understand emotions enough to regulate them efficiently, advancing mastery in both emotional and intellectual capacities (Mayer, Salovey, & Caruso, 2004). When children lack emotional control, they will likely respond poorly to complex problems, specifically regarding math (Cartwright, Kloos, Mano, Hord, 2018). Self-efficacy can affect children's perception of facing and overcoming problems (Spillane, Reiser, & Reimer, 2002). Low self-efficacy can hinder problem solving, which can cause poor emotional management (Cartwright, et al., 2018).

Effectively managing thinking, attention, and behavior can lead to better academic performance. Social and emotional skills are related to better academic and social performance. Controlling emotions during adolescence has been associated with ramifications in adulthood, affecting health and stability (Jones, et al, 2017). There are not many studies conducted, leaving gaps in the literature.

Literature on the relationship between emotional control and math performance is limited. Having more math practice sessions is correlated with improvement in math in homeless children with high emotional competence, not those with low emotional competence (Cartwright, et al., 2018). This is important because if a child with high emotional control faces difficulties in math, they can change their approach and adjust the level of difficulty of their practice. If a child with low emotional control encounters difficulties in math, they may get frustrated and overwhelmed, leading them to quit their math practice. This can affect their future encounters with math. Given these gaps in the literature, the current paper looks at the moderating effect that emotional control has on the relationship between math anxiety and math performance.

Present Study

Our study looks at the moderating effect emotional competence has on the relationship between math anxiety and math performance. We predict that emotional control moderates the relationship between math anxiety and math performance. Our sample size consisted of 27 elementary school children. 15 were 3rd graders and 12 were 4th graders. The children took tests that assessed their math anxiety, emotional control, and grade and age equivalency. After taking these assessments, their math practice was divided into three categories, problems that were below their grade level, problems at par with their grade level, and problems that were above their grade level. Students chose the problem sets, and when they struggled, they were encouraged to choose a slightly easier set. Math performance was based on the percent of correctly answered questions at each student's respective grade level.

Method

The study was carried out in the context of a school enrichment program for 3rd and 4th-graders. These students were encouraged to practice math with an online technology known as IXL (IXL.com). The practice took place twice a week during regular school time. Adult facilitators were present to help children choose practice problems that were at the students' level of math proficiency. The children could also take the tablets home to continue practicing at home.

Participants

Data was obtained from 27 elementary-school students (N = 15 3rd graders; N = 12 4th graders). They were primarily from economically disadvantaged neighborhoods (14 boys; 13 girls). The average age of the participants was 9.58 years old (SD = 0.60).

Details on the Online Technology

IXL is a practice-based math learning application that consists of multiple problem sets. Problem sets are organized by grade level and by topic. Progress in the problem set is tracked by a score. The score starts at 0 and increases if a question is answered correctly. If a question is answered incorrectly, the score decreases. A problem set is marked as "mastered" when it reaches a score of 100. Students were allowed to choose to practice any skill at any grade level or topic.

Assessments

Two assessments were used, one to measure math anxiety and emotional control. The first one pertained to math anxiety, measured with the Mathematical Anxiety Rating Scale, Elementary Form (MARS-E; Suinn, 1988). This is a 26 question assessment. Each statement is rated on a 5-point Likert scale, 1 being not at all nervous and 5 being very, very nervous. The statements are designed to measure the magnitude of anxiety students experience in situations involving math. Some statements on the MARS-E include "Mark how nervous or tense you would feel if you had to decide if this problem is right: (3 + 4) + 2 = 4 + (2 + 3)" and "If you had to add up a cash register receipt after you bought several things." The minimum score on the assessment is 26, and the maximum score is 130.

The second assessment pertained to emotional control, measured using a series of questions that we created, called the Emotional Self-Efficacy Scale (ESE). Our assessment consists of eight statements. Some statements include "I'm good at making myself happy after something bad happens" and "I know how to stop thinking bad thoughts." Each statement is rated on a 5-point Likert scale, rated from 1 (strongly disagree) to 5 (strongly agree). From there, the scores are added up and averaged. The minimum score is 1 and the maximum score is 5.

Procedure

Both the math-practice enrichment and the data collection occurred during the fall semester. Students took the MARS-E and the ESE inventories at the beginning and end of the semester. Students used IXL throughout the semester and practiced various skills at various grade levels.

Coding of Data

To categorize the levels of math anxiety, all of the students' MARS-E scores were averaged. This enabled us to set a threshold that was more suited for the data. Students who scored higher than the average in either math anxiety placed in the "high" category. Students who scored lower than the average in math anxiety control placed in the "low" category.

To categorize the levels of emotional control, all of the students' ESE scores were averaged. This allowed us to set a threshold that was more suited for the data. Students who scored higher than the average placed into the "high" category. Students who scored lower than the average in emotional control placed in the "low" category.

To determine the math performance, a proportion of correctly answered questions was calculated. Performance was determined only off of the questions that the students completed at their grade level, since they could choose to work on questions below and above their grade level. For example, math performance for third grade students was based on the problems the students completed at the third grade level. Math performance for fourth grade students was based on the problems the students completed at the fourth grade level.

Results

Table 1 includes the descriptive statistics of the three relevant measures: emotional control, math anxiety, and math performance. Regarding emotional control, we created two groups: *High* versus *Low* emotional control. Specifically, students who scored above the mean of the ESE were in the high emotional control category ($M = 3.813$, $SD = 0.520$), and students who scored below the mean were in the low emotional control category ($M = 2.455$, $SD = 0.282$).

Table 1
Descriptive Statistics of the Test Measures

	MARS-E Score	RESE Score	Math Performance*
N	27	27	27
Minimum	29	2.125	19.44
Maximum	119	4.5	95.42
Range	90	2.375	75.98
M	71.44	3.411	87.52
(SD)	18.87	0.780	14.31

Notes. Children who did not take both the MARS-E and ESE tests were excluded
* Math performance was calculated as a percentage of correctly answered problems.

Figure 1 shows the percent of correct responses as a function of math anxiety, separated by emotional control. Results show that percent of correct responses remain the same for children with high emotional control, independently of their math anxiety. In contrast, percent of correct responses differed for children with low emotional, depending on their math anxiety: Students with low math anxiety (and low emotional control) performed better than children with high math anxiety (and low emotional control).

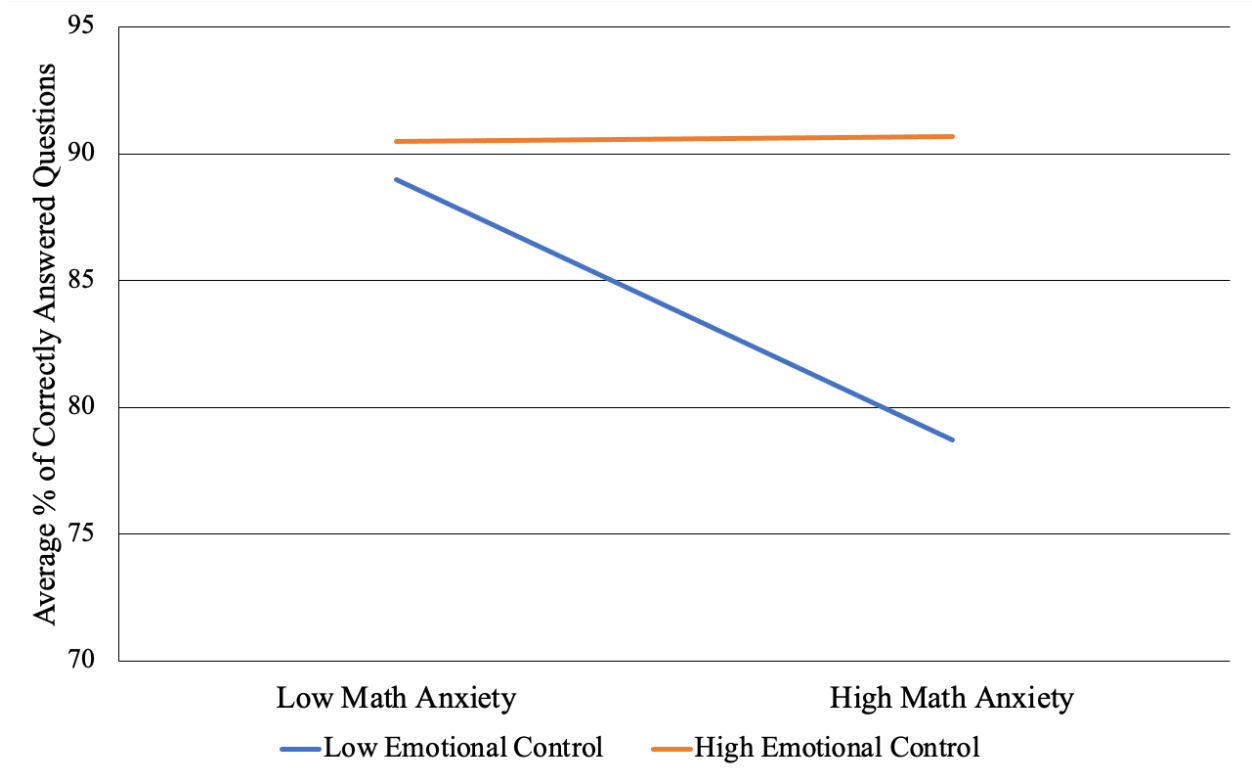

Figure 1. Average percent of correctly answered questions as a function of math anxiety and emotional control.

Discussion

Our findings suggest that emotional control moderates the effect that math anxiety has on math performance. Students' math performance is only negatively impacted by high math anxiety when they have low emotional control. A limitation of our study is the small sample size; it is necessary for more data to be collected to ensure that emotional control moderates the effect that math anxiety has on math performance in other populations. Further research should evaluate the effectiveness of a math-intervention that focuses on increasing emotional control and decreasing math anxiety.

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